DOCTORAL THESIS

The Concept of Fluidity in Eighteenth and Nineteenth-century Science and Literature

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The Concept of Fluidity in Eighteenth and Nineteenth-century Science and Literature

by

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Abstract

This thesis studies the significance of 'fluidity theory' as an eighteenth century 'theory of everything'. It examines aspects of the natural world as represented in eighteenth-century scientific and literary texts. It argues that phenomena such as electricity, light, fire and magnetism were all understood at the time as fluids. In particular, it was supposed that there was a common, divine, all-pervading fluid (an 'Ur-fluid') that subsisted through all things. The fundamental fluid supposed to exist was termed 'ether'. It argues further that, just as Bishop George Berkeley hoped to demonstrate the existence of God by arguing that *esse est percipi* (to be is to be perceived), so eighteenth-century writers aimed to show that these phenomena – electricity, light, fire, and magnetism – were observable or perceptible effects of the divine fluid and the agency of the Creator. This thesis argues that in shaping and forming this understanding, particular figures exerted a powerful influence over eighteenth-century thought. Adapting Harold Bloom's theory of 'the anxiety of influence', this thesis argues that William Gilbert, René Descartes, John Milton and Sir Isaac Newton were all 'strong precursors' for a series of subsequent writers, natural philosophers and experimenters who followed in their wake. For most of these 'latecomer' researchers, the influence of these 'precursors' was largely overwhelming. Yet there were key moments in the history of science, and reflected in the literature, that brought about the demise of belief in an 'Ur-fluid', in 'ether' and in the supposition that an original divine fluid was suffused throughout all creation.

The thesis has been prepared for resubmission. It has been very substantially revised and all the recommendations made by the examiners have been followed up and

responded to in as full a way as the Covid-19 pandemic could allow. I believe the argument has been strengthened by extensive re-writing and research.

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I dedicate my thesis to my mum who has always believed in me.

Introduction: Part One: Fluidity as a 'theory of everything'

What made the eighteenth-century world? Supplying a possible answer to this very large question, Thomas Stanley (1625-78), friend to James Shirley and Richard Lovelace, translated the ancient Chaldean Oracles in 1662:

> THE WORLD.
>
> The Maker who Operating by himself framed the World.
> And there was another Bulk of fire,
> By itself operating all things that the Body of the World might be perfected
> That the World might be manifest, and not seem Membranous.
> The whole World of Fire, and Water, and Earth,
> And all-nourishing Aether
> The unexpressible and expressible Watch-words of the World.
> One Life by another from the distributed Channels.
> Passing from above to the opposite Part,
> Through the Center of the Earth; and another fifth Middle:
> Fiery Channel, where it descends to the material Channels.
> Life-bringing fire.
> Stirring himself up with the goad of resounding Light.
> Another fountainous, which guides the Empyraeal World.
> The Center from which all (Lines) which way soever are equal.
> For the paternal Mind sowed Symbols through the World.
> For the Center of every one is carried betwixt the Fathers.
> For it is in Imitation of the Mind, but that which is born hath some-thing of the Body.
>
> (*Chaldaick Oracles*, p.32)

The poem encapsulates the central concerns of this thesis. The world consists of a 'bulk of fire' that operates in creation and is made manifest in the four elements of earth, air, fire and water. It is an 'all-nourishing Aether' both 'unexpressible' and 'expressible', distributed through creation via a 'fountainous' 'fiery channel' that runs through the centre of the earth. These ideas may seem to us today arcane, esoteric, quaintly eccentric (perhaps even a little foolish), but they are in sum a way of thinking about the world that was prevalent in the eighteenth century but remains largely lost

to us today. This thesis is an attempt to trace out aspects of that way of thinking. It argues that 'fluidity' was central to understanding eighteenth-century debates about key properties and forces in the world.

A commonly-held eighteenth-century belief implied that a variety of imperceptible (sometimes called 'imponderable') fluids were dispersed throughout the universe. P. M. Heimann writes of the way in which 'phlogiston' 'played a central role in eighteenth-century British natural philosophy' (1981, p. 76). This thesis argues that a broadly shared concept of 'fluidity' as a whole played an equally central role. Heimann further explains that 'phlogiston' was regarded as a kind of 'fire, light, electricity and ether' (1981, p. 73). In Heimann's view, 'this unified ether theory stressed the unity and activity of nature' (1981, p. 73). This thesis traces the impact of a theory or concept of fluidity on eighteenth- and nineteenth-century British natural philosophers. It points centrally to the long influence of writers such as Descartes and Newton. As Heimann points out, even for sceptics such as Humphry Davy who abandoned the idea of electricity as a fluid, 'his emphasis on the unity of natural powers echoed the unified ether theory' (1981, p. 80). This unifying idea of a fundamental fluid which filled the created world derived from classical thought, in particular Lucretius's *On the Nature of the Universe* (99-55 BCE). As Charles Coulston Gillespie wrote in 1960, "[t]he role of such imponderable fluids in eighteenth-century science is a complex problem, insufficiently explored" (*The Edge of Objectivity,* p. 205). This thesis is an attempt to set out some of the contours of that problem. It seeks to investigate a number of questions: what did eighteenth-century writers mean by 'fluidity'? How did it become central to eighteenth-century thought? How did the concept of fluidity change over the 'long' eighteenth-century (1700-1850)?

These days the *Encyclopaedia Britannica* tends not to be cited as a respected scholarly source. But its first publication in 1765 was a landmark event. In a manner akin to the work of lexicographers such as John Kersey (1708), Nathan Bailey (1730), and most famously Samuel Johnson (1755), the *Encyclopaedia Britannica* sought to organise the latest known ideas about the world into concise summaries arranged alphabetically. Kersey had defined 'Aethereal matter' as 'a very fine, thin, transparent fluid, that some will have to surround the Earth, but as far as the firmament of fixed stars' (no pagination). Bailey (often reproducing Kersey) acknowledged the degree of uncertainty about the term 'Aether': 'Fluid Aether (if it be a Body), which is extended round our Air and Atmosphere, above it and beyond it up to the planets, or to an indefinite Distance, tho' we scarce well understand what we mean by the word Aether' (sig. F^{r}). Johnson rather more simply defined 'fluid' simply as 'not solid' (1768, p. 136). Ephraim Chambers's *Cyclopædia, or, An universal dictionary of arts and sciences* (1728) carried a substantial essay on 'fluidity' (pp. 57-61) that began by stating, 'melted Metals, Air, Aether, and even Smoak and Flame itself are Fluid Bodies, but not *Liquid* ones; their parts being actually dry and not leaving any sense of moisture' (p. 57). But it would be the *Encyclopaedia Britannica*, first published between 1768 and 1771 under the title *Encyclopædia Britannica, or, A Dictionary of Arts and Sciences, compiled upon a New Plan* that aimed to synthesise contemporary knowledge surrounding such terms.

That people in the eighteenth century understood the physical nature of the world very differently to us is perhaps an obvious point. But a number of fairly recent books have been devoted to exploring those differences. In 1981, G. N. Cantor and M. J. S. Hodge published a collection of essays devoted to the idea of a fundamental, all-encompassing ether, which was supposed to permeate all existence. In many ways this

was a pioneering set of studies, exploring the notion of 'ether' from a variety of perspectives, including its relations to chemistry, physics and theology. What Cantor and Hodge's invaluable book does not do, however, is discuss the impact of these ideas on literature and poetry. This thesis is an attempt to explore that connection. In the introduction, Cantor and Hodge trace through the significance of ether theories from classical times to the end of the Victorian era. The detailed account they provide outlines variations in thinking about the concept, but as the individual essays in this collection make clear, a notion of ether as fluid was fundamental to understandings of the world before the modern age. The notion had a long history and took centuries to finally wane and disappear. Descartes is famous for his dualist approach to human identity and the mind/body question. As Cantor and Hodge make clear, Descartes struggled with the notion of a fine 'subtle' or celestial matter in order to reconcile his ideas of extension and motion with belief in a Creator (p. 12). In certain respects, this fundamental problem of dualism – the question of how, if two realms such as the mind and body are quite distinct, they can interact — goes to the heart of the eighteenth-century notion of fluidity. How could the ethereal fluids of the world, such as fire, electricity or light, be explained in terms of divine origin?

For Cantor and Hodge, there were three main areas of debate related to explaining the interactions between essential fluids of the world. The first was the idea of an intermediary 'effluvium' that allowed physical forces such as motion, repulsion or attraction to operate (see p. 14). The second, involved the notion of 'caloric', essentially "the matter of heat": as Cantor and Hodge put it, "add more caloric, more heat … and the body will become fluid" until the point at which it becomes 'aeriform'

or gaseous" (pp. 27-28). The third, more theological, area focused on the idea of 'subtle spirits' that enabled an interaction between the material and immaterial, for example, the body and mind (p. 28). Cantor and Hodge remind us of the need to accept eighteenth-century theorising in its diversity. They write in their preface, "ether theories often developed differently within distinctive national schools and styles of scientific work" (1981, ix). The key word here is 'national'. This thesis will be largely centred on English ideas regarding fluids in various forms, contexts and writings as the fundamental material of the created world. This is not to say that there were not sceptics. For Scottish philosopher Thomas Reid (1710–1796), no such intermediate 'spirits' were possible, and they must remain mere figments of the imagination (p. 32).

Cantor and Hodge regard these different perspectives as various forms of what they call "ether theory" (see especially pp. 46-54). The purpose of this thesis is to argue that, however variously concepts of ether were understood, they generally came under the overall category of 'fluid'. As P. M. Heimann suggests in his chapter on 'Ether and Imponderables', many early scientists worked with the idea of a 'subtle' or 'elastic' fluid that permeated the atmosphere, rather in the manner of Lucretius's idea of atoms or 'films' as particles of matter. For Heimann, it was mainly after 1740 that early scientists such as Robert Greene, Benjamin Martin and Bryan Robinson inherited Newton's understanding of "ethereal particles" (Cantor and Hodge, p. 64). These were scientists interested in the emerging understanding of electricity. As Heimann writes, "The electrical matter was envisaged as an electrical ether, and Franklin suggested the fire, ether, and electricity were 'different modifications of the same thing." (Cantor and Hodge, p. 71). This single phrase by Heimann forms much of the substance of this thesis. Cantor and Hodge devote a section to Newton's evolving notion of 'ethers' in the plural, yet Heimann writes of Newton's "ether

theory" (1981, p. 64) in the singular and of "its [ether's] status as a Newtonian active principle" (ibid., p. 65).

Whereas Cantor and Hodge tend to present ether as a substance that takes such different forms as light, fire, electricity and heat, this thesis emphasises the point that the concept of fluidity was, for the majority of eighteenth-century scientists at least, 'a Newtonian active principle', that is, a principal substratum for the different manifestations of these natural phenomena. Heimann explains that, for Newton, ether was "a manifestation of God's causal agency in nature" (1981, p. 72). This point shows just what was at stake for eighteenth-century scientists: if the investigation of the fundamental substratum of the created world could demonstrate divine agency, then belief in a divine Creator would not only be vindicated but also finally demonstrated. Heimann points to the continued influence of Newton in eighteenth-century science. He writes that Colin Maclaurin reiterated Newton's idea of gravity as a force driven by an 'elastic aethereal medium'. Yet for Maclaurin, the "terms, *Fire, Electricity, electrical Aether, aethereal Spirit*" were "synonymous" (1981, p. 73). Ether, as a fundamental fluid, was part of a shared understanding or context within which not only individual scientists worked, but poets and imaginative writers too.

We can see something of this tendency towards 'unity' of thinking about a fundamental, subtle or spiritual substance in the example of William Whewall (1794-1864). Whewall is best known as a polymath fellow (and eventually Master) of Trinity College, Cambridge, a writer who engaged closely with contemporary work in physics, astronomy, geology, mathematics and theology. As Richard Yeo has written,

> the range of his writings and accomplishments was remarkable: mathematics, mechanics, architecture, mineralogy, tidology, moral philosophy, political economy, educational theory, natural

> theology, translations of Greek philosophy and German poetry, and the history and philosophy of the physical sciences'.[1]

Yeo here omits mention of Whewell's writings on linguistics, specifically papers on 'English Adjectives', 'Clipt Words' and 'The Use of Definitions' in *Philological Museum* (Vol 1, 1832. See Todhunter, pp. 61-65). Whewall's publications mainly (though not entirely) occurred between 1830 and 1860. In *Astronomy and general physics considered with reference to natural theology* (London, 1833), Whewell argued that light was "produced by the vibrations of an ether" (Whewell, p. 136) and followed this up with a chapter devoted to 'The Ether'. In this chapter, Whewell gives a concise summary of the shared understanding of ether as a fluid in the long eighteenth-century:

> The luminiferous ether then, if we so call the medium in which light is propagated, must possess many other properties besides those mechanical ones on which the illuminating power depends. It must not be merely like a fluid poured into the vacant spaces and interstices of the material world, and exercising no action on objects; it must affect the physical, chemical and vital powers of what it touches. It must be a great and active agent in the work of the universe, as well as an active reporter of what is done by other agents. It must possess a number of complex and refined contrivances and adjustments which we cannot analyze, bearing upon plants and chemical compounds, and the imponderable agents; as well as those laws which we conceive that we have analyzed, by which it is the vehicle of illumination and vision.
>
> (Whewell, pp. 138-9)

Fond of 'tripartite schemes' (cf, Yeo), Whewell maintained that the created world comprised three fundamental substrata: material matter or solids, gaseous fluids and

[1] Yeo, Richard. "Whewell, William (1794–1866), college head and writer on the history and philosophy of science." *Oxford Dictionary of National Biography*. 23 Sep. 2004; Accessed November 2021. https://www.oxforddnb.com/view/10.1093/ref:odnb/9780198614128.001.0001/odnb-9780198614128-e-29200.

ether (Cantor and Hodge, p. 87). But for Whewell, these substrata were all to be conceived of as fluids. Concluding his discussion of 'The Ether', he described these fundamental substances as "the solid and fluid matter of the earth", "an invisible fluid, the air" and "another most subtle and attenuated fluid" [ether], and these comprised "the earth …, the atmosphere and the ether" (Whewell, pp. 140-41).

Whewell studied at Trinity College, Cambridge and went on to become a tutor and fellow there. His academic position enabled him better to connect with other researchers in similar fields. As Yeo points out, Whewell advised William Vernon Harcourt, secretary of the British Association for the Advancement of Science (founded in 1831) to commission annual reports on the state of the various sciences.[2] The *OED* credits him with having first coined the term 'scientist' (in 1834). Whewell corresponded with Faraday and proposed to him use of words such as 'cathode', 'anode' and 'electrode'. But, as Isaac Todhunter, Whewell's early biographer, explains, Whewell was also a poet throughout his career, from his student days at Trinity where he won the Chancellor's prize for poetry to later years spent in verse translation and the study and composition of "English Hexameters" (Todhunter, pp. 166-67; pp. 283-301). Throughout his working life, Whewell also engaged with theology and wrote and delivered sermons. After his death (having fallen from a horse near Trinity), a Cambridge fellow composed a genial funeral oration, describing Whewell as "Newton's child", a man who had sought to "find a God all philosophical" and "to trace the hidden mysteries of God" (Anon., 1866). In its appreciative and almost light-hearted eulogy, the poem also sets out what was at stake for those, like Whewell, who believed that science would ultimately validate religion. To locate an

[2] See Yeo, 'Whewell, William (1794–1866)'.

all-pervading spiritual or subtle substance would be to discern the agency of the Creator. For Whewell and his contemporaries, little could be more important.

Since Cantor and Hodge's pioneering collection of essays, a series of related studies has appeared. Gerrit L. Verschuur's book *Hidden Attraction: The History and Mystery of Magnetism* (1996) is a less scholarly investigation into the relations between these theories about fluidity and ether, and the developing understanding of magnetism, but it usefully covers the gradual coincidence between investigations into magnetic attraction and a broader interest in electricity. Verschuur devotes chapters to Oersted and Ampere, Michael Faraday, James Clerk Maxwell and Heinrich Hertz. But as Cantor rather caustically stated in his review of Verschuur's book, "this is not a contribution to the history of science, but is intended to introduce young people to the mysteries of nature and the excitement of science" (*Isis*, 1994, p. 125).

Brian S. Baigrie's book, *Electricity and Magnetism: A Historical Perspective* (2007) essentially comprises a series of classroom lectures re-designed in book form. The result is a book that traces through the history of investigations into electricity and magnetism, but one that does so largely for non-specialists. Baigrie focuses on novel developments in theory and technology, tracing their trajectory from Thales in ancient Greece, via Petrus (Peter) Peregrinus in the Middle Ages, through to Oersted, Ampere, Faraday, and into the development of cathode ray tubes and x-rays in the twentieth century. In particular, Baigrie usefully contrasts the 'two-fluid' theory of electricity of French chemist Charles François de Cisternay Dufay with Benjamin Franklin's 'one-fluid' conception of electricity, as discussed in Chapter Two of this Thesis.

Steven Connor's *The Matter of Air: Science and Art of the Ethereal* (2010) traces the history of air, which was sometimes viewed as a fluid closely related to electricity and

magnetism (and therefore also descending from an ethereal fluid) in the eighteenth and nineteenth centuries. Connor traces the history of pneumatics through a fascinating set of contexts. The work's subheadings include sections on 'Mesmerism', 'Life-Ether', 'Thinking about Thinking', 'The Thingliness of a Gas', 'High Orgasm' and 'It's a Blast'. Connor's aim would appear to be to present the major historical investigations into conceptions of air in often bizarre medical, theological, psychological and even sexual contexts.

Somewhat similar in scope, but focussing on the ether instead of air, is Joe Milutis's monograph *Ether*. *The Nothing that Connects Everything* (2005). While Cantor and Hodge's authoritative volume on ether describes the intricacies and nuances of early research concerning the potentially 'all-pervading' substance, Milutis' monograph focusses on much more contemporary remnants of ethereal theory in popular culture (for example the 'ethernet'), without addressing in much detail the intricacies and research concerning ether and fluidity in the eighteenth and nineteenth centuries. Hinting in his introduction that "ether is all over the place, and that place is nowhere to be found" (p.x), Milutis' take on ether appears to be designed as a much more light-hearted overview of a concept lost to time.

By contrast, Mary Fairclough's *Literature, Electricity and Politics: 1740–1840: 'Electrick Communication Every Where'* (2017) is an in-depth monograph on electricity, which references fluidity and focusses primarily on the language surrounding the emergence of the science surrounding electrical phenomena. Fairclough focusses particularly on the connections between language, speculative thinking, political polemic and commercial or popular ideas in the eighteenth and nineteenth centuries (see p. 7). Fairclough focuses on the importance of distinguishing

between metaphor or figurative language and what was understood at the time to be a matter of substance or material essence. She begins with a case study of Benjamin Martin, an 'itinerant lecturer, instrument maker and country showmen' who was blocked from membership of the Royal Society and died bankrupt in 1782, possibly through suicide. For Fairclough, the language used to describe or understand electricity was never limited to a single, strictly scientific sphere. Aside from its personal and even sexual implications, it had a progressive force analogous to that of political rhetoric at the time (p. 2). The ability, for example, of a political orator to 'electrify' an audience was just one way in which common speech connected with the 'vitalising language' of electrical discourse (p. 149). As both Humphrey Davy's experiments and Mary Shelley's novel *Frankenstein* illustrate, electrical language had chemical, corporeal and political implications.

Other publications have separately addressed some of the natural phenomena discussed in this thesis. Iwan Rhys Morus' three monographs – *Frankenstein's Children: Electricity, Exhibition, and Experiment in Early-Nineteenth-Century* (1998), *Bodies/Machines* (2002), and *Michael Faraday and the Electrical Century* (2004) – have perhaps received the most critical acclaim for their focus on the public perception of electrical phenomena in eighteenth and nineteenth-century Britain. In a similar vein, Caroline Thomas de la Peña's *The Body Electric* (2003) discusses the impact of electrical experimentation in the United States, assigning particular importance to the role of electricity as a potential cure for physical ailments. A work that specifically connects electric research with literature, discussing in particular the impact of electrical experimentation on the poetry of the period is Jason Rudy's monograph entitled *Electric Metres: Victorian Physiological Poetics* (2009). Paying homage to the creativity sparked by nineteenth-century electrical research, Rudy

documents the far-reaching impact of natural philosophic discourses on electricity on the period's creative writing.

The main scholarly contributions with regard to the role of magnetic research in the long eighteenth century have been made by Patricia Fara, whose monographs *Sympathetic Attractions: Magnetic practices, Beliefs, and Symbolism in Eighteenth-Century England* (1996) and *Fatal Attraction: Magnetic Mysteries of the Enlightenment* (2005), and a variety of additional articles, have elucidated magnetical experimentation from a historical, political and social perspective. In examining some of the natural philosophic treatises on magnetism also discussed in this thesis, Fara focusses especially on the socio-economic context of magnetic experimentation and entrepreneurship against the backdrop of navigation at a time when magnetic compasses became a vehicle for British colonialists. This thesis draws on all of the above publications but differs from them in its focus. Addressing the single concept of fluidity, this thesis draws on two recent studies similar in scope: Sharon Ruston's *Shelley and Vitality* (2005), and Shelley Trower's *Senses of Vibration* (2012). The former monograph focusses on representations of vitality in its analysis of P. B. Shelley's thought and work. This allows Ruston to elucidate the confluence of literary, philosophic and social contexts that contributed to an eighteenth-century understanding of vitality as echoed in Shelley's writing. Ruston discusses electricity and magnetism against the background of a "vitalist theory of life" and briefly touches on treatments of a 'universal fluid' in relation to John Abernethy's suggestion that "vitality is analogous to electricity" (p. 111). This thesis will expand on the relation of electric and magnetic research of the time and focus on fluidity as a central connecting idea. It is similar in scope to Shelley Trower's *Senses of Vibration* (2012), which examines the interconnectedness of literature and science in focussing on vibrations.

Valuable as all these studies are, none squarely address the concept of fluidity that underlies all of these separate phenomena – ether, electricity, magnetism, fire and air. In 'The Revolt of Islam' (1818), Percy Bysshe Shelley describes a storm as a means of expressing both the political turbulence of the 1790s, particularly in France, but also his own disillusionment with that revolution:

> Hark! 'tis the rushing of a wind that sweeps
> Earth and the ocean. See! the lightnings yawn
> Deluging Heaven with fire, and the lashed deeps
> Glitter and boil beneath: it rages on,
> One mighty stream, whirlwind and waves upthrown,
> Lightning, and hail, and darkness eddying by.
>
> (Canto I, ll. 145-150)

Shelley here captures the force of the traditional four elements – earth, air, water and fire — but the huge energy that the lines convey are rooted in a powerful sense of effluvia: 'Earth' and 'ocean' are windswept, 'lightnings' deluge the sky with fire, the deeps 'boil' in one mighty 'stream', and the darkness is described as 'eddying by'. The *OED* gives the earliest use of the term 'imponderable' in natural philosophy as occurring in 1794. In that year, George Adams wrote of 'phlogiston' as "a substance as imponderable as fire" (*Lectures on natural and experimental philosophy*, 1794). But, as this thesis shows, the term was in use long before 1794. It is worth defining this notion, frequently used in conjunction with the concept of fluidity, more closely. The *OED* explains the notion of the 'imponderable' in physics as follows:

> *Adj.* 1.a. Having no weight; destitute of weight: applied formerly to light, heat, electricity, etc., regarded as material substances, and later to the luminiferous 'ether'. Also *figurative*, incalculable, unthinkable.

Another term, used at times interchangeably with 'imponderable', is the word 'subtle'. The language points to the difficulty eighteenth-century writers had in specifying a

notion that remained frustratingly ‘inexpressible’ in Thomas Stanley’s words. It was this indefinability that partly led to scepticism about its value or utility. In 1839, Golding Bird, a noted physician interested in the therapeutic possibilities of electricity, rejected the idea of a universal fluidity which had been thought to fill the universe with “an invisible and imponderable fluid ocean, in which the vast orbs of our universe roll unimpeded in their majestic courses” (p. xxxvii). He did so because, as this thesis argues, the notion of fluidity had been discredited by this time. Yet, his reference to space as ‘an invisible and imponderable fluid ocean’ encapsulates this seventeenth and eighteenth-century concept which underpinned literary and philosophic thinking about the properties of matter in the period.

Fluidity, in this more technical and historical sense, is perhaps best described as an abstract general term that covered the way in which several natural phenomena, including electricity, magnetism, heat, light and fire, were understood and perceived in the late seventeenth, eighteenth, and early nineteenth centuries. For reasons discussed further below, all these naturally occurring phenomena were referred to as ‘fluids’ in treatises and publications of the period, as natural philosophers attempted to analyse and identify what they perceived to be their material, or empirically ‘semi-material’ qualities. There are some significant points to be made at the outset. First, the scientific or technical notion of ‘fluid’ in the period was unstable. Second, it stood at the centre of a variety of contemporary debates. Third, there was no strict division at the time between disciplines: science, natural history, religion and philosophy mingled fairly freely. There was no ‘two-culture’ debate at the time. Fourth, fluidity was understood in narrative contexts, especially in Creationist and Biblical terms. In modern terms, fluidity in its various forms – heat, fire, electricity, magnetism – was

held together by a series of analogies. But that is not how it was understood at the time.

It is important to bear in mind that the concept, tied as it was to Creationist thinking, was explicitly *not* regarded as a metaphor in the seventeenth and early eighteenth centuries. On the one hand, the divine fluid constituents of the universe needed to be realisable or made perceptible. I shall shortly focus more precisely on contemporary efforts to think this problem through. On the other hand, in rendering fluidity perceptible in effects of fire, heat, magnetism and electricity, eighteenth-century natural philosophers or 'scientists uncoupled these phenomena from their divine origin. An increasing professionalisation and secularisation of science in the early nineteenth century led to a waning of belief in fluidity as part of a created order.

The concept of fluidity illuminates several important aspects of writing in the long eighteenth century. In *Paradise Lost* (2nd ed. 1674), Milton presents a curious mix of elements in the depiction of hell, perhaps deriving from the Biblical idea of the 'lake of fire' (cf. Revelations 19:20).

Milton's famous depiction of perdition as a place of 'darkness visible' is developed with further paradoxes, being 'void of light' but also 'glimmering' with 'fiery waves':

> Thus Satan talking to his nearest mate
> With head up-lift above the wave, and eyes
> That sparkling blazed, his other parts besides
> Prone on the flood, extended long and large
> Lay floating many a rood, in bulk as huge
> As whom the fables name of monstrous size
>
> (I: ll. 192-7)

Here fluidity and fire are blended together as one. In Book Ten, Milton describes a tree shattered by lightning, its destruction a sign of God's almighty power:

> Or by collision of two bodies grind
> The air attrite to fire, as late the Clouds
> Jostling or pushed with winds rude in their shock
> Tine the slant lightning, whose thwart flame driven down
> Kindles the gummy bark of fir or pine,
> And sends a comfortable heat from far.
>
> (X, ll. 1053-8)

Like the friction of material bodies grinding against one another, lightning sets fire to a tree and "kindles" a "gummy" bark, forcing the tree to ooze its natural essence. Words are in collision here, like "two bodies" that "attrite" to "fire": the archaic word "tine" means a spike, or harrow and gives an earthy paradoxical sense to the "slant lightning" that splits the tree apart. It is Adam who speaks here, describing God's power and the weakness of humans compared to the elements unleashed by an almighty Creator. In Adam's speech, observable natural substances, bodies, elements or phenomena – air, lightning, fire, heat and the sun – are inherently interconnected parts of God's creation.

Adam's tale of a tree hit by lightning in a thunderstorm is a description of elements compressed together, one with another. Milton understood lightning as a complex phenomenon. Elsewhere in *Paradise Lost*, he details its qualities. In Book Two, Satan refers to God as 'The Torturer' who will shortly hear,

> Infernal thunder, and, for lightning, see
> Black fire and horror shot with equal rage
> Among his Angels, and his throne itself,
> Mixed with Tartarean sulfur and strange fire.
> His own invented torments …
>
> (Milton, 2005, II ll. 66-70)

Once again, Milton resorts to paradoxes rooted in the material world – "black fire", "Tartarean sulfur" and "strange fire" – to evoke a 'mixed' volcanic, infernal liquid.

Eighteenth-century readers of Milton are likely to have fused his descriptions of lightning with the little they understood of electricity: either the electric fluid *causes* fire, or fire might be a way in which fluid reveals itself to the eye. The heat engendered by the blaze is another perceptible quality, "which might supply the sun: such fire to use" (ibid, X, l. 234). Light, heat, fire, fluidity and even the sun are all part of the same set of phenomena. To this understanding, eighteenth-century natural philosophers would add the power of magnetism.[3] While the notion of fluidity encompasses this wide variety of phenomena, I have chosen to focus in this thesis specifically on ether, electricity, and magnetism. Fluidity is key to understanding these phenomena in the period.

My thesis is divided into discussions of different physical manifestations of fluidity. Chapter One examines seventeenth and eighteenth-century conceptions of an original 'Ur'-fluid, ether, which was commonly regarded as the basic building block of all matter. It argues that a notion of an ethereal Ur-fluid lay behind contemporary understandings of several physical phenomena. This notion combined both Lucretian and Christian creation elements. It is found in Milton's *Paradise Lost* but also thereafter in a variety of works in the long eighteenth century. Chapter One argues that, in natural philosophy, the idea of an all-encompassing ethereal medium making up the known universe was fundamental to just about all understanding of matter. Newton's speculative *Queries* in the third part of *Opticks* (1704) gave authority to an abstract, 'imponderable' all-pervading substance that only gradually weakened. The Newtonian idea of a divinely created ethereal fluid influenced a wide variety of seventeenth and eighteenth-century writers after Milton, including Richard

[3] As we shall see in chapters two and three, the attractive powers of magnetism and static electricity were regarded as similar.

Blackmore, James Thompson, Alexander Pope and George Berkeley. These writers tended to view the ethereal fluid as a real, semi-material natural phenomenon of almost boundless power. As the basic substance of all matter, an ethereal Ur-fluid was commonly regarded the common ancestor of all other naturally occurring phenomena conceived as fluids, including electricity and magnetism.

Chapter Two argues that electricity in the period was commonly conceived as a (semi-material), 'imponderable' fluid, and that this conception depended upon an idea that electrical fluid must necessarily have derived from an all-encompassing ether. A conception of ether's fluidity, this chapter suggests, underpins just about all writing on electrical phenomena in the period. Having a divine origin, and closely related to Newtonian 'ether', the electric fluid was viewed throughout the eighteenth-century as one of the most powerful agents of the universe. Contemporary research into electrical fluidity, Chapter Two suggests, was aimed at pinning down what the electrical fluid really was. But the attempt to render electric fluid visible or perceptible had a kind of reverse effect, resulting in a clearer taxonomy and nomenclature that had little room for divine explanations or speculative ideas about universal substances. These investigations were substantially affected by a novel and hugely influential method introduced by French chemist Antoine Lavoisier, whose treatise *Elements of Chemistry* (1789) argued for greater precision and clarity in scientific discourse. Fluidity, a concept that was defined by its subtlety and imponderability, was too abstract a notion to continue in such a revised methodology.

Chapter Three examines the evolution of understandings of magnetism as a descendant from ethereal fluid, and a phenomenon closely related to electricity. It argues that fluidity is central to understanding magnetic research in the period. I first

discuss the way in which a variety of writers sought to explain and so de-mystify magnetic phenomena. These writers included the physician and librarian Gowin Knight and others (such as Tiberius Cavallo, Ralph Walker, and Franz Anton Mesmer), who regarded fluidity as essential to magnetic attraction and repulsion. The chapter goes on to discuss the 1784 Commissioners or 'Franklin Report' which debunked the existence of an animal magnetic fluid. The report weakened arguments for an all-pervading fluid substance behind magnetism as a whole. As with electricity, the supposed 'rendering perceptible' of magnetic fluid had the effect of undermining prevailing notions of magnetic power based on religious or universalist beliefs.

Chapter Four charts the demise of belief in any notion of a divine fluidity. It explores the ways in which later natural philosophers and scientists gradually broke from the influence of 'strong precursors' such as Milton, Descartes and Newton. In Britain, Humphry Davy and Michael Faraday sought to explain electricity without explicit recourse to notions of fluidity. In particular, electrical fluid became just one kind of explanation which was gradually supplanted by a more precise nomenclature. In France, Antoine Lavoisier pushed for a more precise terminology when discussing the effects of electricity. After the Commissioners' Report of 1784 into the viability of claims made by Anton Mesmer and his followers for a so-called 'animal magnetic' fluid capable of bringing healing to the body, belief in the reality of a general Ur-fluid shifted into the realms of superstition. There were residual writers, such as Ralph Walker and Tiberius Cavallo who still clung to the old language of fluidity, others like John Lorimer, Robert Jameson and James Bremner remained sceptical. The science of fluidity was decisively waning.

The contribution to knowledge in this thesis is, essentially, two-fold. First, it documents the ways in which these various discourses, that may seem radically separate from today's point of view, were unified by fluidity – a concept of immense versatility and applicability in the period. Second, in examining natural phenomena commonly classed as fluids in the period, this thesis highlights what was at stake in these scientific investigations. Not only were these phenomena understood as profoundly inter-connected, but they provided a means to understand and even view the agency of the Divine Creator. Fluidity was essentially an eighteenth-century 'theory of everything'. As Stephen Hawking wrote in an entirely different context: "If we do discover a theory of everything ... it would be the ultimate triumph of human reason – for then we would truly know the mind of God" (Hawking, 1989, 193).

Introduction: Part Two: Theorising Literature and Science in the Eighteenth Century

Several interpretative challenges also arise in a project like this. First, there are issues of how to interpret a gradual separation of intellectual spheres or approaches – literary, philosophical, 'scientific' and religious – without imposing modern divisions between the sciences and cultural or literary history. Second, there is the question of how the vocabulary surrounding fluidity should be differentiated in its historical context. Careful distinctions must be made while at the same time acknowledging the difficulties in doing so. There is the question of how literally or analogically we should take historical language that aimed to account for little understood features of the material world. Sometimes, it is hard to gauge just how literal early writers were being, and what we now take as 'poetics' may then have been meant or taken as a real substance. Difficult as it may be today, in some respects to think historically is also to think as a creationist, a universalist, or a literalist. To address some of these issues, this introduction now turns to some preliminary theoretical considerations regarding the concept of fluidity.

In many respects, this thesis aims to historicise the notion of fluidity, to see its meanings in the context of its own time. This may have some possibly surprising consequences. For Newton, "fluxions" and "fluents" were mathematical principles designed to measure rates of change (Kitcher, 1973, pp. 33-49). Water was not, for example, itself deemed a fluid in the eighteenth century. Johnson's *Dictionary* (1755) draws on Newton's definition of water as "a very fluid salt … it seems to consist of small, smooth, hard, porous, spherical particles, of equal diameters, and of equal specifick gravities". Johnson himself defines "Wateriness" in terms of "moisture" (Johnson, 1755, pp 1088-89). He defines both "fluid" and "liquid" as "not solid", and

"liquidity" as a "subtilty" involving "fluid spirits" (ibid. p. 57). We need to be careful and sensitive with regard to such terms. As the example of the lightning-struck tree from Milton shows, water might even appear to be the exact opposite of fluids such as fire, light and heat.

The words 'fluid' and 'fluidity' in the period did not carry quite the same connotations as they do in modern English. In fact, as Johnson indicates, seventeenth and eighteenth- century natural philosophers, poets, religious writers, and lexicographers tended to separate 'fluids' (i.e. somewhat abstract, partly intangible energies or phenomena) on the one hand, from liquids (i.e. more corporeal, observable, tangible, flowing substances) on the other.

For example, Robert Boyle's 1661 essay *The History of Fluidity and Firmness*, published in *Certain Physiological Essays* 1668, examines the different physiological states of various substances. Focusing on a central dichotomy, Boyle suggests that there is no "distinct portion of matter in the world, that is not either fluid, or else stable and consistent" (p. 378). For Boyle, 'fluidity' may account for all substances that are *not* considered 'stable', 'consistent', firm, or even tangible. Further underpinning this distinction, Boyle's essay additionally differentiates between 'liquors' or liquids, such as water or oils on the one hand, and 'fluids' on the other. Describing fluids, those invisible substances which surround the planet, Boyle suggests that

> [T]hey [i.e. various fluids] make a much more considerable part of the universe, than those that are wont to be called 'liquors', maybe argued from hence, that except the Earth, the planets, and perhaps too the fixed stars, the rest of the world, as vast as it is, seems to consist chiefly, if not only, of a serial, thin and fluid substance.
>
> (p. 379)

In Boyle's scheme, 'liquors' or liquids are clearly similar to, yet distinct from, fluids. Chambers's *Cyclopeadia: or and Universal Dictionary of the Arts and the Sciences*

(1728) contains an entry on 'Fluidity' which alludes to Boyle's enquiries into the matter. The entry draws a distinction between liquids and fluids:

> Fluidity, in physics, that state or affection of bodies, which denominate, or render them fluid[…] Fluidity stands in direct opposition to firmness, or solidity […] Fluidity is distinguished from liquidity or humidity in that the idea of the first is *absolute*, and the property contained in the thing itself: whereas that of the latter is *relative*, and implies wetting, or adhering; i.e. somewhat that gives us the sensation of wetness, or moisture, and which would have no existence but for our senses. Thus […], air, aether, and even smoak [sic.] and flame itself, are fluid bodies, *but not liquid ones*; their parts being actually dry and *not leaving any sense of moisture*.
>
> (no pagination, my emphasis)

This definition contains several different strands of thought. First, it builds on Boyle's dichotomy between fluidity and firmness, pointing out that that these two states of matter must stand "in direct opposition to each other". Second, it reinforces a key distinction between fluidity and liquidity by suggesting that liquidity is always empirically perceptible (i.e. leaves a "sensation of wetness of moisture" and "implies wetting or adhering"). Fluidity, which applies to such substances or phenomena as electricity and magnetism, does not leave such a sensation. Third, the term 'fluidity' in Boyle's work applies only to itself: it is, as he puts it, "absolute, and properly contained in the thing itself". As its own category, it constitutes a class of elements within natural philosophy that are imperceptible, conceptually distinct from one another, and not related to substance. Fluids, in eighteenth-century thought, are not linked to an object or substance outside of themselves. At the same time, they were not, in their time, understood or used as a metaphor.

This difference – between understanding what 'fluidity' meant in the long eighteenth century, and how we might comprehend it in the twenty-first century – is significant. To us today, fluidity in science is often a metaphor. We know that there are no

'imponderable' fluids filling the universe. Yet for writers in this period, the essence, or substance of such phenomena as lightning, magnetism or electrical charge was a kind of fluid. Here we get into questions of the kind of language used at the time, and its implications, and the rather different terms in which we understand these phenomena today. Florence Grant has stated that,

> Rhetoricians knew that visual imagery made arguments more forceful, affecting and memorable: 'comparisons and similitudes, drawn ordinarily from sensible things, give us a more easie [sic.] penetration into the most abstracted and abstruse truths'.
>
> (p.495)

Much eighteenth-century science was preoccupied with this paradox: how to discuss, investigate or analyse imperceptible self-contained, free-floating fluids in physical and observable contexts. This thesis argues that the first of these states was understood as 'ethereal', but that once investigated in real phenomena, the term 'ethereal' immediately no longer mattered or held any persuasive force or function. Tracing through the scientific rhetoric that lay behind many of these debates, Alan Wall, in *Myth, Metaphor and Science* (2009), argues that "we can see the ceaseless interchange between scientific definition and metaphor", stating further that "such interchange can confuse the relation between a scientific description of reality and a metaphoric use of language in non-scientific writing" (p.82). The lines between symbol and substance in eighteenth-century science were often blurry. But it is only by understanding 'fluid', as Johnson has it, as 'not solid' that we see these now obsolete distinctions at work.

We might pause here to consider what is meant by metaphor. Paul Ricoeur proposes "a definition of metaphor that identifies it with giving an unaccustomed name to some other thing, which is thereby not being given its proper name" (p. 74). Metaphor then is a "transposition of name" in which the "locus" (i.e. centre) of meaning is not in, or

connected to, the usual or generally accepted notation of a word.[4] The "locus" (p.75) of meaning of a metaphor sits outside itself. Yet, for the eighteenth-century concept of fluidity, this does not apply. The fluids discussed in this thesis show no such transposition of name. The electric, magnetic and ethereal fluids are not referred to in early scientific discourse by way of comparison or with an intention of *likening* them to liquids, or to anything other than themselves. They *are* fluids insofar as they carry all the characteristics of fluids, and in particular, they carry their own essential and divine potential. This is to say, the substances described as fluids at this time denote only their essence: they are, if we are to historicise these terms properly, self-referential. The 'locus' (Ricoeur's term) of fluidity, in this context, is, absolutely and divinely itself.

If we then assume that fluidity is not used metaphorically, does this mean that it is to be understood literally? The answer to this question is not quite as straight-forward as the dichotomy between literal and metaphorical use of language might seem to suggest. First, it is worth considering the Ricoeurian "unity of discourse and the unity of language" (ibid. p. 76). All eighteenth-century discourses surrounding fluidity assume an underlying idea of divine creation – one that is often explicitly invoked, and at other times merely implied. Fluidity functions as a term within a broadly theological, literary and scientific set of discourses. It highlights the fact that science at the time was in search of a language, a more precise mode of description and analysis, and in finding that language, the old terms had to be jettisoned. But this was a process that only happened slowly, and not always progressively. A new way of speaking does not just invent itself. Ricoeur points to this difficulty with reference to

[4] 'Locus' in Ricoeur translates as 'space, aim, point, place, territory, locality, or region (pp. 74-5).

the linguist Emile Benveniste. Benveniste cites (or adapts) a phrase from Aquinas, "nihil est in lingua quod non prius fuerit in *oration*". The phrase reads in English, 'nothing is in the intellect that was not first in speech'. No language, Ricoeur insists, can exist without its broader discursive frame (Ricoeur, p. 79; see also Benveniste, p. 111), Ricoeur emphasises that language cannot exist without its discursive frame. [5] There would be no simple and easy letting go of the Creator, nor of the moral compunction for science to lend its own voice in that Creator's praise.

For a sceptic today, the throne of God might easily be a metaphor, but for a polymath scientist working in the eighteenth century, it was likely to be very real. Anyone struggling to make sense of these terms in the mid-eighteenth century was likely to combine both faith and intellect. For the lexicographer Johnson, 'ether' was "an element more fine and subtle than air". He cites Newton's self-confessed difficulties with the concept in *Opticks*, "for I do not know what this *ether* is", and Locke's understanding of it as an essence that, "can have no other conceivable cause" than its own "cohesion and union". Johnson lists the word 'ethereal' as meaning 'celestial' or 'heavenly'. Joseph Glanville's observation that is ethereal powers "are employed, like the spirits above, in contemplating the Divine Wisdom in the works of nature".[6] As we shall see, the concept of 'ether' remained central to these scientific debates as a way of linking the wider discursive frame of what was then called natural philosophy to creationist thinking. But at a time when philosophers, especially the British empiricists like Locke, Berkeley and Hume, were insisting that all knowledge came through the senses, the task of giving any account of an imponderable, ethereal and

[5] "The phrase is adapted from Thomas Aquinas' "nihil est in intellectu quod non sit prius in sensu" ('nothing is in the intellect that was not first in the senses').
[6] Johnson, I, 723. See Joseph Glanville, *Scepsis Scientifica, or The Vanity of Dogmatizing* (London, 1661) ch. 27, accessed via ECCO.

divinely created fluid out of reach of all sense perception clearly ran into bewildering contradiction.

Related questions and problems arise when we consider the role of narrative in scientific explanation generally, and in evolving concepts of fluidity in particular. Perhaps owing to the fact that the term 'narrative' itself is, in most senses of the word, so closely associated with story-telling, it has, in a way reminiscent of Snow's argument of the *Two Cultures* (see below), been largely eschewed by modern science. Yet, as Mary S. Morgan and Matthew Norton Wise point out, "[t]he role of narrative in the sciences has been neglected far too long". Referring to Gillian Beer's 1983 work *Darwin's Plots: Evolutionary Narrative in Darwin, George Eliot and the Nineteenth Century,* Morgan and Wise point out that "perhaps the best-known study of scientific narratives is by a literature specialist". Further emphasising an apparent aversion to narrative in science, they argue that "[u]ntil now, philosophers of science have not given narrative much credence as having any ontological or epistemological functions, and, if anything, have been deeply suspicious that it could have any such functions" (p.1). However, particularly in natural philosophy in the period discussed here, and especially regarding the concept of fluidity, narrative is a key tool in discussing and observing natural phenomena. In a time of rapid advance and scientific exploration, narrative explanation "took natural history well beyond straightforward description and classification" (Terrall, p. 52).

At perhaps a most basic level, as Currie and Sterelny suggest, "a narrative is a candidate explanation of a particular causal trajectory in the past thought to be of interest in its own right", which "posit[s] links – often causal – between events" (p.

15).[7] It is important to point out that what is meant here is *not* narrative in its classical sense of mere 'story-telling'. Instead, it is a technique which, particularly in the seventeenth, eighteenth and early nineteenth centuries, supplies the gaps between strictly mathematical equations and observations of the rules of physics and a broadly scientifically-minded audience. Currie and Sterelny further argue that "[p]art of the explanatory agenda of historical science involves the identification of similarities between historical trajectories" (p. 15). In seventeenth and eighteenth-century scientific investigation, we see similar trajectories and comparisons between scientific observations of different natural phenomena such as electricity and magnetism. These attempts at explanation-by-comparison, or by analogy, are usually a means to negotiate sensibilities about the divine Creation.

Whereas "narrative is [frequently] understood as 'story'[,] it may be better to understand it as any cognitive structure that connects individual statements and creates some general[,] coherent plot" (Kuukkanen, p. 342, also quoted in Roth, p. 43). Narratives "forge the links between […] more initially evidentially secure elements of [an] overall trajectory" (Roth, p.17). Especially within a narrative that includes fluidity, a concept which is literarily, scientifically, and, perhaps above all, religiously adapted, narrative is crucial. In fact, we may well distinguish between two types of narratives within seventeenth and eighteenth-century scientific explanation which are of interest in this context. Firstly, there is the kind of narrative which connects scientific observations within one experiment or between a string of experiments. This is what Kuukkanen refers to as a 'cognitive structure'. For example, Newton's equations and calculations regarding the passage of light through a prism are

[7] Curry and Sterelny suggest here that narrative is one 'candidate', i.e. one possible way of explaining or linking facts or events.

connected by a procedural narrative[8] in which the author takes a more or less active role in guiding the reader or observer through the experiment. A procedural narrative establishes an experiment's trajectory and its logical outcomes and helps both the reader(s) and the writer(s) interpret data, e.g. Newton's mathematical equations regarding the angles of light entering and leaving a prism. Put slightly differently, the "implications of scientific ideas may manifest themselves in narrative organisations" (Beer, 1990, p. 90). For this thesis, the implications of narrative in natural philosophic writing are especially relevant. Eighteenth-century writing on the topic of fluidity constantly defers to the far grander narrative of God's creation. Fluidity, then, is fundamentally ethereal (i.e. 'heavenly', or 'belonging to the higher spheres), and its qualities and origin are embedded in a religious narrative that still held sway but in fact had nothing new to say.

How then, does Kuukkanen's approach to narrative explanation apply to the concept of fluidity? Some of the 'more initially evidentially secure elements' of *electric fluidity,* for example, are that it is a phenomenon of great force, that it becomes visible as heat or light, and that it 'flows' (i.e. can be transmitted between metallic objects). Each of these observations is explained by, and deduced from, procedural scientific experiments embedded in a narrative. Common reasoning as to why electricity, magnetism, ether, and other fluids, are regarded, at the time, as similar, which qualities they possess, whence they originate, and why these phenomena share a trajectory, is governed to a large extent by *religious* narratives, shaped largely by the first three chapters of Genesis. Religious and cognitive narratives are weighted differently in a number of models of narrative within (eighteenth- century) scientific thought. Daniel

[8] By 'procedural narrative' or 'procedural experiment' is meant any basic explanation that is deduced from a logical trajectory in scientific explanation.

Little's model of 'narrative explanation', for example, encompasses both the temporal trajectory and the causal connection of events in a narrative. According to this conception, a narrative

> is an account of the unfolding of a series of events, along with an effort to explain how and why these processes and events came to be. A narrative is intended to provide an account of how a complex historical event unfolded and why. [It] seeks to provide hermeneutic understanding of the outcome […] and causal explanation.
>
> (cited in Roth, p. 43)

Roth here explains the perplexity, the gaps and incoherences that eighteenth-century philosophers would have faced had they not held to the creation story. These were perplexities that simply could not be admitted or faced without a standard model of physics and the technology to investigate it. It was Nietzsche who wrote of priests that "into every gap they put their delusion, their stopgap, which they called God" (Kaufmann, p. 204) but in the 1700s, writers had no other framework with which to operate, and no alternative story they could tell. Divine creation, referred to or implied in the majority of contemporary natural philosophy, gave the only possible context for all the 'fluid' phenomena discussed here.

The *OED* indicates that some of these early accounts of 'fluidity' and related terms such as 'ether' were not entirely without reason. For the noun 'fluid', *OED* gives two separate meanings. The first of these presents an account not so different from Johnson in 1755: "A substance whose particles move freely among themselves, so as to give way before the slightest pressure." That account continues, "fluids are divided into liquids, which are incompletely elastic, and gases, which are completely so." The second meaning is more limited, historically: "One of several subtle, imponderable, all-pervading substances, whose existence has been assumed to account for the

phenomena of heat, magnetism, and electricity." It is in this second sense that 'fluidity' is discussed in this thesis.

For 'ether', the *OED* has the following entry: 'In ancient cosmological speculation: an element conceived as filling all space beyond the sphere of the moon, and being the constituent substance of the stars and planets and of their spheres. Now *historical*.' It adds a note to the effect that, 'Ether was variously regarded as a purer form of fire or of air, or as differing in kind from all of the four elements. By some it was imagined to be the constituent substance, or one of the constituents, of the soul.' What these definitions show is that none of them are precise or fixed. These terms were used in a cultural context where they served several purposes or were put to a variety of uses.

As already noted, there are few discussions of the uses of narrative in science. One of these, by Paul A. Roth, draws on rather technical language but still sheds some light on how we might begin at least to think about the role of narrative in scientific explanation.

Roth outlines three aspects of narrative's role in scientific explanation. The first is what he calls "the non-detachability of the explanandum from the narrative". By this, he appears to mean that there is no way of thinking through a separation of the thing-to-be-explained and the narrative explanation. The second aspect is what he refers to as "the non-standardised character of event(s) explained". By this, Roth seems to mean the element of contingency or unpredictability in what is being explained. In Roth's words, "wars, revolutions, famines, and other typical foci of human histories […] do not exist as 'standardized' in some conventional theoretical sense, as the periodic table and related laws of compounding standardize[d] events in natural science such as

chemistry" (ibid. p. 4). The third aspect is what he calls the "non-aggregativity of narrative histories". By this he appears to resist the idea that scientific narratives contribute or feed in to a homogeneous "Universal History – some single event that links all possible events under one explanatory rubric" (p. 44). Roth's three aspects of narrative help us to attend to the nuances and complexities of some of these early debates in natural philosophy.

Roth allows us better to understand that the abstract fluids discussed in this thesis are not merely *connected* to their narrative. Instead, the wider divine narrative in which they are embedded *constitutes* both the meaning and value of this semi-material, semi-divine substance. This is what emerges from his first principle or aspect of narrative. He uses the terms 'explanandum' and 'explanans' to distinguish the thing-to-be-explained from its formulated meaning. When it comes to thinking about eighteenth-century concepts of fluidity, these two components are indeed 'non-detachable' or inseparable.

Roth's point about the unpredictable or contingent element in these forms of narrative is similarly useful. While fluidity is not an event, but rather a concept or an idea, and while it appears that Roth explicitly excludes features of conventional science such as "the periodic table and related laws of compounding standardize[d] events in natural science such as chemistry" (ibid)., his point of non-standardisation nevertheless applies. At the very heart of fluidity lies the paradox that, although seventeenth and eighteenth-century natural philosophers attempted to describe it within supposedly scientific parameters, it remains utterly 'un-standardised', and un-standardisable. While the strength of an electric current, or the force of magnetic attraction, may be described by means of mathematical equations, fluidity itself, and the metamorphic

qualities of ether, electricity and magnetism, remained distinctly abstract and variable in meaning throughout the period's treatises on the subject.

Roth's third principle or aspect about the 'non-aggregativity of narrative histories' helps to illustrate the fact that fluidity in the eighteenth-century was understood as a 'physical' phenomenon, yet told as part of a quasi-scientific-religious discourse. Eighteenth-century natural philosophers understandably assumed that these 'imponderable' fluids did indeed feed into one single universal history.

Much of what has been discussed so far feeds into the debate about whether science and literature evolved into two separate spheres or cultures. The idea that narrative has played a part in the development of science can have unsettling implications. Narrative has traditionally been associated with fiction rather than knowledge. It appears to be an easy target for criticism, as pointed out by Curry and Sterelny:

> [T]he charge of 'story telling' is potentially serious; leading to a supposed contrast between the 'real' science, the more-or-less firmly established links between material remains and the past, and 'mere' storytelling, the construction of imagined links between those pockets of evidential confidence" […] Building a narrative might seem unproductively speculative, because a narrative typically involves the reconstruction of causal intermediaries that have left no unambiguous trace in the present.
>
> (p.16)

Especially against the backdrop of seventeenth and eighteenth-century natural philosophy, these criticisms appear to apply. However, in an age that participated in or began a number of scientific revolutions, narrative was often the *only* way in which natural philosophers could make sense of their findings, especially regarding what were deemed divine fluids. Instead of merely connecting 'pockets of evidence' in an otherwise speculative environment, in the seventeenth and eighteenth centuries, narrative enables and encourages further exploration:

> So speculation is a vice – is idle – [only] when it is pointless, when it cannot or does not productively direct further inquiry; when it is not used to construct alternative scenarios to guide a search for evidence which would favour one at the expense of another.
>
> (ibid., p. 17)

It is worth noting that narratives regarding various subtle fluids were *productive* and advanced scientific exploration in the period. They encouraged scientific experimentation and intellectual engagement with abstract ideas and were anything *but* (as Curry and Sterelny would have it) idle. In considering particularly the fluids' possible origin, and in predicting the possibilities arising from their alleged divine potential, contemporary natural philosophers, writers, and theologians continuously widened the scope of intellectual enquiry in the period.[9] Experimenting with substances and phenomena classed as fluids "reveal[s] narrative paths that are neither fully predictable, nor fully explainable, for their ingredients of randomness, variety and unpredictability […] create narrative paths that are themselves a source of illumination to the scientist" (Morgan and Wise, p. 2). This condition applies especially to narratives on fluidity, whose very definition itself involves a degree of 'randomness, variety, and unpredictability'. However, contrary to what this rather loose account of the role of narrative within science may suggest, narratives within science, and 'hard facts', were never mutually exclusive. Instead, they "reinforce[d] each other". The importance of "having a relevant theory", such as the religio-scientific concept of fluidity, "does not substitute for having a rich narrative". Instead,

[9] Predictions on where science, and science using these mysterious fluids, could lead humanity appear frequently in the then arising genre of science fiction. While Mary Shelley's *Frankenstein* is the best known of the genre, standing synonymous with the potential dangers of scientific experimentation, other lesser-known works of prose fiction specifically stress the potential of various (ethereal) fluids. Later nineteenth-century examples that cast a look back at otherwise 'dis-proven' notions of animal magnetism and electricity as a fluid include Bulwer-Lytton's *The Coming Race* (1871) and Bleunard's *Babylon Electrified* (1889/90).

"having a good narrative" like that of the Creation for various divine fluids, "may well embed a relevant theory" (ibid., p. 2).

With regard to establishing an understanding of the natural world as a whole, Mary Terral emphasises a further hermeneutic function of narrative within scientific exploration:

> At one level, narratives served a literary or expository function, engaging the reader by bringing nature, and the naturalist to life on the page. But […] they also carried epistemological weight … [It] provide[d] access to the truths of nature, from very simple details to more general principles.
>
> (p. 62)

To put it simply, "knowing the narrative – put together from the results of observations […] – meant knowing nature" (ibid.) – for natural philosophers and literary religious writers alike. But equally as important was the idea that knowing nature was knowing God.

Some theorists have pointed out potentially different modes of narrative apparent in the fields of science and religion. Jerome Bruner and John Teske have distinguished "between paradigmatic and narrative modes of understanding":

> The paradigmatic mode involves synchronic understanding via logical proof, empirical observation […] The narrative mode involves diachronic understanding via storied accounts of the 'vicissitudes of human intentions' […] organised in time, explanations being not causal but in terms of believable narratives of actors – human or otherwise – striving to do things over time.
>
> (Teske, p.92)

Teske notes that the paradigmatic mode is putatively more characteristic of modern science, whereas the narrative mode is "more characteristic of novelists or poets than of scientists or logicians and arguably more characteristic of religion" (ibid.; see also

Bruner, 1986, p. 12 and Bruner, 1990). This thesis proposes that we should see both forms of understanding – synchronic and diachronic – at work in eighteenth-century writers' belief in the literal (rather than metaphorical) reality of divine fluids. Bruner and Teske's model allows us to take a combinative approach to earlier modes of science and to recognise that nature, for these writers, was ontologically divine, and to study natural phenomena was to uncover traces of divine agency. Explanations of why narratives regarding fluidity proliferated in the period (i.e. why the concept took hold) may be diverse but one of the greatest contributing factors was that to understand the workings of nature – to comprehend ethereal phenomena such as electricity and magnetism – was considered a way of drawing nearer to God, the Ethereal Creator himself. To grasp this idea is to historicise our understanding of fluidity, and science more generally, in the period.

It will be apparent from these considerations, that there are three major strands of thinking about fluidity in the period – natural philosophy, literature and religion. This thesis holds that these three modes of discourse, or strands, combine to form a single cultural field. Indeed, 'fluidity' is the single concept that each of these modes of discourses has in common. 'Fluidity' is the 'glue' that holds these ways of approaching various natural phenomena together. As noted earlier, much of this discussion bears on the so-called 'two cultures' debate – the supposed dissociation of science and the humanities espoused by C. P. Snow. Famously, Snow's account has been reduced to a contest between two cultures. As Snow pointed out, "The number 2 is a very dangerous number" (Snow, p. 9), and yet he bases his argument on a dichotomy in which literary figures and scientists belong to entirely separate fields of intellectual enquiry. Between the two groups, Snow suggests, lies "a gulf of mutual incomprehension – sometimes [paired with] hostility and dislike, but most of all lack

of understanding" (p. 4). Much has since been written to refute what many have pointed out is an oversimplification of a variety of much more complex issues. This thesis situates the concept of fluidity in the seventeenth and eighteenth centuries in a network not of Two Cultures, but One Culture consisting of what now appear as different strands of discourse or intellectual enquiry. The most prominent of these strands are literary, natural philosophic, and religious discourse.

Criticising the stark contrast between two entirely separate domains suggested by Snow, Roy Porter, in 'The Two Cultures Revisited', has pointed to a number of twentieth century theorists who worked towards a kind of "cultural reunification" (Porter, 1996, p. 10). George Levine, in *One Culture* (1987), has further stated that "Snow's analysis was inadequate in ways that more critics than F.R. Leavis have noted" (p.3), arguing that a dichotomy, such as Snow proposes, had never in fact been a reality. N. Katherine Hayles and others have stated further that Snow's representation of this dichotomy is inaccurate as, "science and literature are not above or apart from their culture, but embedded within it" (Hayles, p. 30, also cited in Crossland, p. 4).

Snow's characterisation of scientists and writers as belonging to two tribes simply does not apply to seventeenth, eighteenth, and even nineteenth-century literary, scientific, or philosophic enquiry. We simply do not see any clean-cut boundary between what Snow refers to as the 'Two Cultures'. Considering the vast cross-over between disciplines in the period, Levine's approach to culture is therefore a much better fit. He argues,

> First, science and literature are two alternative but related expressions of a culture's values, assumptions, and intellectual frameworks; second, that understanding science in its relation to culture and literature requires some

> understanding […] of its own internal processes […]; third, that the idea of 'influence' of one upon the other must work both ways.
>
> (Levine, p. vii)

Levine's third point about mutual influence is helpful. Seventeenth and eighteenth-century poets frequently shared an interest in the advances of science. These writers often incorporated 'philosophic' concepts such as fluidity into their works – either referring to them directly, or sometimes obliquely. As Levine suggests, "since at least the seventeenth century, the peculiar authority of science has made it an intrinsic part of general culture, even when in its specialism it grew beyond the reach of popular understanding" (ibid. p.9). Equally, natural philosophers of the period, perhaps first and foremost Isaac Newton, saw a poetic value in uncovering the workings of the natural world, and natural beauty through philosophic, i.e. scientific, enquiry. Science and literature in the eighteenth century were essentially co-dependant modes of discourse. "Literature and science", as Levine argues, "are modes of discourse, neither of which is privileged except by the conventions of the cultures in which they are embedded" (p.3). Further, as suggested by Gillian Beer, "neither literature nor science is an entity and what constitutes literature or science is a matter for agreement in a particular historical period" (Beer, 1990, p. 81).

Returning to Snow's case that there is "no place where the Cultures meet" in the twentieth century, he remarks that [t]he clashing point of two subjects, two disciplines – two cultures – ought to produce "creative chances" (p.17). Roy Porter has described this point as Snow's plea for "the comradely cooperation between writers and scientists" (1996, p.2). Perhaps ironically, what Snow wishes for in making this case is exactly what we find in the period discussed in this thesis. Science and literature in the seventeenth, eighteenth, and nineteenth centuries were clearly in dialogue. The

discourses examined in this thesis have in common the concept of fluidity as a sort of "imaginative currency", which is "set in multiple interpretative relationships and helps to construe the times" (Beer, 1990, p.85).

Not only did late seventeenth, eighteenth and early nineteenth-century writers strive for cross-cultural exchange between literature and science, but religious writing plays a key role in this exchange, especially with regards to the concept of fluidity. In this period, we see no mutual exclusion of natural philosophy and religion, no two discourses at war with each other. Instead, writers of the period are inclined to attempt a synthesis of these two modes of discourse. The vast majority of natural philosophers discussed in this thesis see in religious thought and discourse not a hindrance to the advancement of science or philosophy, but a driving force.

Of the writers who managed to combine natural philosophy with religious belief, Isaac Newton is perhaps the most prominent example. His observations on natural phenomena, for example on the refraction of light, gravity, or ether, were supported by a belief that saw God, the Prime Mover as the centre and quintessential origin of all observable science. Ether, a 'prime fluid' to him was part of Creation. Yet the centrality of a religious mindset to seventeenth and eighteenth-century science, especially Newtonian thought, appears sometimes to be understated. Rob Iliffe, in *Priest of Nature. The Religious Worlds of Isaac Newton* (2017) is the first in recent years to view Newton's achievements through the lens of a deeply rooted, if Non-Trinitarian, Christian belief. For the concept of fluidity, and the Ur-fluid ether, this religio-philosophic synthesis is central – not only because it furthers more widespread interest in other fluids, but also because it leads to a shared underlying hypothesis that

these fluids themselves must be, as Newton, Blackmore, and most other writers discussed here insist, inherently divine.

It might be argued that, when it comes to early ideas of fluidity, there were three cultures in dialogue with one another – natural philosophy or science, literature, *and* religion (Christianity). This thesis examines the conditions sustaining this dialogue in detail. It traces the trajectory of specific ideas. In the last chapter of this thesis, we see that the pressure for increased specialisation advocated of by Lavoisier and Davy led to Michael Faraday shifting knowledge and understanding sufficiently to render electric fluidity a writer's metaphor in the first half of the nineteenth century.[10] Similarly, we see the fading of the concept of fluidity in magnetism, a process that resulted mainly from the 'Franklin Report' of 1784 in which theories of Animal Magnetism were refuted. The last chapter traces the fading or diminishing relevance of the concept of fluidity as an explanatory term, a gradual lessening of the significance of the concept of fluidity in literary and philosophic (i.e. scientific) writing until it was, effectively, lost to history.

[10] See below for an exploration of the question why, in the seventeenth and eighteenth centuries, fluidity is explicitly not used or thought of in a metaphorical sense.

Chapter One: The Ethereal Fluid

In 1839, English poet Philip James Bailey published (at first anonymously) *Festus*, an epic poem on the creation of the earth and the relation between God and men, based on the Faustus legend, and heavily echoing Milton's *Paradise Lost.* In a conversation with Lucifer about the intricacies of the natural world and the creation, Festus asserts,

> All solid now
> Was fluid once, air, water, fire, or some
> Vast permeant element; communal all in one
>
> (ll. 7079-81)

What may at first glance appear to be only a poetic reference to God and the creation is in fact rather more. The words 'communal all in one' remind of Whewell's notion of earth, atmosphere and ether all comprising various forms of subtle or spiritual fluid (Bailey and Whewell were near contemporaries). Bailey's statement has at its core a fundamental attribute of seventeenth and eighteenth- century forms of scientific enquiry that is easily overlooked. Bailey casts an early Victorian look back at seventeenth and early eighteenth- century conceptions of the creation of the universe. As we have seen, air, fire, heat, electricity, magnetism and light were all conceived in terms of fluidity in early eighteenth- century scientific enquiry. What makes these lines from *Festus* especially relevant is their assertion that all these fluids may have been "some vast permeant element; communal all in one". This vast permeating element, although it is only indirectly referenced here, was ether.[11]

This thesis argues that 'ether' lay at the heart of just about all scientific enquiry into natural phenomena perceived as fluids from the late seventeenth century onwards.

[11] The words 'ether/'ethereal' are frequently also spelt 'aether'/'aethereal. I will keep to the former spelling for consistency.

This, I will suggest, is owing to its close conceptual connection to the dominant Deist and Christian creation narratives of the time. Hexaemeric prose and poetry repeatedly referenced an imponderable divine substance which encompassed and made up the earth.[12] Much of what Karina Williamson has called "the physico-theological tradition" of the seventeenth and eighteenth centuries relies on ideas of the ether as a divine constituting element. The reason we see conceptualisations of electricity, air, magnetism, heat, light and fire as 'fluids' results from two assumptions – not just that God created the universe but that He acts *through* the ether. John Milton and Isaac Newton's adoption of this notion of ether lent authority to an idea that then spread into literary, scientific and religious writing more generally. This chapter will discuss representations of the ethereal fluid in Milton's *Paradise Lost*, Newton's *Opticks*, and a variety of publications by poets and natural philosophers who modelled their writings on this now broadly established conception of ether. Richard Blackmore, William Stevenson, George Berkeley, Capel Lofft, and others used the concept of ether as a starting point for their writings on the hidden secrets of divinity in the universe. The idea of the ether as a fundamental 'Ur-Fluid' of divine origin gave rise to a sub-set of theories surrounding other natural fluids, such as electricity and magnetism, which will be discussed in subsequent chapters. Milton and Newton exerted a powerful influence over the scientific imagination of those that followed them and that influence would prove very difficult to shift.

The idea of a space-filling, subtle, invisible medium, sometimes called 'fire', sometimes called 'ether', or indeed 'fiery aether', was by no means an invention of

[12] Hexaemeric is defined as relating to the biblical account of the Creation, or more specifically the period of six days in which God created the Earth according to Genesis.

the seventeenth or eighteenth centuries.[13] This notion of 'ether' stretched back to classical times. Empedocles (c. 490-430 BC) was perhaps the first to speak of such a substance. He introduced the four-element-theory of matter, which proposed the idea that everything in existence must be composed of the four basic elements: fire, water, earth and air. In this model (which was to a certain extent dependent on the translation of Empedocles' works), the ether would belong either into the category of air, or of fire. The four elements he referred to as 'roots', roughly align with some of the eighteenth-century conceptions of the ether discussed in this thesis. As Raymond Prier has suggested, Empedocles frequently used the symbol of the circle to illustrate the interconnectedness of his four root elements. He writes, "[t]he κύκλος [circle] underlies the symbols that form the basic contents of the cosmic mixture. It also unites earth, sea, and air (Γαῖα, πόντος, αήρ — 38.3)." Empedocles refers to this cosmic mixture as the "Titan Aether binding all about in a circle" (Prier, p. 131). Later ideas of the ether, after Plato and Aristotle, only differed from this hypothesis insofar as they regarded complete nothingness between celestial bodies, or a vacuum, as impossible. Aristotle added to Empedocles' four elements a fifth, a certain "element of the stars" (Solmsen, p. 119).[14] Solmsen has briefly characterised this element, discussed by Aristotle in *De Philosophia,* as follows:

> Like the other elements it has its specific 'natural motion', to wit the circular, which makes it possible for Aristotle to explain by a physical 'hypothesis' the celestial motions for which Plato had resorted to the World-Soul. The place of this element is the entire heavenly region, extending from the First Heaven to

[13] The significance of different translations of classical texts is not to be underestimated here. Not only were there different terms for the ether itself, but understandings of the ethereal fluid taken from Greek and Latin classical texts are invariably subject to varying translations. The word 'aether', owing to the complex nature of the concept, is imbued with a plethora of meanings and could be translated as 'sky', 'heaven', 'air', often resulting in a variety of different interpretations.

[14] The assumption that Aristotle originally referred to his fifth element as 'ether' has been contested, most notably by David E. Hahm, who has argued that 'ether' might be the name given to the element as a result of later translations of Cicero's *De Caelo* (see Hahm, pp. 61-3). However, it remains commonly accepted that Aristotle's element was indeed an airy ethereal substance, surrounding and enclosing the celestial spheres.

> the moon; below this, in the regions occupied by the four other elements, it is never to be found.
>
> (ibid. p.119)

Aristotle's idea of the ether as a physical concept combined with Plato's idea of a 'World Soul' and underlines the element's supposed centrality in all physical existence.

The Stoics followed this notion, while adding a further layer to the significance of the ether. They believed that it was not only one of the several basic elements, but ascribed to it divine powers, sometimes even equating 'ether' with deity itself. They "[identified] God now with the world, now with the world-soul, and again with natural law or the ether" (Robins, p. 409). Cicero's *De Natura Deorum* (45 BCE), which contrasts theological views of Stoicism, Epicureanism, and Academia, perhaps most strikingly exhibits this idea. The Stoics' view, he writes, "is that the law of nature is divine", and that "the aether is god" – a god that is invisible, "without sensation" and one which never presents itself. Stoics held "that a reason which pervades nature is possessed of divine power" (I., XIV). This 'reason', according to the Stoics, was the ether and God at the same time.

Somewhat following the Stoic school and his mentor Epicurus, Lucretius, in *De Rerum Natura*, 'On the Nature of Things', published in the first century BCE, ascribes a variety of powers and functions to the ethereal fluid. The ether, in Lucretius' work, surpasses both the mere elemental state described by Empedocles, and Aristotle's theory of a fifth element (or 'quintessence'). One of the work's main arguments concerns the nature of matter. According to Lucretius, matter is never fully destroyed but constantly re-distributed through the universe. This constitutes a cycle of existence in which the elements nourish each other. "Whence is the sea supplied by the springs

within it, and by the rivers without, flowing from afar? Whence does the ether nourish the stars?", he asks, before describing, in very simple terms, the elements' 'imperishable nature':

> For all things that are of perishable body [or 'all things that are mortal'] must have been consumed by infinite time and ages past. But if through that space of time past there have been bodies from which this sum of things subsists being made again, imperishable indeed must their nature be.[15]
>
> (p. 21)

This notion of an infinite cycle of elemental redistribution is reiterated several times throughout *De Rerum Natura*. "That also which once came from earth", he notes, "to earth returns back again, and what fell from the borders of ether, that is again brought back, and the regions of heaven again receive it." The ether, in this second instance, is 'heaven', or the firmament, in accordance with Aristotle. "All stars, Lucretius notes, "are fixed in vaults of ether' (p. 391). Like other elements, the ether is indestructible. However, in its nature as one of the constituting agents of the universe, it seems more complex in nature than the earth, water and fire. Perhaps hinting at the Stoic proposition of divinity in nature, Lucretius suggests that "father Ether ('pater aether', I, l. 250) has cast [raindrops] into the lap of mother Earth", making nature flourish, and rendering the planet a bountiful paradise, in which "crops arise, the branches upon the trees grow green, […] and become heavy with fruit" (p. 23). This life-giving quality of the ether, Lucretius notes, extends not only to nature, but also the human faculties.[16] Speaking of certain 'elements of spirit' (cited p. 217; originally 'animae elementa', III, l. 347), he points out that "he remains in life to whom the mind and

[15] The original Latin is "omnia enim debet mortali corpore" (l. 232).
[16] The analogy bears some parallel with the myth of Danae, to whom Jupiter appeared as a shower of gold. It is worth noting that 'Father ether' merely *gives* raindrops. The ether is not itself a form of rain. Cf. also Stevenson's 1782 'Hymn to a Deity', discussed below.

intelligence remains. He may be a mutilated trunk dismembered all about, the spirit removed all around and separated from the limbs, yet he lives and breathes the vital [aether]" (p. 219).[17] This passage shows Lucretius searching for a way to explain key relations or interactions between mind, the world and the universe. As we shall see in subsequent chapters, such animating powers were still frequently ascribed to the electric and magnetic fluids in the eighteenth century.

Lucretius' description of the ether's role in the initial formation of the earth, given in Book V of *De Rerum Natura*, further underlines both the elevated role of the ether, and its (semi)-material, fluid, qualities:

> In this way, therefore, the heavy earth became solid with compact body , and all the mud of creation , so to speak, flowed together by its weight and settled to the bottom like dregs; then sea, then air , the fiery ether itself, being made of fluid particles, were all left pure, some lighter than others, and ether, lightest and most fluid, floats above the airy breezes, and does not mingle its fluid consistency with the stormy breezes of air: It leaves all things below to be turned upside down by violent tempests, leaves them to be disturbed by wayward storms, while itself bearing its own fires, it glides with unchanging sweep.
>
> (p. 419)

Not only does the 'fiery ether', in its role as the heavenly element, float above the earth and the water, not mingling with the air, but it is also the 'most fluid' of all the elements. It 'glides with unchanging sweep' and is a kind of constant, floating majestically above an otherwise somewhat unstable earth that is subject to ongoing change, and 'turned upside down by violent tempests'. All the same, as Lucretius admits, much remains unknown. Striking an almost mystical tone, he notes that "first-

[17] Rouse chooses to translate this phrase, originally given as "aetherias vitalis" (III, l. 405), as 'vital air'.

beginnings of things cannot be distinguished by the eye", and that there are certain things known to exist, "yet impossible to be seen" (p. 25).

The ether, as the brief discussion above shows, had been a relevant philosophical concept since antiquity. Ancient Greek and Roman philosophers sometimes understood it as a basic element like water and earth. However, the ether frequently surpassed its 'brethren elements' – either because it was regarded as a fifth element, according to Aristotle, occupying the spheres above the earth, which no other element could reach, or because it was equated, according to the Stoic school of thought, with divinity itself. Much later, in the seventeenth and eighteenth centuries, the ether's significance as a powerful, somewhat mystical, abstract medium persisted. In the remainder of this chapter I will argue that John Milton and Isaac Newton served as what Harold Bloom has called 'strong precursors' for ether as a concept which, owing to its diverse qualities, found applications in both the creative and the scientific realms.[18] Most writers drawing on this concept at the time followed Milton's framing of the ether as a heavenly element, or Newton's more 'strictly scientific' notions of the ether as a physical agent in the universe, or both. The seventeenth and eighteenth centuries gave the concept an avowedly Christian inflection. Influenced by Milton and Newton, later poets (Bloom calls them 'latecomer' or 'ephebe' poets) frequently praised the elements' role in the creation as a 'divine Ur-Fluid' or essential matter from which all other elements (and intangible fluids) descend, while scientists used it to support theories of the nature of Creation.

[18] Bloom's theory of influence is applied in his book *The Anxiety of Influence* (1973) to poetry and seeks to explain how new poets struggle to achieve their own voice without being overwhelmed by the styles of the "great" former poets. The 'latecomer' poet (or "ephebe") uses six defensive tropes ("revisionary ratios") to ward off the influence of precursors who might drown out the new poet's own voice. I do not use the technicalities of Bloom's theory, but it is useful because it helps to illuminate intellectual relations between scientific writers in the eighteenth century.

Milton's great Creation epic, *Paradise Lost,* was first published in ten books in 1667, and then re-divided, slightly revised and re-published in twelve books in 1674. Milton's interest in natural philosophy is well-documented. He visited Galileo in Italy, for example, in 1638. In *Milton and the New Scientific Age: Poetry, Science, Fiction* (2019), Catherine Gimelli Martin has argued that "the tendency to regard Milton's thought as a quaint museum piece, or a missing link cast off from the 'great chain' of vital Western ideas, still remains" (p.233). However, as Gimelli Martin explains, the majority of natural philosophers of the eighteenth century were undoubtedly familiar with *Paradise Lost.* Milton's epic employs ideas about the divine creation of matter that remained fundamental throughout eighteenth- and even nineteenth- century natural philosophy. For the purposes of this chapter, we will briefly turn to the representation of ether in *Paradise Lost*, and the notion of the 'ethereal' in Milton's universe.

Milton continually uses the word *ethereal* to mean 'divine', or 'of divine origin'. He speaks of the "ethereal sky" (I., l. 45; V., l. 267), the "ethereal mould", or "etherous mould" (l., l. 139; VI. l. 473) which expels all sin, and describes "ethereal virtues" displayed by angels and heavenly creatures. He calls God the "Etherial King" (II., l. 978) who "created all the ethereal Powers / And Spirits, both them who stood, and them who failed" (III., ll. 100-1). Those spirits or angels he refers to as "ethereal messenger(s)" (VIII., l. 646), or "ethereal people" (X., l. 27). The make-up or built of these ethereal beings is fluid, too. Book VI describes the battle between Michael and Satan, in which Satan is wounded by Michael's sword: "Then Satan first knew pain, / And writhed him to and fro convolved; so sore / The griding sword with discontinuous

wound/ Passed through him" (ll. 327-30). However, Satan's wound quickly closes as he as a divine being, and angels "Cannot but by annihilating die; / Nor in their liquid texture mortal wound / Receive, no more than can the fluid air" (ll. 347-49). Additionally, Milton notes that, as a result of their fluid constitution, angels are able, just like the various fluids discussed by eighteenth-century scientists, to assume any colour shape or size, "as likes them best, condense or rare" (ll. 352-3).[19] All spiritual elements or beings described as 'ethereal' in *Paradise Lost* are taken to be heavenly and perfect, created by God. However, the word *ethereal* carries another layer of meaning. Milton uses it to mean "essential", or perhaps "quintessential", since Milton himself twice uses this adjective.

Book Three of *Paradise Lost* begins with an account of the initial creation of the world, and God's 'Let there be light'. In his panegyric to light, Milton writes,

> Hail, holy Light, offspring of Heaven firstborn,
> Or of the Eternal coeternal beam
> May I express thee unblamed? Since God is light,
> And never but in unapproached light
> Dwelt from eternity, dwelt then in thee
> Bright effluence of bright essence increate.
> Or hear'st thou rather pure ethereal stream,
> Whose fountain who shall tell? Before the sun,
> Before the Heavens thou wert, and at the voice
> Of God, as with a mantle, didst invest
> The rising world of waters dark and deep,
> Won from the void and formless infinite.
>
> (III., ll. 112)

Built by careful repetitions ("light", "bright", "dwelt", "eternal", "who", "Heaven" and "before") this passage constructs a beginning of physical properties from the nothingness of a "void and formless infinite". As Harry Blamires, in *Milton's Creation*

[19] Sylphs in in Alexander Pope's *Rape of the Lock* are based on this Miltonic notion of a spiritual, 'ethereal being' of fluid constitution, as discussed below.

(1971), writes: "Milton speaks of light as the first offspring of Heaven because the book of Genesis records God's 'Let there be light' as his first utterance; but he then makes the alternative claim to define light as beaming co-eternally from the Creator (1 John 1.5)" (p. 65). To this we can add Milton's allusion to 1 Timothy 6: 16 where St. Paul writes of God as "dwelling in the light which no man can approach unto". Milton understands that mystery attaches to such concepts. Invoking a primordial "pure ethereal stream", he asks, "Whose fountain who can tell?" In this passage, the word "ethereal" is immediately connected with the words "effluence", "stream" and "fountain", emphasising the ether's fluid qualities, and describing light as its manifestation. A similar account is given in Book Seven, which recounts the six days of creation: "Let there be light, said God; and forthwith Light / Ethereal, first of things, quintessence pure,/ Sprung from the deep;" (ll. 243-5). Next, heavens are created, stars "sewn" onto it, and the sun is given its "liquid" light:

> Of light by far the greater part he took,
> Transplanted from her cloudy shrine, and placed
> In the sun's orb, made porous to receive
> And drink the liquid light; firm to retain
> Her gathered beams, great palace now of light
>
> (III., ll. 360-63)

Milton is fond of the word "liquid". Near the close of 'Comus' or the 'Mask Presented at Ludlow Castle' (1634), he refers to the "liquid air". Satan in Hell in Book One of *Paradise Lost* is surrounded by "liquid fire" (ll. 229 and 701). In Book Six, Milton sets out a notion of the kind of incorporeal substance of which spirits might be made. The archangel Michael deals Satan a heavy blow but it cannot prove fatal since,

> Spirits that live throughout
> Vital in every part, …

Nor in their liquid texture mortal wound
Receive, no more then can the fluid Aire:

(XI, ll. 344-49)

Miltonic representations of ethereal "liquid" light in creation narratives remained a common trope in the eighteenth century. Aaron Hill, in his 1753 poem 'The Creation', writes "Henceforth, be this bright fluid, day, [God] cried" (l. 26), before he commands the atoms, a "stream" of "springy bodies" (ll. 38-9) to "call your fluid force the atmosphere" (l. 48). James Thomson used similar imagery in his 1726 poem 'Summer', part of 'The Seasons', discussed in more detail below. He depicts light as "Prime Cheerer", "Of all things first and best", and, emphasizing its fluid nature, calls it "Efflux Divine" (ll. 90-3, also quoted in Nicolson, p. 48).

A further discussion of the nature of divine matter in *Paradise Lost* occurs in Book Five, in a conversation between Adam and Raphael in Paradise, in which the archangel reveals the divine origin of all things. He states,

O Adam, one Almighty is, from whom
All things proceed, and up to him return,
If not depraved from good, created all
Such to perfection, one first matter all,
Indued with various forms, various degrees
Of substance, and in things that live, of life

(V, ll. 469-74)

A divine, perfect and pliable, versatile 'first matter' creates all. It is 'indued with various forms, various degrees of substance', and hence capable of releasing or manifesting its potential in the shape of several descendant-fluids, such as electricity, magnetism, heat, light or fire. Milton's conception of "first matter", the ether, had an enduring influence. Samuel Taylor Coleridge, who, in his marginalia to *Paradise Lost,* commented on this view of the creation, called Milton's depiction of the role of

'Empyreal substance' (1: 118) "a perfect enunciation of the only true System of Physics" (p. 70, also quoted in Sugimura, p. 43). Indeed, Coleridge's admiration of Milton's poetic prowess as a better guide to understanding divine sublimity than scientific pamphlets and treatises could convey is undisguised.[20] N. K. Sugimura, in *'Matter of Glorious Trial': Spiritual and Material Substance in Paradise Lost* (2009), offers an incisive analysis of the significance of the views expressed by both Milton and Coleridge. He writes, "[e]specially congenial to Coleridge's mind was the notion that Milton was speaking about prime matter as if it were a quasi-material, quasi-spiritual stuff, capable of connecting two worlds—this and the transcendent— which are poles apart" (p. 43). A supposed connection between worldly and transcendental existence via ether is a vital assumption in the writings of many eighteenth- and nineteenth century natural philosophers. "Prime matter exists as the fluid *hupokeimenon* […], or formless and characterless stuff, of created substance" (p. 43). In Milton's, and also in Coleridge's descriptions, it "is no longer a mere logical fiction. It begins to feel like a something—albeit a something existing predefinition" (ibid.). Through their experimentation with matter and several 'fluids' derived from the ether, scientists of the late seventeenth to early nineteenth centuries sought to make visible this bond, and thus to prove divine agency. If Milton gave a powerful imaginative poetics to the notion of an all-pervading fluid ether, another line of influence for later writers combined science and religion. This influence extended largely from the writings of Isaac Newton.

[20] Coleridge's approval of Milton seems to rest on more than the Miltonic idea of the 'only true system of physics'. In the conclusion to his 1825 work *Aids to Reflection*, Coleridge states "Hence I more than fear, the prevailing taste for Books of Natural Theology, Physico-Theology, Demonstrations of God from Nature, Evidences of Christianity, &c, &c. Evidences of Christianity! I am weary of the word. Make a man feel the want of it; rouse him, if you can, to the self-knowledge of his need of it; and you may safely trust it to its own Evidence - Remembering only the express declaration of Christ himself: No man cometh to me unless the father leadeth him!" (p. 363).

Newton's influence on later natural philosophers was recognised by the satirist Alexander Pope. "Nature and Nature's Laws lay hid in Night: / GOD said, Let Newton be! And all was Light", Pope wrote in his *Epitaph to Newton,* echoing Genesis, and, to an extent, Milton's version of the light-giving moment as the start of all life. Aaron Hill later revised Pope's fragment and wrote, "Oe'r nature's laws, God cast the veil of night / Out-blaz'd a Newton's soul ---and *all* was light". Indeed, Milton's contemporary Sir Isaac Newton, as Ayval Ramati, Frank E. Manuel, and James E. Force have argued, had assumed that he was part of a "remnant, a few scattered persons which God has chosen" (Ramati, p. 407) to uncover the 'truth', i.e. the true workings of the universe, and the secrets of the divine creation. In a letter to Bentley regarding his *Philosophiae Naturalis Principia Mathematica* (1687, subsequently *'Principia,* or *Principia Mathematica'*), Newton states, "When I wrote my Treatise about our System, I had an Eye upon such Principles as might work with considering Men, for the Belief of a Deity, and nothing can rejoice me more than to find it useful for that Purpose" (Cohen, p. 280; English, p. 583). God, he suggests in his published works, created matter first and "continuously preserves creation through secondary mechanical causes" (Ramati, p. 410). Divine agency, to Newton, becomes apparent in the perfection with which God has engineered the universe.

Newton uses the ethereal fluid, the divine ("prime") matter to account for much of his model of space and gravity, but his overall concept of ether as a subtle medium appears to be somewhat similar to what Milton had imagined in *Paradise Lost*. As Kathleen Lundeen points out, "[t]he linking of Milton and Newton was particularly strong among scientists, many of whom included lines from *Paradise Lost* or other poems of Milton's in their astronomy books" (p. 2). Rachel Trubowitz provides a fascinating account of Newton's relation to Milton, which she describes as "less precise and more

contextual". She argues that "both Milton and Newton identified poetry and mathematics as kindred means for strengthening fallen humankind's weak, natural insights into the invisible workings of divinity", pointing out that "[w]hereas Milton imports mathematical analogies into his poetry as a way to heighten our ability to apprehend the divine, not dissimilarly, Newton suggests that mathematics […] can be read poetically as an allegory of God's ineffable powers and attributes" (p. 34).[21] Finally, Marjorie Nicholson, in *Newton Demands the Muse* (1946), has argued that "to understand the full radiance of the light which shines in so much eighteenth century poetry, we must add to the influence of Milton that of Newton" (p.4). Even those eighteenth-century natural philosophers who might, at first glance, want to refrain from such colourful, mystical, or theological renditions of "prime matter" displayed in *Paradise Lost*, referred to Newton's much more 'scientific' version of the ethereal fluid as the basis for their own enquiries and experiments. The status of Milton and Newton as 'strong precursors' for eighteenth century literature and science was unmistakeable.

Other than showing a Miltonic influence, Newton's scientific writings were in large parts indebted to Cartesian models of the natural world – with Newton's *Principia Mathematica* intended as a British advancement of Descartes' *Principia Philosophiae* (1644). Descartes himself referred to fluid particles, and a "first element" ('primum

[21] Trubowitz gives a fascinating in-depth assessment of how poetry (especially his interest in alchemy) may have influenced Newton: His "explications of the metaphors, symbols, and other poetic figures in alchemical verse inspired him to view his own mathematical work poetically: as a source of metaphors for and symbols of his emphatically monotheistic view of the God of Dominion, which informs all of Newton's intellectual endeavours" (p. 36). Newton regarded mathematics as the close appropriation of God's truth, which lies in a realm that is inaccessible to the human intellect. Milton on the other hand, she points out, references his own interest in mathematics is, in part, referenced in *Paradise Lost*, books 1-2 (see p. 37). Mathematics may have been a kind of extension of Milton's own poetic vision. Milton and Newton, despite their different approaches to appropriating divine truth, share a distinct awareness of "the limits of language" (ibid.) and are united in their belief in infallible divinity as the creator of the universe.

elementum', Descartes, p. 246), which he understood as a medium that both contains and is the base material of all other bodies in the known universe. Especially noteworthy in this respect is an article in Part III of the Cartesian *Principia* which may, despite its brevity, scientific tone and plain language, have even served as an inspiration for the Miltonic heavens, as discussed above. It relates to the fluidity of the heavens. Descartes notes the following:

> [I]t must be thought that the matter of the heaven, like that which forms the Sun and the fixed Stars, is fluid. This is an opinion which is now commonly held by all Astronomers, because they see that otherwise it is almost impossible to give a satisfactory explanation of the phenomena of the Planets
>
> (p. 93)

Remarkably, he chooses not to elaborate this fluidity in great detail in Part III of his ground-breaking work, other than to point out that invisible fluids are necessarily components of space as "a void cannot exist in nature" (ibid.). The Cartesian model of fluidity will be discussed in more detail in Chapter Three of this thesis, on magnetism. For now, it is enough to point out that, while the French philosopher's "first element" clearly shaped Newton's conceptions of ether, the Newtonian model of ethereal physics far overshadowed earlier Cartesian hypotheses.

Despite the fact that Newton drew on a variety of poetic and philosophic writings for this conception of an Ur-medium, the value or validity he ascribed to the notion of an imponderable ether, or an ethereal fluid has been questioned. Henry Guerlac has pointed out that "contrary to what various writers have asserted – belief in an aetherial medium was not *throughout* his life 'a central pillar' Newton's system of nature" (p. 45, added emphasis). Indeed, Newton's most focused enquiries into a possible existence of an ethereal medium might have been undertaken in two separate phases

of his life. As early as 1679, long before the publication of *Principia* and *Opticks*, which I will refer to in more detail below, Newton sent a letter to Robert Boyle in which he discusses his early views on an invisible medium which fills all space. "I suppose", he writes, "that there is diffused through all places an aetherial substance, capable of contraction and dilatation, strongly elastic, and, in a word, much like air in all respects, but far more subtile [sic.]." Guerlac suggests that "[b]y the time he wrote the *Principia*, […] Newton had […] come to distrust his own youthful aetherial speculations" (p. 45). However, there *are* indeed some mentions of the ethereal medium, some of them fairly extensive, in Newton's 1687 work, first translated into English in 1729 by Andrew Motte.[22] Discussing the attraction of bodies to each other, Newton notes,

> I here use the word attraction for any endeavour, of what kind so ever, made by bodies to approach to each other; whether that endeavour arise from the action of the bodies themselves as tending mutually to, or agitating each other by spirits emitted; or whether it arises from the action of the aether or the air, or of any medium whatsoever, whether corporeal or incorporeal any how impelling bodies placed therein towards each other.
>
> (Newton, 1729, I., p.262)

All bodies, he argues, are placed in the ether. In the *Principia*, Newton tends to speak of the ethereal medium as 'the air or aether' or vice-versa. What is striking about the passage above is that Newton immediately addresses the causal qualities of the fluid. He uses a chiastic connection of the words 'air or aether' with the words 'corporeal or incorporeal' which neatly distinguishes the two – usually, the word 'air' denotes one of the corporeal manifestations of the otherwise incorporeal phenomenon 'ether'. As with classical writers on the topic, Newton is concerned to uncover the interactions or agencies between supposed ethereal substance and celestial bodies. A further mention

[22] Motte's English translation was based on the 3rd edition of the Latin original, published in 1726.

of the ethereal medium appears in Book Three, which addresses gravitation, and outlines a thought experiment:

> If the aether, or any other body, were either altogether void of gravity, or were to gravitate less in proportion to its quantity of matter; then, because (according to Aristotle, Descartes and others), there is no difference betwixt that and other bodies, but in mere form of matter, by a successive change from form to form, it might be changed at last into a body of the same condition with those which gravitate most in proportion to their quantity of matter; and, on the other hand, the heaviest bodies, acquiring the first form of that body, might by degrees, quite lose their gravity.
>
> (ibid., II., p. 224)

In this passage, the ether is treated ontologically. The thought experiment hints at the ether's metamorphic capabilities: 'if the aether, or any other body, were altogether void of gravity', it might as well, 'by a successive change from form to form', transform into other bodies. While the intention of Newton's supposition is of course to prove that bodies are *not* void of gravity, a hint of the ether as a potentially interactive element remains.

The 'General Scholium' to Newton's *Principia* contains a further, more detailed paragraph on the ether's qualities, complete with a fairly rudimentary 'experiment' conducted in order to prove or confirm its existence. "[I]t is the opinion of some", Newton writes, "that there is a certain aethereal medium extremely rare and subtile, which freely pervades the pores of all bodies" (ibid., p. 107-8). Having described his experiment, which involves consecutively suspending two boxes, (one empty, one filled with metal), on a string, creating two pendulums, and measuring the resistances of each swinging box to the surrounding air, he concludes that "the greater resistance of the full box arises, not from any other latent cause, but only from the action of some subtile [sic.] fluid upon the included metal." The existence of an ethereal medium, he infers, is thereby demonstrated. This part of the Scholium, and Newton's supposition

of a ‘rare and subtile’ medium which ‘freely pervades the pores of all bodies’ applies to both the electric and the magnetic fluid. Scientists of the period therefore frequently referred to variations of this phrase, or quoted it verbatim. The majority of treatises containing an attempt at explaining notions of fluidity at the time also contain some variation of exactly this statement, repeatedly connecting all notions of fluidity and all rare and subtle fluids with the ether. Interestingly however, as will be discussed in subsequent chapters, this phrase, when applied in the contexts of electricity or magnetism, was sometimes misattributed to Benjamin Franklin, veiling its Newtonian origins.

As discussed above, Newton’s *Principia* did contain some early mentions of the ether. Indeed, what is perhaps the most iconic account of its qualities is described in the General Scholium. However, the most comprehensive published descriptions of what Newton understood by this phenomenon is found in the *Queries*, which he added to the 1717/18 edition of *Opticks*, roughly 40 years after his initial engagement with the ethereal medium. The *Queries*, Newton states, were included “in order to a farther search to be made by others” [sic.] (Guerlac, p. 339).[23] Interestingly, as Henry Guerlac writes, Newton had originally intended to include a Part II to the third book of *Opticks*, which “was to marshal experimental evidence for his aether theory”.[24] Yet, despite his fascination with the imponderable substance, his “customary caution won out”, and

[23] Guerlac (1967) has shown that Newton’s revival of his aether hypotheses was inspired by the experiments on electrical attraction and repulsion made by Francis Hauksbee (1660–1713) (pp. 47-49). See also Joan Hawes (1968): ‘Newton’s Revival of the Aether Hypothesis and the Explanation of Gravitational Attraction’.

[24] In his correspondence with Richard Bentley in 1692-93, (first published in 1756, almost 30 years after Newton’s death), pertaining to the relation between matter and the existence of a deity, Newton makes the following remark: “There is yet another argument for a Deity which I take to be a very strong one, but till the principles on which tis grounded be better received I think it more advisable to let it sleep” (Newton, 1756, p. 11). It is possible that Newton was referring to his unpublished speculations surrounding an ethereal medium as a ‘divine first cause’.

"he changed his plan at the last minute, and cast this material, or at least a good part of it, in the form of those new or altered Queries with which we are familiar" (p. 47).

In the *Queries*, Newton generally refers to ether as the "Aethereal Medium", pointing to the properties he associates with it. His 'customary caution' regarding the invisible matter shines through at times, for example, in Q 21, in which he tentatively remarks, "for I do not know what this Aether is" (Newton, *Opticks,* p. 352). Despite this, the *Queries* present the most in-depth description of the supposed qualities of the subtle matter. Ether, Newton assumes, is a substance, a kind of space-filling fluid that holds all bodies in space, and through which light and sound can travel. He asks,

> Doth not the Refraction of Light proceed from the different density of this Aetherial Medium in different places, the Light receding always from the denser parts of the Medium? And is not the density thereof greater in free and open Spaces void of Air and other grosser Bodies […]?
>
> (p. 349)

Ether, Newton suggests, is different from air, and it is denser or rarer in different parts of space. It is, therefore, almost like an invisible, imperceptible, yet somewhat gelatinous medium, which, as the following quote shows, is not only present outside planets and bodies in space but may permeate them. Like other intangible fluids discussed in the course of this thesis, ether, as Newton imagines it, is 'all-pervading':

> Doth not this Aetherial Medium in passing out of Water, Glass, Chrystal and other compact and dense Bodies into empty Spaces, grow denser and denser by degrees […] Is not this Medium much rarer within the dense Bodies of the Sun, Stars, Planets and Comets, than in the empty celestial spaces between them? And in passing from them to great distances, doth it not grow denser and denser perpetually, and thereby cause the gravity of those great bodies towards one another?
>
> (p. 350)

Newton regards the ether's varying density and its great "elastick force [sic.]" (p.351) as a central cause of gravity. This elastic force, Newton argues, is why "Planets and Comets, and all gross Bodies, perform their Motions more freely, and with less resistance in this Aetherial Medium than in any [other] fluid, which fills all Space adequately without leaving any Pores" (p. 352).

How do exactly do these scientific descriptions of an ethereal fluid as a quasi-material substance relate to Newton's religious leanings? There has been some debate over whether Newton's view of space could be classified as a relationist or substantivalist.[25] Edward Slownik has argued for a "tertium quid", stating that "Newton subscribes to a limited or surrogate form of the substance/accident distinction, such that the existence of space is secured […] via God's omnipresence" (Slownik, p. 430). The conception of the ether as described in *Opticks* certainly supports such an approach. The ether, to Newton, is a trace of a remote divinity, whose actions become apparent in the systematic order of the universe. As M. Hughes has put it, Newton's God "is known to exist, but known to exist in a [somewhat] unknowable manner" (Hughes, p. 3), rather as a remote cause than an immediate agency. Kaiser has argued that "[e]ven though they depended directly on God, Newton's supra-mechanical principles were not 'miraculous' or supernatural in the sense of being unpredictable, and they in no way interfered with the ability of scientists to explain phenomena in terms of second causes" (Kaiser, p. 181). As a result, Newton's discussion of ether in *Opticks* may, in parts, appear to be almost secular. However, Hughes points out that "Newton see[s] space as a set of places which are all centres of God's power" (Hughes, p. 10). All

[25] Relationism is understood here as the view that space exists only "as a mere relation among substances [or] entities", while Substantivalism is the approach that conceives space as a substance or entity in itself (Slowik, p. 430).

movements and substances within these places are, to Newton, a result of God's creation. Similarly, as Liam P. Dempsey suggests,

> [F]or Newton, there are genuine causal relations between minds and bodies. Nevertheless, bodies do depend directly on omnipresent God's will, and Newton takes this dependence to have a number of advantages. It eliminates what appears to be a god-independent matter-substance; objective space and the divine will take the place of the supposed unintelligible substrate of matter.
>
> (p. 86)

No precise statement is made about the role fluidity plays in the relations between divine will, created substance and the semi-corporeal, semi-divine space which simultaneously encloses creation, and holds a mysterious, almost boundless potential. But for Newton it must play some role.

In the wake of *Optick*s, the concept of ether found its way into an increasing number of dictionaries and encyclopaedias. In including the ethereal medium in their dictionaries, authors were faced with a very difficult task indeed. They had to describe a substance which, at its core, defies all description. To define the ether, in a nutshell, was to define the indefinable. The following excerpts taken from dictionaries and encyclopaedias between 1727 and 1776 show this dilemma.

Allen's *Complete English Dictionary* describes the phenomenon as "A thin, subtle matter, finer and rarer than air, commencing from the limits of our atmosphere, and expanding thro' all the regions of space". A similar description can be found in An *Universal Dictionary of the English Language* which states that ether is "air, refined, or sublimed. The matter of the highest regions above. [26] An element more fine than

[26] The author of this dictionary is unknown. It was printed for Donaldson in 1763.

air". Both John Merchant and Nathan Bailey, in A *New Complete English Dictionary,* and the *New Universal Etymological English Dictionary,* choose to underline the ether's fluid nature. Echoing Newton, Merchant characterises ether as "the most subtile [sic.] of all fluids" that, he writes, "beginning from the surface or top of our atmosphere, occupies the vast expanse of Heaven". Alternatively, he states, the ether is "that inconceivably fine fluid that fills up the intermediate space between one fixed star and another, as well as between the planets of our solar system". Bailey, in a similar vein, notes that the term 'aether' "is most commonly used to signify a very fine diaphanous fluid, which […] surrounds the earth, up to as far as the interstellar world, and which easily penetrates and runs through all things, and permits all things to run easily through it". In his *Lingua Britannica Reformata,* Benjamin Martin lists two separate entries for 'aether', distinguishing between the elemental ethereal fluid, and the skies and heavens which it constitutes. 'Aether' is, both "The pure air […] The sky. The firmament, the whole region of the air, fire and light above us", and "[a] very thin elastic fluid, readily pervading the pores of all bodies, and by its elastic force expanded thro' all the heavens". All these definitions tend to refer only to Newton's scientific accounts of the ethereal fluid, shying away from more creative descriptions of this potentially divine substance. Perhaps the most remarkably insightful definition of the ether, which encompasses its various qualities *and* applications, can be found in Ephraim Chambers' C*yclopaedia; or, An Universal Dictionary of the Arts and Sciences,* first published as early as 1727, and running into several editions, with two supplement volumes published in 1753. The work was one of the first comprehensive English encyclopaedias published in Britain in the period, which adhered to the alphabetical format we are acquainted with today. Chambers' detailed definition of the ether reveals its multifaceted, intricate nature with remarkable precision,

addressing both the ether's scientific properties as a fluid element or body, and its more abstract, 'non-scientific' applications in poetry. "The philosophers", he notes, "vary extremely as to the Nature and Characters of this Aether". In fact, the lack of a firm, universally accepted definition of the phenomenon is, rather appropriately, itself part of the definition. Beginning, like the entries above, with Newton's description of the ether, Chambers points out,

> Some conceive [ether] as a Body sui generis, appointed only to fill up the Vacuities between the heavenly Bodies; and therefore confined to the regions above our Atmosphere --- Others suppose it of so subtile [sic.] and penetrating a Nature, as to pervade the Air, and other Bodies, and to possess the Pores and Intervals thereof.
>
> (n.p.)

Chambers' reference to the ether penetrating the 'Pores and intervals' of all bodies is an almost verbatim quote from Newton's 'Queries' in his *Opticks*, discussed above. But there is more to the ethereal fluid than Newtonian physics: proceeding then to the flexible nature of the phenomenon, and its applications in philosophy and poetry, Chambers aptly points out that the ether is "an unknown something", which, owing to its intangibility, may be shaped in whatever way poets and writers please. "In effect", he writes, the "Aether, being no Object of our Sense, but the mere Work of Imagination, brought only upon the Stage for the sake of Hypothesis, or to solve some Phenomenon, real or imaginary; Authors take the Liberty to modify it how they please". This help to explain why the ether appears in such a variety of different contexts and genres at the time: "[t]he term Aether [is] thus embarrass'd [sic!] with a Variety of Ideas, and arbitrarily applied to so many different Things." Its power, existence, and extension is per definition limitless – and so were its possible applications in scientific and creative writing.

Returning to Newtonian physics, Chambers remarks that some doubt the existence of such a medium altogether. Noting that the phenomenon is sometimes treated as merely 'imaginary', Chambers writes that the ethereal fluid is very real indeed. He notes that "there are abundance of Considerations [sic.], which seem to evince the Existence of some Matter in the Air, much finer than the Air it self [sic.]." The existence of such an 'Aethereal Medium', he remarks, has been "settled" by Sir Isaac Newton, who has described it as "rarer and more fluid than air, but exceedingly more elastic, and active." Further citing Newton, Chambers discusses some of the most crucial features of the ether as a powerful, possibly divine, substance. "That author [Newton]", he notes, "shews [sic.], that a great part of the Phenomena of Nature may be produced by it." This statement once again underlines the ether's role as an 'Ur-fluid' from which other phenomena descend. It is not only the cause of "gravitation […], the elastic Force of the Air, and of nervous Fibres, and the Emission, Refraction, Reflection, and other Phenomena of Light […], Sensation, [and] Muscular Motion", but also, as further discussed below, a conceptual predecessor of the phenomena of electricity and magnetism. Chambers accurately concludes his definition of the ether by stating that "[i]n fine, this Matter seems the Primum Mobile, the first Source or Spring of Physical Action in the modern System".

In the remainder of this chapter, we will examine treatments of the ether or ethereal fluid in a variety of publications of different genres, including Richard Blackmore's *Creation* (1712), Thompson's *The Seasons* (1726/30), Pope's *Essay on Man* (1734), *Siris* (1744), a Philosophical treatise by George Berkeley, William Stevenson's 'Hymn to the Deity' (1765/82) and Capel Lofft's *Eudosa; or, a Poem on the Universe* (1781). Despite the fact that the ether had such diverse applications, this fluid medium,

in the eighteenth century, remains closely connected to Miltonic, Newtonian, and Christian notions – both in poetry and in scientific writing.

The "physico-theological school", which sought to derive the existence of a divine being from observations of the perfection of the natural world, grew in popularity in the early 1700s and had its peak in the 1750s (Williamson 2004). Writers of this tradition sought to fuse Christian poetics, especially Miltonic epic verse, with Newtonian physics. As Flavio Gregori has shown, Richard Blackmore, member of an influential Whig family, and physician-in-ordinary to King William III, was a somewhat controversial figure in his role as theologian, and writer. He was in equal parts revered and hated.[27] John Dryden hurled frequent criticisms at Blackmore for his heroic poetry (in particular his 'Arthur'), and Alexander Pope continuously mocked Blackmore's sense of grandeur.[28] John Dennis, on the other hand, in praising Blackmore's *Creation* wrote that the "Poem alone is worth all the Folios, that this Libeller [Pope] will ever write, and which will render its Author the delight, and Admiration of Posterity" (cited in Rounce, p. 37).[29] Furthermore, in writing his *Creation* (1712), "Blackmore had the encouragement of Molyneux and Locke, and the approbation of Addison" (Fabian, p. 527). Edward Bysshe "cites Blackmore alongside Dryden, Cowley and Waller as examples of 'noble thoughts […] that are to be found in the best English Poets" (cited in Williams, p. 175). [30]. Samuel Johnson included

[27] Gregori, Flavio. "Blackmore, Sir Richard (1654–1729), physician and writer." Oxford Dictionary of National Biography. Oxford University Press. Date of access 11 Jun. 2022, https://www.oxforddnb.com/view/10.1093/ref:odnb/9780198614128.001.0001/odnb-9780198614128-e-2528

[28] Dryden accused Blackmore of stealing the idea for his epic poem 'Arthur' (see Gregori 2009).

[29] It was Dennis who cruelly mocked Pope (disabled through Potts' disease) as "a hunch-back'd toad".

[30] Locke and Molyneux applaud Blackmore's talent in an exchange of letters (see *Some Familiar Letters between Mr. Locke and Several of his Friend*s, London, 1708; also cited in Fabian p. 527). Molyneux,

Blackmore in his Lives of English Poets, stating, "as an author [Blackmore] may justly claim the honours of magnanimity" (p.64). Although he was a controversial figure of his time, there has been relatively little recent critical interest in Blackmore.

I want to focus here on Blackmore's *Creation*. The work, which has been described as "one of the most thorough going and popular versifications of physico-theological doctrines" (Williamson, p.535), echoes Milton in style while adhering to Newtonian descriptions of the role of divinity and Prime Matter. In the poem's Preface, Blackmore writes "I have chosen to demonstrate the existence of a God from the marks of wisdom, design, contrivance, and the choice of ends and means, which appear in the Universe" (p. XXXIII). The "Cause, which God we name,/ The source of beings and the mind supreme" he proposes, is omnipresent. Gordon Campbell, in his *Commentary on De Rerum Natura*, has described Blackmore's *Creation* as one of "two great anti-Lucretian didactic poems" of the eighteenth century, stating that *De Rerum Natura* to Blackmore, was a deeply "subversive text" (p. 5).[31] Indeed, Blackmore refutes Epicurean notions of a coincidental formation of the earth, and the Lucretian thought of divinity within matter, or at least the suggestion that divine qualities could be completely innate in matter. In Book Three of his work, Blackmore attacks both Lucretian, and Spinozist pantheist, or, as he would argue, atheist views. He outlines Spinoza's 'labour'd scheme of impious use" (III, l. 748). Spinoza, he writes, would propose that,

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in a letter to Locke dated 1679, points out that Blackmore had "exquisite touches", particularly with regards to his interpretation of "Mr. Newton's philosophy" (ibid., p. 229).

[31] Campbell cites Melchior de Pilgnac's *Anti-Lucretius*, published posthumously in 1745, as the other such poem (p. 5).

Substance no limit, no confinement knows,
And its existence from its Nature flows.
The substance of the universe is one,
Which is the self-existent God alone

(ibid., ll. 750-3)

Such a scheme, in which substance is a heathen, quasi-idolatrous, self-existent God, or an 'Aggregated God' (ibid., l. 758), could never account for the intricate Creation of the Planet. By proposing such theories, Blackmore complains, Spinoza "Declares for God, while he that God betrays" (ibid., l. 745). Throughout his life, Blackmore resolutely opposed what he saw as atheistic tendencies in natural philosophy.

Williamson rightly asserts that "Blackmore's trinity of 'Beauty, Order, and Harmonious Laws' invokes the aesthetic appeal of the Newtonian system" (p. 536). The ethereal fluid, in such a system plays its own significant part. Blackmore writes of "The vast etherial [sic.] interposing space" (IV., l. 487), and of "th' ethereal plains" (ibid., l. 732) which extend between the planets. Echoing Milton's notion of fluid ethereal light, he even notes how heavenly floodgates rule night and day:

How the bright Sluices of Etherial Light
Now shut, defend the Empire of the Night,
And now drawn up with wise alternate Care,
Let floods of Glory out, and spread with day the air

(VII., l. 504)

Blackmore's main criticism of Lucretian philosophy and the power of the elements concerns divine agency. He is a fierce defender of the Newtonian system, insofar as he insists on God as the one Prime Cause or Mover of the universe. Blackmore's view of God as a distinctly *active* agent in Creation may be much more pronounced than even Newton's own. A random, unguided collision of atoms, which Lucretius had proposed, could not possibly have resulted in the creation of the Earth, Blackmore argues:

Could atoms, which with undirected flight,
Roam'd through the void, and rang'd the realms of night,
Of reason destitute, without intent
Deprived of choice, and mindless in event,
In order march, and to their posts advance,
Led by no guide, but undesigning chance?

(IV., ll 90-95)

Instead, he insists that there must be an original "spring of motion" (ibid., l. 255), a conscious architect, who arranged earthly and heavenly matters, and put all elements in their separate places, for "Matter, as such, abstracted in the mind / We from a Pow'r to move divested find" (ibid., l.265). The elements may not be innately divine, however their motion, given to them by God, the Prime Cause, *is*. Blackmore points out that God actively imbues them with this power after their initial inception:

A Pow'r to Nature giv'n by Nature's Lord,
When first he spoke the high Creating Word:
When for his World Materials he prepar'd,
And on each Part this Energy conferr'd

(ibid., ll. 269-72)

If motion, a physical phenomenon observable in nature, is regarded as divine, it follows that indeed *all* other natural, observable processes which involve movement or the transmission of energy, such as storms, bolts of lightning, or magnetic attraction, must equally be considered revelations of divinity. In such a conception of the universe, the elements, among them ether, are God's tools which render his omnipotence visible. Every movement, every perceptible change in nature, according to Blackmore is the result of "the Will, the Power, the Hand of God" (II., l. 350). In fact, such natural phenomena may be the only way in which the human mind could process divine Power.

As Gregori demonstrates, Blackmore drew on Milton and Newton in his aim to inhabit the roles of both poet and scientist. In Blackmore's Christian ontology of the universe, the ether is like water, earth and fire, one of the elements whose *movements* indicate God's agency and will. While Blackmore notes that the ether too, is secondary to the divine being, rather than an innately divine substance *sui generis*, he nevertheless hints at the ethereal fluid's special, conceptually elevated state. He notes that the Earth, though it is perfect in its own way, is "not like th' etherial [sic.] worlds refined" (III., l. 313). Furthermore, emphasising a human thirst for knowledge, he suggests that "The Mind employed in Search of secret Things" would have to travel "Thro' all th' Etherial Regions (ibid., l. 363), but would there be "stopp'd by aweful [sic.] Heights and Gulphs immense/ Of wisdom, and of God's Omnipotence" (ibid., ll. 367-8), only to find itself 'trembling', gazing, and "Lost in the wide inextricable Maze" (ibid. l. 370). To Blackmore, this 'ethereal region', sealed off from the human intellect, is the source, the container, and the home of divine wisdom. The ether, in its airy, mysterious, intangible form, is therefore perhaps the element, medium or substance closest to God, both spatially and conceptually. It fills or constitutes an intermediate stage between the earth and human intellect on the one hand, and heavenly, divine omnipotence on the other. Hinting at a connection between the ethereal fluid and human knowledge, Blackmore points out that only Christianity can bring humans closer to this ethereal wisdom. Only the firm belief in an actively ruling God "[c]an to the soul impart etherial [sic.] light" and "give life divine and intellectual sight" (II., p. 53). What we see in Blackmore is a near-complete fusion of Miltonic and Newtonian ideas about ether. In terms we might take from Harold Bloom, the long shadows of these two 'strong precursor' writers stretch over the eighteenth century so dominantly that later

writers such as Blackmore can only be seen as consolidating an already long-established understanding.

"Come gentle spring, ethereal mildness, come", begins 'Spring' the first instalment of James Thomson's series of Poems entitled 'The Seasons', first published as a collection 1730. The first line of 'Summer', meanwhile, hails the arrival of the hottest season that comes "From brightening Fields of Ether fair disclosed". As we have seen, Thompson makes a Miltonic reference to ethereal liquid light as God's 'Prime cheerer', in 'Summer'. In 'Spring', the terms 'ether' and ethereal' have several functions. They denote the sky, emphasizing the sublime vastness of the upper regions of the atmosphere, while at the same time describing an enticing, heavenly, almost paradisiacal serenity in nature. But in these poems, the ether, yet again, is not void of its scientific connotations. Natural beauty in Thomson's 'The Seasons', is explicitly examined through a Newtonian prism. Connell has pointed out that Thomson's collection of poems "played a crucial role in the popular diffusion of Newtonian natural philosophy" (p. 1).

Speaking of showers in spring, Thomson writes, "At first a dusky wrath they seem to rise / Scarce staining the ether" (ll. 148-9). Similarly, his description of passing clouds, contains a reference to the ethereal medium: "Chief should the western breezes curling play, / And light o'er the ether bear the shadowy clouds" (ll. 397-8). James Sambrook, correctly notes that, rather than just alluding to the sky or the air in general, Thomson's ether denotes "the tenuous, fluid medium by which light is transmitted". Directly quoting Newton's 'Queries' in *Opicks*, Sambrook states further that "it also refers to the upper sky, since the ether is 'expanded through all the heavens'" (Thomson, p. 7;

Newton, *Opticks,* p. 349). Indeed, Newtonian notions of the ethereal fluid appear throughout the poem. Thomson's description of the beautiful spectacle of a rainbow in the skies is especially noteworthy in this respect:

> Meantime, refracted from yon eastern cloud,
> Bestriding earth, the grand ethereal bow
> Shoots up immense; and every hue unfolds,
> In fair proportion running from the red
> To where the violet fades into the sky.
> Here, awful Newton, thy dissolving clouds
> Form, fronting on the sun, thy showery prism;
> And to the sage-instructed eye unfold
> The various twine of light, by thee disclosed
> From the white mingling maze
>
> (ll. 203-12)

Thomson's description of "the grand ethereal bow" denotes a natural phenomenon of almost divine beauty. The term "ethereal" here alludes both to the heavenliness of the aerial spectacle, and to Newton's own ethereal speculations. Directly referencing "awful Newton", Thomson refers to the scientist's experiments in *Opticks*. The rain and clouds in the sky act as "thy showery prism", and the rainbow becomes at once a vast demonstration and heavenly validation or proof of Newton's optical experiments. The cloudy prism splits beams of light, "the white mingling maze", into single colourful strands, resulting in a revelation of the entire spectrum of colours "to the sage-instructed eye".[32] Perhaps however, this section on "the grand ethereal bow" has implications that surpass the poem itself. Not only is the rainbow an example of the sublime beauty of the heavens, but the cloudy prism may also function as an analogy

[32] In a recent article, Katarina Maria Stenke (2016) further emphasises the ways in which "labyrinths and mazes abound in James Thomson's *The Seasons*", and argues that "the maze provides Thomson with a conduit into the entwined traditions of Western literature. (p. 6). In the context of natural philosophy that recognises all natural phenomena as resulting from an omnipotent God, the maze, she argues, "can evoke both the sublime complexity of the Creation and the concomitant threat of amazement (p. 10).

revealing the aims of many natural philosophers following in Newton's wake. The prism renders all colours visible, which had previously remained 'hidden' in light. Analogically speaking, the ether as an Ur-fluid could be regarded as a bundle of white light which, guided through the right prism, could reveal the various fluids it contains. It was the scientists' task, as I will discuss in subsequent chapters, to 'find the right prism', to make visible the ether, and split it into its individual components.

Returning to Thomson's depiction of Newtonian natural beauty, 'The Seasons', was not the only time that the poet paid his respects to Newton. Shortly after Newton's death in 1727, around three years before the publication of 'The Seasons', Thomson had expressed his admiration for Newton in his eulogy entitled 'A Poem sacred to the memory of Sir Isaac Newton', "the earliest and most successful of several rival commemorative eulogies" (Connell, p. 2). It is in this poem that Thomson first employed imagery of Newton's ethereal rainbow that was to be re-used in 'The Seasons': "E'en Light itself, which every thing displays [sic.]", Thomson states, "Shone undiscover'd, till his brighter mind/ Untwisted all the shining robe of day" (1830, ll. 96-98). He continues as follows:

> And, from the whitening undistinguish'd blaze,
> Collecting every ray into his kind,
> To the charm'd eye educ'd the gorgeous train
> Of parent colours. First the flaming red
> Sprung vivid forth; the tawny orange next;
> And next delicious yellow; by whose side
> Fell the kind beams of all-refreshing green.
> Then the pure blue, that swells autumnal skies
> Ethereal played; and then, of sadder hue,
> Emerg'd the deepen'd indigo, as when
> The heavy-skirted evening droops with frost;
> While the last gleamings of refracted light
> Died in the fainting violet away.
>
> (ll. 99-111)

Once again, the rainbow is described as a display or revelation of ethereal beauty through Newton's prism.[33] Newton's unparalleled wisdom, Thomson writes, saw "The finish'd university of things/ In all its order, magnitude, and parts" (ll. 140-41). Newton was the "philosophic sun" (l. 90) that first shone a light on God, the Prime Cause "Who fills, sustains, and actuates the whole" (l. 143). Now that death had taken Newton's soul from the earth, he may himself "lift […] his column to the skies" (l. 175). Thomson declares,

> Yet I am not deterr'd, though high the theme,
> And sung to harps of angels, for with you,
> Ethereal flames! ambitious, I aspire
> In Nature's general symphony to join.
>
> (ll. 8-11)

Thomson's reference of the 'ethereal flames' is not only conceptually but also poetically versatile. It encapsulates the characterisation of the ethereal fluid as the element of the heavens, and its close connection with heat, light and fire. It also once again reminds the reader of Newton's own speculations about an ethereal fluid in *Opticks*. Thomson notes that Newton himself, after his death, will have found his place in the ether, looking down, observing the lower plains like the 'Prime Mover' whose actions he may have uncovered through this mysterious medium:

> […] but *Newton* calls
> For other notes of gratulation high,
> That now he wanders through those endless worlds
> He here so well descried, and wondering talks,
> And hymns their Author with his glad compeers
>
> (ll. 180-84)

[33] Epstein and Greenberg have offered a detailed analysis of the Newtonian Rainbow as a scientific and literary trope in eighteenth- century writing in 'Decomposing Newton's Rainbow' (1984).

Connell has pointed out that "[t]he heavenly transit of the philosopher's soul at once confirms the 'harmonious System' of the Newtonian cosmos and vindicates his enduring faith in a divine creator" (p. 1). Newton's spirit, Thomson suggests in his eulogy, may itself have at long last reached the ether, or the ethereal regions he had described during his terrestrial existence.

While the satirist Alexander Pope did not make the ether a central subject in his writings, references to this mysterious fluid appear in *The Rape of the Lock* (1712/14), his translations of Homer's *Iliad* (1715-20) and *Odyssey*, and, perhaps most notably, his *Essay on Man* (1734). In a memorably amusing moment, Pope echoes a section of Milton's *Paradise Lost* when a tiny spirit, or 'sylph', is cut in two: he writes, "Fate urg'd the shears, and cut the Sylph in twain, / (But airy substance soon unites again)" (Canto III, ll. 51-2). His description of Sylphs, spirits of the air, echoes not only Paracelsus, who was perhaps the first to refer to such beings, but also the Miltonic notion of angelic beings whose bodies consist of an ethereal fluid. [34] Pope's comical Sylph, cut in two with a pair of scissors, heals instantly, like Satan in *Paradise Lost*, who (in Book VI, ll. 323-331) had been wounded by in his fight against the archangel Michael. Pope's recurring allusions to an ethereal substance may have been drawn from his interest in the poetry of Virgil and Homer, but also from his passing acquaintance with Rosicruceanism. In a note to his Translation of Homer's *Iliad*, Pope explains that "[T]he ancient philosophers supposed the Aether to be igneous, and by its kind influence upon the Air to be the cause of all Vegetation" (p. 47; also cited in Pope, 1950, p. 103).

[34] Paracelsus first described the Sylphs in his *Liber de Nymphis, Sylphis, Pygmaeis et Salamandris et de Caeteris Spiritibus.* Cf. Paracelsus; von Hohenheim (1922).

Further allusions to an ethereal substance appear in Pope's work in his *Essay on Man* (1734), which Maynard Mack has described as Pope's attempt "to give a poetic definition of the problems of man's nature and God's justice outside the sphere of religious allegory, heroic drama, and scriptural story, where they had […] been confined before" (Pope, 1950, pp. lxiv-lxv, also cited in Cutting-Gray, p. 480). At the time of publication the work was met with both of praise and scepticism concerning Pope's orthodoxy and ways in which the poet portrayed Man's relation to God.[35] Pope's indebtedness to Milton, evident throughout *The Rape of the Lock* , is apparent from his intention in the *Essay on Man* to "vindicate the ways of God the men" (Ep. 1, l. 16), which directly references Milton's wish to "justify the ways of God to Men". Pope's uses of the 'ether' in his *Essay on Man* are Miltonic insofar as they denote a live-inspiring, divine substance, given to humanity in a "Vast chain of being! which from God began" and descends through "Natures ethereal, human, angel, man" (ibid., l. 237-8). Emphasizing the divine origin of all creation, Pope notes that "All are but parts of one stupendous whole, / Whose body Nature is, and God the soul" (ibid., ll. 267-8), and that all is "Great in the earth, as in th' aethereal frame" (ibid., l. 270). Commenting on the role of an ethereal medium within this Creation, Pope notes further, in Epistle III,

> Whate'er of life all-quickening ether keeps,
> Or breathes through air, or shoots beneath the deeps,
> Or pours profuse on earth, one nature feeds
> The vital flame, and swells the genial seeds
>
> (Ep. III, ll. 115-118)

[35] For a more detailed account of contemporary criticism on the poem, refer to John Barnard's *Pope's Critical Heritage, (pp. 278-316)*, which contains a number of responses to Pope's *Essay on Man*, most notably perhaps by William Warburton (pp. 307-15) and Jonathan Swift (p. 281).

Pope may not be entirely serious in these lines but this passage encapsulates the versatile nature of the ether which 'pours profuse on earth', emphasizing its fluid nature.[36] Another shadow of influence is identifiable here. This passage in particular echoes Dryden's translation of Virgil, who in the *Aeneid* writes of "one common soul [which] inspires and feeds, and animates the whole", and of "an active mind infused thro' all the space" (cited in Pope, 1950, p. 104). While by this "active mind" originally describes the mind and will of the creator that is present everywhere, this line may yet have further implications for the mind not only of God, but of man. Indeed, Pope's depiction of the 'all-quickening ether' seems to contain the key to human intellect. A 'vital flame' 'swells the genial seed', the seed of intelligence, and gives to man wisdom, reflection, and morality, poured down from the heavens by God himself. Pope's ether in this passage is not only the substance or matter out of which God may made his entire creation. Pope describes an ether of morality, or of intellect, or quite simply, an "ether of human understanding" (Cutting-Gray, p. 487).

However, this 'ether of human understanding' is, although given by the Creator, not unlimited, or all-encompassing. Instead, "[t]he poem at once denies that [it] extends to the boundaries of the cosmos, and it devotes most of its lines to filling out the picture of that cosmos" (ibid.). Man is urged not to break the 'vast chain of being', and not to elevate himself beyond his station. Scientific enquiry, Pope insists, is to be conducted with caution and humility. Man should never "quit […] sense and call Imitating God" (Pope, 1950, Ep. II, l. 26). In one of his earliest works, the *Essay on Criticism* (1711), Pope famously wrote:

[36] It is important once more to note that by this 'pouring' of an ethereal fluid, Pope does *not*, as one might assume, mean rain falling down from the skies, as will be discussed below, in the context of William Stevenson's 'An Hymn to the Deity'.

> Nature to all things fix'd the limits fit,
> And wisely curb'd proud man's pretending wit:

In similar vein, urging a warning to those who Pope felt were playing with fate in trying to unveil God through their experiments, he writes in the *Essay on Man*,

> Trace Science, then, with Modesty thy guide;
> First strip off all her equipage of pride;
> Deduct what is but vanity or dress,
> Or learning's luxury, or idleness
>
> (ibid., ll. 43-46)

While Milton wrote in earnest, Pope was clearly willing to satirize Miltonic epic. But despite the generic differences, they share a very similar understanding. While an ethereal, life inspiring, genius-feeding, divine, fluid substance was given by the Creator, Pope notes that humankind, or 'Man', cannot and should not, try to fathom the wisdom of the ethereal heights of the Creation but instead be "as blest as [he] can bear" (Ep. I, l. 286). For, after all, "One truth is clear, 'Whatever *is*, is *Right*'" (ibid., l. 294).

George Berkeley (1685-1753), Bishop of Cloyne, most known for his advancement of 'idealism' – that existence was conditional upon perception – connected natural science, philosophy, and religious beliefs in his 1744 treatise entitled *A Chain of Philosophical Reflections and Inquiries Concerning the Virtues of Tar-Water*, also known as *Siris*.[37] The work promotes tar-water as a unique a panacea for a variety of diseases.[38] In explaining the virtues of his remedy, Berkeley engages in a discussion

[37] Immaterialism is defined as the school of thought with proposes "that matter does not exist, and that what perceivers typically call the physical world consists entirely of minds and ideas" (Fields, p. 8).
[38] Tar water was a popular 'medicine' in the eighteenth century, despite its foul taste. Like many other such quack elixirs, it was said to cure a variety of ailments, including small-pox, scurvy, ulcers, pleurisy, asthma and rheumatism. The drink's popularity was revived in the Victorian era, and even appears in

which references the ether or ethereal fluid as a central part or constituent of the universe. Berkeley's view of divine presence and agency in this treatise relies on, and is intrinsically linked with, his belief in the ethereal fluid as a divine substance.

As his correspondence shows, Berkeley remained on cordial terms with Pope. He wrote admiringly of *The Rape of the Lock* (Letter 1 May 1714; Hight, p. 116-17) and Pope later invited Berkeley to stay at his country villa (Letter dated Sunday [c. 1721?], ibid, pp. 163-64). Unlike his friend, Berkeley's interest in ethereal fluid was altogether more serious. Encapsulating the veiled but omnipresent power of the ether, Berkeley notes that "[t]he seeds of things seem to lye [sic.] latent in the air, ready to appear and produce their kind, whenever they light on a proper matrix", and that "[t]he whole atmosphere seems alive" (p. 65). What follows is a detailed discussion of the ether and its history and role in ancient Greek and Chinese civilisations. "This pure fire, aether or substance of light", Berkeley points out, is "invisible and imperceptible to all our senses", and could be "perceived only by its effects, such as heat, flame and rarefaction" (p.77). Ether, once more, is pictured as an 'Ur-fluid' which becomes perceptible only through its various descendants. The phenomenon's divine properties, Berkeley notes, are not only embedded in Christianity, but also had their place in ancient Chinese philosophy. As he points out,

> [a] notion of something divine in fire, ordering the whole world, and animating it's [sic.] several parts, was a tenet of very general extent, being embraced in the most distant times and places, even amongst the Chinese themselves; who make tien, aether, or heaven, the sovereign principle, or cause of all things.
>
> (pp.82-3)

Dickens' *Great Expectations*, in which Pip and his brother are forced to drink the substance. Tar water is certainly among those kinds of cures that would be referred to as quackery. The fact that it was advertised as a remedy by a philosopher as universally respected as George Berkeley shows the exceptionally fine line between 'quackery' and respectable philosophy and medicine. Who was deemed a quack and who was not was frequently just a question of a person's reputation, their intentions, and, maybe most of all, general consensus.

Indeed, a notion of ether as an *explicitly divine* substance with the capacity to order and animate the universe pervades his discussion of atmospheric matter. Berkeley is naturally "impelled by a desire to bring men to a sense of the immanence of Deity" (Tipton, p. 297). His discussion of the phenomenon is an attempt at a reconciliation of science and Christianity, and seeks to bolster theology through 'ethereal science' and his philosophy of "immaterialism". In his view, the divine presence and agency are revealed through the ether. The force of this all-pervading element, Berkeley argues, is "[a] sufficient proof not only of the power of fire, but also of the wisdom with which it is managed" by God (p. 77).[39] Berkeley embeds the ethereal medium in Christian belief. He refers to Bishop Patrick, who "gives it as his opinion, that in the beginning, the Shecinah, or divine presence […] appeared by light or fire". The 'vital flame', Berkeley points out, is "the cause of all motions in the body of man, whether natural or voluntary". He adds that "[i]t would be endless to enumerate all the passages of holy scripture, which confirm and illustrate this notion, or represent the Deity as appearing and operating by Fire" (p. 86).

Much has been made of Berkeley's disputes and disagreements with Newton concerning the nature of God and absolute space in *Berkeley's Treatise Concerning the Principles of Human Knowledge* (1710), and *De Motu* (1721). It is not possible to give a full account of these disagreements in this chapter.[40] Instead, I want to focus on

[39] Berkeley, although admitting that the terms *aether* and *fire* were used interchangeably, even in ancient times, uses the latter term more frequently. He does so for several reasons. Firstly, he believes (along with Dutch botanist, chemist and medic Herman Boerhaave) the word 'fire' may more accurately account for the atmosphere's heterogeneous nature, which, he insists, may not be entirely captured by the word *ether*. Secondly, although the words 'fire' and the 'ether' refer to the same divine, invisible phenomenon in this context, Berkeley would want to distance himself from Newton's ether as a result of their somewhat conflicting philosophies. Finally, Berkeley's choice of words will certainly have been influenced by the image of the animating "vital flame" (p. 77) with the power to bestow all beings with life.

[40] For an in-depth account of Newton's and Berkeley's differing views on motions, fluxions, and absolute space in relation to their differing theologies, see M. Hughes' 'Newton, Hermes, and Berkeley'

Berkeley's account of Newton's ether in his treatise on tar-water. In *Siris*, especially with regard to the significance and role the two philosophers ascribe to the ethereal fluid, their disagreement seems more nuanced than is sometimes suggested. Berkeley refers to Newton's theory of the ether as discussed in *Opticks*, noting that the latter seems unable to account for all phenomena of space. "The laws of gravity, magnetism, and electricity are divers [sic]. And it is not known what other rules or laws of motion might be established by the author of nature" (p. 110), Berkeley points out, focussing once again on divine agency. He continues his attack on Newton by stating, "to explain all those various motions and effects, by the density and elasticity of aether seems incomprehensible" (p. 112). This statement may appear to contradict Berkeley's earlier assumptions concerning the role of the ethereal fluid. I assume it points to a more subtle critique of Newton's Arianism, and his proposed system of the universe, in which God appears to be the remote cause of a natural order, rather than, as Berkeley (and Blackmore) would suggest, an immediate, omnipresent agent. "We cannot make even one single step in accounting for the phenomena [i.e. gravity, magnetism, attraction and repulsion], Berkeley suggests, "without admitting the immediate presence and immediate action of an incorporeal agent, who connects, moves, and disposes all things, according to such rules, and for such purposes as seem good to him" (p. 112). Newton's main fault, according to Berkeley, may just be that he does not account for God's immediate agency quite enough. To Berkeley, the ether is what makes divine presence immediately apparent. To him, the fluid is not, as Newton might argue, merely a remnant of a divine primal cause.

(1992). W.A Suchting, in 'Berkeley's Criticism of Newton on Space and Motion' (1967), further compares differing views on space, extension and relative motion.

Berkeley's philosophy of idealism may shed a light on the multifaceted role of the ether as a semi-divine, semi-corporeal phenomenon. Berkeley argues that "[i]n strict truth, all agents are incorporeal and as such are not properly of physical consideration" (p. 118). I have discussed above Berkeley's acceptance of ether as a substance, particularly in a theological context. His assumption that "all agents are incorporeal and not properly of physical consideration" may, at first glance, contradict his famous '*esse est percipi*', but it reinforces his Christian belief, as well as his philosophy of Immaterialism, in proposing that divine agency may not be fully understood by human faculties. Once again, the ether is portrayed as an intermediate concept or substance. This Ur-Fluid, imperceptible but of divine origin, fills a conceptual intermediate stage not only between the human intellect and divine omniscience, as Blackmore had suggested in *Creation*, but also between the heavenly incorporeal, and the earthly corporeal plains. It is "latent and unobserved 'till some accident produceth it into act, and renders it visible in it's [sic] effects" (p. 72). The ether's various descendants, heat, light, magnetism, electricity and fire, *are* perceptible as effects that pointed to divine agency as their cause. For many natural philosopher and writers at the time, and especially for Berkeley, rendering ether perceptible was key.

As William Stevenson (1719?-1783) proclaims in the preface to a collection of poetry published in 1765, "For my own part, if permitted to declare my own opinion, I would much rather deserve the respectable character of being inoffensive in my writings than enjoy the Immortality of a Lucretius or a Bolingbroke, with the afflicting consciousness […] of having exhibited ethics or philosophy, in improper attitudes, embarrassed the understanding of mankind, or corrupted the principles of the heart"

(p. xv.). While Stevenson, a physician working in London and Bath during his lifetime, did certainly not achieve anything like the fame of Lucretius, he appears to have been a rather contentious figure during his lifetime. His works in medicine resulted in the damning portrayal of the physician as someone whose "pen was venomous", and who "spent his life lampooning and being lampooned" (D. Power, p.1). [41] His endeavours in poetry however seem so far removed from controversy that it is difficult to believe they should have been composed with the same 'venomous' pen. Stevenson's poetical works appear to have escaped critical notice or attention, despite the size of his corpus of poetry.[42] I intend here to focus on his 'Hymn to the Deity, in Imitation of the CIVth Psalm', first published as part of the collection of poetry in 1765, which was revised and re-published almost 20 years later, shortly before Stevenson's death in 1783. The poem, in line with popular discourse at the time, depicts the ether or ethereal fluid as a central part of God's Creation. Williamson's two separate versions of this 'Divine Ode' (Stevenson, 1765, n. 1), which offer slightly different depictions of the ethereal fluid, shed light on the physical as well as conceptual versatility of this celestial substance and assert that the ether was a fluid medium, owing to its close connections to Christian scriptures.

[41] Stevenson reached the peak of his medical career in the late 1770 and early 1780s. His medical publications include *A Successful Method of Treating the Gout by Blistering* (1779); *Cases of Medicine Interspersed with Strictures Occasioned by some late Medical Transactions in the town of Newark* (1782); *Candid Animadversions on a singular gouty case, to which are prefixed strictures on royal medical colleges, likewise a summary opinion of the late disorder called the influenza* (1782), as well as his damning report entitled *Considerations on the Dangerous Effects of Promiscuous blood-letting and the common preposterous administration of Drugs* (1783).

[42] Stevenson's *Original Poems on Several Subjects* (1765), reprinted with corrections as *Poems, moral and descriptive, on several subjects* (1782) is an extensive collection, published in two volumes. It contains, amongst other works, his 'Progress of Spring'- a work in six books -, an 'Ode on Spring', as well as his poems entitled 'On Harmony', and 'On Marriage'. His poetical works seem to have gone relatively unnoticed. The article on Stevenson in the ODNB makes no mention of it. He saw himself as following in the footsteps of "the Doctors […] [Samuel] Garth and [John] Armstrong, who supported the double character of Physician and Poet with equal dignity and success" (1765, p. xi).

Stevenson begins his Hymn of the Creation by depicting the Almighty God who "clothes himself, unsufferably bright, / In all the pomp of uncreated light (ibid., ll. 13-14), begins by forming the sky. The poet writes,

> He spreads the spacious skies beneath his feet,
> Like a vast curtain, or expansive sheet;
> While æther swells transparently around,
> Pure elemental fluid without bound
>
> (ibid., ll. 19-22)

The transparent ether as a 'pure elemental fluid' is present in the first moments of the Creation.[43] It is limitless and all-pervading. Stevenson modified this section of his poem for the 1782 version of his poem, which reads as follows:

Beneath his feet he spreads etherial space,
Void, yet fill'd up, expansion without place;
A gen'rous, life-inspiring fluid found,
On which subsist his glorious worlds around.

(1782, ll. 17-20)

Quite why Stevenson may have changed this passage is difficult to determine. Perhaps, the alterations were made to avoid closeness to Lucretius, who described a pure 'elemental' fluid, and whom Stevenson portrayed, as Richard Blackmore had done in 1712, as "embarrass[ing] the understanding of mankind" (ibid., p. xv.). Whatever the reasons for the alteration, Stevenson adds dimension to the ethereal medium in the

[43] Cf. the corresponding verses of the Psalm: "Bless the Lord, O my soul. O Lord my God, thou art very great; thou art clothed with honour and majesty. Who coverest thyself with light as with a garment: who stretchest out the heavens like a curtain" (King James Bible, Psalm 104, 1-2).

later version of his poem, by depicting it as a "life-inspiring fluid", the primordial matter of God's entire Creation.

The 'Hymn to the Deity' also contains the recurring trope of the Miltonic ethereal creatures as described in *Paradise Lost,* and a Newtonic, divine 'ethereal bow', as portrayed for example by Thomson in 'The Seasons' and his eulogy to Newton. Stevenson writes that God "bids the rainbow's dewy prisms extend", so that "From clime to clime the sign æthereal's seen" (ibid. l. 160-1).[44] Angels, the ethereal creatures in Stevenson's poem, are rather like the 'ethereal people' in *Paradise Lost,* depicted as "spirits of pre-eminent degree" (ibid., l. 40), and "Efflux of breath divine, first-born of light" (ibid., l. 42):

His ministers bright rang'd before him stand,
To watch each signal of supreme command;
Active, as glances of ethereal fire,
To execute what his behests require

(ibid., ll. 43-46)

In the corresponding section of revised version of the poem, Stevenson further describes the angels as "Coruscant heralds borne on wings of fire" (1782, l.39), once more emphasizing the versatility of the ethereal fluid. Ethereal beings made out of this substance are creatures of the air, of light and fire simultaneously first-born, since the ethereal medium as an Ur-fluid inhibits and combines all those elemental qualities.

There is yet another vital alteration that Stevenson made for the re-publication of the poem which is curious and informative in equal measure. It concerns lines 77-80 in the 1765 version, and lines 69-72 in the revised version respectively. In the original

[44] Cf. the 1782 version: "From clime to clime the god-like sign is seen" (1782, l. 153).

poem, Stevenson describes rain that, given by a benevolent almighty God, sustains and feeds nature:

> From his fraught clouds descend the timely rains,
> To fatten and refresh the thirsty plains.
> Æthereal fluid, of prolific pow'r,
> To give the vernal and autumnal hour
>
> (1765, ll. 77-80)

To some extent, this passage, although it is of course explicitly Christian, echoes the Lucretian notion of a 'Father ether' ('pater aether') giving rain to the Earth. However, the rain itself, in this instance, is an 'ethereal fluid'. Notably, Stevenson chose to make changes to this line for the 1782 version of the 'Hymn to the Deity' which reads as follows:

> From his fraught clouds descend the timely rains,
> To fatten and refresh the thirsty plains;
> *Celestial fluid*, of prolific pow'r,
> To give the vernal and autumnal hour
>
> (1782, ll. 69-72, added emphasis)

This correction, the alteration from "aethereal" to "celestial fluid", provides an insight in several ways. First, it reinforces the notion that the term 'ethereal fluid' in the period usually denotes an imponderable, invisible, intangible, floating medium, rather than water, or, in this case, rain. Stevenson presumably rectified his 'error' to avoid confusion. Second, the line in the original poem demonstrates how the term ether, or 'ethereal' in the period were not only matters of scientific enquiry, but that they became part of poetic diction, and were at times used to evoke images of divinity or

perfection, and at other times merely in order to elevate a poet's language by referring to this medium of higher spheres.[45]

Despite his occupation as a physician, Stevenson never suggests the ethereal fluid as a potential cure in any of his medical publications, but tends to revert to more 'earthly' remedies. In his 'Hymn to the Deity' however, the ethereal fluid is once more depicted as a primordial divine substance which makes up the heavens, the atmosphere, and the 'ethereal creatures'. Stevenson essentially weaves this Lucretian fluid into his poem inspired by a Psalm, anchoring it in an explicitly Christian narrative.

Over 120 years after Milton's *Paradise Lost*, ideas of the ether were still frequently represented in poetry. In 1780/1, English lawyer, radical editor and writer Capel Lofft (1751-1821) published his poem *Eudosia: or, a Poem on the Universe,* which discusses ideas about the role of the ethereal fluid in the divine creation. The work is a late example of the "physico-theological movement" which had reached its peak, between around 1750 (Williamson, 2004). Both Newton's and Milton's influence on Lofft's work are apparent. Lofft had even edited his own volume of *Paradise Lost*, specifically commenting on Milton's poetic language. He was admired by his contemporaries as "an earnest black-letter enthusiast in literature, and in private life an amiable man" (1824, *The New Monthly Magazine,* p. 328) and was said to be following in Milton's own poetic footsteps. In 1801, poet George Dyer even wrote an

[45] The ether or ethereal fluid frequently appears in the poetry of the period, often without being further discussed. Examples of this divine substance as part of elegant poetic diction, often depicting a kind heavenly love or affection for someone, can be found, to name but a few examples, in Benjamin Hawkshaw's 'The Vision' (1693) which depicts the feeling of love clothed "in ethereal Robes of Light" (l. 3). In Mary Masters' 'Sent to a Lady with Myrtillo's Poems' (1733), the speaker hopes "to paint thy ev'ry Grace" (l. 3), "The meeting Virtues; perfectly imprest / On sacred Sheets, in thy Ethereal Breast" (l. 5-6), while Thomas Park's poem entitled 'To William Rowley, M.D.' (1797) describes the latter as "Touched by Philanthropy's ethereal Flame" (l. 12).

'Ode to Lofft', in which he states, "Thus Milton lives, and thou, my Lofft, / (For thou shalt have this heart's esteem) / Still shew thy Milton in his virgin-dress" (ll. 41-43).[46] As for contemporary poetic connections, Lofft was patron of the lesser-known poet Robert Bloomfield, and a friend of the more famous Samuel Taylor Coleridge.[47]

Lofft's poetry combines a lofty Miltonic style of verse with a strong Newtonian influence. His lengthy work *Eudosia* encompasses seven books, dedicated to 'the Earth', 'the Planet', 'the Seasons and the Zodiac', 'the Fixed Stars', 'Eclipses; Phases of the Planets and Tides. Light and Colours', evidently modelled on Newton's *Opticks*, and a final chapter 'on Comets; the Elements; and Electricity'. William Powell Jones, in 'Newton Further Demands the Muse' (1963) has argued that "six of the seven books [of *Eudosia*] are a belated tribute to astronomy and the orderly motion of the celestial universe revealed in the *Principia*" (p. 304). Indeed, Lofft frequently mentions and alludes to Newton, stating that "all will be true which is presumed on the hypotheses of Sir Isaac Newton so far as our subject is here concerned" (Lofft, p. 213).

It would exceed the limitations of this chapter to discuss the poem in its entirety. Instead, I will focus on Lofft's representation of the creation of the universe, and the role and composition of the elements, to underline the significance of ether, the divine fluid which forms the basis for all the other fluids discussed in this thesis. Lofft, following Newton, proposes that there must be an active divine agency which imbues the elements with their powers. However, his recurring emphasis on the changing, metamorphic nature of the elements also shows his admiration of "the vivid and

[46] Dyer supposedly wrote his Ode on a sheet of *Paradise Lost*, which resulted in the poem's laborious title 'Ode XV Written on a Blank Leaf of Milton's Paradise Lost, Presented by the Editor Capel Lofft to the Author'.

[47] See Ditchfield, G. M. "Lofft, Capel (1751–1824), radical editor and writer." *Oxford Dictionary of National Biography*. Oxford University Press. Date of access 15 Jun. 2021, <https://www.oxforddnb.com/view/10.1093/ref:odnb/9780198614128.001.0001/odnb-9780198614128-e-16930>

enchanting colours of Lucretius" (p. 246), whom he praises at length in the notes to his work. Quoting Locke's *Essay on Human Understanding,* which states that within God's Creation, "by […] gentle steps things ascend upwards in degrees of perfection" (Locke, p. 556, cited in Lofft, p. 244), Lofft further emphasises that there may well be a kind of perfect, divine, aggregated or condensed form of Prime Matter. Indeed, *Eudosia* frequently describes a kind of 'conceptual aggregation' of the elements. Different forms of matter often appear as somewhat condensed into one. Such a 'condensation' of natural power into one prime element is strongly reminiscent of the ether as a divine 'Ur-fluid'.

Inviting Eudosia the muse, and his readers, to marvel at "those great wonders all around in the pure Aether" (I., ll. 38-9), Lofft begins the first book of his poem by discussing the make-up of the Earth and the universe. He suggests that,

> Whate'er we see, around, beneath, above,
> Through the great series of still flowing years,
> Which comprehends all of created things
> Antiquity the universe hath named. [48]
>
> (ibid., ll. 43-6)

Lofft emphasises that the origin of the universe is to be traced back to divine creation. All created things, he continues "keep […] the order given by the ONE who made and rules it [sic.]" (ibid., ll. 49-50). All beings can "witness the elements, / Earth, and the thinner waters, and the Air, / Higher than these, and Fire that soars above" (ll. 64-6), and enjoy nature's diversity. "Our atmosphere", the poet points out at a later point in the poem, "[m]ay drink the vapour, and derive / From the ethereal fluid kindly dews" (VI., ll. 140-2). Lofft repeatedly points out the significance of divine origin, revealing

[48] It is remarkable that even time, i.e. 'still flowing years', is likened to a fluid in this instance. Such an assumption was, even at the time, rather unusual.

one of the fundamental reasons why such a variety of natural phenomena were regarded as related fluids:

> The native form, which matter bears,
> Is thus divided on the scale of truth
> Perhaps one simple form of matter, first
> Obedient to the high creating will,
> Forms are Earth, and Water, and the Flame and Air.
>
> (I., ll. 71-5)

Once again, we see "one simple form of matter", a divine ethereal fluid which is the basic building block, a kind of original or primal element in its 'native form'. This line is reminiscent of Milton's "one first matter all", which appears in Book Five of *Paradise Lost*, as cited above. Like Milton, Lofft imagines this fluid as 'first obedient to the high creating will'. The original element (though not explicitly called 'ether' here) is, like all the fluids that derive from it,

> Too subtle for the sense, apt to assume
> All forms, and active equally to change
> For Water into Earth transforms, and Earth
> Vanishes into Water; into Fire
>
> (I., ll. 77-80)

This description both echoes an Empedoclean notion of the four basic elements, and encapsulates the enormous potential held by the ether. It is divinely versatile in nature, flexible, changeable, and transmutable. As Lofft puts it, "This mighty World is Metamorphose all" (ibid., l. 85), and the elements transform, from one state to the next, owing to their shared conceptual origin. This conceptual aggregation is why the different fluids described by philosophers at the period are similar, and yet may have a variety of different names. The following passage from Book VI, 'On Comets; the

Elements; and Electricity', illustrates Lofft's understanding of the concept of fluidity. A variety of terms refer to one and the same fluid substance:

> Of Fire should we attempt to speak, which dwells
> In every substance; active or inert,
> Or visible or latent? As the modes
> Of its existence vary, suited names
> Distinguished the determin'd quality:
> Phlogiston called in quiescent state,
> When agitated gently, *Phosphorus*,
> *Electric,* when the agitation more
> And when excited in the last degree,
> The principle of light and heat exerts
> Its utmost force, we give the name of Fire
>
> (VI, ll. 414-24, original emphasis)

Lofft struggles to distinguish fire, electricity, heat and light since they are so closely connected to the common ancestral fluid.[49] This conceptual confusion seems in no way problematic to Lofft. Instead, it is a testimony to the complexity of God's Creation. Finding "suited names" to "distinguish […] the determin'd quality" or manifestation of an ethereal Ur-fluid articulates a need for a taxonomy of chemistry. In the end, however, the terms philosophers used seem to be less relevant, however. Creation, in many ways inaccessible to human understanding, accounts for all these natural wonders. Lofft states that "whatsoever name you give" (I., l.86) to the ever-changing, intangible fluid substances in nature, it must be "Retain'd, that Matter, such as we behold,/ In the vast system, owes its energy/ To the Almighty Power" (ibid., ll.88-90). As a political radical and a Dissenter who inclined towards Unitarianism,

[49] 'Phlogiston' is a substance that eighteenth and nineteenth century scientists believed to inherit a capability of combustion. All flammable matter contained this substance, while anything lacking in 'combustibility', or anything that had already been burnt, was described as 'de-phlogisticated'. Joseph Priestley conducted a variety of experiments surrounding the substance. Lofft, in *Eudosia* displays his fascination with the phenomenon of 'phlogistic' (VI, l. 499; l. 503), or 'phlogisticated Air' (ibid., l. 447; l. 466), by paying tribute to "the glorious labours and sagacious art" (ibid., l. 411) of Priestley.

Lofft had much in common with his friend Coleridge, to whom he wrote an admiring sonnet.

Coleridge held both Milton and Newton in very high esteem. While he once wrote, "I believe the souls of five hundred Sir Isaac Newtons would go to the making up of a Shakespeare or a Milton" (Griggs, *Collected Letters*, vol 2, p. 709), he had a life-long interest in science. As a young man, he developed an idea of the 'one life' with his friend and associate Robert Southey. Coleridge married Sarah Fricker, the sister of Southey's wife Edith. They even sought to establish a community in America organised by principles of "pantisocracy" where the "one life" would be practised each day. Later, after the failure of the 'pantisocracy' plan, in 1806, Coleridge met the natural philosopher Alexander von Humboldt in Rome, and seems thereafter to have been interested in Humboldt's ideas (Wiegand, 2002, pp. 105-113). It is hard to say when and where Coleridge met Capel Lofft but that meeting is likely to have happened after 1798 and Coleridge's associations with Wordsworth.

But for all Coleridge's admiration for the two great intellectual precursors, Milton and Newton, Coleridge expressed doubt about the idea of a homogeneous substance underlying all things. He wrote:

> Having reasserted that I no more confound magnetism with electricity, or the chemical process, than the mathematician confounds length with breadth, or either with depth; I think it sufficient to add that there are two views of the subject, the former of which I do not believe attributable to any philosopher, while both are alike disclaimed by me as forming any part of my views. The first is that which is supposed to consider electricity identical with life, as it subsists in organized bodies. The other considers electricity as everywhere present, and penetrating all bodies under the image of a subtile fluid or substance.
>
> (*Hints Towards a More Comprehensive Theory of Life*, 1848, p. 49)

Coleridge famously entertained a notion of 'Multeity in Unity'. In his unfinished *Sketch of a Theory of Life* (posthumously published in 1848), he expressed doubt as to whether the supposition of an all-pervading fluid lying behind phenomena such as electricity and magnetism was valid. He added,

> I must reject fluids and ethers of all kinds, magnetical, electrical, and universal, to whatever quintessential thinness they may be treble distilled, and (as it were) super-substantiated … I miss the connecting link between this imaginary ether and the visible body, which then becomes no otherwise distinguished from inanimate matter, than by its juxtaposition in mere space, with an heterogeneous inmate, the cycle of whose actions revolves within itself.
>
> (ibid, p. 24)

Perhaps as a result his association with Humphry Davy (as we shall see in Chapter Four) Coleridge barely refers to ether in his poetry. He refers to "ethereal multitudes" in his *Ode to the Departing Year* (1796), to "some island in the ethereal heights" in his drama *The Piccolomini* (posthumously published in 1840) and "the bright blue ether" in the verse-drama *Zapoyla* (1815-16). It would take, in Bloom's terms, only a strong poet to begin to articulate this divorce between the ether and fundamental states of matter. The language of ether lingered as a kind of archaic synonym for 'heavenly' or 'atmospheric' but for Coleridge and Wordsworth, it had largely a metaphoric role. Wordsworth's poetry in relation to the natural philosophy in the period has been discussed at length in Thomas and Ober's *A Mind Forever Voyaging* (1989). Wordsworth appears to have understood the ether in a similar way to Coleridge, in terms of a concept that expresses not only the intricacies of Newtonian natural philosophy, but also heavenly natural beauty. Wordsworth admired Newton's achievements. At a young age, while at Hawskshead Grammar School, he was said to

be “poring over Newton’s *Opticks*” (p. 32; see also Moorman, p. 57). *The Prelude* refers to the great scientist three times in total, once referring to “Newton’s own etherial Self” (III, l. 269). Discussing at length the significance and meaning of the word ‘ethereal’ in the Newtonian sense, Thomas and Ober remark on Wordsworth’s choice of words in describing Newton’s superior intellect. “What more appropriate word could he have been prompted to use”, they ask, “than the adjectival form of that noun which pointed to the substance through which worked all the fundamental laws which Newton had discovered and which Newton himself thought was the very essence of material creation at the hand of God? (Thomas, p. 34). In Book Six of *The Prelude*, Wordsworth uses the word ‘ethereal’ to refer to the heavenly beauty of nature:

> Over the smooth sands
> Of Leven’s ample estuary lay
> My journey, and beneath a genial sun,
> With distant prospect among gleams of sky
> And clouds, and intermingling mountain tops,
> In one inseparable glory clad,
> Creatures of one ethereal substance met
> In consistory, like a diadem
> Or crown of burning seraphs as they sit
> In the empyrean.
>
> (Wordsworth, VI, ll. 514-519)

The poet’s references to parts of nature as “Creatures of one ethereal substance” recalls the notion of a divine ether as an Ur-fluid or building-block of a universe which, in line with Coleridge’s idea of ‘Multeity in Unity’, all parts of nature assemble to form one sublime whole.

We have seen in this chapter that the influence of Milton and Newton extended far beyond the seventeenth century so far as the understanding of ether was concerned. In Shelley’s terms, they cast giant shadows of futurity upon the religious, literary and

scientific ways in which the material of the cosmos was comprehended. In many respects, these three kinds of discourse – religion, science and literature – comprised the 'one culture' of undivided analytic thought. Indeed, Coleridge made it his explicit aim to achieve in his youth what he called 'the one life', and Wordsworth shared this sense of the world as bound up in a comprehensive totality. In Bloom's terms, Milton and Newton were the 'strong precursors' whose influence was felt long after their era. But for what Bloom calls 'latecomer' writers, that influence still proved overwhelming. Writers such as Blackmore, Stevenson and Lofft seem to have remained largely bound to that influence. In Coleridge and Wordsworth, we see a shift in the use of this kind of language and this kind of thinking away from a physical, ontological literalism and into the realms of poetic diction and metaphor.

Chapter Two: The Electric Fluid

In many respects Milton's declared aim, at the start of *Paradise Lost*, to "justify the ways of God to men" also described the essential project of much eighteenth-century science. This chapter argues not only that electricity was understood as a divine fluid at the time but that, for many early scientists, to make this fundamental, invisible, subtle or aethereal 'fluid' empirically observable was to see the reality of God. Bishop George Berkeley adopted one route towards that ultimate aim by arguing that *esse est percipi* (or 'to be is to be perceived'). In short, he argued that there must be an all-perceiving Being who keeps all things in existence (Warnock, 1967, p. 4). Eighteenth-century scientists were preoccupied with what was fundamentally a similar project of empirical inquiry although with different methods and techniques. The newly discovered force of electricity, embedded invisibly at the heart of nature, was understood as an 'aethereal' fluid and thus as inherently divine. To observe it was to bring into human view the divine creative agency.

Spanning the period roughly between 1748 and 1832 – from Franklin to Faraday – this chapter analyses how eighteenth and nineteenth-century assumptions regarding the concept of fluidity shaped ideas of electric force. It argues that as a series of natural philosophers, scientists and writers struggled to comprehend or describe electrical force, they relied upon notions of fluidity that traced back to Newton and Milton. "[E]ach in their different ways, and in different contexts", as John Meurig Thomas has pointed out, Franklin, Faraday and all natural philosophers and writers in between, "established a language of electrical discourse" (p. 523). The concept of electric fluidity lay firmly at the heart of this discourse.

When writer, orator, political activist and natural philosopher John Thelwall read his *Essay Towards a Definition of Animal Vitality* to the *Physical Society* in the Theatre of London's Guy's Hospital in 1793, he chose the following words to conclude his lecture:

> [W]hat can we discover so competent to the task—so subtile, so powerful, so nearly approaching to that idea of an ethereal medium, which some philosophers have supposed necessary to complete the chain of connection between the divine immortal essence, and the dull inertion of created matter, as the electric fluid? – That principle, whose presence, under such a variety of forms, is constantly presenting itself to the researches of the philosopher! – whose agency, in so many of the phenomena of nature, we are daily detecting!
>
> (Thelwall, p.41, also cited in Morus, 2009, p. 266)

Thelwall's essay seeks to identify, even to render observable an "ethereal medium" or intervening substance in what he calls "the chain of connection" between the divine and material realms. He sees the newly discovered force of electricity as approaching this medium.. The 'daily' detectings of an electrical fluid are, for him, potential manifestations of 'the divine immortal essence', but they are also indicators still in need of further explication. While Thelwall's main questions as to the origins of life remain largely unanswered by the end of his lecture, his concluding remarks encapsulate what was at stake in his 'daily detecting', his experiments and investigations – nothing less than the revelation of divine agency. As Paul Gilmore and others have argued "Electricity […] was a particularly potent phenomenon for Romantic thinkers, as it seemed to suggest connections between the material and the spiritual and between seemingly disembodied mental processes and sensual experience and to embody a force that might join otherwise atomized individuals" (Gilmore, p. 161).

The bulk of Thelwall's essay discusses the role of blood in supplying the body with vitality, while also examining a possible "superadded" vitality (Thelwall 1793, p.3) responsible for the animation of all living organisms. One of the most productive contexts in which the phenomenon has been discussed more recently is the Vitality Debate of the late eighteenth and early nineteenth centuries. At its centre was "a new general concept of life", as Sharon Ruston has put it (Ruston, p. 24), which suggested electricity as a possible vital agent or principle, crucial to the first inception of all life. Closely connected to these discussions, if not always emphasised, was the idea that electricity might have been a divine phenomenon potentially given to earth by a divine Creator – a powerful force to be harvested by brave natural philosophers and physicians for the good of mankind. As we have seen, Thelwall himself articulates a key connection between a 'divine immortal essence', the ether, and the electric fluid.

Early writers on the topic of electricity – including Benjamin Franklin, Joseph Priestley and John Wesley – all relied upon ideas of fluidity to explain the supposed (semi-) material characteristic of electric matter. Crucially, it was the aim of Franklin and his contemporaries to make observable (i.e. to render visible or perceptible, for example in the form of light or electric sparks) the electric fluid but what this move would effectively do is detach it from the divine, to make it non-'aethereal'. Understanding the observable effects of electricity had a paradoxical outcome. On the one hand, those effects were assumed to be derived from an all-pervading divine fluid. Yet on the other hand, that assumption would fall away simply because it became unnecessary.

We still speak today of electricity as 'flowing' but while this remnant of eighteenth-century electrical discourse remains, the understanding of electricity went through

major changes in the late eighteenth- and early nineteenth-centuries. Closely examining publications on electricity by Humphry Davy and Michael Faraday, this chapter argues that the naturalization of electric fluidity can be traced to two major shifts in electrical discourse in the late eighteenth and early to mid- nineteenth centuries. Led by Antoine Lavoisier's 1789 *Elements of Chemistry*, the last decade of the 1700s saw a renewed drive for classification and quantification of both chemical elements and natural phenomena. Late eighteenth- and early nineteenth-century electric experimenters followed this drive towards more precise scientific classification, and at the same time became increasingly sceptical regarding the concept of fluidity, whose abstract nature stood in sharp contrast to more precise scientific rationalisation. An imperceptible fluid, characterised only by its subtlety, semi-materiality and possible divine origin, simply had no place in the post-Lavoisier world of tables of chemical elements.

With this shift to a more empirically-focused understanding of electricity came a linguistic change in classifications and terminology. While fluidity never entirely vanished from electric discourse, scientific understanding of the phenomenon rapidly evolved. Whereas fluidity had been thought to be the original state of electricity as a semi-material substance, Michael Faraday and others understood fluidity increasingly as a metaphor for electric phenomena. Fluidity, in treatises by Faraday, tends to be merely one of many ways in which electricity could be understood. Both for electric and magnetic discourse, discussed in the next chapter, the fading significance of fluidity marked the beginning of (in Blakean terms) a fall into division, from the 'one culture' of combined scientific, creative and religious discourses, to a context where science increasingly diverged from religion.

Static electricity (a term coined in 1892, *OED*, static, n. †3) was perhaps first observed in around 600 BC, when Thales of Miletus, discovered that a kind of attractional form of energy resulted from friction between pieces of amber. At this point, no connections had been made between lightning and this kind of charge. However, in *De Rerum Natura,* Lucretius – perhaps not surprisingly, considering his extensive comments on the elements and the ether – not only linked lightning to this first element, but also made a remarkable comment on its potentially 'flowing' properties. Speaking of lightning as a kind of heavenly fire, similar to but slightly different from terrestrial flames, he noted lightning's ethereal origin:

> It is very easy for us to explain by reasoning of the mind why the fire of lightning has a far more penetrating flow than our fire that arises from terrestrial torches; for you could say that lightning, the heavenly fire, is finer and made of smaller shapes, and therefore passes through openings through which this fire of ours […] cannot pass.
>
> (Lucretius, p. 125)

Further emphasising the idea that lightning must first come from the heavens, Lucretius articulated an idea, a variant of which would last into the eighteenth century. As we shall see, it was an eighteenth-century commonplace that divine electricity was first given to earth by God, in a cascading flow from the heavens to earth. Although lightning was not explicitly connected to electricity or electrical fluid at this point but viewed instead as a variation of fire, Lucretius states that "it was lightning that first brought fire down to the earth for mortals, and from this, all blazing flames have been spread abroad" (p. 463).

Over two millennia after Thales' initial musings on the properties of static charge, the word *electricus*, meaning 'like amber', was still used to refer to the kind of energy that is produced when rubbing certain materials, such as metals metal, glass, etc., against each other. The word *elektron*, Greek for 'amber', is the root for the English word

'electricity'. English physician and writer Sir Thomas Browne first used the term in his 1646 treatise *Pseudodoxia Epidemica,* referring to this same notion of static charge. "Crystall will calsefy unto electricity", he notes, "[which] is a power to attract strawes [sic.] or light bodies, and convert the needle freely placed" (Browne, p. 51). Robert Boyle (*Experiments and Notes about the Mechanical Origin or Production of Particular Qualities, including some notes on Electricity and Magnetism*, 1676), and Francis Hauksbee (*Physio-Mechanical Experiments,* 1709), are some of the best-known early contributors to the study of static electricity.[50]

The study of electric energy, from its earliest stages had always had an almost mystical appeal, even outside the strictly scientific realm. The somewhat mysterious, largely unknown qualities of electricity were occasionally referred to in poems, before electricity formed its own major branch of scientific enquiry in the latter half of the eighteenth century. An example of a literary treatment of electricity that addresses a growing fascination with the phenomenon in the years leading up to Franklin's discoveries is German philosopher Georg Matthias Bose's epic poem *Die Electritricität nach Ihrer Entdeckung und Fortgang [Electricity after its Discovery and Development]* (1744). This work registers the perplexing and extraordinary power of electrical forces. Bose describes experiments in static electricity and encourages more (German) philosophers to get involved in the research so enthusiastically taken up in Britain and France at the time. The opening lines of his poem are as follows:

> Ihr Dichter, deren Geist Apollens Blitz bestrahlt,
> Und die ihr die Natur so schön, so lebhafft mahlt,
> Steht keiner von Euch auf, den stoltzen Seltenheiten
> Der Electricität ein Denckmahl zubereiten?

[50] See Hankins (1985): *Science and the Enlightenment* for an excellent overview of early investigations into electricity and electrical charge.

Reißt sie denn nicht so wohl euch Seel, und Geist, und Sinn
Bis zur Verwunderung, ja zum Erstaunen hin

(Bose, p.1)

You poets, whose soul is lit by Apollo's lightning,
And who paint nature so beautifully, so vividly,
Will none of you rise to set a monument
To the proud rarities of electricity?
Does it not entrance your soul, your spirit, and mind
Into amazement, yes, into astonishment[51].

The entrancing, inspiring qualities of this phenomenon, Bose insists, must be investigated, and written about, by poets 'who paint nature so beautifully, so vividly'. In what follows, the poem references a number of British and continental natural philosophers involved in static electrical experimentation. Amongst them "the noble Briton Gray" (Stephen Gray, 1666-1736) who, the poet insists, managed to electrify wood, rocks, leaves, sand, a chicken, hay, water and lead, and concluded that there was not one thing on the planet which was not electric in some respect (p. v).[52] Throughout his various experiments in static electricity, Gray had introduced the concept of 'electric virtue', an idea closely related to a model of electric fluidity, to describe electric conductivity.[53] Bose continues to encourage his readers to follow Gray's example and engage in their own electrical experiments, so that they may join the ranks of respected philosophers inspired by the wonders of electricity.

[51] My translation..
[52] Bose refers to "Der edle Britte Gray" [sic.] Original quotation: "Kein eintzger Cörper ist, der nicht electrisch sey [sic.]".
[53] Documenting a supposed close conceptual relationship between electric and magnetic phenomena, magnetic attraction in the eighteenth century was also frequently termed 'vertue/virtue', as discussed below.

Benjamin Franklin's contribution to the discourse of early electrical research, though initially overshadowed by his political achievements, has been discussed at length, predominantly by I. Bernhard Cohen (1996), and more recently by Edmund S. Morgan and C. R. C. Baxfield (2013). While Franklin was certainly not the first to explore electric forces through experiment, he is regarded as "the first scientist to win an international reputation in the new branch of science [i.e. natural philosophy]: electricity" (Cohen, p. 4) His famous kite-experiment was one of the first to conclusively demonstrate a link between the previously studied static electricity and lightning, potentially given to Earth by a divine creator.

More recent critical interest in Franklin's electrical researches has tended to focus on his struggles to reconcile experiment with religious doctrine, and on how his beliefs regarding electric divinity compared with those of his fellow electrical experimenters. Baxfield has argued that Franklin's experiments were "naturalistic and reactive towards providential theories of natural harmony and electricity provided by English experimentalists Stephen Hales, William Watson, and Benjamin Wilson" (p. 179). It was Watson's view, Baxfield suggests, that electrical "natural philosophy restored man's relationship with God" (p.180). Similarly, Baxfield argues that Wilson was "amongst a generation of Newtonian natural philosophers who married electricity, God's special providence and social status" (p. 183). In contrast, Baxfield characterises Franklin's own view of electric natural philosophy as "secularizing and directed towards mundane human needs" (p. 180). Franklin's own publications show that he was a keen follower of Newtonian physics, adhering in particular to Newton's ethereal speculations, and so was perhaps inevitably a believer in a connection between electrical and divine force. Indeed, differences in doctrine between most English electrical researchers at the time tended to exist only in nuances of

interpretation. Franklin shared with most of his contemporaries a fundamental working hypothesis of electric fluidity. As Cohen has pointed out, "Franklin's own concept of an electrical 'fluid'", was, like that of his contemporaries, "based on the Newtonian model [of an ethereal fluid]" (p. 4). Underpinning virtually all of Franklin's experiments on electrical force was an antecedent Newtonian 'Ur-fluid. which lay firmly at the heart of his and his contemporaries' electrical speculations.

Before analysing Franklin's 1747/8 ground-breaking electrical treatise, *Experiments and Observations on Electricity*, it is worth examining his views on fluidity as a whole. In a letter to David Rittenhouse, read at the *American Philosophical Society* in 1788, Franklin elaborates on his view that fluidity must be vital agent in all naturally occurring phenomena.[54] Light, heat, fire, and electricity – sometimes referred to as 'electric fire' in reference to the model of heavenly fire also articulated by Lucretius – according to Franklin all share a fluid nature.[55] Clearly drawing on a Newtonian ethereal fluid as the basis for his model of fluidity – in this case the fluidity of light – Franklin argues,

> Universal Space […] seems to be filled with a subtle fluid, whose motion, or vibration, is called light. This fluid may possibly be the same with that, which being attracted by, and entering into other, more solid matter, dilates the substance by separating the constituent particles, and so rendering some solids fluid, and maintaining the fluidity of others.
>
> (Franklin, 1934, p. 387)

Franklin goes on to explain that objects void of this fluid "are said to be frozen". Objects that hold an adequate quantity are in a state of 'natural heat', and for those

[54] David Rittenhouse (1732-96) was an inventor and astronomer who succeeded Franklin as President of the *American Philosophical Society* (1790-1796).

[55] Franklin's letter documents the implied interconnectedness of natural phenomena in eighteenth-century scientific discourse. He shows that heat light and fire are essentially believed to be different manifestations of the same fluid.

objects that hold excessive quantities of this fluid, it is called 'fire' (ibid.). Where an excessive quantity of this fluid occurs in the human body, Franklin reasons, this would be referred to as 'fever'. Further discussing this fluid of heat or fire in his letter, Franklin notes a hypothesis clearly based on a notion of a (Newtonian) ethereal fluid, discussed in the previous chapter. He asks, "[m]ay not this fluid […] be capable of penetrating and entering into all bodies", before continuing to pinpoint a variety of the fluids' possible agencies. Concluding with yet another question that links back to ancient ethereal creation myths, he finally asks: "May it not have been from such considerations that the ancient philosophers supposed a sphere of fire above the air of our atmosphere?" (p.388).

Franklin's 1747/8 work *Experiments and Observations on Electricity,* originally a collection of letters, uses this model of fluidity, and marks a turning point in eighteenth-century electric discourse. To some extent, this work shapes the way we think about electricity even today. As I. Bernhard Cohen has remarked, Franklin "was fully aware of Newton's concept of the aether as a means of explaining attraction [and] Franklin's own concept of an electrical 'fluid' was based on the Newtonian model" (p. 4). As we have seen, a conception of electric fluidity, closely modelled on an ethereal Ur-fluid is the central hypothesis informing all of Franklin's electrical researches. Relying on a notion of static electricity that had previously been established, Franklin did not introduce radically any new definition of the phenomenon. All the same, he is frequently regarded as the 'inventor' of modern electricity. Two key factors discussed in *Experiments and Observations* "moved electricity from the periphery to the center of scientific attention" (Hankins, p. 55). First, Franklin's letters recognise a key connection between static charge and electricity, and in turn between electricity and lightning. Second, Franklin argues that

there must be a universal electric ‘equilibrium’, i.e. an equal distribution of fluid electric matter in charged bodies and in the atmosphere as a whole.

The Franklinian hypothesis of an essential equilibrium of electric force is sometimes referred to as the “system of plus and minus electricity” (Heilbron, p. 353). Quaker and physician John Fothergill, editor of *Experiments and Observations,* explains Franklin’s conception of electric force as follows:

> [Franklin] exhibits to our consideration an invisible, subtile matter, disseminated through all nature in various proportions, equally unobserved, and, whilst all those bodies to which it peculiarly adheres are alike charged with it, inoffensive.
>
> (Franklin, 1748, preface)

Like the majority of hypotheses concerning electric and/or magnetic fluidity, Franklin’s model of electricity has its origin in a theory of subtle, invisible matter, closely resembling the ethereal Ur-fluid and supposedly dispersed through the atmosphere. That electricity must be closely connected to a model of matter resembling a potentially divine ether seemed to explain why electricity could reasonably be referred to as a fluid substance. The Franklinian posit of an electric fluid equilibrium suggests that electricity’s implied divine potential remains imperceptible in a state of equal distribution throughout the atmosphere. However, “[i]f an unequal distribution is by any means brought about”, he holds, this subtle and all-encompassing substance becomes perceptible, and sometimes visible in its force. Making electricity visible through a natural or artificially constructed imbalance or unequal distribution of this fluid thus serves as proof that the electric fluid is “perhaps the most formidable and irresistible agent in the universe” (Franklin, 1751, preface, n.p.).

Franklin's fascination with and insistence on the significance of fluidity as an (invisible) agent in science fuelled his researches into electricity. A further factor that renders *Experiments and Observations* so significant within electric discourse of the period is that Franklin is the first philosopher of the period to describe electricity as *one* fluid. In doing so, he rejects French models that regard electricity as consisting instead of two related fluids. Finally, *Experiments and Observations* (quoted above) lays out fundamentally new arguments in electric theory. It suggests not only that lightning is a form of the previously discovered electricity, also named 'electric fire', or the 'electric fluid', but also that this particular natural phenomenon occurs as a result of an unequal distribution in the air. [56] The idea of an equilibrium, which is achieved through the flow or exchange of electricity, is given particular emphasis in Franklin's letters. He describes several experiments to demonstrate this hypothesis, including the following:

> Place an electrified phial on wax; take a wire (g) in form of a *C*, the ends at such a distance when bent, as that the upper may touch the wire of the bottle, when the lower touches the bottom: Stick the outer part on a stick of sealing wax (b) which will serve as a handle. Then apply the bottom end to the bottom of the bottle, and gradually bring the upper-end near the wire in the cork.

This description of the experiment's setup is rather laborious and formal. However, perhaps owing to his excitement over the result, Franklin conveys what follows in far more colourful, abstract, and almost poetic language. Rendering the electric fluid perceptible through this experiment is described as follows:

> The consequence is, *spark follows spark*, till the equilibrium is restored. Touch the top first and on approaching the bottom with the other end, you have a *constant stream of fire*, from the wire entering the bottle. Touch the top and

[56] Natural philosophers such as Stephen Gray (1666-1736) were certainly aware of the connection between lightning and electricity, decades prior to Franklin's inquiries. However, the success and popularity of the American's experiments and publications finally seemed embed this fact in a kind of collective consciousness. Franklin is therefore widely credited with this discovery.

> bottom together and the equilibrium will soon be restored, but silently and imperceptibly; the crooked wire forming the communication.
>
> (p. 6, added emphasis)

Franklin's discoveries, his one-fluid hypothesis, his theory of a fluid electric equilibrium, and the connection he makes between (static) electricity and lightning, have been described as "perhaps the most dramatic and far-reaching findings in eighteenth-century science" (Schiffer, p. 161). The impact of Franklin's research was not limited to natural philosophic discourses alone. This newly discovered power in nature was absorbed by aspiring poets too and described in terms of fluidity, stream, flow and creative charge.

In a work conjecturally dated 1784, Edward Thompson described the atmospheric effects of a mountain range in similar terms:

> The sulph'ry mountain, whose electric pow'rs
> Stop'd ev'ry flying cloud, and drew their show'rs
> Upon the hard, parch'd, dried, and thirsty earth,
> Which drank the waters, and gave vapour birth;
>
> And with the rains collected all the winds
> That fill'd the atmosphere—these Nature binds
> Within the circle of electric charm,
> Till charg'd, and swol'n too high, they burst in storm:
>
> (Thompson, II, ll. 208-15)

Erasmus Darwin wrote in *The Botanic Garden* (1799), describing lightning:

> The rapid Fire-ball through the midnight air;
> Dart from the North on pale electric streams,
>
> (Darwin, ll. 1. 128-9)

Similarly, in 1829, Theodore Dwight described the heaven as ‘highly charged with electric fluid’ and as ‘overcharged with true electric shot’ (Dwight, 1829, pp. 69-70).

Benjamin Franklin’s speculations on electrical fluidity led, via the often-cited kite-experiment, to the invention of the lightning rod. The magnitude of this discovery which seemed to allow mere mortals to tame the supernatural force of lightning is frequently reflected not only in philosophic but also literary electric discourse of the period. Following Franklin’s drawing of the electric fluid from the heavens, anecdotes of his experiments merge into a literary trope frequently recurring in prose and poetry for decades to come, even into Victorian times. In 1791, the American newspaper ‘The Echo’ published a poem by Lemuel Hopkins which aimed to preserve a real event “consecrate[d] in deathless verse”. The poem tells of a horrendous thunderstorm, “with lightnings never seen and thunders never heard” (l. 38). Hopkins describes the destructive power of the event as ‘etherial war’ (l. 22) ranging in the skies, hinting at hypotheses of an ethereal Ur-fluid as a first building block of the Earth’s atmosphere. Hopkins’s lines point to ethereal powers responsible for this terrifying event in which man is but an inferior spectator. However, as the poem suggests, Franklin’s invention, the ‘thunder poles’, help prevent further destruction of the village struck by the storm: “Those guarded frames by thunder poles secur’d, / Tho’ wrapp’d in sheets of flame, those sheets endur’d” (ll. 27-8). In a footnote, Hopkins remarks, “Those buildings that were defended by electric rods, appeared to be wrapped in sheets of livid flame, and a flood of the pure fire rolled its burning torrents down them with alarming violence.” The metaphor ‘a flood of fire’ and ‘burning torrents’ draw on conceptualisations of electricity as a fluid, as well as pointing out electricity’s close relation to – or perhaps

even unity with – fire, as discussed by Franklin. The philosopher's lightning rods tame the force of the electric fluid, saving a town which might otherwise have been destroyed by a violent electric torrent.

In 1811, William Hamilton Drummond wrote in a poem entitled *The Giant's Causeway* in which he invokes Lucretius's early interest in the atmospheric effects of fire (3.1-2). He describes of "torrents of electric fire", the "electric flame" and "electric glories" (2. 345, 385, 3.72,). He appears to refer to the Northern lights as seen from a cliff at Benmore in Scotland, describing the effect of a "luminous appearance" caused "probably by the attraction of the electric fluid from the surrounding air" (p. 19). His poem also recalls the death in 1753 of Georg Wilhelm Richman who attempted to replicate Franklin's kite experiment, writing of "the philosopher struck dead by the electric fluid which he was drawing into his room for the purposes of experiment, Aug. 6 1753" (p. 7).

Roughly 30 years later, in 1826, Charles Thompson chose a similar subject for his poem entitled *The Storm; a Fragment, in imitation of Cowper.*[57] The poem does not refer to Franklin explicitly, but it is a further example of the fascination with lightning and thunderstorms inspired by eighteenth and early nineteenth-century researches into electric phenomena. It tells the story of a ship sinking during a thunderstorm, as witnessed by the narrator. The description of the spectacle is similar to Hopkins's insofar as it is referred to as a "ruthless war of the contending elements" (ll. 11-2), in which the vessel is destroyed by the force of the waves and a strike of lightning:

[57] The work Thompson is alluding to in this title is possibly Cowper's *A Thunder Storm*, which is however rather unlike Thompson's poem.

O’er her broad stern the waves tremendous broke;
Th’ electric fluid thro’ her rigging played---
Her masts---her cordage---devastating all,
‘Till the ribb’d hulk no longer marr’d its force

(ll. 23-6)

Thompson’s poem focuses on the destructive power of thunderstorms, and the war of the elements, with the electric fluid playing only a minor role. However, the language used in referring to the spectacle is similar to Hopkins’ earlier poetic treatment of a thunderstorm. The terminology of fluidity is still used to describe lightning and electricity in this and other literary works, even at a time when electric fluidity has become gradually less prevalent in scientific discourse. Thompson’s poem is not just a single exception in this respect. In 1843, John Castillo, widely referred to as the ‘Bard of the Dales’, contributed to the literary trope of the thunderstorm with his poem of the same title. The work, published in *Awd Isaac, The Steeplechase and Other Poems*, a collection of miscellaneous verse reverts to early eighteenth-century natural philosophic and religious writers in its interpretation of lightning as a visual reminder of the power of God. A thunderstorm sets a pseudo-apocalyptic scene in which the Almighty is a wrathful God and, to devout Christians, protective saviour at the same time:

Thou dost from perils screen his naked head,
Which in a moment fill the world with dread;
Thou, while *thy lightnings* flash, and thunders roll,
Dost whisper secret peace into his soul!

(ll. 5-8, added emphasis)

Lightning is explicitly pictured as a demonstration of divine power and wrath, in accordance with a commonly held view of the electric fluid as descending from a divine ether. As a result of such divine connections, the poem conjectures that

lightning is to be feared only by atheists. Firm believers on the other hand need not fear the fluid's force: 'While flaming lightning flash'd around our feet,--- / Yet by the flash, in each believer's face / We read the sign of confidence and peace'(vv. 22-4). The 'flaming fluid', running 'from north to south' (l. 38), straight out of heaven's gates, contrasts almighty and untameable force with human weakness. It strikes 'more quick than either thought, or sight of man' (l. 37) and is a reminder or a warning 'against that day,/ When earth and sky shall melt, and pass away!' (l.42).

Franklin's lightning experiments gained attention both in and outside of the scientific community, and paired with a fascination with the power of thunderstorms were frequent subjects of literary writing. In Britain, natural philosophers tended to follow in Franklin's wake. Indeed, a large number of scientific publications on the subject in the next ten to twenty years after *Experiments and Observations on Electricity* appear to be modelled Franklin's publication in style and content, sometimes describing experiments that differ only in slight detail from Franklin's, sometimes giving verbatim accounts, and repeatedly referring to the Franklinian model of fluid electricity.

Franklin's electrical experiments describing sparks, shocks, and an established "equilibrium", provided tropes for non-scientific writing. The idea of a constant flow and exchange of forces resulting in a kind of universal balance became metaphors for his own understanding of political conflict and social harmony. As Jessica Riskin has argued, "The same conservationist teleology and the same interaction between freedom and constraint [of natural forces restoring balance] were at work in his

moralist writing" (pp.73-4). In *The Botanic Garden* (1791), Erasmus Darwin wrote about Franklin and the American Revolutionary War:

> So, born on sounding pinions to the West ,
> When Tyrant-Power had built his eagle nest;
> While from his eyry shriek'd the famish'd brood,
> Clenched their sharp claws, and champ'd their beaks for blood,
> Immortal Franklin watch'd the callow crew,
> And stabb'd the struggling Vampires, ere they flew.
> The patriot-flame with quick contagion ran,
> Hill lighted hill, and man electrised man;
> Her heroes slain awhile Columbia mourn'd,
> And crown'd with laurels Liberty return'd.
>
> (ll. 361-70)

Darwin uses electrical metaphors to pick up on Franklin's moral and ideological view of the conflict. The verses 'The Patriot-flame with quick contagion ran/ Hill lighted hill, and man electrised man' emphasise the symbolic force of the electric fluid that sweeps across the newly-born American nation. America's 'patriot-flame', flows up and down the hills to "electrise" every person in its path. The spread of revolutionary ideas moves like a contagious current of electricity, and the transmission of ideas happens in a steady, flowing manner.

With the conflict of the American War of Independence simmering in the background, a conflict of ideas about electricity, lightning and the possibility that nature held an invisible but extraordinary power took place. Over several months, Benjamin Franklin, Republican and Liberalist, and Benjamin Wilson, Monarchist and Royalist, exploited a debate over lightning rods to promote their respective political viewpoints.[58] The metaphor of a revolutionary electric fluid continued to be employed in moralist writing even after Franklin's death in 1790. Robert Southey, a close friend

[58] For a detailed account of the Franklin-Wilson debate, and the means employed by each party in an attempt to win the upper hand in this scientific and ideological conflict, see Mitchell (1998).

of Franklin's, juxtaposes electricity and truth to express revolutionary ideas in his rendition *of Wat Tyler*: "The electric truth shall run from man to man" (p. 15; also cited in Fulford, p. 181), and similar imagery is used by Coleridge in his *Lectures on Politics and Revealed Religion* (1795).[59] At the time when he had been forming his vision of a utopian society, a 'pantisocracy', with Southey, he reflects on the suppression of British radicals, some of whom chose to free themselves by emigrating to America. He states, "every town is insulated, the vast conductors are destroyed by which the electric fluid of truth was conveyed from man to man, and nation to nation" (p. 313; also cited in Fulford, Lee, Kitson, p. 189).

Darwin, Southey and, to a limited extent, Coleridge's uses of fluidity in their literary and contemplative writing underline the concept's versatility as a literary trope. Whether it was used to convey revolutionary thought, idealism, or potential, the electric fluid regularly found its way into political/radical prose and poetry as metaphor expressing ideas of motion, moral guidance and persuasion and conviction.

Joseph Priestley (1733-1804) left a rich corpus of published writing in a variety of different areas of enquiry, ranging from religious to philosophical treatises. As Robert E. Schofield notes, Priestley was in his own time best known as a theologian and writer of sermons. Yet Schofield also observes that one of the strongest influences on Priestley throughout his career was Isaac Newton.[60] These facts make him an intriguing figure, particularly with regard to the language he cultivated. In the context

[59] The dramatic poem *Wat Tyler* was written in 1794, but not published until 1813.
[60] Schofield, Robert E. "Priestley, Joseph (1733–1804), theologian and natural philosopher." *Oxford Dictionary of National Biography*. 23 Sep. 2004; Accessed 16 Jun. 2021. https://www.oxforddnb.com/view/10.1093/ref:odnb/9780198614128.001.0001/odnb-9780198614128-e-22788.

of eighteenth-century science, Priestley is most frequently associated with his theories in the field of 'pneumatics', more specifically his discovery of oxygen.[61] Priestley was the first to isolate and identify ammonia gas, nitrous oxide, nitrogen dioxide, sulphur dioxide, and, most important, of oxygen. But his contribution to the science of electricity must not be underestimated. Priestley's *The History and Present State of Electricity*, published in 1767, spans several hundred pages. Comparing natural philosophers who build on works of the past to conquerors informed by histories of previous wars, he notes that "the labours of one are not only analogous to those of another, but in an immediate manner subservient to them" (p. v). Consequently, he pays tribute to a series of natural philosophers and their research into electricity, such as Martin Folkes (1690-1754) and William Watson (1715-87). The hypothesis of an equilibrium between positive and negative electricity, he notes,

> generally goes by the name of Dr. Franklin, and there is no doubt of his right to it; but justice requires that I distinctly mention the equal, and perhaps, prior claim of Dr. Watson, […] Dr. Watson showed a series of experiments to confirm the doctrine of plus and minus electricity to Martin Folkes, […] and, to a great number of fellows of the Royal Society, so early as, the beginning of the year 1747, before it was known in England that Dr. Franklin had discovered the same thing in America.
>
> (Priestley, 1775, p. 419)

Yet, despite his insistence that English scientists may have beaten Franklin to his discoveries, Priestley's reliance on the latter is undeniable. Michael B. Schiffer suggests that "[b]ecause Franklin furnished detailed advice to Priestley while the latter wrote his book, we can reliably take Priestley's account as the gospel according to Franklin" (p. 310). Citing Priestley, who admits that he obtained a "few particulars

[61] See Schofield, and Priestley's *Transactions* (1775) and *Experiments and Observations on Different Kinds of Air* (1774-86).

[…] from the best authority", Schiffer adds that this authority "could only have been Franklin" (ibid.).

Priestley's view of the value of natural philosophic hypotheses surrounding electric fluidity is complex. John McEvoy, in *Electricity, Knowledge and the Nature of Progress in Priestley's Thought,*

> seek[s] to relate Priestley's work in electricity not only to his convictions on scientific method, but to a conceptual framework that manifests the synoptic unity of existemological [sic.], metaphysical, methodological, theological, and strictly scientific parameters in his thinking.
>
> (p.2)

McEvoy's aim of portraying interdisciplinary unity within Priestley's work however necessitates that we "de-emphasize the historical context of Priestley's works in favour of an appreciation of the internal structure of his thought (ibid.). However, considering the narrative in which electric research was embedded at the time, a devaluation of the historical context surrounding scientific enquiry seems counterproductive. Scientific developments in the eighteenth century must be examined within their historical contexts. McEvoy's portrayal of Priestley as a progressive is centred on the concept of unity or interdisciplinarity. While "[m]any of Priestley's contemporaries discovered a unity of electrical, chemical, and thermal phenomena, by relating them all to the action of a single imperceptible causal agent, or aether", McEvoy argues that "Priestley's metaphysical interest in the interaction between nature and the human understanding in natural philosophy leads him to express this view of the unity of nature in terms of a unity of the disciplines of nature" (p.19). Commenting on the value Priestley ascribes to theoretical frameworks and abstract concepts, McEvoy suggests,

> Indeed, Priestley's epistemological principles denied any validity to such eighteenth-century ideas as imponderable fluids, imperceptible aethers, point atoms, or internal structures. To the extent that these views transcended the narrow bounds of appearances, Priestley valued them only for their heuristic service to the imagination in the discovery of new facts.
>
> (ibid.)

However, Priestley's *History and Present State of Electricity* (1767) strongly suggests otherwise. Priestley repeatedly refers to the passing or non-passing of what he calls an "electric fluid" in his own experiments and those of others, including investigation by Franklin (p. 209). Appearing over sixty times in his treatise, the term 'electric fluid' to Priestley fulfils much more than merely an 'heuristic service to the imagination'. To reject the concept of fluidity would have been to reject the discoveries of all those scientists that Priestley felt indebted to, and paid tribute to, including those of Newton, Watson, and Franklin. Writing a history of the science of electricity, he necessarily participated in a discourse strongly shaped by the notion of somewhat abstract, semi-material fluidity.

In a section entitled 'Queries and Hints Concerning the Electric Fluid', Priestley considers the constitution of an all-encompassing ethereal fluid, and discusses a possible existence of several rather than just one (electric) fluid. Additionally, he establishes a connection to the Ur-fluid, ether, referring especially to the Newtonian model:

> Is there only one electric fluid, or are there two? Or is there any electric fluid *sui generis* […], distinct from the ether of Sir Isaac Newton? […] Does not some particular order of the particles, which Sir Isaac Newton supposes to be continually flying from the surfaces of all bodies, constitute the electric fluid; as others, he imagined, constitute the air, and others the ether, &c.?
>
> (Priestley, *History*, 1775, p. 499)

This deliberation indicates Priestley's uncertainty as to an exact make-up of the electric fluid, and his frustration with the lack of a more precise terminology for scientific phenomena. He cites Watson's theory that in the way in which electrical charge can stimulate a silver leaf, an influx and efflux of electric ether must take place (pp. 142-3). Priestley himself states that there must be at least one fluid, the one that Newton suggested to form ether. Whether or not the electric fluid may be regarded as a specific variety or type of ether, or as an entirely separate entity, Priestley's reflection demonstrates that the concept of fluidity remains vital in his scientific discussion. He repeatedly employs the terms 'fluid' and 'electric fluid' in descriptions of his own experiments concerning electric sparks, charge and 'electrical explosions' (pp. 675, ff). While neither Milton nor Newton knew anything of electricity and its supposed operations, what unites later scientists such as Watson and Priestley to these 'strong precursors' is the concept of electrical charge as an observable effect of a more hidden and divine ethereal fluid. Priestley, like all other natural philosophers at the time, was bound by the concept of fluidity as a central pillar in electrical researches following in the wake of Newton, Franklin, Watson and other natural philosophers of his era.

As we have seen, electricity was a topic of keen interest to religious writers such as Blackmore and Priestley. John Wesley (1703-1791), theologian turned natural philosopher, similarly held a belief that there was one subtle, all-encompassing divine fluid that was fundamental in the creation of the earth. His 1778 treatise *The Desideratum, or, Electricity Made Plain and Useful* connects religious discourse with the philosophic concept of fluidity. By combining the hypothesis of the existence of

an electric fluid derived from a heavenly ether with Christian doctrine, Wesley argues that electricity must be a gift from God. He suggests therefore that the fluid should be harnessed and utilised to cure a variety of human illnesses. This synthesis of discourses in *The Desideratum* is enabled by the versatility of the concept of fluidity. The treatise is perhaps one the best eighteenth-century examples of both the way in which religious, and literary discourses were linked by the concept of fluidity, and of the way in which complex hypotheses surrounding this mysterious fluid made their way into popular culture. Henry D. Rack has appropriately described Wesley as a 'cultural mediator', and Deborah Madden ascribed to Wesley "the mediation of complex material to the literate and semi-literate in eighteenth-century England", which "was intimately linked to Wesley's rhetoric of 'plain' language" (p. 14). Wesley's main reason for getting involved in electrical science was to appeal to poor sick people and to offer them alternative therapies, divine healing methods, which might well attract more followers to Wesley's religious persuasion. As Paola Bertucci has argued, "Wesley's involvement in the art of healing was […] both a practical example of active faith and a means of spreading his credo" (p. 352). In Wesley's works, the role and agency of the electric fluid is understood through a combination of religious belief, and scholarly discussion of electrical natural philosophy.

In *The Desideratum*, Wesley acknowledges Franklin, to whom he is "chiefly indebted […] for the Speculative part" (p. III). In agreement with Franklin's hypothesis of fluid equilibrium, Wesley points out that a positively charged cloud must release its effluent quantity of the electric fluid into the air, and then down to Earth, forming a flash of lightning. Conversely, he suggests, negatively charged clouds, which are charged with less than their' natural quantity' of the electric fluid, draw electricity out of the earth: "Such a cloud therefore coming within a due distance of the earth, will receive from

it a flash of electric fire" (ibid., p.27). This explanation is akin to Watson's theory of electrical flow as passing by *efflux* and *influx*. Wesley suggests on this basis that, when a cloud is negatively charged, "It is really the fire from the mountains or other parts of the earth, which strikes into the cloud; and not, as we imagine, fire from the cloud that strikes into the earth" (ibid., p.25). He uses Franklin's model of unequal charge to explain the phenomenon of lightning. Crucially however, he insists that God re-establishes an equilibrium of charge through the electric fluid. In a somewhat curious interpretation of the Franklinian model of electric balance, Wesley regards rain, which he suspects contains portions of the electric fluid, as a lifesaver for both humans and animals. Perhaps rather amusingly, this conjecture leads him to suppose that rain is God's gift to man, helping to fend off the dangers of a lightning strike. "By wetting men or beasts", Wesley proclaims, "it saves many lives". Wesley urges his readers to see, therefore, "the wisdom and goodness of Him who sendeth forth lightnings with the rain!" (p.26).

Wesley's insistence of the divine quality of the electric fluid causes him to suggest its usage for the cure of a plethora of diseases – a view was also echoed also in his sermon 'On the Education of Children', in which he states, "Let it be carefully remembered all this time, that God, not man, is the physician of souls; that it is He, and none else, who giveth medicine to heal our natural sickness" (quoted in Bertucci, p. 348). Furthermore, contributing to the Vitality Debate, he makes a connection between diseases and the nervous system and suggests that "the electric ether is the only fluid in the universe, which is fine enough to move through [the nerves]" (p. 5). His model underlines the flexibility and adaptability of the abstract concept of fluidity. First, the above line combines the hypothesis of an electric fluid with its conceptual 'ancestor', the Newtonian ether, to form a notion of 'electric ether'. Second, it documents the

semi-material, almost shape-shifting qualities of such a fluid. According to Wesley, it is 'thin enough' to move through the nerves, in a manner similar to the abstract ethereal fluid and regarded as subtle enough to penetrate all bodies. At the same, Wesley portrays the 'electric ether' as a variation of the commonly cited 'nervous fluid', somewhat analogous to blood running through human veins: "[w]hat if the nervous juice itself be a fluid of this kind?", Wesley asks, speculating on the semi-materiality of such a versatile and adaptable ethereal electric fluid.

Medical interest in the therapeutic possibilities of electricity was growing at this time. Physical conditions that Wesley promises may be alleviated through "electrification" or "electrifying" are diverse and range from "Agues", "King's Disease", and "palpitations of the heart" to rheumatism, ringworms, and "oe-hurt" (pp. 42-3). Electricity, he proclaims "seems therefore to be the grand Desideratum in physic, from which we may expect relief when all other reliefs fail, even in many of the most painful and stubborn disorders" (p. 43). Like others who ventured to advertise electricity as a universal remedy, Wesley came under close scrutiny by his contemporaries, a number of whom suggested he stick to being a minister. One of his most prominent critics was physician William Hawes, founder of the *Royal Humane Society*, who, having read Wesley's earlier medical work *Primitive Physick* (1747), writes,

> This writer […] has laboured to give mankind the most unfavourable ideas of the practitioners in physic and pharmacy… If Mr Wesley's character and conduct, as a divine, a politician, and a practitioner in physic, were to be examined with the same degree of candour that he hath exercised towards others, he would certainly not appear in the most advantageous light.
>
> (Hawes, as quoted in Heitzenrater, pp. 129-30)

Criticisms of this kind were not unusual.[62] But Hawes' treatment of Wesley's work reveals a somewhat elevated status of the study of electricity in medical practice. As Richard Heitzenrater has argued, "even a cursory analysis reveals some notable omissions in Hawes' criticisms. Wesley's frequent prescription 'to be electrified', is never challenged by Hawes except in its use as a remedy for 'old age'" (p. 129). The supposed special properties of the electrical fluid in curing diseases were acknowledged even by members of the medical faculty, making it almost impossible to discern eighteenth-century 'electric quacks' from genuine doctors. Wesley's religious zeal however set him apart from those seeking profit from supposed electrical remedies. His medical studies are rooted in the belief that electricity is a divine fluid, a tool given to humans to cure diseases.[63]

The motif of 'divine electricity' was picked up by Wesley's colleague, Anglican priest and poet Edward Perronet who published his poem 'On the Wonders of Electricity, and other Branches of Natural and Experimental Philosophy' in 1775. Natural philosophy, the "sacred art" and "sure guide to nature's laws", Perronet writes, would prove the existence of a divine being, "the Great Supreme" or "Primal Cause" which was regarded as becoming apparent whenever the subtle electric fluid became visible or perceptible in its effects. Perronet's poem pinpoints the intricate connection between the electric and ethereal fluids, and crucially describes God's mode of creation:

[62] It is worth mentioning that such criticism was not solely directed at Wesley's scientific and medical pursuits. It was motivated frequently by a rejection of his Methodism.

[63] There has been some debate about the extent to which Wesley may have used science and medicine to attract new Methodist 'disciples' (see for example Bertucci, and Madden). For the purposes of this chapter, I focus on the ways in which religious and natural philosophical discourses were combined to portray the electric fluid as a divine phenomenon.

That great Supreme, whose all commanding skill
Bespoke all being, and directs its will:
Himself a centre that no limit knows,
And whence creation, as its fountain, flows;

(p.64)

Creation itself *flows* as a fountain from a divine being. Electricity, supposedly given to humankind in this same fashion, is therefore necessarily conceptualised as a fluid.[64] Perronet's poem hails God, "whose eyes are lightning" (p.65) as giver of universal balance, or the much-cited equilibrium first suggested by Franklin: "See then His hand by each just balance known/And its vast force from mighty levers shewn" (ibid.). Both Wesley's and Perronet's writing are informed by the same abstract concept of fluidity, and both authors emphasise that, to render the operations of ether observable and know the properties of various semi-material divine fluids, is to know the workings of a divine creator. The great aim of eighteenth-century science was to turn faith or belief into knowledge. It is only fitting that an emphatic appeal should conclude Perronet's poem: "Go on, great bard, and shake the electric rod/ Till fools grow wise, and Atheists own a God!" (p. 66)

Perhaps one of the most entertaining pieces based entirely on the conception of electricity as a semi-material, divine fluid is a publication entitled *Intellectual Electricity, Novum Organum of Vision, and Grand Mystic Secret* (1798) by William Belcher, who refers to himself as "a rational mystique" (p. i). Belcher was well-read and had a working knowledge of scientific publications of the period, but he did not belong to any group of acclaimed and well-respected natural philosophers. Having

[64] The same conceptualization applied to magnetism, which is also referenced in Perronet's poem.

spent the period from "1778 to 1795 in a madhouse at Hackney" (Ingram, p. 187), he was certainly not a credible philosopher to his contemporaries. Allan Ingram has described Belcher's publication as "a parodic scientific-religious pamphlet exploiting the potential of a style of ambiguous sanity" (ibid.), and most recent treatments of Belcher's work tend to neglect its originality and relevance as a result of this view. While Belcher was likely to have been referred to as a quack or even a madman, his musings on intellectual electricity, though in part satirical, document the wide appeal of a mysterious, potentially divine fluid. Belcher's personal story of being regarded as a lunatic, while being highly educated and well-read at the same time, points to a prominent dilemma of the medical and scientific professions at the time. The line separating those that were considered 'serious', honourable, highly-regarded men of the medical faculty, and those who were discredited as dishonourable, madmen, or quacks was blurred. Belcher's publications are located at an intersection between literary and natural philosophic discourses. They illustrate once more how considerations on fluidity led to a convergence of various strands of discourse. In their creative, literal treatment of natural philosophy, they document a development of new hypotheses on workings of the soul, the production, transmission and flow of ideas and creative potential, and the role of the electric fluid in those processes.

In *Intellectual Electricity* (1798), Belcher announces that he intends to "sketch a new theory of electric and anti-electric medicine; illustrate the medium of matter and spirit; declare the source […] of religious apprehensions; ascertain, familiarize and anticipate Immortality, and light the passage to Eternity" (pp. 18-19). In order to do this, he draws up comparisons between oxygen and electricity, electricity and the soul, and, crucially, between electricity and the nature of creative ideas and their transmission. Metaphors taken literally are the driving force behind most of this publication

concerning the soul, thought, divinity and creativity against the background of the powers of the electric fluid. In accordance with contemporary discourse surrounding vitality, Belcher discusses the electric fluid in a somewhat *Frankenstein*-esque description, though some years before Shelley's 1818 novel. He states,

> Though I do not believe that the electric fluid how exquisitely rare, and, at the same time, powerfully elastic so ever to be divine; I, as already suggested, surmise that it may be the divine agent in raising the dead.
>
> (Belcher, *Orthodoxy*, p. 3)

While he does not describe the electric fluid as divine as such, there is a strong implication of what may be referred to as the 'vital spark' so often hinted at but never openly discussed in *Frankenstein.* Belcher's publication comes just nine years after electric experiments conducted by Luigi Galvani that seemed to show a causal connection between muscle contraction on frogs' legs, and electricity.[65] Galvani "ascribed these movements to an electrical fluid of power, innate in the living frame […], which he denominated Animal Electricity" (Ure, p. 283). Experimentation surrounding electricity and dead bodies was becoming fashionable, from the turn of the century right up to the publication of *Frankenstein.*[66]

Belcher largely refrains from referring to those experimentalists whose descriptions of animated corpses shocked eighteenth-century audiences. Instead, his hypotheses are based on an apparent connection he establishes between the electric fluid and the soul, both in his view essential for (human) life. Describing the human soul in a manner analogous with various subtle, semi-material fluids, Belcher argues that it does

[65] Volta was to discover that it was the metals used in Galvani's experiment, not in fact the frogs' legs, which 'produced' electricity.
[66] For a more detailed account of eighteenth-century electric experimentation, particularly on dead bodies, see Rudy, pp. 21-4.

not "consist […] of such matter as we are acquainted with" (Belcher, p. ii), but that it must be "subject to the laws of matter" (ibid., p. i). Drawing on the notions of charge, repulsion and attraction, and regarding human emotion as equally valid as scientific discoveries, he surmises that love and hate, among other sentiments, are the results of those scientific principles acting on the soul (ibid.).[67] In drawing a vital connection between human life and the ethereal and electric fluids, he states that the soul "is possibly communicated by sparks of the aether, electricity, or oxygen, or by their union", adding that "perhaps also magnetism has a share in the human constitution and affections, and morality is its polar star" (ibid., pp. i-ii). The electric fluid, Belcher further states, may play one or more of the following roles in conveying ideas:

1) By means of the identity of the electric and nervous fluid?
2) By its action on the nervous fluid, whether they are identical or not.
3) By its action on the blood, on supposition of the blood's vitality.
4) By its action immediately on oxygen known to mix with the blood in the lungs, and to be in a manner the breath and spirit of life. […]
5) Through its subtile [sic.] communication with the sensory
6) By its direct access to the Soul
7) By its being the vehicle of Spirit

(ibid., pp. v-vi)

While particularly his first point seems to imply an early notion of electric impulses in the brain and the nervous system, the overall tenor of Belcher's work is less scientific and more centred on creativity as opposed to science than the above quote suggests. Electricity, he suggests, functions as a kind of impulse that facilitates creative thought. Fluidity (i.e. the conception of electricity as a fluid) is the vehicle that drives or enables all thought processes. "[O]ne good spontaneous flash of intellectual fire is worth many forced", he argues, noting further that "ideas, apparently clothed in particles of electric or oxygenous fire, are by coruscation both natural and

[67] Belcher's account of human love or hate, and magnetic attraction and repulsion in animal magnetism will be discussed further in my chapter on magnetism and Mesmerism.

sometimes artificial, communicated to the sensory, and thence to the soul" (pp. ii-iii). Belcher draws on earlier publications by English physician and scientist David Hartley (1705-1757) who, in his *Observations on Man* (1749) "combined ideas about the psychology of mental associations with the conjectures drawn broadly from neuroanatomy, mechanics, optics and electricity" (Whitaker, p.177) in his 'Doctrine of Vibrations'. As Shelley Trower has pointed out in *Senses of Vibration*, Hartley had probably made "the first comprehensive attempt to integrate associationist philosophy with Newtonian physics, to ground mental processes in the physical" (p. 16). Belcher seeks to combine Newton's *Opticks*, Hartley's theory of vibrations, readings of Kant on morality, and the concept of fluidity to support his hypothesis that ideas, like the ether or the electric fluid, may be a semi-material substance. He states: "And if, according to Newton's assumption, electricity depends on the aether that pervades the skies and the frame of man in common, 'conversation in Heaven' may be more than metaphorical" (Belcher, pp. xii-xiii). Analogous to the electric fluid or the ether, ideas may be fluid and floating, as Belcher further suggests:

> The spirit of animation probably consists, more or less, of the nervous fluid; but whether it is according to Gavini [sic., i.e. Galvani] and others, the very same with the electric fluid, or aether; or whether it is, merely stimulated by the former from without, I presume not to say. But perhaps, according to mid hypothesis, there may be a mixed collision, and coruscation of some fine dissimilar substance within the body, blending, but not uniting, with some other from without.[68]
>
> (ibid., p. 34)

[68] Belcher then cites Erasmus Darwin, who, he suggests "almost stumbled on my discovery". Darwin had suggested that blindness could be cured by passing "very minute shocks" through the eyes. This, as stated in Darwin's *Zoonomia* (1794-96), could be achieved by putting a piece of silver under the patient's tongue, and a piece of zinc on top of it, before repeatedly bringing the edges of the two metal plates into contact (Belcher, p. 34). Belcher regards this experiment as a conformation of his hypothesis of the similarity between the nervous, electric and aetherial fluids.

This theory of floating ideas, or floating genius, Belcher himself interprets in a poem he had previously published as part of a collection entitled 'The Galaxy' in 1790, and which he includes in *Intellectual Electricity*. His 'Electric Oxygenous Pindaric Ode', to be purchased at the made-up 'Office of Mystics and Intellectual Electricity, 333 Oxford Street' portrays the fluctuation, flow and transmission of ideas as follows:

> When rage collides the kindling frame
> Or wit coruscates meteor-flame;
> Or when the cheering bowl invigorates the soul
> And music's strings vibrating dance
> And thrilling, enjoyment enhance;
> Then *th' Electric Spark* clashes,
> With *Oxygen* flashes
> Expanded genius flows,
> Each gen'rous spirit glows,
> And mortals to Heaven advance.
>
> (Ibid., p. 174, original emphases)

His 'Ode' focusses on images of constant movement, flow, and transmission. Ideas of fire, electricity and vibration merge to create imagery of inspiration and creative excitement and enjoyment. The '*Electric Spark'* and '*Oxygen*' in their clash act as a catalyst for creative energy, produce flowing genius and enhance creative spirit to widen horizons. The image of mortals' advancement to Heaven suggests a creation of supernatural insight which mortals can achieve once inspired by a clash of natural forces or a sort of mysterious mingling of various imponderable fluids.

Belcher clearly did not regard himself as a quack. He frequently sought to use his knowledge of contemporary scientific discussion to advance his career, not just in the scientific, but also in the creative/literary realm. He advertised his 'Galaxy' collection of poetry in London newspapers around the time of its initial publication. An advertisement in the *General Evening Post*, published on December 28th, 1790 reads

as follows: “On this day was published […] The Galaxy: consisting of a variety of sacred and other poetry. The Whole original and new. By W. Belcher […] To this original publication the reviewers are kind and partial” (Issue 8932, Dec. 1790). The reviewer’s kindness however seems to have been made up, or it quickly turned against the author. In a 1792 issue of *The World*, an outraged, hurt and defiant William Belcher writes in his ‘Appeal to the Public’,

> When an author (and everyone has at first a name to acquire) sees himself proscribed by a set of men, who (a few excepted), are mere trading society, often actuated by envy or malice, and always by self-interest, whilst they mechanically profess a zeal for Literature, and feelings to which their souls are utter strangers – when an author is thus cruelly injured, candour may excuse him for transcribing the judgement of a critic […] and candour and good nature ought also to induce persons, inhabitants of a nation called liberal, to see with their own eyes, whether or not he has been injured by the misrepresentation of reviewers .
>
> (n.p.)

To convince his readership of the quality of his poetry, and to defy reviewers, Belcher then proceeds to offer copies of the volume, free of charge, in a somewhat desperate attempt to rescue his damaged reputation. Copies “may be had on trial, and returned if not approved of, as tastes may differ.” But is not only his defiance and anger that makes this advertisement worth noting. Belcher, scientist, poet, and businessman, also promotes one of his own inventions at the end of his complaint. A mysterious fluid, an “External Vegetable Tincture for costive and ill habits of the body [...], which renders the use of inward medicine unnecessary to convalescents.” He concludes his statement with a pledge to truth and honesty: ‘I pledge my word and honour, which, certainly, I would not for the truth of any imposition” (*The World*, November 23, 1792. Issue 1842).

Belcher's true intentions may remain unclear, although particularly his defence in *The World,* connected with a promotion of his wondrous tincture point to dubious motives. However, whether ill-inspired or not, Belcher's career is an example of how contemporary scientific discussions centred on electricity could permeate imaginative literature in their treatment the creative process. Belcher's work documents that eighteenth-century notions of flow, transmission, and a generation of creative genius frequently relied on existing scientific conceptions of fluidity – in this case the electric fluid.

As a mysterious agent and potential cure to a variety of different diseases, the electric fluid naturally lent itself to those who sought to make large profits through selling their somewhat dubious treatments. It is difficult to discern honest doctors from profit-seeking quacks, but there are some examples that leave little doubt as to the sellers' intentions.[69] At the time of William Belcher's publications on *Intellectual Electricity*, Elisha Perkins, American physician, rose to fame by exploiting the mysteries of the electric fluid. 'Perkins's Metallic Tractors' made him, perhaps one of the most infamous quacks of the period. The instruments, two 3-inch metal rods, sold for five guineas per set, were, as so many medical contraptions of the time, inspired by a (then failing) Mesmeric practice.[70] Dr Perkins had noted a twitch in a patient's muscle as he had touched it with a metallic instrument during surgery, which caused him to sell his metallic tractors as medical conductors of the electric fluid.

[69] For more on intentionality and distinguishing honest medical professionals from quacks, see Porter, 1989, pp. viff.
[70] For an in-depth discussion of Mesmeric practices based on magnetic fluidity, see chapter 3 of this thesis.

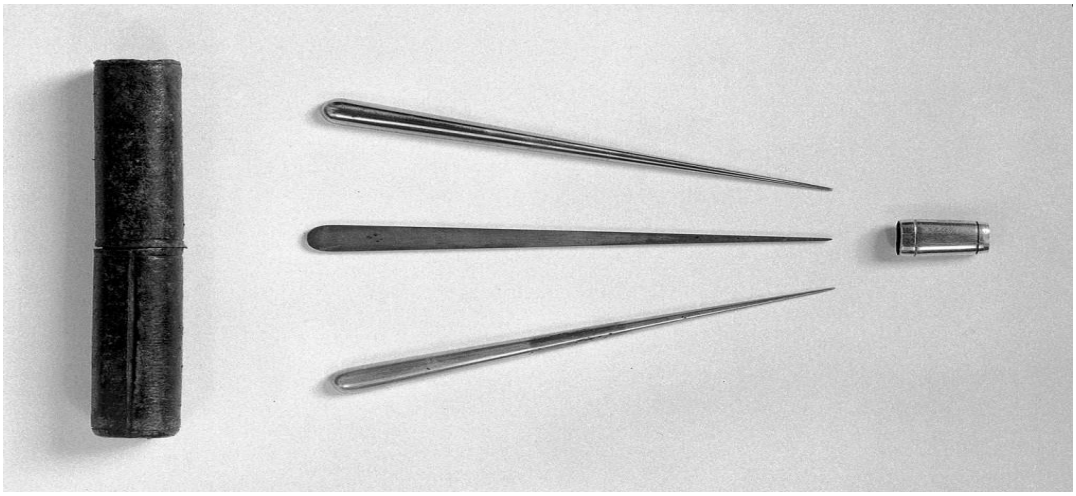

Figure 1: Elisha Perkins' Patented Metallic Tractors. Credit: Wellcome Collection. Accessed via Wellcome Collection.org.

It was Perkins's son Benjamin who sought to advertise the Tractors in Britain, after Elisha's death in 1799. To introduce the British medical profession to his wonders of medicine, he published a treatise entitled *The Influence of Metallic Tractors on the Human Body, in removing various painful Inflammatory Diseases, such as Rheumatism, Pleurisy, some Gouty Infections &c*. The work relates the invention of the tractors and their success and fame in America, which was achieved only after overcoming widespread opposition.[71] Elisha managed to distance himself from Mesmeric practices, which had been dealt a blow by the publication of the Commissioners' Report. While Perkins was keen to point out the differences between his treatments and any magnetic cures, pointing out that he instead is relying on "the late important discoveries of Galvani, and the ingenious [electrical] experiments of Valli, Volta, Fowler, Moro and Cavallo", the supposed effectiveness of his Metallic

[71] Perkins describes his father's initial struggle of overcoming doubts and concerns voiced by other doctors at the 'general Medical Convention'. What makes these tales remarkable is that these concerns, Benjamin Perkins insists, were informed by widespread aversion to Mesmerism in America: "The first impressions on these gentlemen was, that the operation of the *Metallic Influence* was merely a revival of *Animal Magnetism*" (Perkins, p. 7). It was only after Elisha had convinced his colleagues that his instruments had nothing to do with Mesmerism, that he gained their support.

Tractors is rooted, like that of Mesmerism, in the belief of the effectiveness of imponderable, all-powerful fluidity. In a manner similar to descriptions of the effectiveness of an animal magnetic fluid, Perkins describes the effectiveness of his Tractors as follows:

> After all these discoveries of a certain *influence,* by whatever name it is called, in the nervous system of animal bodies, which has properties, and is subject to the same laws, in many respects, as the electrical fluid, and which may be excited or educted [sic] by the application of metallic substances, would it appear strange to a philosopher, or would it exceed the credulity of a well-informed Physician, that *Metallic Points,* applied to persons diseased with pain, had given relief?
>
> (Perkins, p. 27, original emphases)

The assumption that a proposed substance in the nervous system is very similar to the electric fluid and could therefore guide and influence its flow through the body, is similar to the notion described by William Belcher. Perkins states that every "sensation is dependent upon this energy", and subsequently "pain, or supersensation, can only depend on an accumulation of the electroid [sic.] fluid" (p.94). Perkins managed to convince a number of highly regarded members of the medical faculty in America and Britain. 'Perkinism', James Delbourgo writes, would "prove durable enough to achieve an institutional culmination of the Perkinean Society of London in 1803" (p.644), reminiscent of various mesmeric circles flourishing in Paris in the latter half of the eighteenth century.

In defence of his model of medical electric fluidity, Perkins' treatise includes a plethora of accounts, given by supposed patients, and 'doctors' who purchased the tractors to use them in their practices. It would exceed the limits of this chapter to discuss them all in detail; suffice it here to give two examples. Frederick Dalcho,

"M.D., surgeon in the Army of the United States", reports the treatment of one of his patients who, over the course of twenty years, had been "much afflicted with a spasmodic affection on the left side of his head" (p.44). Dalcho recounts that his patient had been hit by so strong an attack "that [the patient's] intellectual functions were entirely deranged". After a few treatments with the Perkinean Tractors, he insists, "he became perfectly easy and free from pain […], no indisposition remaining but what is consequent on age" (p. 45).

A contributor referred to as 'Reverend John Devotion' gives an especially lively account of his use of the tractors on patients, and on himself. He insists to have successfully treated "a sea captain" (p.79) who "had no belief in the efficacy of [the] *Metallic Tractors* but is now captivated with the relief they have afforded him. After having also experimented on several family members, the Reverent decides to try the rods on himself:

> I soon found the electric fluid passing through my leg […], the next morning found my face puffing on the left side. I then reasoned thus – I have drawn the electric fluid of three persons into my own body.
>
> (p. 80)

The Reverend then goes on to relate the tale of how he "drew the electric fluid from [his] leg", and "scattered it through [his] whole frame". Perkins chooses to attach his reply to the patient, in which he insists that "as the *Metallic Tractors* act upon an established law of nature, there is no fear that they will want power so long as the electric rod will draw electric fire". He concludes by hitting out at his critics, saying that "all the unbelief and buffoonery of the envious will not hinder its effects" (p.81). Such miraculous recoveries, as these accounts supposedly showed, were a frequent

effect of the use of the Metallic Tractors. Patients "throw[ing] aside [their] crutches" (p.61), or suddenly declaring themselves entirely free from pain (pp. 64, 67) were not uncommon, and all owing to the wondrous power of the nervous and electrical fluids being guided, drawn, directed through patients' bodies, by the Perkinean rods.[72]

Figure 2: James Gillray, 'Metallic Tractors', showing Elisha Perkins. Caricature of Perkins Tractorising a Patient. For dramatic effect, the image shows electric sparks flying out of Perkins' Metallic Tractors, even though the electric fluid remained invisible during this treatment. Credit: Wellcome Collections. Accessed via wellcomecollection.org.

Treatments such as that suggested by Dr. Perkins also attracted criticism and ridicule from contemporaries, particularly after the disproval of the existence of a related

[72] Perkins's reliance on the concept of fluidity was key to his endeavours as a doctor and businessman. Material Rhetoric perfectly lends itself to the discussion of this, and multiple other examples of quackery, and even 'proper' medicine of the period. This approach, introduced by Hawhee and Holding, takes "as parameter the stuff that necessitates and facilitates rhetorical exchange, centering on suasion's matter". It "attend[s] to 18th-century rhetoric's materiality and make[s] a place in the histories for theorizing how rhetoric works to change the body and mind constitutively". Seventeenth- , eighteenth- and early nineteenth- century experiments concerning the natural origins of fluidity, as well as its role of the human mind, soul, and body were frequently conducted through specially designed apparatuses, such as the Perkinsean Tractors, which de-etherised the fluids, i.e. were designed to make them visible or perceptible.

animal magnetic fluid, in Paris (see chapter three). Perhaps surprisingly, it was a work intended to satirize those faculty members who opposed the Metallic Tractors, which also seemed to accomplish the opposite. Using the pseudonym Christopher Caustic, Thomas Green Fessenden (1771-1837), an acquaintance of the Perkins family, published his Poetical Petition Against Tractorising Trumpery in 1803,[73] channelling frequent allegations of quackery against Perkins into a literary, pseudo-scientific work. Caustic, the poem's narrator, whom Fessenden modelled after an old-fashioned doctor, and who presents himself as "fellow of the Royal College of Physicians, Aberdeen, and member of no less than nineteen very learned societies", launches an attack at the 'Perkinsean Institution'. It was Perkins, Caustic laments, who drove him, the well-learned and immensely highly regarded physician, out of business with his "metallic mischief makers" (p. I) that "tractorise away our guineas" (p.50). What follows is a lengthy account of the doctor's abilities and education, which amounts to nothing when faced with Perkins' instruments that magically cure patients. An enraged doctor argues,

> That none should ancient customs vary,
> Nor *leges physics mutare*;
> And thus to gain a cure unlook'd for,
> The patient *save*, but *starve* the doctor [sic.]
>
> (p. 51, original emphases)

Although Fessenden wrote the poem to defend Perkins's Tractors, the text continuously blurs the line between satire and criticism. The poem could easily be read as a satire, not of the sceptical medical profession, but of the money-making

[73] Fessenden published a slightly altered version entitled *Terrible Tractoration* in 1836. This version quotes Franklin's 1788 letter to Rittenhouse about the role of fluidity (as discussed above). In 1809 Fessenden published a further satirical poem on quackery, alliteratively entitled 'Pills, Poetical, Political, and Philosophical, Prescribed for the Purpose of Purging the Public of Piddling Philosophers, Penny Poetasters, of Paltry Politicians, and Petty Partisans, by Peter Pepperbox, Poet and Physician'.

‘Tractorizer’, Perkins himself. In a way reminiscent of Mesmer’s medical practice, the Perkins family had only managed to rise to such fame, or infamy, by utilising a model of (electric) fluidity as the basis for his Metallic Tractors. Unsurprisingly, the Perkinean fame was equally as short-lived as that of Mesmer.

In the latter half of the eighteenth century, experimentation surrounding the phenomenon of electricity sparked new interest in this powerful fluid. Although research into static electricity had been conducted over several centuries, it was arguably not until Benjamin’s Franklin’s publications that the science of electricity formed its own branch of scientific enquiry. As a result of the spectacle surrounding electric experimentation, the ambiguity of terms classifying the phenomenon, and of course Franklin’s fabled kite-experiment, a fascination with electricity went far beyond scientific treatises alone and frequently found its way into the poetry of the period. The electric fluid, a mysterious, swift, powerful and invisible agent, informed scientists and creative writers alike. The conception of electricity as a fluid owed much to both Christian creation narratives and Lucretian thought. In the years following Franklin’s *Experiments and Observations*, the notion of electric flow facilitated a plethora of creative treatments of an otherwise strictly scientific phenomenon.

The plurality of texts on the uses of the electric fluid was largely owing to two ambiguities. Firstly, the concept of fluidity that gave birth to eighteenth- century understandings of electricity was multi-faceted, imprecise and adaptable. Secondly, the fact that literary/creative interests on the one hand, and scientific ones on the other hand were not separate at the time, enabled writers to combine scientific observations with creative licence to enhance the impact of their apparent discoveries. Intellectuals of the period were rarely ‘just’ natural philosophers, or creative writers. Publications

on electricity tended to be infused with writers' agendas and the electric fluid frequently became an instrument in conveying certain brands of politics. Franklin and Wilson instrumentalised the electric power in a dispute over lightning rods – a surrogate war over opposing attitudes to the American Revolution. Political writers used imagery of the electric fluid sweeping the American nation as a 'patriot-flame' running 'with quick contagion'. Writers like William Belcher combined the scientific discourse of electricity with philosophic musings about the constitution of life in linking the electric fluid to the nervous and vital fluids. These findings were then used to promote Belcher's poetry in which the transmission and flow of ideas, inspired by the electric fluid took centre stage. Religious writers such as John Wesley saw Franklin's publications as confirmation that the electric fluid must flow down from heaven, like rain, as a gift from God. It would be foolish, he insisted, not to use this gift by sending the electric fluid through the bodies of the sick to cure them with God's power. Many were convinced by electricity's healing powers, and so it was perhaps not surprising that the fluid would soon be sold as an invisible cure by quacks such as Benjamin and Elisha Perkins who 'tractorised' their patients insisting that, in directing the electric fluid through the human body, the tractors acted 'on an established law of nature.'

The last decade of the eighteenth, and the first half the nineteenth century mark a change in the understanding and conceptualisation of electricity as a fluid in the scientific arena. Humphry Davy following in the footsteps of French chemist Antoine Lavoisier, promoted a formal, detached approach to the explanation of scientific phenomena, and the classification of substances. Fluidity as an abstraction did not feature in his 1806 Bakerian lecture on Electrochemistry. Indeed, following Davy's lecture, there was a general decline in the significance of the concept of fluidity in

electro-science. Instead, the electric fluid made way for other expressions, such as ‘electric current’, ‘electric energy’, or quite simply ‘electricity’. Faraday continued to pursue this drive for clarity in scientific description. While he did not tend to refer to electricity as a fluid in his *Experimental Researches*, his approach was less prescriptive than that of his predecessors. Instead of insisting on a specific model as a means of explanation, Faraday offers fluidity as only one of several possible gateways into understanding electricity. To Faraday, at this point, electric fluidity had become nothing more or less than an analogy to clarify scientific processes. His main reason for doing so links back to earlier conceptions of fluidity, namely that all fluids share one characteristic. This characteristic is *motion* or *transmission*. While Faraday saw fluidity as one possible analogy explaining the electric current, the concept was no longer crucial to explaining electrical phenomena.

While the significance of the concept of fluidity in discussions of electricity faded gradually following Davy’s Bakerian Lecture, it remained a literary trope for decades to follow. Charles Thompson and John Castillo’s poems referencing lightning and fluidity (1826, 1843, as discussed above) are just two examples of such literary treatments in which, the ‘electric fluid’, or ‘electric fire’ reappeared as a mysterious all-powerful force. In the period following the first decade of the nineteenth century, writers continued to exploit the old scientific concepts with poetic licence. Imagery surrounding the flow of electricity and the transmission of energy remained applicable to a variety of different contexts.

An analysis of religious, literary and semi-scientific texts has shown the significance of a divine, abstract substance called the ‘ethereal fluid’. In this chapter, an analysis of scientific, political and literary writings relating to the science of electricity in the

eighteenth and nineteenth centuries has been undertaken with the aim of demonstrating two broad but significant points: firstly, that electricity, and particularly the conception of electricity as a fluid is linked to earlier concepts of the divine ethereal fluid; and secondly, that there was a gradual change in eighteenth-century discussions of electricity in terms of fluidity. As a result of its close connection with the divine ethereal fluid, the electric fluid itself was not, initially, non-religious or secular. However, despite the long shadows on Milton and Newton in their influence over later scientific and poetic writing, a gradual diminishing of religious implications in discourse of electricity becomes apparent over time, while the notion of fluidity in electric discourse becomes something of a linguistic fossil. By the latter half of the nineteenth century, on the contrary, in treatises by Humphry Davy and Michael Faraday in particular, we see a rising awareness of the significance of metaphor and analogy in scientific explanation. By this time, electricity is still sometimes referred to in terms of fluidity, but the concept ceases to be essential and becomes only one of several ways in which the phenomenon of electricity might be referred to or explained.

Chapter Three: The Magnetic Fluid

This chapter examines the status of magnetism as a fluid from the seventeenth to the early nineteenth century. Its principal aim is to demonstrate that the concept of fluidity was central to understandings of magnetism in the period. The story of magnetism's relationship to both electricity and ether at this time is complex and multi-layered. To begin with, seventeenth and eighteenth-century discourse on the topic illustrates the period's commonly held belief that there were two different kinds of magnetism. On the one hand, the terms "terrestrial" or "mineral" magnetism in the period refer to occurrences of a magnetic fluid supposedly present within or surrounding inanimate objects, such as stones, metals and crystals. On the other hand, "animal magnetism" at the time is usually understood to comprise all forms of a magnetic fluid present in or surrounding the human body, and all medical practices which employ the magnetic fluid to the body in an effort to heal disorders and diseases.

This chapter recognises these different strands of discourse within the field of magnetic research by examining discussions of terrestrial magnetism, and animal magnetism. However, it argues that both kinds of magnetic discourse share essentially the same underlying hypothesis of magnetic fluidity as a central model explaining magnetic phenomena. The potency of both sorts of magnetism as portrayed by writers in the period is rooted, like that of electricity, in the phenomenon's conception as a fluid. Like the electric fluid, the magnetic fluid in the period is frequently regarded as a substance of divine origin, owing to its perceived relation to or descent form the ethereal Ur-fluid.

Milton made only one reference to magnetism in *Paradise Lost*, but when he does so his reference clearly links with the idea that Creation forms a homogeneous whole or

system. Making his way from Hell to Earth, Satan settles at the 'orb of the Sun', and notes its 'all-cheering' power:

> The great luminary
> Aloof the vulgar constellations thick,
> That from his lordly eye keep distance due,
> Dispenses light from far; they, as they move
> Their starry dance in numbers that compute
> Days, months, and years, towards his all-cheering lamp
> Turn swift their various motions, or are turned
> By his magnetic beam, that gently warms
> The universe, and to each inward part
> With gentle penetration, though unseen,
> Shoots invisible virtue even to the deep;
>
> (III, ll. 576-86)

Once again, we see Milton's notion of a primordial "invisible virtue" constituting the universe at work. By the early eighteenth-century, the particular uses and powers of magnets were more widely understood. In *Gulliver's Travels* (1726) Jonathan Swift's eponymous hero makes a remarkable observation when he spots a mysterious large object in the sky. Gulliver states,

> I turned back, and perceived a vast opaque body between me and the sun, moving forwards towards the island: it seemed to be about two miles high, and hid the sun six or seven minutes, but I did not observe the air to be much colder, or the sky more darkened, than if I had stood under the shade of a mountain.
>
> (p.167)

It soon becomes clear to him that what he is seeing is in fact a vast "Floating Island", owned by the King of Laputa.[74] Once he is able to board the floating landmass, Gulliver describes to his reader in great detail. The significance of this chapter on the island has been discussed at length, perhaps in most detail by Nicolson and Mohler, who have described it as "one of the most remarkable pseudo-scientific passages in the literature of the eighteenth century" (Nicolson, 1937, p. 406). It is certainly one of the most impressive representations of eighteenth-century natural philosophic discourse on magnetism within the literature of the period. The island, Gulliver writes, owes its remarkable floating powers to a great magnet at its heart which, depending on its position, can raise or lower it, or propel it forwards. As Gulliver points out,

> By means of this lode-stone, the island is made to rise and fall, and move from one place to another. For, with respect to that part of the earth over which the monarch presides, the stone is endued at one of its sides with an attractive power, and at the other with a repulsive. Upon placing the magnet […] with its attracting end towards the earth, the island descends: but when the repelling extremity points downwards, the island mounts directly upwards.
>
> (Swift, p. 179-80)

Swift's understanding of magnetism (or the 'lode-stone') appears to have derived from William Gilbert's *De Magnete* (1600) and the *Philosophical Transactions* published by the Royal Society closer to the novel's publication date. However, Nicolson and Mohler conclude after citing several possible models that the author might have drawn on that "[t]he ultimate source to Swift's imagination of his floating adamantine island will probably never be defined, for the creative imagination is a law unto itself" (p.

[74] As Gulliver explains: "The word, which I interpret the […] 'Floating Island', is in the original 'Laputa'; wherof I could never learn the true etymology. 'Lap' in the old, obsolete language, signifieth 'high', and 'untuh' a 'governor', from which they say by corruption was derived 'Laputa' from 'Lapuntah'" (p. 172).

106).[75] The precise source for Swift's creation of the island may remain obscure but magnetic fluidity, or the conception of magnetism as a fluid, informs Swift's understanding of this section of Swift's tale.[76] The island floats and is navigated above the level of the ocean in a way reminiscent of ships sailing the sea. It moves by powers of attraction and repulsion, forces which were understood as the operations of fluid, and it regulates its intake of water by rising or descending above or below cloud level.

Writing on "the phenomena of magnetism", the 1795 Dublin edition of the Encyclopaedia Britannica states, "the subject indeed is more difficult than that of electricity; for in the latter, the fluid is often made visible and otherwise perceptible by our senses; but no experiment could ever render the course of magnetism perceptible otherwise than by its effects" (Vol 10: p. 433). The same article goes on: "the latest discoveries and electricity have naturally suggested another theory, viz. that the magnetic phenomena may be occasioned by a fluid analogous to the electric, or perhaps by the very same" (Vol 10: p. 433). The article explains a number of suppositions that had been made: that "this fluid is sufficiently subtle to penetrate the substance of all terrestrial bodies, and like the electric fluid is supposed to be repulsive of itself"; but "there is a mutual attraction between the magnetic fluid and iron"; that "the magnetic fluid passes without difficulty" between iron and "electrics"; and that "all ferruginous [ferrous] substances contain a quantity of magnetic fluid equably dispersed through their substance when those bodies are not magnetic. In this state. They showed neither attraction nor repulsion, because the repulsion between the

[75] Richard Head published a satirical pamphlet entitled *The Floating Island, or, A new discovery* in 1673.
[76] Gulliver cites the 'magnetic virtue' when referring to magnetic force, which, as further discussed below, is closely related to a model of magnetic fluidity.

particles of magnetic fluid is balanced by the attraction between the matter of those bodies and the fluid" (ibid.).

A lengthy entry for 'Plastic-Nature'[77] in the 1795 Dublin Edition of the *Encyclopaedia Britannia,* illustrates how common this notion was:

> If magnets operate by means of a fluid issuing from them (See 'magnetism'), those who hold the solidity or impenetrability will maintain that each atom of the magnetic fluid is solid and impenetrable. That we do not see nor feel these atoms, will be considered as no argument that they do not exist; for we do not see, nor in a close room feel, the atoms, of the surrounding atmosphere.
>
> (Moore, p. 28)

While magnetism is not the entry's main focus, its parenthetical appearance documents a widely held conception of a magnetic model in which magnetism clearly exists as an invisible force – and one that may in some cases entirely escape empirical classification or verification. For Samuel Vince, writing in 1796, magnetic fluid was one form of the primordial 'imponderable' fluid that subsisted in all things:

> Different fluids have different degrees of fluidity, according to the facility with which the particles are moved one amongst another. Water and mercury are the most perfect non-elastic fluids. Many fluids have a very sensible degree of tenacity, and are therefore called imperfect fluids. Besides the fluids which come under this definition, there are others, as the electric and magnetic fluid, light, and fire.
>
> (Vince, 1796, p. 2)

[77] Plastic-nature is defined briefly as "a certain power by which, as an instrument, many philosophers, both ancient and modern, have supposed the great motions in the corporeal world, and the various processes of generation and corruption, to be perpetually carried on" (Moore, p. 28), as implemented by mechanical or divine powers.

Fluidity shapes the language in which magnetism was understood from the seventeenth- century onwards, and it is this key feature that leads to later theories and suppositions about its possible healing powers.

Critical interest in theories of magnetism in the Enlightenment seems to have subsided in recent years, having been at its height in the late 1990s and early 2000s. Patricia Fara's body of work on magnetism in eighteenth-century Britain is perhaps the most substantial critical contribution on the subject, with several articles and monographs, including her 2005 work *Fatal Attraction: Magnetic Mysteries of the Enlightenment*, and its precursor *Sympathetic Attractions: Magnetic Practices, Beliefs, and Symbolism in Eighteenth-Century Britain* (1996). The latter is an impressive and comprehensively researched study which sheds light on the role of magnetic phenomena from a socio-political, as well as a commercial viewpoint. Fara aims to provide a "revised historical vision" (p. 5) of magnetism in the period, focussing especially on the role of compasses and navigation as a key factor of commercial expansion of eighteenth-century England as a colonial power. She suggests that "practical magnetic expertise lay mainly in the maritime community, in the hands of men admired for their skill as they navigated the oceans to increase England's trading wealth and international possessions" (p.6). Yet, there are key aspects of eighteenth-century magnetism that she omits, as will become clear.

While this chapter takes inspiration from Fara's work, its focus is different. This chapter departs from Fara's work in three key respects. First, it recognises fluidity as a central underlying concept underpinning all eighteenth-century descriptions of magnetic attraction. The essence of magnetism, as it is described in eighteenth-century

works remains largely a side note in Fara's work.[78] While she does not make fluidity a central part of her work, she states that "[f]or much of the eighteenth century, natural philosophers retained the word 'virtue' for describing a magnet's concealed power". The reasoning behind such a characterisation, according to Fara, is eighteenth-century natural philosophers' attempt to "avoid any specific ontological commitment" (p. 33). This thesis argues that magnetism was understood at the time in terms of fluidity. In doing so, it holds that those eighteenth-century writers who understood magnetism in terms of a real fluid held an ontological commitment to seeing a relationship between the magnetic fluid and a broader, divine, ethereal Ur-fluid commonly discussed in magnetic treatises of the period. Without recognising this central aspect of magnetism, the theology of science at the time is missed. The being of magnetic fluid was held to derive ultimately from the being of God.

Second, Fara argues, lending the scope of her work a particular emphasis on navigation in the context of English imperialism, that "[t]he magnetic activities of English natural philosophers differed from those of their Continental counterparts in several different ways". In making this argument, she further suggests a strict dichotomy of magnetic enquiry based on natural philosophers' nationality and intellectual focus. English natural philosophers of the period, she argues, "concentrated on experiment" (Fara, 1996, p.16). They "prized the utilitarian benefits more highly than postulating complex explanatory mechanisms", she suggests, and "continued to disregard magnetic theories as fruitless hypotheses" (p.17). Continental natural philosophers, particularly the French, she proposes on the other hand, "directed many of their experiments towards developing theories of circulating subtle matter to

[78] I use the term 'essence' historically, to describe the quintessential features of the magnetic fluid as discussed in eighteenth-century treatises.

explain magnetic behaviour" (p.16), in a culture where "genius was cultivated, refined, encouraged" (p. 17). This chapter argues that the distinction Fara draws here is, to some extent, over-stated. An analysis of eighteenth-century contemporary treatises on terrestrial magnetism (predominantly by English or British authors), and treatises on "animal magnetism" (principally the writings of the Austrian Franz Anton Mesmer, based in Paris for the majority of his career), shows that there is no such discrepancy in eighteenth-century natural philosophers' approach to magnetic theories, particularly with regard to a commonly held belief in magnetic fluidity. Perhaps one of the most prominent examples illustrating a shared epistemological foundation of French and English researches into the subject is Newton's work on the ether which, in some respects, bears a striking resemblance to the Cartesian model of fluid magnetism. Fluidity, this chapter argues, is a vital concept that underpins and guides magnetic exploration by both English and Continental natural philosophers conducting research in both "terrestrial" and "animal" magnetism.

Fluidity is not only at the centre of a debate to which both French and English philosophers contributed. It also unifies and links several strands of discourse in natural philosophy in a way that has tended to be neglected. Fara points out that, "Writers carefully drew up lists comparing the characteristics of electrical and magnetic effects", before then adding that they "almost universally concluded that their differences outweighed their similarities" (p.19). An analysis of a variety of different seventeenth and eighteenth-century publications on the relations between electricity and magnetism suggests that this statement appears to be a misreading. As Samuel Vince suggested in 1796 (above), magnetism, as discussed in eighteenth-century treatises, was commonly regarded as a sibling phenomenon to electricity. This is owing to a widely proposed and accepted hypothesis recurring in treatises on the

subject, which postulates that these phenomena share fluidity as their essence, with the ethereal Ur-fluid, and consequently divinity itself, as their common conceptual ancestor.

This chapter argues that the magnetic fluid, in both strands of magnetic discourse, was regarded as inherently related to electricity; that this subtle 'attractive' fluid was viewed as conceptually derived from the ethereal fluid, i.e. as a form of ether made manifest; and that conceptions of magnetism as a (divine) fluid were central to the pseudo-medical science of Animal Magnetism, or Mesmerism. Contrary to Fara's claim that "most authors stressed the futility of generating unsatisfactory explanations of the mysterious magnetic phenomena" (1996, p. 20), examinations of treatises by William Gilbert, René Descartes, Gowin Knight, Patrick Dugud, Leslie, Ralph Walker, Tiberus Cavallo, and others will illustrate the ways in which fluidity shapes and advances the discourse on "terrestrial" magnetism in the period. A discussion of these treatises shows in particular how the magnetic fluid was understood to become visible, perceptible, or observable' and examines eighteenth- century hypotheses on how the magnetic fluid was understood to affect the Earth. Furthermore, this chapter argues that Mesmerism, frequently dismissed as a form of quackery, relied on the same principle of fluidity as enquiries into terrestrial magnetism and was deeply rooted in Newtonian ethereal. Both terrestrial magnetism and Animal magnetism, this chapter argues, depend entirely on a model of magnetic fluidity.

As we shall later see in Chapter Four, the demise of the concept of fluidity within magnetic enquiry in the period can at least in part be attributed to the 1784 *Commissioners' Report* and its damning verdict on Mesmerism. That report suggested that animal magnetism, by then equally a magnetic practice and an attractive business,

was in fact nothing more than eloquent quackery. The aftermath of the report's publication is a gradual disappearance, or fading validity of fluidity as an explanatory concept responsible for the action of both terrestrial and animal magnetic forces. This process (i.e. the demise of fluidity in discourses on magnetism) was partly owing to terrestrial magnetists' attempts to dissociate themselves from the vocabulary of an animal magnetic pseudo-science.

Before discussing terrestrial and animal magnetism in the eighteenth century, a brief look at the history of magnetic enquiries sheds light on the origin of such complex, abstract theories as magnetic fluidity. Like discussions of the ether, and of electricity, early speculations on magnetism and the properties of natural magnets date back to ancient Greece. Perhaps the first known mention of magnetic attraction is attributed to Thales of Miletus[79] (c. 624-546 BC) by none other than Aristotle. Thales showed an awareness of the magnetic attraction of loadstones, and is said to have assumed that "the magnet has a soul" (Aristotle, p. 5), which he suggests may be attracted to, or feel 'sympathy for' iron (cf. Ida, p.428, n. 2).[80] An idea of such an animate, if not sentient magnetic soul of loadstones, was revived at different intervals throughout the centuries, perhaps most notably in William Gilbert's *De Magnete* (1600), discussed in more detail below.

[79] Thales, one of the 'seven wise men of Greece', primarily studied geometry. None of his writings seem to have survived. However, his views, as described by Aristotle and his contemporaries, are of further interest with regards to materiality and a 'first cause'. He is said to have believed that the 'arche' (ἀρχή), the 'first principle' 'origin', or 'source of action' was water – and that the earth itself floated on water. This hypothesis is closely related to ancient theories which identified the ether as such a first fluid medium.

[80] For an in-depth discussion of Thales' speculations on a first cause, divinity, and matter, see Mansfeld, 1985.

Perhaps not surprisingly, considering his lengthy remarks on the ethereal fluid, Lucretius, in *De Rerum Natura*, also addressed the mysteries of the magnet. Taking some poetic liberties inspired principally by Milton and Pope, Thomas Creech's satirical 1714 translation of the work renders Lucretius' magnetic considerations in Book Six as follows:

> Now sing, my Muse, for 'tis a weighty Cause,
> Explain the magnet, why it strongly draws,
> And brings iron to its fond embrace:
> This men admire for they have often seen
> Small rings of iron, six or eight or ten,
> Compose a subtle chain, no Tye between:
> But, held by this, they seem to hang in air,
> One to another sticks, and wontons there;
> So great the Loadstone's Force, so song to bear.
>
> (Creech, ll. 894-902, also cited in Ida, p. 427)

Although we see here reference made to a 'subtle chain' or iron rings, with 'no tye between', but instead 'held' by an invisible force or medium, Lucretius' subsequent explanation of why magnets act in such a manner unfortunately becomes a little lost in Creech's poetic translation. The original Latin, and W. H. D Rouse's more literal translation of the work, shows some early notions of fluidity underpinning magnetic conjectures. Lucretius writes,

> In the first place, from everything that we see there must of necessity continually flow [*fluere*] and discharge and scatter bodies which strike our eyes and excite vision. There is a continual flow of odours from certain things, as there is of cold from rivers, heat from the sun, spray from the sea-waves, that devour the walls beside the shore.
>
> (Lucretius, p. 563)

The magnetic force, Lucretius presumes, must flow from magnetic bodies, and the loadstone in particular. "It must be", the philosopher reasons, "that very many seeds

flow out from this stone, or, let us say, a current which by its blows beats away all the air that lies between the stone and the iron" (p.569). In this mechanical explanation of magnetic flow, an implied negative pressure caused by the air between the loadstone and a piece of iron being 'blown away' by the magnetic current results in the magnet's attractive force. Lucretius suggests that iron may be drawn towards the loadstone by a kind of vacuum caused by the magnetic current. As we shall see below, this notion had a long legacy for seventeenth and eighteenth-century natural philosophers.

In his 'Epistle to Dr. Charleton', first published in 1663, Dryden writes:

Gilbert shall live till lodestones cease to draw
Or British fleets the boundless ocean awe.

(Dryden, ll. 25-6)

These lines hint at the significance of a man whose relative anonymity remains quietly disproportionate to his momentous achievement in seventeenth-century discourse on magnetic force. Fortunately, as James Livingston has light-heartedly remarked, "at least one of the conditions" outlined in Dryden's homage to the philosopher, "still ensures [Gilbert's] immortality" (p. 453). Gilbert's 1600 work *De Magnete Magneticisque Corporibus, et de Magno Magnete Tellure* ('On the Magnet and Magnetic Bodies, and on That Great Magnet the Earth', subsequently 'De Magnete'), first translated into English by P. Fleury Mottelay in 1893, is one of the first substantial modern treatises written by an Englishman that is devoted entirely to attractive forces and magnetism. The work, which asserts the inherent magnetic qualities of planet Earth itself, has been described as "the first seventeenth-century physics compatible with a non-Ptolemaic cosmology (Freudenthal, p. 22). Freudenthal, Thompson, and

others have discussed the validity of Gilbert's magnetic speculations at length, focussing specifically on the works relation to Aristotelian and Paracelsian theory. Especially with regard to magnetic fluidity, Gilbert's treatise serves as a 'strong precursor' (in Bloom's terms) for later eighteenth-century writers on the causes and constitution of magnetic attraction. While Gilbert, also referred to by some as "the father of electrical sciences" (Thompson, p. 611), perhaps surprisingly does not refer to the magnetic *fluid* in particular, much of his discussion relies on magnetic, electric, and other 'effluvia', anticipating closely related to eighteenth-century notions of fluidity. Perhaps similar to what Lucretius had described as odours, i.e. 'emissions' of sorts, Gilbert regards these effluvia as 'exhalations' by different bodies. For example, he notes that "[t]he air is but exhalation and the effluvium of the earth given out in any direction" (p. 339-40).[81] "Electric effluvia", by contrast, "differ much from air, and as air is the earth's effluvium", since "electric bodies have their own distinctive effluvia". These effluvial substances, Gilbert further assumes, cause (magnetic) attraction between bodies, as "each peculiar effluvium has its own individual power of leading to union" (p.92). In the same manner, all metals, Gilbert assumes, are thus "informed by the same metallic vapour" (Freudenthal, p. 26), which draws them to the "loadstone".

The word "exhalation" used by Gilbert to describe the magnetic force here is much more than yet another way of describing magnetic fluidity. It is a hint of Gilbert's theory being rooted deeply in an animist model of the universe, in which the Earth, and all magnetic bodies are infused with life, if not a form of what might be referred to as a kind of magnetic reason or faculty. "The earth's magnetic force and the formate

[81] The term 'exhalations' in this respect is borrowed from Aristotelian philosophy (cf. Freudenthal, p. 25).

soul or animate form of the globes", Gilbert suggests, "exert an innate action, alive [*vividum*], definite, directive, harmonious, through the whole mass of matter" (Gilbert; Book 5, chapter 12, also cited in Fletcher, p. 2). In this model, magnetic fluidity is informed by cognate iron and loadstones, leading to a union or "confluence", the description of which, in Gilbert's treatise, resembles the meeting of two lovers, destined by a higher force to come together:

> And a loadstone recalls the cognate substance, iron, to formate energy and gives it position: hence does it leap to the loadstone and eagerly conforms thereto (the forces of both harmoniously working to bring them together); for the coition is not indeterminate and confused, it is not a violent inclination of body to body, not a mad chance confluence.

The magnetic effluvia, directed by cognate magnets, act not through rough force, but in such a way as to establish a confluent equilibrium of attractive force. Gilbert further suggests,

> Here no violence is offered to bodies, there are no strifes [sic.] or discords; but here we have, as the condition of the world holding together, a concerted action- to wit, an accordance of the perfect, homogeneous parts of the world's globe with the whole, a mutual agreement of the chief forces therein for soundness, continuity, position, direction, and unity.
>
> (Fletcher, pp. 3-4)

Fluidity ("effluvia") thus lies at the heart of Gilbert's model of magnetism. It is the agent that enables the meeting of the loadstone and the iron, not through force, but like a gentle invisible wave of heaven-sent direction. The magnetic exhalations and magnetic fluidity, in the philosopher's discussion, equal "soundness, continuity, position, direction, and unity", as originally intended by God for a harmonious universe. Fluidity is the medium or vehicle by which a harmonious confluence, or a meeting of two cognate magnetic bodies could be completed.

Taking into consideration the fact that much of the Newtonian ethereal speculations were in part based on an earlier conception of a Cartesian 'first element', and that Descartes defined a so-called 'fluidity of the heavens' (see chapter 1), it is not surprising that the French philosopher also made a considerable contribution to the early science on magnetism. While Gilbert may have been the first to ascertain that the Earth had a magnetic core, Descartes was perhaps the first to thoroughly articulate, and illustrate, an early understanding of the planet's magnetic field. His model of terrestrial magnetism is articulated in impressive detail in his 1644 *Principia Philosophia,* specifically in 'Part IV, 'Of the Earth'. Descartes' speculations on magnetism are too extensive to be discussed in complete detail in this chapter. Included in his deliberation on the constitution of magnetic force are a multitude articles on the subject, including a list of 34 different observations on magnetism and its interactions with the Earth and atmosphere (cf. *Descartes*, Miller, p. 252). Christoph Lüthy has argued that "[m]aybe no example is better suited to documenting the degree to which imagination and visual persuasion have replaced legal necessity in the concluding part of the *Principia* than Descartes' famous explanation of magnetism" (p.120). While this suggests a degree of 'unscientific' thought to accommodate a somewhat far-fetched theory, Descartes' speculations on magnetic fluidity, are grounded in a highly sophisticated model of minute corpuscles. Once again, the fact that these atom-like substances are not empirically verifiable, to Descartes and his contemporaries, does not negate their existence.

The Cartesian model of terrestrial magnetism relies fundamentally on the flow of "grooved [magnetic] particles" (Descartes; Miller p. 243.), which are propelled by, and similar to, a 'first element' (his *primum elementum*), drawn on by Newton himself

for his thought-experiments on the ethereal fluid.[82] Grooved magnetic particles, Descartes suggests, "are carried along by the impetus of the first element, to which they belong" (p.256), suggesting once more an inherent connection of the magnetic- and an ethereal Ur-fluid. Considering a possible divine involvement in the creation of magnets, Descartes proposes that fluid magnetic particles, "driven into the pores of a rock or other body, form a magnet" (p.243). Like Gilbert, to whom Descartes refers with admiration rather than Anglophobe sentiment, calling the Englishman "the principal investigator of magnetic force and the first discoverer of that which is contained in Earth" (p.262), the French philosopher holds that the Earth itself must be the biggest of all magnets (p. 243).[83] The planet, and all magnets, he further argues, have special pores or 'channels', through which the grooved [magnetic] particles can flow from one pole to the other, parallel to its axis. Through magnets, Descartes further specifies, these particles "flow very rapidly, without hindrance" (p. 253), while in water or air, their flow is significantly slower.

This flow of grooved magnetic particles through special channels in magnets are essential components in a Cartesian model of the Earth's magnetic field. Such a magnetic field, according to Descartes, is hence formed by the fast, continuous flow of the particles through the channels, as illustrated in the (remarkably accurate) illustration published (see Figure 3) together with his magnetic observations in the 'Principia. The corresponding discussion captures the essence of the model of the Cartesian magnetic vortex, based on a model of fluid magnetism and ether:

> After those grooved particles have traversed the whole intermediate earth from one hemisphere to the other along straight lines […] they return through the

[82] The original Latin for these magnetic particles is "*particulae striatae*" (cf. Descartes, 1962, p.187)
[83] Here, Descartes refers in particular to Book III, chapter iii of Gilbert's *De Magnete* (1600).

surrounding aether to that same hemisphere through which they earlier entered the earth, and this flowing through the Earth again, form a kind of vortex.

(p. 243)

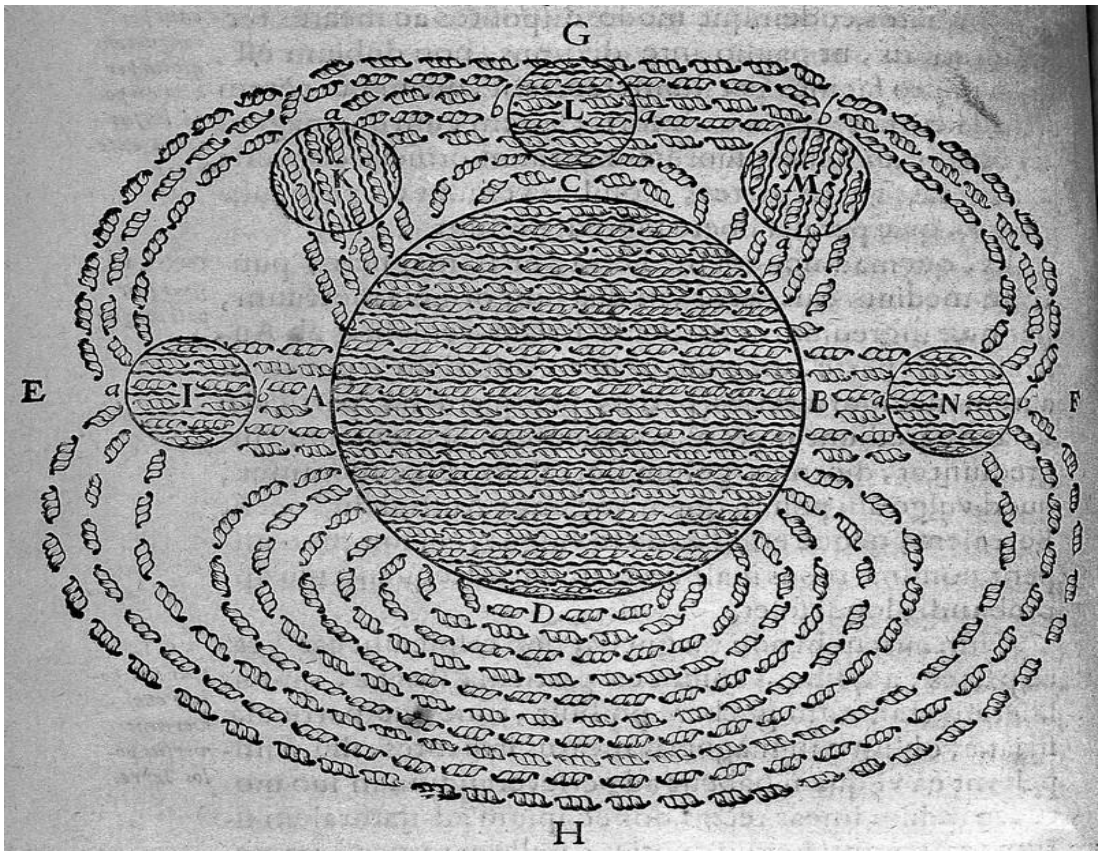

Figure 3: Descartes, *Opera Philosophica*. Amsterdam: L. Elzevier, 1650. Illustration on page 268. This image shows the 'grooved magnetic particles' flowing around the Earth and creating a vortex. Credit: Wellcome Collection. Accessed via wellcomecollection.org.

Even though Descartes does not refer to a 'magnetic fluid', he identifies grooved, magnetic, invisible and imperceptible particles as flowing in a manner similar to the flowing movement of his first element, or ether. The concept of fluidity as an underlying principle of his hypothesis applies not only to his model of the constitution of the Earth as a whole, but also to his description of other materials and bodies, as well as other forms of attraction, such as that caused by static electricity. His

discussion of the causes for attraction between a magnet and a piece of iron, equally relies on a language of fluidity. Iron, Descartes suggests, must have pores or channels similar to those of the Earth, through which the grooved particles can pass freely. Accordingly, "when a magnet has been brought near [to iron]", the philosopher explains, "the grooved particles rush into the pores of the Iron with great force, like a torrent" (p.259). Attraction caused by static electricity (for example between a piece of glass exposed to friction and a piece of cloth), on the other hand are not caused by the flow of the magnetic grooved particles in his model. In this case, the attraction according to Descartes, must be based on the flow of the first element itself, which is subtle enough to pass through tiny fissures in the glass, as it is "extremely fluid" (p.273). Descartes' speculations on a 'first element' clearly inspired, but were overshadowed by, Newton's ether, documenting wide-ranging similarities of English and Continental researches into fluid matter. Unfortunately, the Frenchman's hypotheses on a magnetic flow seem to have been, at least in part, forgotten – perhaps eclipsed by his achievements in the realm of the philosophy of knowledge. In public perception and memory, these achievements outshine Descartes' ventures into natural philosophy, and render his contributions to natural science – based entirely on a model of imponderable flowing particles descendant from a first element – almost forgotten. As the brief look at the history of early magnetic enquiries illustrates, notions of fluidity were not entirely a product of eighteenth- century natural philosophy. However, the 1700s and 1800s provide a unique environment of philosophical and scientific discussion in which ideas of magnetic fluidity flourished like never before – and never again afterwards (as discussed in the next chapter). Descriptions of mineral or terrestrial magnetism in eighteenth-century treatises frequently illustrate the widely accepted belief of a close conceptual relation between magnetism and the ether, as

well as between the electric and magnetic fluids. Especially since Franklin's mid-eighteenth-century electric investigations brought electricity to the attention of a broader audience, mineral magnetism was regularly discussed in the context of electrical experimentation, with the magnetic fluid taken to be a kind of sibling phenomenon to electricity, ultimately descending from a prior, all-pervading ethereal fluid.

In these investigations, we see a collaborative effort between English and continental philosophers building on each other's theories of magnetism, and acknowledging their counterparts, rather than a culture of competition between English and French philosophers, as suggested by Fara. Descartes draws on Gilbert's work on the Earth's magnetic core for his own deliberations on fluid magnetic particles, while much of Newton's ethereal speculations are based on a Cartesian "first element". Not only did these philosophers express admiration for each other's works, but they served as (in Bloom's terms) "strong precursors" for those who followed in studies and representations of magnetism. Gilbert, Descartes and Newton shared similar aims in a joint trajectory of magnetic enquiry, which is sometimes misrepresented as an Anglo-French conflict of discovery.

Those who followed in the wake of these three "strong precursors", included Gowin Knight, Patrick Leslie, Ralph Walker and, most famously, Anton Mesmer. As we shall see, each of these (again, using Bloom's terms) "latecomer" experimenters in magnetism ultimately failed to break decisively from the 'fluidity' model of magnetism. Several years before Franklin's electrical breakthroughs, Gowin Knight, published his *Attempt to demonstrate that all the Phenomena in Nature may be*

explained by two simple active Principles: Attraction and Repulsion (1748) which establishes fundamental principles of magnetic phenomena based on Newtonian natural philosophy. Knight was a physician, but also an "inventor of geo-magnetic instruments" (Fara, 2004, p. 1). He "revolutionized the experimental and commercial uses of magnets [and] was the first person who successfully marketed artificial magnets". As one of the most influential natural philosophers concerned with the study of mineral magnetism at the time, "Knight rose through ability, patronage and commercial opportunism to dine with nobility and be discussed by the King" (Fara, 1995, p. 10). In 1756, he became the first principal librarian at the then newly-founded British Museum. Knight's comprehensive treatise acts as a landmark in the scientific study of "mineral" magnetism and was frequently referred to by natural philosophers investigating the properties of the mysterious magnetic fluid. His work discusses repulsion and attraction as two central observable phenomena in nature, together with examination of a relation between the electric and magnetic fluids in a Newtonian system of physics. Fara states that Knight "presumably scoured Newton's work for guidance" and she notes further that even the format of Knight's treatise, "resembled Newton's *Principia* – the same quarto size, well produced and neatly laid out like a geometrical argument in numbered propositions and corollaries" (Fara, 2005, p. 134). Knight's work illustrates the close conceptual relations between the supposed electric and magnetic fluids, resulting in their perceived shared divine origin. Additionally, his treatise, which takes the Newtonian model of physics as its guide, treats the magnetic fluid as an invisible, albeit very 'real' phenomenon within natural philosophy in the period.

"A greater Progress", Knight suggests at the beginning of this work, "has been made in Physicks by Sir Isaac Newton alone, than by all the Philosophers before or since

him put together" (Knight, p.1). Following Newton's example, Knight begins with the premise of God as a Prime Cause responsible for all phenomena observable in nature. "There is a Being of Infinite Wisdom, and Goodness, and Power, the first Cause of all Things", he proclaims, before following this proposition up as follows:

> If we admit that GOD, the Supreme Being, is the first Cause of all things; all other causes must be either immediately, or mediately derived from Him.
> (…)
> Immediate Causes are the Acts of GOD himself; depending only on His Will for their existence and Continuance.
>
> (p. 3)

Attraction and repulsion, the two phenomena at the centre of his treatise, then must be, like all other phenomena, the results of God's will, for "Nature does nothing in vain" (p. 3). These two opposing forces, according to Knight, must be "immediate causes" existing in the universe. He further argues that a certain "repelling fluid", which encloses all particles, must keep the corpuscles of substances apart or distinct from one another. In explaining that there must necessarily be two principles of attraction and repulsion, Knight once again refers to the "greatest of natural philosophers", stating that "Sir Isaac Newton has laid it down as a Rule, that no Causes ought to be admitted than are really found in Nature, and are necessary towards explaining the several Phenomena: And also, that Effects of the same kind proceed from the same Cause." (pp. 3-4). This proposition points towards the Newtonian hypothesis of a primal ethereal fluid. Such a divine medium, first descending from God, facilitates several other phenomena and produces effects of similar kinds – electricity, magnetism, heat, light and fire.

Knight's treatment of the relations between the magnetic and the electric fluids suggests that he understood them as inherently related, complementary, or parallel to one another. This perceived similarity between the two fluids becomes apparent in two

ways. First, Knight states that "all bodies are electrical, or capable of being made so: and, [like magnets,] "electrical bodies both attract and repel" (Knight, p. 7). Second, further emphasising the close conceptual relation of the magnetic and electric fluids, he argues that "[l]ightning is the strongest power yet known, in producing a stream of magnetism" (p. 88; see also Imison, p. 167). This statement, which is reiterated verbatim in various treatises on the subject following Knight's publication, underpins the notion that the electric and magnetic fluids were regarded as being thus entwined. They constitute different manifestations of essentially the same phenomenon: both descend from the same original divine substance, or Ur-fluid, ether. The previous chapter has discussed the ways in which the electric fluid was thought to pervade the universe like the Newtonian ether, and that lightning in particular was frequently regarded as a divine act of giving the electric fluid to the atmosphere. In a similar manner, natural philosophers of the period proposed a number of hypothesis on the ways in which the magnetic fluid was thought to arrive on Earth – one of them being that the magnetic fluid might accompany its electric sibling fluid on its travels to Earth in a bolt of lightning. Knight proposes a slightly different process by which he believes, the magnetic fluid in Earth is continuously replenished. "There must be some Cause", he argues, further emphasising magnetism's proposed divine root, "that first gave magnetism to the Earth, and continues to renew it". "This Cause", he further suggests, employing the language of fluidity, "must act in such a Manner, as to make the Magnetical Stream enter at the South Pole of the Earth" (p. 93). In a model of terrestrial and atmospheric magnetism that appears essentially Cartesian, but with a distinctly Christian twist, Knight asserts that the "magnetical stream" must flow through the earth, parallel to its axis, in a manner that implies a divine being pouring the magnetic fluid straight down on to the Earth from the Heavens.

Knight's views on magnetism help us understand commonly held eighteenth-century hypotheses relying on fluidity. In Fara's view, "[f]luid was a particularly useful word for Knight because it could mean either gas or liquid, and so might reasonably be expected to have some strange properties" (2005, p. 134). But fluidity in magnetic and electric discussions of the period is much more than just a term which helps writers avoid making an ontological commitment. Knight's treatise shows not only the qualities that he ascribed to the magnetic fluid, but also serves as an example of how the natural philosopher envisages this invisible medium to become perceptible, or observable. To name here but one example of his various experiments involving magnets and iron filings, Knight suggests,

> Let two Loadstones be laid at some distance from each other; lay over them a piece of paper, and sprinkle them with filings; and strike the table to make them all range themselves in the direction of the magnetic virtue. Now let us reason what appears: The filings which lay betwixt the two paper surfaces […], are disposed in right lines, running from the south pole of one to the north pole of the other; from whence I conclude that about the axis, the magnetic stream runs directly out of the South of one, into the North of another.
>
> (Knight, G., p. 72)

The flow of the magnetic fluid here becomes visible in its effect of moving the iron filings, and aligning them with the poles from which the fluid flows. While the fluid itself may not be visible, its actions in moving the iron filings, to Knight, document that such a fluid is very real. Fara has suggested that "In describing his observations [Knight] constantly slipped verbally between the filings that he could see and his streams of fluid that were hypothetical" (p. 136). However, these considerations on the perceptible nature of the magnetic fluid that document its materiality show that the natural philosopher does not 'slip' at all. By contrast, the fact that he switches so readily between descriptions of visible effects of a proposed fluid on the one hand,

and the iron filings themselves on the other, documents rather his understanding of the real, ontological nature of magnetic fluidity in this context. The invisible fluid, in his model, appears just as ontologically valid and 'real' as the visible iron filings. According to Fara, "Knight regaled his readers with tedious accounts of iron filings marshalled into order by his circulating fluid" (1996, p.136). But there is another way to see his work. Knight's various experiments are an attempt at proof or validation of his fluid hypothesis. The magnetic fluid, in moving iron filings, here is regarded as becoming perceptible not in itself, but by its actions and its effects.

Knight's experiments lend credibility to his model and emphasise that the magnetic fluid, though at times invisible, is anything *but* imaginary to him and his readers. To understand the true value of fluids as invisible but real substances in Knight's and other eighteenth-century treatises on the subject, it may be useful to consider a distinction between fictions and hypothesis. "Fictions are expedient and service to science", K. J. Fink (1982) argues, "but scientific hypotheses on the other hand assume a high probability of truth and it is expected that eventually their conceptual constructions will agree with reality" (p. 73). As Knight's description on his experiments shows, magnetic fluidity was not seen as a fiction and its invisibility did not mean that it was regarded as non-existent. To Knight, the conceptual construction of the magnetic fluid flowing through the pores of all bodies agrees with the reality of the iron filings being moved by an invisible, yet real fluid.

Fink's model applies not only to Knight's conception of the magnetic, but also the 'phlogistic fluid', or Phlogiston, that shares some of the characteristics of other such invisible fluids. Fara has argued that "For Knight, Phlogiston was not an imaginary

subtle fluid, but was real, visible and made metals look black" (Fara, 2005, p. 138). Knight states,

> That there is in Steel a very large quantity of phlogiston, is beyond doubt: It was observed in Prop. 76 that Blackness, when it appeared in Metals, was owing to the phlogiston which does not reflect light like other bodies. Accordingly, soft steel has a dusky appearance, so that we see the phlogiston in its pores with the naked eye. When it is very hard, the appearance is quite otherwise: It is then white […]. Where now is the phlogiston? Is it shed away, or is it only retired behind the scenes? It is certainly no longer visible. If it remains, it must have penetrated deeper into the substance of the steel, and have hid itself in the invisible pores.
>
> (Knight, G. p. 83)

Fara suggests that Knight viewed subtle fluids such as the magnetic fluid as merely imaginary, whereas Knight's Phlogiston, she argues was 'real' and 'visible'. The argument of this chapter is that Knight's conception of phlogiston, which is also a subtle fluid, does not stand in opposition to the magnetic fluid. He conceives of phlogiston as a substance just as valid as the magnetic fluid – at times visible in its effects, and at other times subtle enough to 'retire behind the scenes'. For Knight, the perceptible and observable movement of his iron filings caused by a magnet was proof of the existence of a subtle magnetic fluid.

Knight's was the first of a series of publications that established a broader scientific consensus about the nature of mineral magnetism in the eighteenth century. In these publications, magnetism is throughout described as a fluid which ultimately descends from a prime medium, and from God himself. Despite this general similarity between publications on the matter at the time, there were also subtle differences in these accounts. Patrick Dugud Leslie (1751-1783) was a little-known physician and natural

philosopher whose works have tended to go unnoticed.[84] He spent most of his professional career researching the generation of heat in humans and animals, as well as the physiological impact of heat in human beings. His work on the contagiousness of the influenza virus, published in1782, just a year before his death, was perhaps his most influential publication. However, it is Leslie's publications in the run-up to this treatise that provide an insight into commonly held conceptions of the make-up those elements or substances widely regarded as fluids in the period, amongst them magnetism. His 1778 dissertation *A Philosophical Enquiry Into the Cause of Animal Heat*, originally published in Latin three years earlier as *Dissertatio Physica Inauguralis de Caloris Animalium Causa*, examines, amongst other things, the "prevailing opinions on the cause of animal heat", and "the connection of animal heat with the state of motion in the sanguiferous system" (p.38). Placing great value on Phlogiston his treatise he argues that "[h]eat is in the universe the chief cause and principle of activity" (p. 9). What Leslie understood by 'heat' was a particular form of universal ethereal fluid, a felt manifestation of the divine Ur-fluid.

In the context of his researches into heat, Leslie also makes some key observations concerning the fluidity of magnetism as a result of the attractive power's close relation to heat and ether. Leslie's treatise contains perhaps one of the most eloquent, clear and concise accounts of the role and constitution of the concept of fluidity in magnetism and electricity in the period. "It was formally said", Leslie states, referring to the gravitational experiments of Isaac Newton, "that gravitation is effected by the pressure

[84] Three surviving publications of Leslie's body of work include *Observations on Wounds of the Head* (1776), *A Philosophical Inquiry into the Cause of Animal Heat* (1778), and *An Account of the Epidemical Catarrhal Fever, commonly called the Influenza* (1782). Perhaps surprisingly, critical interest into Leslie's research has been minimal, and although he seems to have been rather successful in his own time, his achievements seem to have been deemed not important enough for the physician to even be noted in the *Oxford Dictionary of National Biography*.

of the universal elastick [*sic*.] aethereal fluid". Announcing his own magnetic speculations, he then proposes that "attempt shall now be made to show that attraction depends on the same subtile [*sic*.] medium fixed and modified in bodies". Highlighting the fluids' close connection, Leslie further suggests that "[t]he most striking instances of attraction are those of electricity and magnetism" (p.187). What follows is an interesting account of the manifestations of these two phenomena as descendants from the ethereal medium, which become perceptible only in their effects. Referring first to magnetism's sibling phenomenon, the electric fluid, Leslie argues,

> With respect to [electricity] I need only observe, that it is the obvious effect of exciting into motion a certain subtile [*sic*.] fluid, lodged on the surface and in the pores of bodies, which fluid, to every appearance, is the ether of Newton, and the phlogiston of the chymists [*sic*.].
>
> (p. 187-8)

This reasoning is in line hypotheses regarding electricity in the period, described in the previous chapter. It proposes that electricity is ether made visible: but ether only becomes visible in its effects, in this case the discernible power of electricity. Leslie's electric hypotheses led him to reason that the same applies to the magnetic fluid. He notes that "the cause of magnetic attraction is more obscure and has been long a noted problem in physics", before announcing confidently that "the veil in which that dark mysterious question was so long inwrapped, is now removed". His hypothesis of a conceptual similarity of electricity and magnetism is based entirely on the concept of fluidity. He argues,

> For many late accurate experiments have not only shown, that polarity may, with as great certainty, be communicated to steel by electricity as by the magnet, but likewise that it is entirely abolished by calcination[85]: *an irrefragable proof that*

[85] The term 'calcination' here refers to the process of burning, or heating an object to high temperatures. In the eighteenth century, it was frequently used in the context of phlogistic experiments.

> *the attraction of electricity and magnetism* are owing to *the same material cause*, the ethereal phlogistic fluid.
>
> (p.188)

This statement at first may appear to document the philosopher's uncertainty, rather than any 'ontological commitment'. However, in grouping together or 'synchronising' various elements heat (calcination), electricity, magnetism and phlogiston, Leslie's argument highlights both the versatility and complexity of fluidity as a concept that underlies all contemporary notions of these various imponderable elements. His account of these fluids further highlights the commonly held belief that these various naturally occurring phenomena, magnetism and electricity in particular, were closely related, owing to their implied shared origin. To use a Darwinian analogy, Leslie regards magnetic fluidity and the other fluids as different species of the same genus, descended from an ethereal "phlogistic" Ur-fluid.

A similar approach to the similarities between magnetism and electricity, their shared physical properties, and their divine powers given to earth through their combined descend from heaven, is found in yet another detailed treatise on magnetism in the period, though the original purpose of the world was somewhat removed from Leslie's physical or medical considerations. Ralph Walker, son of a Scottish farmer who had settled in the British colony of Jamaica in 1783, after having gone to Sea and become the "Master of several trading vessels in the West Indies, the Baltic and America", left his home to return to London for a grand undertaking. He made this trip in order to present his research on magnetism and compasses to the 'Board of Longitude', in the

hope of obtaining a monetary reward. [86] His resulting *Treatise on Magnetism*, published in London in 1794, was originally not intended for publication. However, as Walker states in his introduction, any improvements that he recommends should be made to compasses "could not be well explained, without entering at some length into what I think the principles of magnetism" (p. 6).[87] Walker's work on magnetism has been discussed mostly against the background of his researches and manufacturing of different compasses, the main topic of this *Treatise on Magnetism.*[88] For the purposes of this chapter, I will focus specifically on the basic 'principles' of magnetism on which he bases his research, and argue that these, again, are properly accounted for by the concept of fluidity. Walker's contribution to the science of magnetism both reinforces points made by Knight about the relation and interconnectedness of various imponderable fluids, and, once more, identifies magnetism as electricity's divine sibling phenomenon, regarding both as derived from an ethereal Ur-fluid.

Walker begins his discussion of magnetism with a reference concept of the imponderable fluids, of which the magnetic fluid is but one. He notes,

> As no theory has as yet been established, or has proved to a conviction, what magnetism is, it will be no presumption to hazard a conjecture, that it is a fluid element which pervades this globe, or perhaps the whole universe. That our atmosphere is in part composed of magnetism, or magnetic matter, as well as of air […] and fire, there can be but little doubt. These fluids have all a great affinity to each other; particularly the electric and the magnetic.
>
> (p. 9)

[86] The Board of Longitude was a government institution established in 1714 that operated until 1828. It encouraged inventions and innovation that would help navigators determine their exact longitude at sea. For this purpose, several acts of parliament were passed, among them 'An Act for Providing a Publick Reward for such Person or Persons as shall discover the Longitude at Sea' (RGO 14/1: 10-95). A number of prizes were administered, the first prize being a reward of £ 20.000. However, this prize was never awarded, even though the issue of establishing longitude at sea was eventually solved.

[87] Walker did not manage to convince the board of the practicability of his method for determining longitude at sea with his 'meridinal compass'. However, it was decided that he should continue to improve his investigations. The board ordered one of his compasses and subsidized his researches, paying him the sum of £200. See Carter, p. 6.

[88] For brief discussions on Walker as a manufacturer of compasses, see Fara, 1996, pp. 83; 135-6; 144-7.

This description of the magnetic fluid is strongly reminiscent of Newtonian notions of the ether. Walker identifies magnetism as one of the imponderable fluids that "pervade […] the globe", or "the whole universe", along with air and fire. Like the ethereal fluid, Walker argues, "Magnetism, from the smallness of it's [*sic*.] particles, is enabled to pervade every other matter whatsoever". What Walker introduces is the idea that there must be an aspect of magnetism that is able to permeate matter. The magnetic fluid is described as ubiquitous and, like Newton's ethereal medium, 'all-pervading'. He states,

> every thing [*sic*.] that has, or may have had any affinity with this earth, must, in some degree be impregnated with a certain quantity of ferruginous [magnetic] matter, however small the quantity may be, and imperceptible to us; therefore every globule of air […] may […] become in some degree possessed of every quality of it.
>
> (p.15)

The "magnetic effluvia" (p.17), Walker further suggests, basing his treatise on Knight's earlier influential work on attraction and repulsion, make their way down to earth from the higher parts of the atmosphere. For Walker, the earth itself is 'impregnated' with magnetic influence, especially around its northern and southern poles, just as in natural and artificial magnets. "If the magnetic power was not a fluid or an atmospheric element, but an inherent principle in the Earth" (p. 11), Walker argues, the poles of magnets would be constant and unalterable. However, since magnetic poles, for example, in a magnetised piece of iron, can be reversed at will, Walker holds, one must assume that magnetism is instead present in the atmosphere as a divine "external principle" acting on the Earth (p. 12). Walker places strong emphasis on the resemblances between the phenomena of electricity and magnetism. Like Leslie, he adds further reasons for this fluid kinship between magnetic and

electric phenomena, concerning in particular positive and negative 'charge' which he believes both fluids to exhibit. "Positive and negative electricity", he reasons, "cannot be produced separately". Similarly, "[i]n Magnetism, one polarity cannot be produced without the other" (p. 10). This argument concerns the 'universal equilibrium' achieved by the equal distribution of those 'imponderable fluids' in the atmosphere that were the topic of the previous chapter. In any theoretical framework which posits matter striving towards an equal distribution of energies, no single charge or polarity may exist without its counterpart. What Franklin had argued in his research on electricity, Walker assumes, must also be valid for the magnetic fluid.

Giving anecdotal evidence in a further attempt to emphasise how closely related the electric and magnetic fluids were, Walker's treatise then examines the processes by which these atmospheric elements infiltrate or intrude, from the higher spheres of the universe, down to the earth. What follows is an account of an eerie incident that is somewhat reminiscent of the conventions of gothic fiction, illustrating the convergence of philosophic (i.e. early scientific) and literary discourses. The writer, who vows at the beginning of his treatise that his work would be "divested of the tinsel and technical terms of the professional philosopher, that it may be more easily understood" (p.9, also cited in Fara, 1996, p. 144), tells the tale of a house "shattered by lightning" in Jamaica in the month of September in 1792.[89] One person was killed by the electric force that hit the lodging. In the aftermath of this traumatic event, residents and mourners made a rather curious discovery that they supposed must be

[89] Walker's insistence on the use of simple language divested of the 'terms and tinsel' is the reason why he reverts to anecdotal evidence in his treatment of magnetism, rather than giving mathematical calculations. The concept of fluidity however, is still employed frequently as a way of conceptualising magnetism, once again hinting at the versatility of the concept which transcends disciplines. It was considered not 'too scientific', while at the same time forming the basis for any scientific or creative enquiry into the phenomenon.

closely connected to the energy released by the bolt of lightning. Walker's version of this discovery reads as follows:

> A girl who […] stood close to the one that was killed […] took out her needles soon after, to assist in making a dress for the one that was dead; the needles stuck together in her hand so strongly, that she took the points of her scissors to separate them; and so powerfully were they and the scissors magnetic that part of the needles stuck to them in different directions, and they lifted up the remainder like a thread, each needle hanging by the end of another.
>
> (pp. 10-11)

In this account of a lightning strike, an invisible fluid has become manifest and observable only in its effects. Walker's explanation of the curious incident further highlights magnetism's and electricity's shared ethereal origins. Walker deduces from the string of electrified, magnetic needles that the magnetic and electric fluid make their way to the earth together, bound into one. He suggests that, owing to their close conceptual and physical relation, the two fluids must pass down to the earth from their heavenly spheres. Similar to Knight's account of the fluids' shared journey to earth, Walker's treatise suggests that a bolt of lightning coming from the higher parts of the atmosphere must bring to the planet the electric *and* the magnetic fluid at the same time:

> [A]lthough the magnetic fluid may be inactive in the atmosphere at some distance from the earth, yet it may be […] put in motion by the concussion of the electric matter in the clouds, that an accumulated body of each of these fluids (their affinity being so very near to each other), do in general descend together, to their common recipient, the Earth.
>
> (p. 11)

Walker's description suggests that when an 'inactive' fluid at a great distance from earth is 'put in motion', as in the attraction of a magnet, it has both electrical and magnetic effects. Another point that Walker shares with Knight is his discussion of a

Prime Cause responsible for 'pouring' the magnetic fluid down on the earth. While the introductory pages refrain from addressing the role of a Prime Cause in the distribution of the magnetic fluid, Walker, as Knight before him, eventually refers to the perfection of a system created by an almighty being. In chapter V of his work, which examines 'the dip of the magnetic needle' (something Walker is able to calculate precisely), he pauses to praise God for His gift of the magnetic fluid, along with a justification of British colonialism which he portrays as enabled by God himself:

> Nothing shews the Supreme Architect in a more exalted point of view, than the simplicity of his own works, and that they may be all made subservient to our use, when once we have got a just conception of them; […] By it [magnetism / the magnetic fluid] He enables us to behold his works, and our fellow creatures, in all the different corners of the world […] to colonize and carry on commerce for our benefit and happiness.
>
> (p.43)

In Walker's view, magnetism is an effect of divine agency: "He enables us to behold his works". Scientific, political, and religious discourses here combine with pioneering exploration. Walker's search for 'a just conception' of physical forces confirms him in his own religious and cultural beliefs. In this conception of colonialism, God chose to give magnetism to the earth. Just as the ethereal fluid is made manifest, visible, and perceptible in the magnetic 'dip of the needle', so God is manifest in the relentless progress of Western economic expansion. The colonist has divine justification of his own enterprises. As Patricia Fara has pointed out, "by citing this divine sanction of the financial advantages of invention [scientists and entrepreneurs] effectively translated commercial activity into holy commandment (Fara, 1995, p. 9). Once the

magnetic fluid, given to man by God, is no longer mysterious but can be 'made subservient', man himself may ride its currents to the point where he is placed "over all his other creatures in it" (Walker, p. 43).

Tiberius (Tiberio) Cavallo (1749–1809), son of a Neapolitan physician, originally moved to London in 1771 with the intention of establishing a career as a merchant. He quickly rose to fame in the City as a natural philosopher and became a Fellow of the Royal Society in 1779. Cavallo's scientific researches in Britain were diverse and influential. They included experiments on animal electricity as well as different kinds of air. Additionally, long periods of his extraordinary career were dedicated to his enquiries into mineral magnetism. Cavallo gave annual *Bakerian Lectures* on his scientific discoveries between 1780 and 1792. Between 1790 and 1795, he published *A Treatise on Magnetism in Theory and Practice*, which summarises some of his magnetic lectures, deduced from his electrical researches.

In the preface to his *Treatise on Magnetism*, first published in 1795, Cavallo states that the object of his present work, "is to exhibit a comprehensive view of the present state of knowledge relative to magnetism" (p. v). In accordance with magnetic discourse at the time, he frequently refers to magnetic phenomena in the context of its fluid constitution. As was characteristic of treatises concerning the magnetic fluid at the time, we find in Cavallo familiar strains of thinking: the nature of magnetism as a sibling fluid to electricity; an implicit similarity between magnetic and ethereal fluids; and of the Omnipotence of God the Prime Cause. The fluid qualities of magnetic phenomena, he notes, can be deduced from the science of electricity. Referring to Benjamin Franklin and Franz Aepinus, Cavallo writes,

> From the […] more common hypothesis of electricity, which goes under the name of Dr. Franklin's, Mr. Aepinus is led to imagine, that there exists a fluid productive of all the magnetic phenomena, and consequently to be called to magnetic fluid; that this fluid, is so very subtile [*sic*.] as to penetrate the pores of all bodies.
>
> (p. 134)

As with Walker, we see a concern to explain influence by means of the porous nature of material bodies. But there can be little doubt about the fundamental assumption Cavallo makes in his exploration of magnetic occurrences. He writes of "a fluid productive of all magnetic phenomena", and a fluid "so very subtile as to penetrate … all bodies" (ibid.). A unifying Ur-fluid remains as the underlying explanatory model for understanding distinct natural phenomena. But there was a form of magnetism that would come under increasing scrutiny and scepticism at the time.

In tracing through the evolution of thinking and writing about magnetism, the case of Anton Mesmer is (perhaps unsurprisingly) unusual. Mesmer followed strongly in the wake of those precursor scientists who insisted on magnetism's 'fluid' nature and origins, but sought himself to become a powerful influence in the field of health and therapy. In particular, Mesmer sought to establish himself as the founding father of a new kind of science focused on "animal" rather than "mineral" or "terrestrial" magnetism. An early description of what was understood by this term runs as follows:

> *Magnetism, animal*: An appellation given by some designing or self-deceived operators upon the credulity and purses of mankind, to certain practices, by which, under the pretence of curing diseases, various effects were produced on the animal economy.
>
> (Rees, no pagination)

This scathing definition taken from the 1819 edition of the *Cyclopaedia, or Universal Dictionary of Arts, Sciences and Literature*, provides a glimpse of the poor reputation

of animal magnetism as a form of medical enquiry after 1800, in the wake of a landmark 1784 "Commissioners Report" which proved the animal magnetic fluid and its effects on the human constitution to be non-existent, or rather as a figment of the imagination. "An ample detail of this investigation", the encyclopaedia entry drily remarks further, "will be found under the article 'Imagination" (ibid.). Yet, before the publication of the report (discussed in more detail in the next chapter), animal magnetism was considered by many not only as a valid form of scientific enquiry related to "terrestrial" magnetism, but also a form of medical treatment with almost divine healing potential, dependant entirely on the action and influence of a supposed animal magnetic fluid. Close reading of Franz Anton Mesmer's body of work on the subject, from the period between 1766 and 1800, shows the significance of the concept of fluidity as the base or underlying principle for an entire branch of this (pseudo-) medical practice. However, as we shall see in the next chapter, the publication of the Commissioners Report in 1784 constituted the downfall of fluidity as a descriptive concept within magnetic discourse – not only in the dying branch of animal magnetism, but also in all magnetic enquiry.

In 1766, Franz Anton Mesmer, then student of medicine at the university of Vienna, wrote in his 'Dissertatio Physico-Medica de Planetarum Influxu' what was to become the basis of the (pseudo-) medical discipline named after him.[90] This *faux* discipline would later bring him both the highest esteem, and immeasurable disgrace. The branch of medical enquiry also termed 'Animal Magnetism' (though not explicitly referred to as such in Mesmer's first publication) combined theories of Mineral Magnetism with

[90] Mesmer's 'Dissertatio Physico-Medica de Planetarum Influxu' was translated into French as 'Dissertation Physico-médicale sur l'influence des planètes', and into English as 'Physical-Medical Treatise on the Influence of the Planets'.

medical enquiry, proposing that illnesses and disorders in the human body were caused by disturbances of the 'equilibrium' of fluids in the organism.[91] By guiding the magnetic fluid through the human body, Animal Magnetists claimed they could re-establish an equilibrium, thus healing their patients.

Key to understanding Mesmerism, but somewhat disregarded or overlooked, is the concept of fluidity in discourse on magnetism. Mesmer's remarkable career and enormous success, both as a physician, and as a kind of 'guru' to his followers, is built upon a conception of (animal) magnetism as a subtle, imperceptible influence – an imponderable fluid. As Crabtree (1993) has argued, "Mesmer conceived of this influence as something so subtle in essence that one would hesitate to call it 'matter'" (p. 4). Descriptions of the magnetic fluid as an inherently divine descendant from an ethereal fluid, together with allusions to an ethereal medium itself, are present in Mesmer's entire body of work, composed over roughly thirty years. References to fluidity, and an ethereal, or "universal fluid" (Mesmer, 1980, p.34) feature especially frequently throughout his medical publications.[92] The concept of fluidity opens up for Mesmer the possibility of applying magnetism to medical enquiry. Exploiting the mysterious allure of magnetic fluidity, he quickly rises to become one of the most celebrated and controversial medical figures of the eighteenth century. While, from a contemporary perspective, it may appear easy to condemn Mesmer as a quack aiming

[91] By the 'fluids' in the animal body that the animal magnetists sought to balance were meant the nervous fluid (which was frequently regarded as electricity itself), and the magnetic fluid. Mesmer does not typically mean blood or water when he refers to the fluids of the animal body, although some of his model of Animal Magnetism is drawn from early theories of the humours, in accordance with the Galenic doctrine.

[92] Owing to the size of the corpus of Mesmer's publications, a textual study of fluidity in his work presents a challenge. An analysis of key terms and motives in his work is further complicated by the fact that Mesmer published works in Latin, German, French, and English, and it is sometimes difficult to determine which language a work was published in originally, before being translated. Owing to the multitude of translations of his nonetheless similarly titled works, key concepts, such as the concept of fluidity, may well get lost in translation. For the purposes of this analysis, I will refer to, or give the original source wherever possible.

to enrich himself, an analysis of his writings shows that Mesmer himself was heavily invested in what he and others then believed to be valid medical practice. As Crabtree writes, “Mesmer was talking not about an occult astrological influence but about a purely physical, scientific one” (Crabtree, p.4). With this in mind, at least for the earlier part of his career it may be unjust to condemn his intentions. In his own era, his rooting of what he believes to be an animal magnetic force in the context of fluidity lends credibility to his practice and allows him to position Mesmerism alongside “terrestrial” magnetism as a separate but similar discipline within magnetic enquiry.

In his first published, foundational work on the subject, a dissertation at the University of Vienna, Mesmer describes the underlying hypotheses of his system of Animal Magnetism, ultimately derived from Newtonian physics concerning the movement of the planets. Mesmer’s Newtonian observations of the moon’s influence on the earth, and on tidal fluctuations caused by the moon’s gravity form the basis for his own brand of Animal Magnetism. He describes in detail a threefold conjecture from the physics of tidal movements of the sea to related but invisible tidal movements of various imperceptible atmospheric fluids, and subsequently to analogous tidal movements of the magnetic fluid in the human body. He states, “Since these facts are established one can most easily apply this more general doctrine to the atmosphere”, since “the ebb and flow take place in the air in the same manner as in water” (p.12). A supposed fluidity of air and of the earth’s atmosphere are a key step towards Mesmer’s hypotheses about a potential influence of the magnetic fluid on the human the body. If the moon, through its gravitational force could effect an ebb and flow of the atmosphere, then, he proposes, a similar effect could be reproduced in a patient’s body.

An ‘ebb and flow’ within the body and caused by the action of the planets, he assumes, resembles the “lunar flux” (p.11), that causes both the tides of the sea and the atmospheric changes of the air. He further suggests that,

> [t]here is, in addition, another kind of influence, which acts upon the animal body, an influence which does not seem to depend upon these usual properties of the atmosphere, but rather depends directly on that force which, being prevalent in the vast spaces of the skies, affects the most interior portions of each material body, retains the enormous spheres in their orbits and deviates and disturbs them from their straight-line movement.

Elaborating on this added influence, he describes an all-powerful “force” responsible for nearly all processes in the animal (human) body. Although not explicitly stated here, this fluid force is evidently drawn from Newton’s own speculations on an ethereal fluid. Mesmer writes,

> There is a force which is the cause of universal gravitation, and which is, very probably, the foundation of all corporal properties; a force, which actually strains, relaxes and agitates the cohesion, elasticity, irritability, magnetism and electricity in the smallest fluid and solid particles in our machine.[93]
>
> (p. 14)

Newtonian ethereal influences are clearly visible in this description of the force. Hence, in his early publications, Mesmer chooses to term this basic principle “Animal Gravity” (ibid.). All throughout his career, his publications display an acute awareness of the difficulty of categorizing, describing, or naming such a complex, fluid, force or medium.[94] Adapting the vocabulary of philosophic discourse, he alludes to “invisible fluids” that are almost other-worldly, and possibly divine in essence. Building on a

[93] ‘Our machine’, refers to the animal, or human body.

[94] Mesmer frequently refers to the significance of nomenclature in the context of naming intangible matter. This awareness is perhaps best documented in a later publication in which he discusses a kind of conceptual super-ether as the closest medium not only to God, but to ‘truth’, as discussed further below.

narrative first constructed by Newton, he asks a pointed rhetorical question: "Who would not know that the most important changes of states in our body are produced by means of substance, which, because of their subtlety, we hesitate to call 'matter'?" (ibid.). Magnetic fluidity, as this quotation suggest, remains a semi-material phenomenon in Mesmer's model of medicine. It is too subtle for the senses. Still, as Mesmer would suggest, its effects on the animal body are potentially far-reaching and might revolutionise medical practice.

In his 1775 work *Schreiben über die Magnetkur* [*Writings on the Magnetic Cure*], which contains a letter to Dr. Unzer, 'Schreiben an einen auswärtigen Arzt' ('Letter to a foreign physician')[95], Mesmer recounts the cure of a female patient by means of attaching magnets to her body. These, he argues, were able to re-establish a natural equilibrium of the nervous fluid. Mesmer's report contains several observations on the magnetic fluid and its similarity to electricity. Reiterating the commonly accepted hypothesis of the sibling fluids, he writes that "I observed that magnetic material is almost the same as [the] electric fluid, and that it is propagated by intermediary bodies in the same way as is [the] electrical fluid (Mesmer, 1980, 2, p. 27). He adds that he "filled bottles with magnetic material in the same way as one does with [the] electrical fluid" (ibid., p. 28). His *Schreiben and einen auswärtigen Arzt* marks a particular point in his career. While Mesmer reports that the successful cure of his patient was achieved by attaching physical magnets to the patient's body, he also states that he was able to magnetise any body or object he desired, solely through his mind. "I have

[95] Bloch and Hilgard suggest that this publication was first published in French as 'Lettre sur la cure magnétique à un resident a l'étranger'. However, Michael Yonan's suggestion that the original letter was written and first published in German seems much more likely (Yonan, p. 153).

magnetised paper, bread, wool, silk, leather, stones, glass, water, different metals, wood, men, dogs – in a word, all that I touched, to the point that that these substances produced the same effects on the patient as does the magnet" (p. 28). The following excerpts, the first from the German original, and the second from Bloch's English translation, make some further key remarks about the ways in which his magnetic therapy operated:

> Nach den Grunsaetzen meiner Theorie, nach den gemachten Beobachtungen und Versuchen, schreibe ich dem Magnet eben keine specifische [sic.] Kraft auf die Nerven zu; ich bin der Meinung, seine Wirkung bestehe blos [sic.] darin, dass er wegen seiner unbegreiflichen Subtibilitaet und wegen seines [sic.] analogy mit dem fluido nerveo, womit er das Innerste durchstroemet, nach der Starke und Menge, und nach den Theilen wo er angebracht wird, eine kuenstliche Ebben und Fluth verursache, und die Ungleiche Austheilung und dispensation des fluidi nervei und dessen verwirrte Bewegung durch seinen gleichfoermigen Strom wiederherstelle, und denjenigen Zustand hervorbringe, den ich die Harmonie der Nerven nenne.
>
> (Mesmer, 1776, pp. 10-1)

> I do not believe that the magnet has a specific property by which it acts upon the nerves; I merely suppose, conforming to the principles of my theory, that magnetic matter, by virtue of its extreme subtlety and its similarity to the nervous fluid, disturbs the movement of the fluid in such a way that it causes all to return to the natural order, which I call the harmony of the nerves.
>
> (Mesmer, 1980, 2, p. 29)

First, it is necessary to bear in mind that the English translation misses some of Mesmer's points, and omits some of the language of fluidity he employs. The German version of this paragraph refers to 'an artificial ebb and flow,' or low and high tide, [*kuenstliche Ebbe und Fluth*] caused by the magnetic fluid. Furthermore, it states that the 'return to the natural order' within the body is achieved by what Mesmer refers to as an "even current" [*gleichfoermiger Strom*] of magnetism. Second, this paragraph, and what it implies about fluidity within the magnetic cure is perhaps the most significant statement of Mesmer's entire work. It is *not* the magnet itself that is key in

Mesmer's brand of Animal Magnetism, but the subtle magnetic fluid, and its similarity to what Mesmer refers to the nervous fluid (the 'fluido nerveo'), which pervades the air and all bodies, and which Mesmer is supposedly able to manipulate and direct. It is at this point that Mesmer fully dispenses with any physical objects, particularly magnets, as aids for his therapy. Instead, he relies completely on the fluidity of magnetism as an invisible, all-pervading substance which he claims to be able to affect. A hypothetical magnetic fluidity and its supposed intangible force takes precedence over merely physical magnets: fluidity alone, irrespective of any loadstone, becomes the sole central argument of Mesmeric treatments.

Mesmer's reasons for taking this step are difficult to determine, but they certainly result in a deep belief (or the pretence of it) in the divine powers of the magnetic fluid.[96] Abandoning the mineral magnet altogether, Mesmer makes himself the divine fluid incarnate. Relying solely on the operations of a supposed magnetic fluid consolidates his role as a particularly wondrous healer. Claiming divine magnetic fluidity for himself instead of relying on a physical object to exert its fluid powers enables him to further market his supposed ability to "imitate artificially the periodic revolutions of the ebb and flow" (Mesmer, 1980, 4, p.48) within the body. *Figure 4* shows a mesmeric practitioner following this model. For the purposes of the illustration, the animal magnetic fluid, perceived to be invisible, is represented by straight black lines, to illustrate the implied fluid magnetic force employed by Mesmer and his peers. "I have always stressed in my writings", Mesmer reiterates in his

[96] Much of this decision may have been owing to Mesmer's desire to monopolise magnetic medicine. At all times in his career, his practices were controversial. Mesmer's friends and allies often became his opponents, either because they had been disillusioned, or because they sought to profit from his discoveries. Mesmer's feud with Maximillian Hell, who had once helped him produce magnets for his cure may have been particularly significant. By abandoning magnets as medical instruments, Mesmer was no longer reliant on his contemporaries in promoting his practice.

Dissertation on the Discovery of Animal Magnetism (1766), "that the use of the magnet, however convenient was always imperfect without the assistance of the theory of Animal Magnetism".[97] The magnet, he argues, may be an intermediary conductor, but never the original cause or source of the magnetic fluid. Since his insistence on using only this invisible medium led to frequent accusations "that the cures announced by myself were imaginary and that my theory was nothing but an illusion", he writes that "[t]he desire to refute such errors once and for all […] led me to the resolution to make no further use of electricity or of the magnet from 1776 onwards" (ibid., p. 56). In the further course of his career, he continuously cites magnetic fluidity as the main pillar of his work.

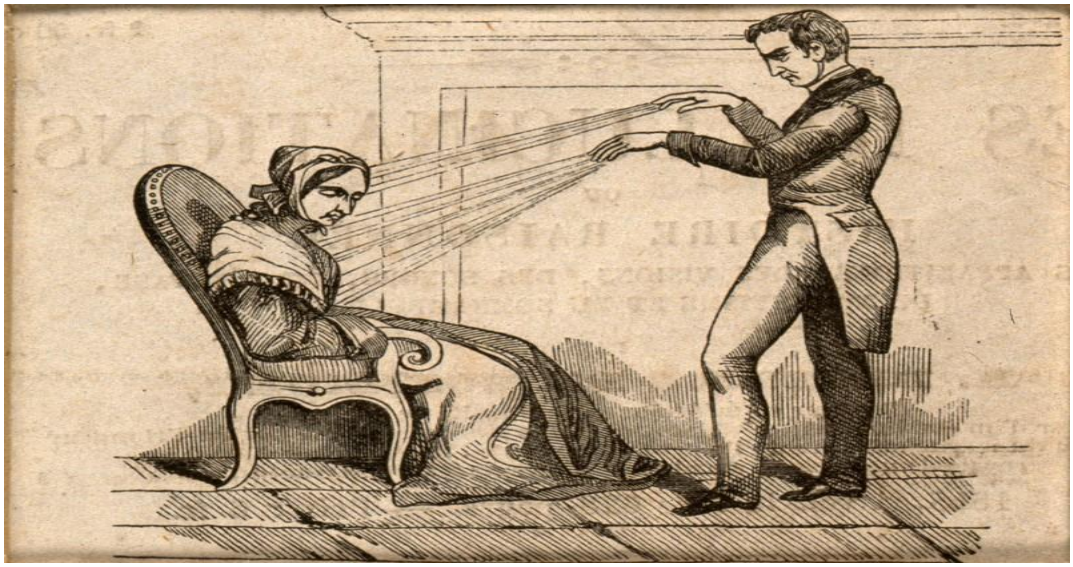

Figure 4: A practitioner of mesmerism using animal magnetism on a woman who responds with convulsions. Wood engraving. Credit: Wellcome Collection. Accessed via wellcomecollection.org.

In his *Discourse on Magnetism [Discours de M. Mesmer sur le Magnétisme*], published in 1782, six years after his decision to abandon physical magnets, Mesmer

[97] This work was originally published as *Mémoire sur la Découverte du Magnetisme Animal* in 1779.

reiterates the Newtonian influence on his theory regarding animal magnetism, that is related both to mineral magnetism and the electric fluid.[98]

> For a long time I have supposed that a universal fluid exists in nature, a fluid which penetrates all animate or inanimate bodies. The phenomena of electricity, as well as those of magnetism, affected his opinion of mine. Thus, I adopted the theme of the noble Newton regarding celestial bodies.
>
> (1980, 3, p. 33)

Adding to this hypothesis, he then continues to argue that fluidity is the basis not only for animal and mineral magnetism, as well as for electricity, but that it also underpins and constitutes a whole variety of other natural phenomena frequently discussed in scientific discourse in the period, among them ether and phlogiston. He notes,

> Since time immemorial one has spoken of sympathy, antipathy, of attraction, repulsion, of ethereal matter, of phlogiston, of subtle matter, of animal spirits, of electrical matter, and of magnetic matter. All these agents, whose action is as real as the existence of light – Do they not proclaim the widespread universal fluid, but combined differently in accordance with the substances and their manner of being or of action? This view has nothing which opposes reason.
>
> (ibid., p. 34)

Mesmer here once more anchors his animal magnetism firmly in the discourse of fluidity. The commonly held consensus that a variety of subtle fluids were regarded as variants of the same Ur-fluid, and shared the same divine origin, allows him to merely add his own brand of the (animal) magnetic fluid to the mix. All of these fluids, 'whose action is as real as the existence of light', act in accordance with the same fluid principle which forms the basis of Mesmer's brand of animal magnetic therapy. As we shall see in the next chapter, it is only when it is found that his animal magnetic

[98] Mesmer's 'Discours de M. Mesmer sur le Magnétisme' was published by Paulet *in L'Antimagnétisme, ou Origine, progrès, décadence, renouvellement et réfutation du magnétisme animal*, and taken from the earlier article entitled "Recueil des effects salutaires de l'amant dans les maladies", (Geneva 1782). See also Bloch and Hilgard, pp. 31-39.

fluid cannot be rendered observable or perceptible that Mesmer's fluid magnetic empire begins to fall.

Magnetism, like its sibling phenomenon electricity, in the seventeenth and eighteenth centuries relied fundamentally on fluidity as an underpinning model, mode of description, and material substance. As this chapter has shown, discussions of magnetic force, both in the areas of terrestrial and animal magnetic researches, posited fluidity as the phenomenon's essence. While its conception as a subtle, possibly divine fluid meant that magnetism was understood as an (at times) imperceptible substance, this conception in commonly held hypotheses neither negated the fluid's existence, nor its ontological validity. Both sub-branches of magnetic natural philosophy, "terrestrial" and "animal" magnetism at the time relied on the same fluid principle, posited as the basis for all magnetic enquiry by both English and Continental natural philosophers.

Fluidity, then, was for much of the eighteenth century a bridging element that connects creative, philosophic and religious discourses on the properties of magnetism. The gradual diminishing of this concept coincided with an increasing secularisation of natural philosophic discourses. It led eventually to a growing divergence of literary treatments of the phenomenon on the one hand, and more rigorously scientific examinations of magnetic force on the other hand. Although somewhat overlooked in contemporary critical research, the concept of fluidity, however subtle in its description and supposed appearance, formed the basis of all magnetic enquiries of the seventeenth and eighteenth centuries.

Chapter Four: The Demise of Fluidity Theory

So far we have seen that the notion of a subtle fluid underpinned virtually all discourse about electricity, fire and magnetism in the eighteenth century. This poetically mysterious and scientifically fundamental medium was, at the time, inseparably linked to Christian creation narratives. An ethereal substance or medium was perceived to be a central constituent of the universe, created by an omnipotent God. All other natural phenomena perceived as fluids in the period were thought to descend from the ether, a kind of Ur-fluid. If physical phenomena led back to a divine substance, the religious dimension of material nature would be demonstrated. This chapter analyses a shift in scientific discourse in which fluidity begins to take a less central role. It takes the topic of electricity first and then magnetism to highlight the ways in which fluid explanations declined in these subjects.[99] Yet it shows that even in accounts by sceptics regarding ethereal fluids such as Humphry Davy, Samuel Taylor Coleridge and even Michael Faraday, the influences of precursors like Milton and Newton and the language of fluidity only slowly faded from the scientific imagination.

Rendering various ether-derived fluids visible and quasi-material was frequently regarded as a confirmation of the existence of divinity. This process also led to the invention of countless applications and cures based on divine healing. However, there is a clear shift in the second half and end of the eighteenth century in approaches to electricity, magnetism, and natural sciences in general. In the late eighteenth- and early nineteenth century, we see an increasing secularisation of scientific enquiry into

[99] I have chosen to discuss electricity first, followed by magnetism, in order to follow the central subject matter of Chapters Two and Three.

natural phenomena. Within the sub-branch of electrical science, this change was driven by scientists such as Humphry Davy and Michael Faraday who strove to implement more exact scientific terminology following Antoine Lavoisier's revolutionary *Elements of Chemistry* (1789).[100] In the scientific sub-branch of magnetism, this process began after a report commissioned by Louis XVI of France regarding Animal Magnetism which led to the demise of Mesmer's model of fluidity. This gradual secularisation of scientific enquiry in the period coincides with a decline in the use of the concept of 'fluidity', which was then no longer the *sole* explanation for the qualities or features of electricity and magnetism, and other imponderable fluids.

It is impossible to determine a precise time, publication or event that may have led to a declining significance of fluidity within natural philosophic discourse of the eighteenth and early nineteenth centuries. This chapter, however, explores two key reasons for this decline: first, experiments designed to render ethereal fluid observable ended in failure, and second, the quest to establish a divine agency in natural phenomena was displaced by alternative explanations. The ether faded from scientific understanding in the twentieth and twenty-first centuries but retains some residual aspects of its early conceptualization.[101] After all, we refer to electricity as 'flowing' even today and use the term 'current' to refer to electric energy.

[100] This work was originally published as *Traité Elémentaire de Chimie* in 1789.

[101] In 1887, the Michaelson-Morley experiment disproved the existence of a luminiferous (light-bearing) ether. Michaelson and Morley had originally hoped to prove the existence of 'aether winds'. While this remained unsuccessful (giving them a reputation of having conducted the 'most famous failed experiment'), the Michaelson-Morley experiment is perhaps the most notable breakthrough in physics of the late nineteenth century. Albert Einstein felt indebted to the two physicists and is reported as stating, "If the Michelson-Morley experiment had not brought us into serious embarrassment, no one would have regarded the relativity theory as a (halfway) redemption" (Fölsing, 1998, p. 219).

Electricity, in treatises after 1800, was regarded less and less as a mysterious, imponderable fluid of divine origin. This change was driven in part by a movement in natural philosophy at the end of the eighteenth century, led by French philosopher Antoine Lavoisier. Lavoisier's 1789 work *Elements of Chemistry* postulated that all phenomena in natural philosophy should be described and catalogued in terms of chemical elements, in order to make them both classifiable and quantifiable. A supposedly divine, semi-material electric fluid, derived in both concept and substance from an equally 'unscientific' ethereal fluid, stood in sharp contrast to these attempts to rationalise natural sciences, and had no place in the first iterations of the periodic table. Applying the newly introduced scientific rigor to their own electric researches, scientists such as Humphry Davy and Michael Faraday tended to refrain from referring to abstract electric fluidity where possible.[102]

In tandem with this drive for classification, we see a shift in the conceptualisation of electric fluidity. Whereas electric fluidity throughout the seventeenth and eighteenth centuries had been regarded as an invisible but nevertheless very real semi-material phenomenon, its classification as a fluid shifted from mere descriptor or signifier to an analogy or metaphor. The existence of electricity (though now no longer regarded as of divine origin) remained undisputed, but fluidity, in treatises by Davy, Faraday and others, was slowly reduced to being only one of several ways in which electricity could be understood. To put it simply, Davy and Faraday saw fluidity not as electricity's material reality, but merely as one of many analogies or metaphors to describe electric energy.

[102] Where fluidity is referred to in both Davy's and Faraday's scientific publications, its scope differs significantly from any applications of the concept prevalent in the eighteenth century, as discussed further below.

It may perhaps seem counterintuitive to include Antoine Lavoisier, a French philosopher frequently regarded as the founder of modern chemistry, in a discussion of electric fluidity, when he himself had little or no interest in conducting electric experiments. However, Lavoisier's contribution to natural philosophy, and principally his treatise *Elements of Chemistry*, first published as *Traité élémentaire de Chimie*, went far beyond the newly-founded discipline of chemistry alone. Tragically, Lavoisier was executed by guillotine in 1794 and the third edition of the *Traité* laments Lavoisier's untimely death just after the French Revolution, stating that "the most perfect government would scarcely have succeeded, to France and to the world, to repair the prodigious injury that loss has produced to chemistry, and to all the sciences […] with which it is connected" (p. xi). Lavoisier's work is central to an understanding of the context the treatise provided for a restructuring of scientific disciplines. With regard to fluidity, it paved the way, amongst other ground-breaking discoveries, for the shifting relevance of this concept within electrical science, and for a gradual fading of fluidity from natural philosophy or science as a whole.[103] Both Humphry Davy and Michael Faraday adhered to a new nomenclature introduced by Lavoisier to account for their electrical researches. In the related branch of magnetic enquiry, Lavoisier's work was a contributor to a demise of Creationist ideas regarding magnetic fluidity, which was dealt its final blow by the publication of the Franklin Report, co-authored by Lavoisier.

[103] While there were a number of additional factors that ultimately led to magnetic fluidity's slow disappearance form natural philosophic or scientific discourse, a drive to rationalise natural philosophy led by Lavoisier also played its part in a more secularised understanding of magnetism.

Lavoisier's contribution to the development of natural philosophy and the establishment of more exclusively 'scientific' fields of enquiry has been explored at length, principally by Charles Coulston Gillespie (1960) and Henry Guerlac (1967). While Gillespie has pointed out that "the *Elements of Chemistry* is no mere discourse of method", detaching him from the influence of Descartes, natural philosophers followed in Lavoisier's wake, including electric experimenters Humphry Davy and Michael Faraday. It was Lavoisier's innovations in nomenclature that were instrumental in the gradual disappearance, or shifting relevance of fluidity within electric and other 'fluid discourses' of the period. In the 'Translator's Advertisement' to the work, Robert Kerr, member of the Royal College of Surgeons, signals that the significance of Lavoisier's treatise may have been owing just as much to its use of language as to any of its other scientific discoveries.[104] Indeed, as Gillespie has argued, "[t]he *Elements of Chemistry* has none of the inaccessibility of Newton's *Principia*" (p. 203), but it equally avoided the speculative nature of argument of the Newtonian *Opticks,* which had allowed the concept of fluidity to flourish in natural philosophic discourse. Lavoisier himself introduces the work now frequently referred to as the 'textbook of modern chemistry' by quoting the Abbé Condillac's musings on language: "We think only through the medium of words -- languages are true analytical methods" (p.xiii). Transferring this idea to science and the formation of a strictly scientific nomenclature, he argues,

> The impossibility of separating the nomenclature of a science from the science itself, is owing to this, that every branch of physical science must consist of three

[104] Kerr comments on the work and his endeavour to give the treatise to the public "in an English dress" (p. v) in the 'Translators advertisement'. He insists "that his [own] knowledge of the composition of language fit for publication is far inferior to his attachment to the subject" (pp. v-vi), and that "he has earnestly endeavoured to give the meaning of the author with the most scrupulous fidelity, having paid infinitely greater attention to the accuracy of translation than to elegance of style" (p. 5).

> things, the *series of facts* which are the objects of the science, the *ideas which represent these facts* and the *words by which these ideas are expressed.*
>
> (p. xiii, added emphases)

This understanding of language and expression in relation to science is crucial. According to both Lavoisier and Condillac, "Algebra, in the most simple, most exact and best manner possible, is at the same time a language and an analytical method" (ibid.). Lavoisier's approach transformed natural philosophy into a much more mathematical discipline, in France as well as in England. As June Fullmer has remarked, "Lavoisier's lessons found their mark [and] natural philosophy, and especially chemistry, was thought to be a matter of naming names" (p. 54). Applied to an abstract concept of fluidity, both the idea of an abstract, imponderable, subtle substance, and the term 'fluid' which represented not one but several interconnected, inherently divine phenomena, was too inexact for this new scientific mode of classifying information that favoured facts and precision over a creative, Romantic expression regarding scientific phenomena.

The demise of fluidity as a concept useful in electrical research was hastened by Humphry Davy (1778-1829). Davy's work is particularly interesting for the way in which he engaged with poetry and natural philosophy, and to the degree he drew on yet also helped to separate the two evolving disciplines. While he was a practised poet in his youth, Davy's scientific publications make little or no use of poetic language. Instead, Davy (as a scientist) strove for clear, concise and unambiguous language in his lectures on chemistry and electricity. His works, particularly his 1806 Bakerian Lecture *On Some Chemical Agencies of Electricity,* document a shift or transition in the late eighteenth and early nineteenth centuries, in which natural philosophic and

creative discourses diverged to form more separate fields of enquiry. Classifications of electric phenomena in terms of fluidity become less relevant and are largely avoided in Davy's publications on electrochemistry. However, images of fluidity, derived in part from Davy's researches remained a source of language for poets like Coleridge.

Davy is remembered by his brother John as a "reciter of stories, in which his inventive and imaginative faculties […] were early exercised, and of which proofs remain in some sketches of romance" (Davy, p.8). Indeed, Davy's interest in poetry preceded his scientific enquiries as his brother remarks: "Chemistry, which he marked as a branch of his professional studies, had not, it would seem, amongst these studies his earliest attention" (ibid., p. 15). The following rhapsody of uncertain date was found by his brother 'amongst his commonplaces'. It captures Davy's fascination with science *and* the imagination:

> Oh, most magnificent and noble nature!
> Have I not worshipped thee with such a love
> As never mortal men before displayed?
> Adored thee in thy majesty of visible creation,
> And searched into thy hidden and mysterious ways
> As Poet, as Philosopher, as Sage?
>
> (ibid., p. 14)

Davy crucially envisions himself in three roles, "as poet, as philosopher, as sage". The rhapsody, an Ode to "most magnificent and noble nature" which is waiting to be discovered and worthy of being worshipped, displays Davy's poetic ambition. While he describes nature in poetic language, he also attempted to separate the three roles he refers to in the verses above. David Knight observes that "contemporaries were struck

by the boldness of his imagination throughout his life" (p. 68).[105] Perhaps the most prominent of those contemporaries with whom Davy shared a mutual sense of admiration was Coleridge, who described him as follows: "there is an energy, an elasticity in [Davy's] mind, which enables him […] to analyse all questions, pushing them to their legitimate consequences. Every subject in Davy's mind has the principle of vitality" (ibid., pp. 73-4).[106] Even this poetic description of Davy's character echoes natural scientific discourse of the period. Coleridge visited several of Davy's lectures at the Royal Institution, which "he attended to improve his stock of metaphors" (Knight, 1967, p.67). Indeed, the ways in which Coleridge processed Davy's lectures and scientific discoveries are as fascinating as they are puzzling. One of Coleridge's diary entries, composed after his attendance of one of Davy's lectures, reads as follows:

> The Poles of Ice render the Torrid Zone Habitable & the ~~la~~ [sic] very much later accumulation & Extend of Ice at the South Pole necessary to preserve the Ice at the North/? How?
> The non-conducting power of Fluids – else all Ice/ the high conducting power of air/ else all Scorch and Conflagration/–
> Davy's Hypothesis of the Aurora Borealis/ – Sir Isaac Newton's of Light / each Particle every where [sic.] in the course of Eternity.
> Contrast of colours – /two pillars/ & wear green Spectacles/ O what a lovely Purple when you pull them off // vice versa! [sic.]
>
> (Coleridge, 1962, entry 1974)

[105] Davy's poetic ambitions are frequently overlooked because of the magnitude of his scientific legacy. Perhaps surprisingly, a reference to 'Davy, the poet' is made in George Eliot's *Middlemarch.* In a conversation between Mr Brooke and Chettam, who had been studying Davy's *Agricultural Chemistry,* the latter states, "Sir Humphry Davy: I dined with him years ago at Cartwright's, and Wordsworth was there too – the poet Wordsworth, you know […] But Davy was there: he was a poet too. Or, as I may say, Wordsworth was poet one, and Davy was poet two. That was true in every sense, you know" (p. 16).

[106] The close friendship between Coleridge and Davy is documented by their regular correspondence published in Davy's biography entitled *Fragmentary Remains* (published 1858).

The entry is a kaleidoscope of associations and highlights how Coleridge drew on Davy's scientific discoveries in electricity and chemistry for his own creative output. Coleridge's reference to "Sir Isaac Newton's [hypothesis] of light", and his line on "each particle every where in the course of Eternity", echo the notion of a Newtonian Ur-fluid which was commonly regarded as being the essence or main constituent of all elements present in the Universe. The poet's note on "[p]oles of Ice", "the non-conducting power of Fluids" (probably a reference to one of Davy's electrochemical experiments similar to those discussed in his first Bakerian lecture) and "Davy's hypothesis on the Aurora Borealis" are curiously juxtaposed with a "contrast of colours". As Cathleen Coburn notes, "in one of the 1804 series Davy said 'the appearance of the Aurora Borealis is probably owing to electrical changes taking place in the air around the poles" (*Notes*, entry 1974). For all, Coleridge's specific doubts about ether, a generalised fluidity informs his understanding of the world. These references to various fluids, to ice, colours, and his fascination with the northern lights remind of parts of Coleridge's 'Rime of the Ancient Mariner', first published in 1798. Coleridge's Notebook entry refers to arctic ice and the contrast of colours (possibly produced in an Aurora Borealis). In the poem we see exactly this combination of imagery 'floating by': "ice, mast-high, came floating by/ As green as emerald" (Coleridge, p. 189, ll. 53-4). Similarly, the verses "The water, like a witch's oils,/ Burnt green and blue and white (p. 191, ll. 129-30) may refer to the reflection of the northern lights in the water, while at the same time possibly alluding to a chemical flame test Davy might have produced in one of his experiments. Coleridge also makes reference to the "Fire-flags sheen" (p. 199, l. 314), lighting up the desolate scene, and finally "The lightning fell with never a jag" (l. 325).

Coleridge clearly drew inspiration from Davy's chemical researches, and Davy himself had tried his hand at poetry in the earlier years of his career. Yet Davy's publications on electricity mark a loosening of the grip of fluidity as a concept on the scientific mind. His first Bakerian Lecture, given in 1806, illustrates the kind of detached, formal, approach, proposed by Lavoisier.[107] Davy's lecture, in disregarding fluidity as a descriptive entity, documents the gradually fading significance of the concept within electrical discourse in the early nineteenth century. Davy's comprehensive lecture *On Some chemical Agencies of Electricity* "detail[s] some minute (and I fear tedious) experiments" (p.1), conducted to ascertain how electricity behaves when in contact with other substances, including water, several different acids, and a variety of chemical solutions. Following Lavoisier's example, Davy's own researches on electricity are presented in a much more sober tone than treatises by his predecessors. The titles of some of his other publications, including his *Elements of Chemical Philosophy* (1812) and *Elements of Agricultural Chemistry* (1813) are a nod to Lavoisier's *Elements of Chemistry.* The influence of 'strong precursors' like Milton and Newton was at last beginning to wane. Davy does not propose any spectacularly new findings in his Bakerian lecture, nor speculate on a divine origin of electricity. Instead, in accordance with the neutral classifications of chemical elements in Lavoisier's 1789 treatise, he presents electricity in terms stripped of any fluid divine connotations. While Davy is of course aware of "the novelty of the phenomena, their want of analogy to known facts, and the apparent discordance of some of the results" (p.1), he does not revert to any hidden, mysterious, or divine

[107] Davy's relationship to Lavoisier was complicated and shaped by a number of disagreements, principally on the existence of phlogiston, and Lavoisier's suggestion of a substitute 'principle of heat' which he termed 'caloric'. While Davy may have disagreed with some of Lavoisier's chemical hypotheses, he remains indebted to the Frenchman's methodology which prescribed a stricter rationalisation of chemical elements and phenomena.

power as a means of explanation. He chooses to refrain from any abstract concepts or terminology so frequently used in the context of electrical speculations in the eighteenth century. Electricity, in his lecture, is explicitly not referred to as a subtle fluid. Instead, he uses phrases like ‘electrical energy’, ‘electrical agency’ or, quite simply, *just* ‘electricity’. Davy’s choice to disregard fluidity in his treatise also necessarily affects the way in which he views other naturally occurring phenomena which were commonly regarded as encompassed by the concept, including light and heat. Davy asserts that “heat and light are the common c*onsequences*” (p. 42, added emphasis) of his experiments involving electricity.

While the word ‘fluid’ appears frequently in his Bakerian Lecture, Davy consistently uses the term ‘fluid’ to mean ‘liquid’, opposing earlier seventeenth and eighteenth-century discussions, which defined fluids as explicitly ethereal and abstract:

> In 1802, I found that the positive energy of the hydroguretted sulphurets with regard to the copper was sufficient to overpower that of the iron ; so that the electricity did not circulate from the copper to the iron, and from the iron to the fluid, as in common cases, but from the copper to the hydroguretted sulphuret, and from the hydroguretted sulphuret to the iron.
>
> (p.37)

What this excerpt shows clearly is that electricity here is no longer recognised as a part of the concept of fluidity. It is a self-contained phenomenon, and the term ‘fluid’, although used in the same sentence, here denotes a liquid, or a solution, not any kind of abstract mysterious force.

Humphry Davy’s approach to electricity in his Bakerian Lecture may seem an unimportant detail at first glance, but it is in fact a key step for the advancement of

electrical enquiry in the nineteenth century. This shift recognized electricity as a separate energy and detached it from a conceptually related variety of different supposed 'fluids'. An introduction of more distinct nomenclatures in chemistry, and the newly emerging branch of electro-chemistry, led to a gradual separation of the latter from the literary and creative arts and also accelerated a de-mystification of natural phenomena. Davy's scepticism regarding fluidity would have a significant legacy for the ground-breaking electrical studies of his laboratory assistant Michael Faraday.

In a short essay, composed as part of his numerous moral and philosophical 'mental exercises', Faraday (1791-1867) writes on the roles of judgement and the imagination. He states,

> Judgement is united to learning […] Its employment is the finding of differences and truth is its offspring while imagination is busy in tracing likeness and wit is the result —it would be too much perhaps to say which produces the greatest satisfaction but certainly that resulting from judgement is the noblest and that of imagination the most enticing but where a union of the two takes place in a strong degree there will always be a great cause for our admiration.
>
> (Jenkins, pp. 53-4)

Faraday here contrasts judgement, the finder of truth, with the powers of the imagination. Perhaps the most striking point he makes here is that neither one of these two mental faculties is necessarily superior to the other. Faraday calls judgement 'the noblest' and imagination 'the most enticing', but it is only in their unison that the two can produce the most impressive and admirable result. This passage is significant in several ways. Firstly, it is a concise review of scientific practice prior to the more advanced enquiries of Lavoisier, Davy and, of course, Faraday's own researches into electricity. His words sum up scientific argument in the eighteenth century, in which

the imagination played a significant role in shaping scientific ideas and concepts. Secondly, the passage reveals some maxims that Faraday adheres to throughout his scientific career. He underlines the importance of precision and accuracy but at the same time leaves some space for the imagination as the driving force behind pioneering ideas – but only so much that scientific accuracy will never be clouded by the "delusive vapours of Imagination" (ibid., p. 54).[108] The passage above can be read as the foundation for much of Faraday's scientific work.

Faraday continues his essay with a discussion of the mind, and the generality and abstract nature of ideas. He writes,

> it may be that the mind has conceived a plan which of itself is of so general and extensive a nature [..] that it requires still to be divided and subdivided before it can decide where to settle: therefore it is not the want but the superabundance of subjects which present themselves that are the cause of difficulty [sic.].
>
> (ibid.)

This description aptly fits the concept of fluidity in (electrical) science: fluidity, as discussed here, was an abstract, broad idea which encompassed a wide variety of different, more or less related phenomena. Yet Faraday, a follower of Lavoisier's new scientific nomenclature, also sought a more exact categorisation of scientific phenomena. He followed in Davy's footsteps in broadly adhering to the new taxonomy introduced by Lavoisier. Yet at the same time, Faraday, perhaps more so than most before him, also displayed an acute awareness of the importance of language, metaphor and analogy in expressing and conveying complex ideas.

[108] This phrase refers to Faraday's 'The Origin of a Critic – A Fable', in which he fittingly describes the power of judgement and reason through poetry, the language of imagination. He writes that once "Reason's sun darts through the mazy gloom/ […] no more, deceitful visions play/ Which led the wanton mind so far astray.", and "inlieu of scenes from fairy land/ Corrected vision finds a cottage stand" (Jenkins, p. 130).

Faraday's *Experimental Researches in Electricity* (1832) is one of the milestones in electrical science. It is one of the first substantial works on electromagnetism, and discusses the relation of electricity and magnetism, or, as Faraday puts it, the "evolution of electricity from magnetism" (p.5). The work expands Davy's work on "electro-chemical decomposition", and even discusses the "absolute quantity of electricity in the molecules of matter" (p.5). His discussion of the intimate relation of electricity and magnetism echoes eighteenth-century notions of the concept of fluidity in which electricity and magnetism were regarded as different manifestations of the same phenomenon. Faraday, as we shall see, clearly draws on this interconnectedness of the phenomena. His motivations for doing so, are grounded in his earlier 'Mental Exercises' (c. 1818) and differ largely from earlier approaches to the 'mysterious' concept of fluidity. Andrea Henderson has argued that

> Faraday resisted the fluid metaphor and sought to use less freighted language to describe what he called electricity in a "dynamic state" […]. In his view, "when the natural truth and the conventional representation of it most closely agree, then are we most advanced in our knowledge"
>
> (p. 391)

Indeed, Faraday's *Experimental Researches* suggest that he strove to simplify scientific writing and discourse. However, an apparent rejection of the concept of fluidity in his work is by no means drastic but instead appears to be much more nuanced. Faraday still refers to electric fluidity, but his use of the concept differs in scope and implied meaning from the ways in which electric fluidity had frequently been portrayed in the eighteenth century. In line with scientific discourse of the period, he holds that several different natural phenomena are inherently related. At a meeting of the Royal Society in 1845, Faraday's paper *On the Magnetisation of Light and the*

Illumination of Magnetic Lines of Force was read, and Faraday's view was summarised as follows:

> "For a long time past, the author had felt a strong persuasion […] that among the several powers of nature which […] produce different classes of effects, there exists an intimate relation, that they are connected by a common origin […] and are capable […] of being converted the one into the other."
>
> (Anon., 1845, p. 210)

This view is clearly informed by the commonly held eighteenth-century hypothesis according to which various different 'imponderable' phenomena share the same fluid origin. Faraday clearly did not abandon the concept of fluidity completely, although he tended to refrain from using the word 'fluid' when referring to electricity in his treatises. Instead, like Davy before him, Faraday, mostly uses the term to mean 'liquid'. In doing so, he shows an acute awareness of the changeability of expression and language. His *Experimental Researches,* contains a brief summary of several electrical theories accepted at various points in history, including, for example, the theory of two electric fluids, one positive one negative, discussed by Franklin and his French counterparts. Faraday hesitates to declare any of these hypotheses to be untrue, but recognizes that there may be different ways of understanding this abstract concept. His views on the movement and transmission of electric energy demonstrate his awareness of mental imagery in conveying complex ideas. One of the aims of *Experimental Researches*, in Faraday's own words, was to "to investigate experimentally the inductive effect of electric currents" (p. 7). "By *current*", he states further on into the treatise, "I mean anything progressive, whether it be a fluid of electricity, or two fluids moving in opposite directions, or merely vibrations, or, speaking still more generally, progressive forces" (p. 91). This statement echoes his earlier comments (in 'Mental Exercises') on the role of the imagination in science.

The language he uses in describing particular electrical experiments in his treatise is dictated by a stricter nomenclature in science. Faraday recognises that, with a growing secularisation and specialisation of electric discourse, various earlier models of electric force, including fluidity, the model of vibrations, or progressive forces, are likely to be displaced.

Faraday clearly sought to *avoid* what Aaron Cobb has called a "framework theory-dependence", that is, the process by which "the descriptions of experimental results derive their meaning from the particular theoretical framework generating the experimental inquiry" (p. 625). As a result, Faraday's *Experimental Researches* marked a point of (linguistic) change for the concept of fluidity in electro-science and a break in the line of influence from Newtonian science.

The scope and application of fluidity in Faraday's writing is vastly different from eighteenth-century publications on the subject. Where fluidity had been regarded as the essence of electricity and other related phenomena, it was now merely a metaphorical descriptor – one of a variety of 'modes of understanding'. What mattered to Faraday in explaining electrical phenomena was that it was a force or power in constant motion. The way in which this is expressed, whether by referring to it as flow, vibration, or simply force, to Faraday seems to have been secondary. In Faraday's work, the 'electric fluid' no longer has any link to former notions of ether. Fluidity is no longer regarded as electricity's essence. Instead, it is one of several descriptors for conceptualising electric energy.

A greater precision in language played a large part in Davy and Faraday's shift away from the concept of fluidity. This is similarly true of researches into magnetism following Lavoisier's treatise, but it was also the public undermining of Franz Mesmer

that decisively signalled an end to theories regarding magnetic fluidity. The decline in those theories was not a sudden or linear progress within one singular or straightforward narrative. This was further complicated by the conceptual distinction between the 'two magnetisms', one terrestrial or mineral, and one (supposedly) animal. Simon Schaffer has argued that "[t]here was something like a *crisis of facts* in the late Enlightenment and its immediate aftermath" (p. 120). In the discourse of Animal Magnetism, this crisis was brought about to a large extent by the Royal Commissioners' Report, first published by the Royal Academy of Medicine in France in 1784, which denounced Mesmeric practices as quackery, and heralded the end of 'Animal Magnetic' practices.

Where fluidity had been a concept that unified not only animal and terrestrial magnetism, but also literary, scientific and religious discourses on the subject, we see a growing divergence of these discourses in the aftermath of the publication of the Commissioners' Report. Central to this divergence was the notion of the imagination, referred to with increasing frequency in discourse postdating the publication of the Commissioners' Report. Allusions to the imagination, we will see, are relevant in two ways in this context. Firstly, the report "urged that it was the power of imagination that produced the crises falsely attributed to the agency of a universal magnetic fluid" (Schaffer, p. 132). Secondly, and as a result of 'animal magnetic' fluidity losing its validity as a medical agent, discussions of the phenomenon postdating the publication of the report are more frequently assigned to the more creative or literary fields of enquiry, as opposed to scientific or indeed religious forms of discourse.

Not only did the publication of the Franklin Report put an end to most mesmeric practices, but it also resulted in a growing scepticism towards the concept of fluidity

in magnetic discourse as a whole, i.e. in researches into terrestrial magnetism. Perhaps in an attempt to dissociate themselves from dubious practices, natural philosophers of the period were increasingly inclined to try to find other ways of explaining and conceptualising magnetic phenomena in the wake of the report's damning verdict. Magnetic fluidity, increasingly regarded as a concept too abstract for scientific discourse, fades into insignificance in the first decades of the nineteenth century.[109]

Prior to the report, Mesmer had been living a luxurious life in Paris at the height of his career. Dozens of (predominantly female) patients regularly flocked to his practice, hoping to be magnetised by his marvellous and mysterious fluid. In a city "besotted with the wilder claims of science", as Claude-Anne Lopez has so aptly put it, "[p]eople felt surrounded by wonderful, invisible forces: Newton's gravity […] ; Franklin's electricity, popularized by a fad for lightning rods; the miraculous gases of the balloons that lifted man into the air" (p.326). Fluidity, and abstract fluids within medical and philosophic discourses at the time frequently transcended discursive boundaries to make it into popular culture. Mesmerism, particularly *en vogue* in Paris at the end of the eighteenth century, is the prime example of such a phenomenon. More generally speaking, "[t]here were enough fluids, sponsored by enough philosophers, to make a reader's head swim" (ibid.) in France at the time, making Paris the ideal environment for Mesmer's magnetic practice to flourish. However, in a decision going against this popular fluid-craze, King Louis XVI elected to commission a report dedicated to examining the workings and effectiveness of 'Animal Magnetism'. This

[109] At this point and hereafter, the concept of magnetic fluidity moves to be echoed almost exclusively in literary discourses. Examples of such literary references to an eighteenth-century concept of fluidity are such as Bulwer-Lytton's *The Coming Race*, discussed further in the conclusion to this thesis.

report would prove devastating. No matter his fame, Mesmer's doubters were on the rise, despite Marie Antoinette, Louis' wife and daughter of Marie Therese, being one of his most famous and influential patients and advocates.[110]

The 1784 report was compiled and submitted by a team of five commissioners, amongst them Benjamin Franklin, Antoine Lavoisier and Joseph-Ignace Guillotin. The treatise, which details both the supposed workings of the 'animal magnetic' fluid, and the experiments and trials undertaken to disprove the existence of any medium that could have any physical effect on the human organism, is sometimes referred to as the first modern clinical trial (cf. Herr, p. 346). In a series of trials, model patients, amongst them the commissioners themselves, were repeatedly subjected to the magnetic fluid, with or without their knowledge. In comparing patients' reactions to the supposed treatment, and setting up what might, in modern medicine, be referred to as a control group, the commissioners set out to document whether patients could feel any physical impacts of being magnetised, or whether the suggestion of such a process resulted merely as a sort of placebo-effect. While the aims and results of the report are noted in a manner consistent with a more strictly scientific approach, its tone and verdicts at times remind the reader more of a satiric account of pseudo-medical practice. Beginning in a more factual tone, the report highlights the commissioners' commitment to precise science as opposed to speculation, as follows:

> It was the duty of the commissioners to confine themselves to arguments purely physical, that is to the momentous effects of the fluid on the animal frame, excluding from these effects all the illusions which might mix with them, and assuring that they could proceed from no other cause than the animal magnetism.

[110] Mesmer had fled Austria for Paris in 1778 after failing to cure blind pianist Maria Theresia Paradis. After falling out with the medical faculty, Austrian Archduchess Maria Theresa commissioned a report proving that Mesmer's magnetic methods were a hoax. At the time, however damning the verdict given in the Austrian report, Mesmer's move to Paris helped him preserve his reputation and build a new medical following.

While Mesmer himself was not consulted for the report, his disciple Charles Deslon was persuaded to assist the commissioners, and to demonstrate a number of animal magnetic procedures according to the Mesmeric system.[111] Introducing the report, a board of scientists demarcate the subject and scope of the momentous treatise as follows:

> The object of this system was a fluid extremely subtle, upon which were bestowed the magnificent titles of the soul of the world, spirit of the universe, and universal magnetic fluid, and which was pretended to be diffused through the whole space[…], to animate the system of nature, to penetrate all substances, and to be the vehicle to animated bodies in general.
>
> (Franklin, 1785, p. 2)

The inefficacy, or non-existence, of the animal magnetic fluid according to the report is a foregone conclusion at this point.[112] In prefacing the results of the investigation, the writers of the introduction express not only their scepticism of Mesmer's system, but refer also to the fact that his magnetic theories, however mystical, were not entirely original. "The animal magnetism", they state, "held a principal rank among the systems which were embraced in that period of literary history[113], when suppositions

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[111] Charles Deslon, (sometimes 'd'Eslon') (1750-1786) was a member of the medical faculty in Paris, and one of Mesmer's most ardent followers who fiercely defended the system of animal magnetism as a medical practice. He himself published several articles on his magnetic practice, including *Observations sur le magnétisme animal* (1780), and, following the publication of the Commissioners' Report, *Observations sur les deux rapports de MM. les Commissaires Nommés par Sa Majesté pour l'examen du Magnétisme Animal, par M. Deslon* (1784).

[112] This circumstance vexed Mesmer, who in turn wrote letter to Benjamin Franklin, denouncing Deslon's practices and insisting that the scientist was clearly not capable of demonstrating the powers of the magnetic fluid adequately. In an attempt to defend his reputation, Mesmer states that Deslon had "dared to ask the government for a committee to come verify at his home a discovery which is not his own, a discovery which he stole from its inventor, and which, whatever anyone says, he could only use in an illicit manner". He proceeds to suggest that he had been betrayed by Deslon, lamenting how unfairly he had been treated by both his former disciple, and by the commission. "How feeble and imperfect is the knowledge that [Deslon] stole from me" (Mesmer, 1784), he protests. Naturally, Mesmer's complaints were unsuccessful, as the commission's report conclude that any brand of animal magnetism relied purely on patients' imagination, and not on any subtle magnetic fluids.

[113] The authors here explicitly refer to a period in literary history, rather than natural philosophy, perhaps in an attempt to emphasise the mystic, imaginary, 'non-scientific' nature of the Paracelsian theories, and to further separate literary and philosophic (i.e. scientific) discourses.

were admitted to hold the place of facts" (ibid.). Paracelsus, as the subsequent chapters of the report reiterate frequently, had expressed ideas concerning some subtle animal magnetism nearly three hundred years prior to Mesmer.[114]

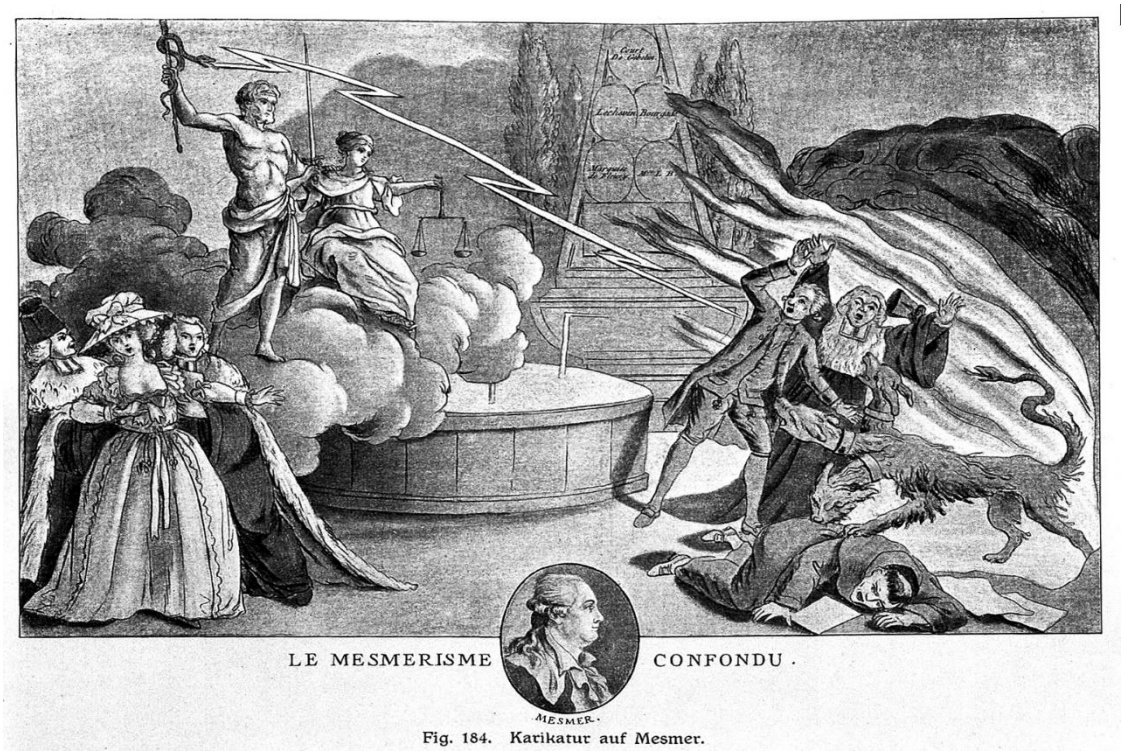

Fig. 184. Karikatur auf Mesmer.

Figure 5: Mesmerism Confounded. The Image shows Mesmer's disciples struck by Justice and Truth, by means of Franklinian Lightning. The death of discourse surrounding the animal magnetic fluid is caused by Franklin himself, whose assertions on electric fluidity shaped eighteenth-century understandings of fluidity. Credit: Wellcome Collection. Accessed via wellcomecollection.org.

The first practical observations described in the Commissioners' Report concern the fabled mesmeric 'baquet' (simply translated in the English version of the report as 'bucket'), a large wooden tub filled with iron and attached to a long iron rod. When holding on to the rod, Deslon had explained, the patients could be magnetised. While this treatment, accompanied by piano music as a further 'conductor' of the animal

[114] It is no secret that Mesmer was in part indebted to the ideas of Paracelsus and he proudly announces this in his early publications. Mesmer's opponents in the report however emphasise that Paracelsus' own hypotheses, particularly those regarding a planetary influence on the human body, had been disproved as occult and myth long before Mesmer's own engagement with the subject.

magnetic fluid, frequently seemed to result in patients' violent convulsions and spells of fainting and deliriousness, the commissioners resist the lure of the fluid, stating in a somewhat theatrical description of their search of the non-corporeal magnetic fluid within the wooded container, "that the bucket contained no substance either electric or magnetical". They thus "cannot infer any physical agent capable of contributing to the imputed effects of the magnetism" (pp. 24-5). The commissioners' most pressing interest in the report is to render the animal magnetic fluid visible or otherwise perceptible, in order to determine its usefulness. Issuing a highly sceptical review, the report states,

> The most certain method of determining the existence of the animal magnetic fluid, would have been, to have rendered its presence capable of being perceived by the seness [sic, i.e. 'senses'], but much time was not necessary to convince the commissioners that this fluid is too subtle to be subjected to the observation.

The commissioners concluded that an animal magnetic fluid could not be rendered visible, unlike its electric sibling fluid, whose existence could be thus proved. An animal magnetic fluid, should it exist, they therefore argue, "is not like the electrical fluid", in this respect, since the latter could be rendered "luminous and visible". Playing on the double meaning of the word 'insensible' allows the commissioners to comment further on the fluid's failed appearance, and to make a moral judgement concerning mesmerists and their patients. The action of the animal magnetic fluid, they state,

> is not, like the attraction of the loadstone, the object of our sight; it has neither taste nor smell, its process is silent, and it surrounds you or penetrates your frame, without your being informed of its presence by the sense of touch. If therefore it exists in us and around us, it is after a manner perfectly insensible.
>
> (p.30)

The existence of electricity and mineral or terrestrial magnetism, are at no point questioned in the report. However, unlike the 'insensible' animal magnetic fluid, both the former subtle fluids electricity and terrestrial magnetism could be made observable, and their existence and conception as a fluid proved. Electricity could be demonstrated (or drawn from the ether) by the impressive production of sparks in experiments. The (terrestrial) magnetic fluid could be made visible in its effects of attraction and repulsion. A mesmeric animal magnetic fluid however, could not be thus observed or validated. In a concluding statement, the report thus comments that "[t]he animal magnetism may indeed exist without being useful, but cannot be useful if it do [sic] not exist" (p. 29), and similarly, that, [t]he experience of the efficacy of remedies is always […] attended with some uncertainty; in the case of the magnetism [i.e. the animal magnetic fluid] the uncertainty has this addition, the uncertainty of its existence" (p. 35).

Despite the damming verdict of the Commissioners' Report, Mesmer initially continued to pursue his career outside of France. He never abandoned his theories, remaining adamant that his universal magnetic fluid existed and was bestowed with divine healing properties. In one of his last major treatises, *Dissertation by F. A Mesmer, Doctor of Medicine, On His Discoveries (Mémoire de F. A Mesmer, docteur en médicine, sur ses découvertes*), first published in 1799, fifteen years after the report, fluidity remains at the core of his medical speculations. In this treatise, Mesmer engages in a discussion of fluidity that is even more abstract than any descriptions of his particular kind of magnetism discussed in his previous works. Mesmer uses the concept of fluidity to suggest to his reader a system that points not only to ethereal

phenomena in nature and science, but to a more idealist sense of the highest degree of 'truth' or divinity imaginable in nature. Almost echoing notions of idealist Romantic thought, Mesmer writes,

> I have been able to trace the phenomena which I have taken unexpectedly from Nature, to the common source of all things. I believe I have opened a simple and direct path to the truth, and have, to a great extent, rescued the study of Nature from illusions and metaphysics.
>
> (Mesmer, 1980, 6, p. 96)

Fluidity constitutes this 'direct path' to wisdom in Mesmer's later work. He argues that once complex specificities are removed from the language of science and natural philosophy, one can "arrive at the purity of truth". In a model that is once again highly reminiscent of an ethereal Ur-fluid, Mesmer concludes that names for matter or substances, such as "the spirits, the "divinities", "the central fire [principle of life]", perhaps even the term, 'animal magnetism' may be a hindrance, and that "we will arrive at truth when we have succeeded in not acknowledging physical substance except for matter" (p. 97). Where the examination of his animal fluid theory by the Commissioners had failed, we now see Mesmer attempting to pile subtlety upon subtlety to ground his theory in the highest degree of abstraction instead. While still emphasising that the fluid he has in mind perhaps bears the closest resemblance to the Newtonian ether, he reasons that even this Ur-fluid may not be the closest of fluids to God, or to truth. Mesmer conjectures instead that the interstices "of the air are occupied by what is called the ether, finally, those of the ether are filled by a substance that is *even more fluid*, for which no name has been determined" (p.98, added emphasis).

Yet, for all these attempts to salvage his theory and reputation, Mesmer was unable to convince patients to return to his practice. John Martin, philosopher and religious

writer, in a letter published 1790, perhaps most aptly summarises a growing consensus of the inefficacy of an animal magnetic fluid:

> Indeed, men are [now] so reluctant to suppose that such a mass of matter as has been mentioned, so heterogeneous, and so various, as never in any two places, or for one single hour to be the same near the surface of any particular body; men are so unwilling to suppose that such a mass of matter, or a distinct property of it, or of aether gliding through it, is under the dominion of mortal hands, that this argument is seldom urged, except it be in some convenient corner.
>
> (p. 35)

Inventing ever more creative defences of his animal magnetic fluid model caused Mesmer's practice to be taken less and less seriously by the general public. His attempts at a metaphysical defence of animal magnetic fluidity illustrate the flexibility and high degree of abstraction ascribed to the concept in the period. However, where fluidity had once been productive in promoting his brand of animal magnetism, its abstract nature was now beginning to be a hindrance to credibility.

As damning as Martin's verdict may seem, the Commissioners' Report did not immediately result in the outright disappearance of animal magnetic practices, even after Mesmer left Paris in 1785. As Fulford has argued,

> With Mesmer gone, animal magnetism might have died. It did not, because scientific and medical practice was insufficiently centralized for the official rejections to undermine its popularity as a natural therapy and because many people were already alienated by the claims of the established authorities to decide what was and was not proper knowledge.
>
> (Fulford, 2004,1, p. 65)

However, despite the fact that Mesmer himself sought to continue his animal magnetic quest long after the publication of the Commissioners' Report, the treatise's verdict on the (non-) existence of Animal magnetism, a supposed fluid separate from mineral

magnetism, had an enormous impact in the medical community as Mesmer's doubters and enemies found themselves vindicated. In an unpublished letter written at his French residence in Passy on 25 August 1784, shortly after the publication of the report, and addressed to his grandson William Temple, Benjamin Franklin himself comments on the possible aftermath of his work, whose impact, he fears, may well surpass the boundaries of magnetic enquiry to impact not only philosophic but also religious discourse. He states,

> The Report is publish'd and makes a great deal of Talk. Every body agrees that it is well written; but many wonder at the Force of Imagination describ'd in it, as occasioning Convulsions, &c. and some fear that Consequences may be drawn from it by Infidels to weaken our Faith in some of the Miracles of the New Testament. I send you two more Copies. You would do well to give one to the French Ambassador, if he has not had it. Some think it will put an End to Mesmerism. But there is a wonderful deal of Credulity in the World, and Deceptions as absurd, have supported themselves for Ages.
>
> (Franklin, 1784)

While he is well aware of the impact of the report, Franklin's rather careful assessment of the state of Mesmerism, in particular his remark that 'there is a wonderful deal of credulity in the world', is perhaps owing to the fact that William Temple was himself a member of one of Mesmer's Societies of Harmony (cf. Lopez, p. 330). However, what is perhaps most striking about his letter is Franklin's remark on a potential effect of disproving mesmeric theories on religious beliefs. The fact that "some fear that Consequences may be drawn from [the report] by Infidels to weaken our Faith in some of the Miracles of the New Testament" is significant in several ways. First, it emphasises the way in which Mesmer, during his time in the French capital, had become more than an eccentric experimenter. He had stylised himself as a semi-divine miracle healer, operating with a divine medium. Second, Franklin himself makes a point about the way in which philosophic or scientific discourse may start to become

secularised. The (animal) magnetic fluid, as a result of the findings of the commissioned report, lost its validity as a universal panacea, deriving ultimately from God. While the report is explicitly concerned with the animal magnetic fluid and does not question the existence of terrestrial magnetism as a whole, nor its perceived fluid constitution, it may well be one of the first instances of the period in which an abstract, invisible and intangible scientific phenomenon, closely associated with divine powers, was rendered secular. As Martin Priestman has put it, in *Romantic Atheism* (2000), "[b]y the end of the 1790s, […] deist language had increasingly been either dropped hastily or replaced by declarations of thoroughgoing atheism, founded on philosophical materialism" (p.186). Accordingly, as the Commissioners' Report suggests, an animal magnetic fluid, was viewed as neither divine nor capable of healing powers. The commissioners' treatise decisively stripped the animal magnetic fluid of its divine connotations but could not avoid a potential and implicit critique of its readers' religious beliefs.

Franklin himself noted the role of the imagination in occasioning supposed effects of an animal magnetic fluid. Animal magnetic fluidity was now allocated more firmly in creative or literary, non-scientific discourses. "For historians of European science", Emily Ogden has argued, "the report on mesmerism has served as the emblem of a moment when imagination seemed to impinge especially insistently on natural-philosophical enquiry". It "provided a vocabulary and a *locus classicus* for cases of imaginative delusion in general", she further suggests, "so that 'mesmerism"' came to represent […] not just the medical practice itself but errors like those its patients had committed, wherever such errors should appear -- even in the very heart of enlightened natural philosophers" (p.147). Where, for the first half of the eighteenth century, magnetic fluidity had linked the discourses of terrestrial and animal magnetism, now

a deeper divide opened up between natural philosophy, and poetic treatments of magnetism in creative writing. Jonathan Miller has noted "the extent to which animal magnetism gripped the nineteenth century imagination" (p. 718). Indeed, it was the imagination and poetic discourses only to which animal magnetic fluidity seemed confined after 1800.

Fluidity's disappearance from magnetic discourses, was a slow, non-linear process. As Kuhn has argued in *The Structure of Scientific Revolutions* (1962), "the emergence of new theories is generally preceded by a period of pronounced professional insecurity" (pp. 67-8). Treatises by Ralph Walker and Tiberius Cavallo, published in the 1790s after the Commissioners' Report, still referred to the magnetic fluid as an integral part of terrestrial magnetic discourse. By contrast, other natural philosophers writing at the turn of the century displayed more scepticism regarding suppositions of magnetic fluidity. As an example, John Lorimer's 1795 publication *A Concise Essay on Magnetism*, begins to question Gowin Knight's fluid hypotheses. "His opinion was", Lorimer recounts, "that this Earth had originally received its Magnetism […] by a shock", and his "meaning appears to have been, that this was the course of the magnetic fluid". Alluding to the dangers of hypotheses and the value of a more empirical approach, Lorimer then adds that his own essay aims to "avoid suppositions merely theoretical". Such an approach stands in stark contrast to a model of an ethereal fluid, a possibly magnetic substance whose very constitution was defined in eighteenth-century treatises as imponderable and indefinable. Concluding his verdict on hypothetical magnetic fluidity abruptly, Lorimer then surmises that natural

philosophers should "not attempt to explain the causes of magnetism on any theory however plausible" (p.32).

While Lorimer's scepticism towards a 'purely hypothetical' magnetic fluid is only a snapshot, publications on the subject the first decades of the nineteenth century seem to be markedly different from those published only fifteen years earlier. The number of publications dedicated to terrestrial magnetism as a natural phenomenon seems to decline as a whole. Publications on the subject at this point tend to be concerned more with the potential use of the magnet, particularly in navigation, and only a fraction discuss the origin or ontological qualities of magnetic phenomena.[115] Second, in those nineteenth-century publications in which magnetism is discussed, especially in the field of mineralogy, magnetism seems to be rarely, if at all, described in terms of fluidity. Instead, the phenomenon is referred to as a variety of 'magnetic or attractive powers', or 'forces', or – quite simply – as just 'magnetism'. For example, Robert Jameson, in his 1816 *Treatise on the External, Chemical and Physical Characters of Minerals,* states quite plainly that "Very few minerals are magnetic, it is a character which occurs principally in ores of iron, or in such minerals as contain a portion of metallic iron" (p. 303). Jameson makes no assumptions as to how the minerals may have been imbued with magnetic qualities, and does not speculate on how a magnetic fluid might exude from metals. It appears that hardly any publication after 1800 makes any reference to any divine qualities of magnetism.

It is possible that by abandoning the concept of fluidity, natural philosophers experimenting with terrestrial magnetism in the period sought to disassociate themselves from the mesmeric pseudo-science. Another possible explanation could be

[115] It is only at this point that navigational researches into magnetism become much more prevalent than any discussion of the ontological qualities of magnetism.

that, just as in the electrical sub-branch of natural philosophy, scientists attempted to be more precise after Lavoisier's revolutionary treatise on the *Elements in Chemistry* which called for a more precise nomenclature. Some scientists in the field of mineral magnetism tried to circumnavigate questions of fluidity in the wake of the Franklin report. James Bremner's 1825 treatise, confidently entitled *The Mystery of Magnetism, Fully Discovered by Experiments Intuitively Evident which Admit of no Question* (1825), is similar in content to other eighteenth-century publications that rely on the concept of fluidity as a means of conceptualising magnetism. Yet Bremner makes no explicit use of the fluidity model in his publication, perhaps to avoid sceptical ripostes and potential comparisons to animal magnetic quacks who so heavily relied on the properties of a (non-existent) animal magnetic fluid. He announces at the start of his treatise his desire to rely only on precise terms, in order to avoid confusion. "My purpose has been to make every particular part to be distinctly understood", he notes, "and to guard, as far as possible, against being misunderstood, I have very frequently repeated the precise terms, Attraction, Repulsion, Magnite, Iron, Needle, etc, which is unpleasant to the ear but necessary to keep the object always distinctly in view." (p. 4). While refusing to address the concept of fluidity for his description of magnetic force, Bremner consistently uses the term 'Magnite' to describe a particular substance imbued with magnetic power. 'Magnite', in Bremner's treatise functions as an almost perfect substitute for the phrase 'magnetic fluid', while adhering to the conceptual framework provided by the fluidity model. In line with eighteenth-century magnetic discourse, he states that, "[t]hough the magnetic substance be invisible, we need have no more difficulty in conceiving, or at least in admitting, that matter infinitely below our senses may exist" (p. 15). Magnite, he notes, must be this invisible phenomenon or substance, capable of rendering objects magnetic. The following definition,

describing this ‘new principle in science’, shows that his ‘Magnite’ is in fact a substitute term for the previously adopted concept of magnetic fluidity. “Magnite pervades the most solid substances as if they had no existence,”, he argues, “not however, as if it passed through them, but, as if it existed in them, and formed the base of every variety of existing matter” (p.18). But it is telling that throughout Bremner’s *The Mystery of Magnetism* there is no mention at all of those earlier ‘strong precursors’ Milton, Descartes or Newton.

Conclusion

The history of ethereal fluidity which began before the time of Lucretius (99 BCE– c. 55 BCE) ended with a now famous scientific test, the Michelson–Morley experiment. This experiment was conducted in the spring and summer of 1887 and was the first investigation to conclusively disprove the existence of ether, which up to this point was still understood as a space-filling medium through which light could travel. The experiment sought to test the existence of an all-pervading ether by comparing the speed of light at different angles. Since no measurable difference could be found, the notion of a space-filling ether-medium akin to water or air was abandoned. In the early twentieth century, Albert Einstein wrote: "If the Michelson–Morley experiment had not brought us into serious embarrassment, no one would have regarded the relativity theory as a (halfway) redemption" (Fölsing, p. 219). The experiment, to which Einstein felt so immensely indebted for his theory of relativity, has also been referred to as "the most famous failed experiment in history" (Blum, p. 98). [116] Enduring longer than humoral medical theory, a conception of the ether lasted almost two millennia, from its initial inception until its final scientific disproof.

It is difficult to ascertain the extent to which figures such as Newton, Berkeley, Blackmore, Stevenson and Priestley, for example, formed a community of scholars. Newton left behind an extensive correspondence and was clearly in regular dialogue with other members of the Royal Society, including Robert Boyle.[117] He was also famously in dispute with contemporaries such as John Flamsteed on astronomical

[116] The experiment was originally designed to prove the existence of a luminiferous or light-bearing ether, with the help of a variety of apparatuses, including Michelson's 1881 'Interferometer' used to detect such a medium.
[117] Newton's letters are available online at https://www.newtonproject.ox.ac.uk/texts/correspondence/all

theory and Gottfried Leibniz on calculus. Jonathan Swift, Joseph Addison and Richard Steele were personal acquaintances of Bishop George Berkeley and Berkeley's similarly extensive correspondence includes exchanges with Samuel Johnson and Alexander Pope (Hight, 2012). Berkeley took issue with Newton on a number of mathematical questions and issued a critique of Newton's account of motion (Whitrow, 1953). Benjamin Franklin met Joseph Priestley in London in 1766, and they continued to correspond thereafter (letters between the two survive from 1772 and 1780). John Locke and William Molyneux wrote in their correspondence of their admiration for Richard Blackmore (see p. 67 above). But there appears to be no substantial evidence that writers such as Capel Lofft, William Belcher or Elisha Perkins were part of a community of scholars in regular debate with one another. Yet, despite the fact that experiments in natural philosophy in the long eighteenth-century tended to be carried out in relative isolation, each of these figures was working with a shared pool of ideas about an all-encompassing substance.

The argument of this thesis has been that eighteenth-century science and literature depended, implicitly and sometimes explicitly, on an understanding of an all-pervading fluid. Electricity, fire, light, lightning and magnetism were all understood in terms of this apparently divine subtle fluid. This understanding was shaped largely by the strong influence of Milton, Descartes and Newton writing in the seventeenth century. Moreover, the various effects of these phenomena were taken to be a sign of the divine agency made visible. Fluidity gave to these effects a unity which bound together literary, natural philosophic and religious strands of discourse from the late seventeenth into the mid-nineteenth centuries. Gillespie wrote that the concept of fluidity in the eighteenth century had been "insufficiently explored" (p. 205). This

thesis has been in significant respects a response to Gillespie's point. Accordingly, it has discussed the ethereal origins of the concept of fluidity, along with its implications for magnetic and electric discourses of the long eighteenth century.

The first chapter of this thesis identified the ethereal fluid as a fundamental Ur-fluid supporting ideas in the seventeenth and eighteenth centuries about the nature of the world. The idea of a divine ethereal medium was revived and adapted by seventeenth and eighteenth-century writers and philosophers, predominantly by John Milton and Isaac Newton. Milton's *Paradise Lost* (1667/1674) and Newton's *Opticks* (1704) were the main literary and philosophic works that firmly established the idea of a heavenly ether in the discourse of the period. The influence of Milton and Newton proved overwhelming for the majority of natural philosophers who followed them over the next one hundred or so years. As this thesis has shown, the ethereal Ur-fluid was a recurring notion in philosophical treatises in the literary, philosophical and natural philosophic publications of the period. Works including George Berkeley's *Siris: A Chain of Reflections and Inquiries* (1744) and Richard Blackmore's *Creation* (1712) drew on a blend of Newtonian and Miltonic notions of ether. An understanding of the notion of fluidity helps elucidate the complex nature of the supposed ethereal phenomena described in these works – phenomena which might otherwise be misunderstood, or appear puzzling at best.

The model of fluidity not only helps us to understand the meaning and impact of notions of ether in the long eighteenth century, but it also underpins researches into electricity and magnetism in the period, which, as I have argued, were frequently referred to as different manifestations of the same phenomenon (i.e. an ethereal Ur-fluid). This thesis has shown that descriptions of electrical phenomena in the period

relied heavily on the concept of fluidity as an explanatory framework. Fluidity, as analyses of works by Benjamin Franklin, Joseph Priestley and John Wesley have illustrated, was a vital component of early electrical researches. Franklin's 'One-Fluid' theory bears the concept in its name, but experiments by his contemporaries equally relied on this notion. In publications like Priestley's *History and Present State of Electricity* (1767), Wesley's *The Desideratum, Electricity Made Plain and Useful* (1778), and a variety of poetical treatments of mysterious and all-powerful electrical forces, the concept of fluidity was key.

Chapter Two of this thesis has argued that the key reason why electricity was first understood as a fluid was because of its conceptualization as a form of ether. The process of rendering this heavenly electrical fluid visible, served not only as a scientific spectacle (as recent critical research has frequently suggested), but also as a far more serious and substantial advance in knowledge: proof of the existence of an all-powerful God, whose ethereal creation became visible in its effects. For Berkeley, in *Treatise Concerning the Principles of Human Knowledge* (1710), '*esse est percipi*', or 'to be is to be perceived'. The importance of the effects of electricity, lightning, fire and magnetism lay in their potential to reveal the existence of a divine Creator.

The 'Floating Island' in *Gulliver's Travels*, which navigates across oceans is perhaps the most well-known literary representation of the concept of magnetic fluidity. As apparent in treatises by eighteenth-century natural philosophers such as Gowin Knight, Ralph Walker, and the Frenchman René Descartes, magnetism was frequently viewed as a sibling phenomenon to electricity, with its perceived fluid, ethereal origins. As in electrical researches, the attempt to render a magnetic fluid visible through experiment was another route to reconciling science with a divine ethereal

Creator. This applied to both strands of natural philosophic discourse within magnetic exploration: terrestrial and animal magnetism (Mesmerism). The concept of fluidity unified these two forms of magnetic enquiry. Whereas Animal Magnetism has often been portrayed merely as a pseudo-medical practice promoted by ingenious quacks, understanding the concept of fluidity which underpinned all magnetic enquiries at the time helps us to recognise that eighteenth-century philosophers as well as a 'mesmerised' general public may have had a good reason to believe in the supposed powers of such an animal magnetic fluid.

In tracing the origins of the concept of fluidity back to its ethereal roots, and discussing the implications of this model in the natural philosophic, theological and literary discourse throughout the late seventeenth and early eighteenth centuries, this thesis has shown that a notion of such imponderable fluids unified not only various strands in natural philosophic discourse of the period (on ether, electricity and magnetism). The concept of fluidity, perhaps owing to 'imponderable' nature, was an invisible tie, a central idea that held various forms of literary, religious and philosophic enquiry closely together. It was only after the effects of these phenomena were thoroughly tested that magnetism and electricity were no longer regarded by scientists as ontologically fluid or divine. As this thesis has argued, fluidity as an abstract concept ceases to appear almost entirely within late nineteenth-century scientific discourse. Any remnants of the fluidity model, when they do occasionally occur, appear only as fictional and poetical subjects of the period, and no longer serve as an underlying hypothesis for scientific exploration.

While the focus of this thesis has been the examination of fluidity as it was described, perceived, and realised in the long eighteenth century, the literary legacy of fluidity

opens a productive area of potential future research into Victorian ideas shaped by the concept. Charles Dickens famously had a keen interest in mesmeric practices, as has been discussed at length by Fred Caplan and Stolte. Several other, perhaps lesser known, novelists in the period still reference fluidity in their works. As examples, we may take Albert Bleunard's *Babylon Electrified* (1889) and Edward Bulwer-Lytton's *The Coming Race* (1871).[118] In looking back to eighteenth-century conceptions of fluidity, these novels situated the concept in a new and hitherto unknown literary context – that of science fiction.

Bleunard's *Babylon Electrified: The History of An Expedition Undertaken to Restore Ancient Babylon By the Power of Electricity and How it Resulted*[119] is a novel first published in English in 1888/9, the title of which broadly summarises its plot.[120] The story's protagonists tell of their plan to revive Babylon by the powers of the electric fluid. Bleunard's story is set at the time of the novel's publication, although its genre is futuristic. In describing the various experiments and undertakings necessary to bring electricity to the ancient city – an attempt that fails dramatically – the novel reflects on eighteenth- and early nineteenth-century research on electric phenomena. The following passage, an observation by protagonist Jack Adams in the library of his fellow explorer, echoes the history of electrical research:

> Heaps of paper, covered with figures and algebraical calculations, were spread out before him. […] He seemed like a magician evoking the spirits of earth and heaven. And was he not in truth a magician, this man bent over his work? Oh, surprising power of mind, he was fathoming nature, that eternal enigma. A modern Titan, he combined and amalgamated the power of the mysterious element in his mathematical formulas. Under his skilful hands heat and light, movement and chemical force, were transformed at will into that unseizable

[118] This work was also published as *Vril: The Coming Race.*
[119] Bleunard (1852-1905) was a French academic and writer and 'doctor of sciences', according to the novel's title page.
[120] The novel was published in French as *La Babylon Electrique* (1888).

> fluid, electricity. Guided by the formulas of the illustrious physicists of our century […] he manipulated at pleasure the various manifestations of force.
>
> (Bleunard, p. 20)

The above is just one of several references to electrical fluidity throughout the novel. While the excerpt alludes to "figures and algebraical calculations", at its centre is the more literary rendition of electrical fluidity manipulated by a God-like scientist, who is able, like an ethereal Creator, to transform the various phenomena 'heat, light, movement, and chemical force […] into that unseizable fluid, electricity'. Bleunard is clearly referencing eighteenth-century understandings of electric fluidity to convey the powers of electricity. The ultimate failure of the protagonists' plans to electrify Babylon is a result of their inability to master the divine fluid.

A second novel that similarly echoes eighteenth-century discourse surrounding fluidity is Edward Bulwer-Lytton's *The Coming Race,* published at first anonymously in 1871. The concept of fluidity, as discussed in this thesis, enables us to understand the novel in its full complexity. Bulwer-Lytton tells the story of a hidden underground futuristic society of considerable size, discovered by chance by a nineteenth-century "desultory American opportunist" of English descent (Judge, p. 137). Although it was relatively successful at the time of its publication, with "five editions having been published by then end of 1872" (Wagner, p. 379), the novel has since received relatively little critical attention. In 1965, Geoffrey Wagner described the work as a "forgotten satire" (Wagner, p. 379). More recently, Jennifer Judge has discussed Bulwer-Lytton's work with respect to its qualities as a "Menippean satire" (Judge, p.137), in that it is "episodic, involves marvellous journeys, and is a highly "intellectualized" form that unsettles systems of knowledge" (p.139). Viewing this Victorian work in relation to eighteenth-century fluidity discourse allows us to add

further light to these views. The futuristic society of the Vril-ya, the narrator tells his readers, owes its degree of material, spiritual, societal and social advancement to "the all-permeating fluid which they [the Vril-ya] denominate Vril" (Bulwer-Lytton, p. 24). This substance, the description of which is clearly reminiscent of Newton's speculations raised in his *Queries*, draws on the eighteenth-century conception of fluidity discussed in this thesis. Significantly, Bulwer-Lytton incorporates characteristics frequently associated with magnetic, electric, and ethereal fluidity in the period to inform his own model of an imponderable super-fluid used by the Vril-ya. The narrator describes the capabilities of this fluid as follows:

> This fluid is capable of being raised and disciplined into the mightiest agency over all forms of matter, animate or inanimate. It can destroy like the flash of lightning; yet, differently applied, it can replenish or invigorate life, heal, and preserve, and on it they chiefly rely for the cure of disease, or rather for enabling the physical organisation to re-establish the due equilibrium of its natural powers, and thereby to cure itself. By this agency they rend way through the most solid substances, and open valleys for culture through the rocks of their subterranean wilderness. From it they extract the light which supplies their lamps, finding it steadier, softer, and healthier than the other inflammable materials they had formerly used.
>
> (p.24-5)

This late Victorian description of such a versatile fluid, capable of giving those who control it near-divine powers echoes the idea of a 'Vast permeant element; communal, all in one', referred to in *Festus*, and cited in the first chapter of this thesis. *The Coming Race* utilises seventeenth and eighteenth-century natural philosophic discourse to inform its own – explicitly fictional – rendition of the concept of fluidity. A subtle substance "capable of being raised and disciplined into the mightiest agency over all forms of matter, animate or inanimate" draws on the notion of a divinely powerful Ur-fluid ether (discussed in Chapter One), while its ability to "destroy like the flash of lightning", or to "replenish […], invigorate life, heal and preserve" echoes the conception of electric and magnetic fluidity examined in Chapters Two and Three of

this thesis. However, Bulwer-Lytton elevates this conception of eighteenth-century fluidity by taking its all-permeating nature literally: Vril is portrayed to be the fundamental unifying substance of a society that has "matured […] from political infancy by virtue of vril: a force that installs in the populace the same ideal habits promoted by Victorian physiological psychologists" (Judge, p. 142). The portrayal of societal advancement 'by virtue of vril' is a striking use of the concept. Not only is the Vril-ya's permeating fluid all-powerful in terms of its physical capabilities, but it also instils in them their morals and values and – quite literally – their virtue: "by one process it destroys, by another it heals – by one it can rend the rock, by another disperse the vapour – by one it affects bodies, by another it can exercise a certain influence over minds" (Bulwer-Lytton, p. 51). As discussed in this thesis, eighteenth-century discourse on natural phenomena frequently employed the term 'virtue' interchangeably with 'fluid'. Virtue, in Bulwer-Lytton's work, is not only to be understood in its contemporary sense. Virtue, and Vril as a whole in the novel are literary remnants of conceptions of fluidity within eighteenth-century discourse, adapted for the purposes of a Victorian satire.

Since the turn of the twentieth century, the concept of fluidity has all but disappeared from modern discourse. Yet, as this thesis has illustrated, this concept was a vital part of natural enquiry in the long eighteenth-century, echoed in philosophic, literary and religious writings of the era. Regardless of the model's flaws, in the period discussed in this thesis fluidity was a widely accepted and hugely significant concept that spurred on research into the (perceived) natural phenomena ether, electricity, magnetism, and related subjects perceived as fluids. An understanding of a notion of imponderable fluidity is invaluable for our understanding of literature and history of science in the long eighteenth century. The concept, or mode of understanding natural phenomena

as potentially divine, semi-material substances was critical to natural philosophic and literary exploration of the period. Understanding today what eighteenth century writers meant by imponderable fluidity elucidates eighteenth-century literature and natural philosophy in ways that tend to be neglected. Taken literally at the time, it was essential to knowledge of the world in the era, even if the concept of fluidity has by now disappeared into the – now entirely metaphorical – ether.

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