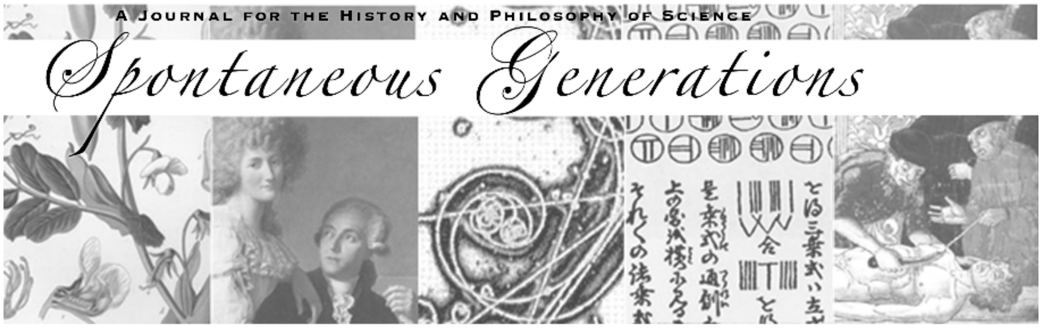

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Source: *Spontaneous Generations: A Journal for the History and Philosophy of Science*, Vol. 6, No. 1 (2012) 15-23.

Published by: The University of Toronto
DOI: 10.4245/sponge.v6i1.17158

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Published online at jps.library.utoronto.ca/index.php/SpontaneousGenerations
ISSN 1913 0465

Visual Representation and Science

Visual Figures of the Universe between Antiquity and the Early Thirteenth Century*

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The paper raises the question of the function of visual representations in medieval cosmographical texts. It proposes to view diverse functions of figures in relation to changing discursive environments, including differing philosophical positions and changing social and intellectual contexts. It further suggests a distinction between figures that were elaborated within the highly specialized disciplines of mathematics and philosophy of nature in Greek Antiquity and figures that were instrumental in transmitting accepted world models, thus avoiding the opposition between scientific and unscientific types of verbal and pictorial documents. Simplifying changes, when figures are abstracted form their geometrical context and accompany doxographical, descriptive accounts, are characterized in terms of schematization. Concomitantly, mathematical and philosophical demonstrations tend to give way to proofs of a predominantly rhetorical nature: images are verbally construed and, in order to enhance these, actual visual figures—mostly linear, diagrammatic constructs—are added. With regard to the Middle Ages, the paper distinguishes two principal periods: the period from the seventh to the eleventh century and the period of the so-called twelfth-century Renaissance. First, the verbal and pictorial cosmological corpus of Roman origin gave rise to explanations and variations but not to consequential theoretical developments and cosmological diagrams tended to fuse with summarizing tables at this time. Then, during the twelfth century, mathematical and philosophical documents of a specialized kind that were translated from the Arabic and also from the Greek became available in the Latin West. In mathematics, specialized types of study remained, however, sparse. Continuous elaborations of the assimilated material set in later only, within the thirteenth-century university context. Nevertheless, twelfth-century authors of cosmographical accounts became increasingly aware that their expositions and visual figures were ultimately derived from geometrical models of the universe. More diversified types of demonstration and corresponding visual figures were being used, as exemplified by William of Conches' *Dragmaticon philosophiae.*

* Received 25 April 2012.

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This paper raises the question of the function of visual representations in cosmographical texts dating from the seventh to the twelfth century. Further, it is concerned with the related questions of criteria of analysis and of the value of visual representations as historical sources. Indeed, not only have the majority of historians of cosmology dismissed the early Middle Ages due to the fact that there is no "scientific progress" to be observed, but they also tended to disregard visual representations, limiting their inquiries to the doctrinal aspects of textual sources. In adopting this attitude, they were in line with ancient and medieval authors who, following recurrent formulas, tended to consider visual figures as nothing more than duplications of verbal statements, a posteriori additions made for the purpose of clarification and better understanding, as exemplified by Macrobius's influential ca. 420-430 *Commentary on the Dream of Scipio*: "Since the way to understanding is facilitated by the [use of our] eyes, that which has been enunciated in [our] exposition will be submitted to [our] view" (Macrobius 2001, bk. I, chap. 21, par. 3).

However, there is a marked discrepancy between stereotyped formulas referring to visual figures on the one hand, and the variety of argumentative strategies—or types of demonstration involving images of the universe—on the other. Nevertheless, formulas sometimes vary together with these strategies. Again, Macrobius offers a telling example. Following his remark on the function of the first visual figure of his text—namely that of the seven concentric planetary spheres and the central terrestrial sphere—he specifies that the figure in question is instrumental in uncovering causal relations, that is, the reason for the unequal periods it takes planets to traverse the zodiac (Macrobius 2001, bk. I, chap. 21, par. 5). Thus, in order to circumscribe the diverse functions of figures, it is necessary to take into account the discursive environment of both introductory formulas and visual representations: in what circumstances and to what end do authors refer to visual representations? Moreover, since the verbal environment and the status of these representations depend, to varying degrees, on differing philosophical and theological positions, these are to be identified as well. Thirdly, in order to avoid what might be termed an essentialist approach in analyzing the function of visual figures, changing historical, social, and intellectual contexts need to be differentiated.

When late-antique and early-medieval cosmographical texts refer to visual representations of the universe in terms of mere summarizing repetitions of verbal statements, this almost appears as an inversion of what may be construed as their "original" setting. In Greek antiquity the visual dimension of ideas about the universe, that is, the all-encompassing heavenly sphere, was of central importance both in mathematical astronomy and in philosophy, whence Plato's insistence on the etymology of *ouranos*, which was interpreted to signify "to see" (Plato 1963, 396 B; 1953-1956, VI: 509 D). Conceptions of a spherical universe were developed by way of geometrical reasoning, which relied on both imaginary figures and figures drawn on a surface. They were elaborated verbally by reference to letters of the alphabet and constituted a necessary part of geometrical propositions and demonstrations. Within the Platonic philosophical tradition, which dominated, albeit in a very reduced form, in expositions on the universe during the first part of the Latin Middle Ages before it was revived in the twelfth century, the universe was considered to be an object of both intellectual and sensual vision and, by corresponding reasoning, of a mixed nature. Cosmological speculation was considered to be scientific in so far as it relied on necessary and true suppositions, on evident intelligible principles—axioms in the mathematical context—and proceeded by way of deductive demonstrations that led to a grasp of ultimate principles. But speculating on the heavenly sphere also involved visual sense data, which were thought to provide no more than probable knowledge.

All in all, in the Greco-Roman world geometrical models were instrumental in construing the universe as an object of intellection and observation. However, delimitations between these two complementary, as well as gradual ways, of understanding and explaining the form, structure and functioning of the universe were not always clearly traced (Brisson 1997, 95-111). This relative indetermination reflected negatively on the status of visual representations, which remained ambivalent throughout, both for authors of ancient or medieval texts and then for historians. On the one hand, images were supposed to reflect intelligible, ontologically prior forms; on the other hand, these were mediated by mere material, man-made figures.

Whatever the specificities of early Greek geometrical speculations on the universe may have been, elaborations of hypothetical systems of spheres and circles and also of theories of the bodily constitution of the world took place within the highly specialized disciplines of mathematics and philosophy of nature. Whether expressed verbally or pictorially, basic concepts of the universe did not remain confined to the esoteric circles of mathematicians and philosophers; elaboration gave way to transmission, first within the Hellenistic and then the Roman world. The dissemination and wider acceptance of a selection of cosmological concepts entailed a number of changes in verbal expositions and accompanying visual figures, which are best characterized in terms of schematization. Expositions on a given subject and corresponding visual figures were reduced to their essential features; former hypotheses coalesced into facts; demonstrations were abbreviated or abandoned altogether and reduced to their results. Figures visualizing the structure of the universe and the supposed movements of celestial bodies were abstracted from their geometrical context. Being no longer part of geometrical demonstrations, they were variously associated with astronomical and physical summarizing, descriptive accounts of the universe—cosmographies—and underwent corresponding simplification and changes, the loss of lettering being one of the more conspicuous signs of this evolution.

What, then, were the basic visual representations that were retained in summarizing, descriptive expositions on the universe? The structuring principles of Greco-Roman cosmology—grounded in both Platonic and Aristotelian ontology—being those of the perfection of the spherical form and of the circular movement that takes place in the heavenly sphere, the circle represents their most fundamental synthetic visual equivalent. From this both visual and conceptual matrix is derived the entirety of basic visual figures of the universe. These constituted a pictorial corpus that was transmitted continuously from Antiquity to the late Middle Ages: 1) an all-encompassing circle denotes the outer limit of the finite spherical universe. 2) Inner, concentric circles mark the divisions into planetary and sublunary, elementary spheres, down to the earth. 3) Reduced to five (four) parallel lines, the major circles structure the outermost sphere of the constellations, while also dividing the innermost, terrestrial sphere into its climatic zones. 4) More specifically with regard to astronomy, diverse configurations of circles correspond to varying hypotheses about the apparently irregular movement of planets (i.e. eccentrics and epicycles). 5) Following the peripatetic physical tradition, series of crossing circle segments set out within a delimiting circle symbolize qualitative seasonal change. This type of figure indicates the cyclical alteration of elementary, sublunary bodies as induced by the course of the sun on the ecliptic (see Figure 1). 6) Finally, also with regard to the sublunary part of the universe, wind diagrams were among the most widely used visual figures.

In doxographical and descriptive accounts of the universe, mathematical and philosophical demonstrations tended to give way to proofs of a predominantly rhetorical nature. The forcefulness of arguments no longer hinged on rigorous demonstrations, but on diverse methods of rhetorical persuasion (Cassin 1997, 15-29). Accordingly, expositions of cosmological doctrines were sometimes accompanied by proofs that consist in conjuring imaginary visual representations in the form of comparisons. Then, in order to enhance verbally construed images, actual visual figures were introduced into the text. But while rhetorical persuasion per se has long been a subject of study, the diverse modes of transition from the level of verbal to that of pictorial expression remain to be investigated.

From a chronological point of view we can observe the recurrent process of schematizing presentations of prior complex, often purely hypothetical constructs, in Antiquity and the Middle Ages. In Antiquity, specialized types of study were pursued in major centers of learning; in parallel, summary and simplified cosmological accounts were circulated in a variety of contexts. A very small selection of these were transmitted to the early Middle Ages, which retained the basic Greco-Roman conceptions of the universe in spite of very different social, intellectual and religious contexts. From the early seventh

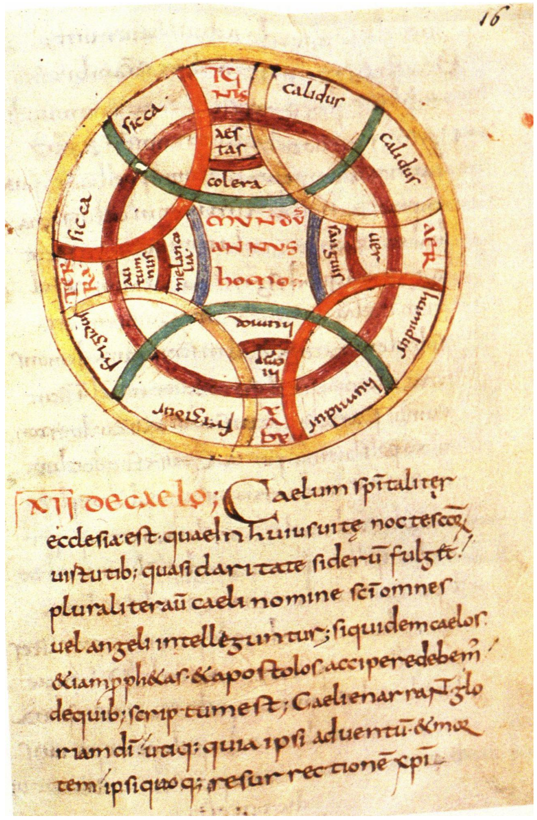

Figure 1. Isidore of Seville. *De natura rerum, "Mundus Annus, Homo."* Munich, Bayerische Staatsbibliothek, clm 16128, f. 16r (s. IX). Courtesy of the Bayerische Staatsbibliothek.

century onward, prior to the so-called Renaissance of the twelfth century, the prevailing rural contexts, where oral communication played a dominant role, made studies of a highly technical and specialized nature near impossible. With very few exceptions the knowledge of geometry had disappeared, and with it the practice of geometrical demonstration. The intellectual milieus having been predominantly monastic and clerical, principles regarding the universe that were held to be ontologically prior and evident in Antiquity, such as, above all, the one of an eternally revolving and divine spherical heavenly orb, had become obsolete. Also, contemplating the harmonious universe as an exercise of perfecting man's soul was no longer a valid goal. As a consequence, cosmographical expositions tended to be separated not only from their mathematical, but also from their former philosophical and theological frames. And since establishing the lunar-solar Church calendar was among the main reasons for maintaining the ancient cosmological frame, the corresponding doctrines were associated with the practical discipline of time reckoning. Yet, no theory-practice relation developed; no deductions from geometrical models were made.

All in all, prior to the twelfth century the doxographical corpus of ancient origin gave rise to explanations of content and to corresponding variations in argument and visual figures, but rarely to consequential theoretical developments, and even less so to continuous changes. Also, variations were frequently of an esthetical nature or resulted from the copyist's limitations in understanding. On rare occasions only were there introduced new visual schemata, such as the one of the intersecting circles of Mercury, Venus and the Sun, which was devised during the early Carolingian period. It was devised in order to clarify corresponding, all-too elliptical Plinian textual passages. (Pliny 1950, II: 63-64; Eastwood 1989).

Isidore of Seville's *On the Nature of Things* (ca. 613), in many respects the last Roman cosmography, also marks the starting point of the corresponding medieval literary genre. It remained—along with Bede's eighth-century treatise by the same title, but which is devoid of visual figures—an authoritative reference text up to the eleventh and even into the twelfth century. The expositions by the bishop of Seville are accompanied by visual figures that have a predominantly summarizing function. But this document is also of special interest in that it includes, in one instance, a rhetorical argument that had originally been developed in relation to actual visual evidence. Thus, concerning the question of the moon's source of luminosity, Isidore follows Saint Augustine in rejecting the opinion "of some" that the moon has its own source of light. In what may be supposed to have been an originally oral context, a wooden sphere painted half white and half dark was turned in front of an audience in order to persuade it of the absurdity of this doctrine. (Isidore of Seville [1960] 2002, XVIII: 1-4). The *On the Nature of things* merely retains the verbal account, while the Spanish recensions of the later *Etymologies* by the same author reproduce the object in question.

Beyond Isidore of Seville's cosmography and prior to the twelfth century, visual cosmological figures are found, above all, in the hundreds of so-called computistical compilations. These associate expositions on the universe with rules and tables relating to time reckoning. From a doctrinal point of view, the history of pre-twelfth century expositions on the physical universe as mediated by this type of document may seem poor. Yet, there are to be observed alterations in visual figures—mostly of Roman origin—that are very instructive with regard to methods of transmitting and acquiring knowledge in a mostly rural and monastic context. Their predominantly mnemonic function results in pictorial forms and arrangements that are characteristic of the early Middle Ages: linear, that is, diagrammatic constructs which mimetically refer to the spherical form of the universe and its parts are being invested with verbal and numerical lists of data extracted from the discursive context. In other words, diagrams tend to fuse with tables. Of course, this type of figure must have antedated the Middle Ages, but not much evidence has survived. The circular figures of the seasons and the year, of the macrocosm and the microcosm in

Isidore of Seville's *On the Nature of Things*, which necessarily reflect models that are lost, are already a combination of linear constructs and discrete verbal elements. Be that as it may, the numerous visual figures of this type are characteristic of early medieval computistical compilations. Thus, in Abbo of Fleury's ca. 1000 abundantly illustrated computistical and cosmographical compilation, the Macrobian figure of the universe, with its concentric planetary spheres, is combined with texts and lists relating to zodiacal signs (Macrobius 2001, bk. I, chap. 21, par. 3-4; Obrist 2006). Some 150 years later, William of Conches used terms related to a table to refer to the circular figure of the twelve-winds when announcing one of his numerous visual representations of the *Dragmaticon philosophiae* (1147-1149): "There are other names of the winds, which you find on the map of the world, [and] which we add to the figure below" (William of Conches 1997, bk. V, chap. 2, par. 11).

During the twelfth century, social and intellectual settings undergo profound changes; there emerge urban and lay educational centers. Mathematical and philosophical documents of a specialized kind are now translated from the Arabic and also from the Greek. While natural philosophy—of a predominantly Platonizing tendency—is first developed in medical milieus and by such philosophers as William of Conches, Adelard of Bath and Hermann of Carinthia, the reacquisition of geometry—the entirety of Euclid's *Elements*—and of theoretical mathematical astronomy—above all, Ptolemy's *Almagest*—remain hesitant and sparse. Specialized types of study, especially in mathematics, remain restricted to very small, ephemeral scholarly circles of translators. Continuous elaborations of the assimilated material, and especially of Aristotelian cosmology, set in only once a proper institutional setting develops, that of universities, from the beginning of the thirteenth century onward.

In the domain of cosmography, the new twelfth-century context gives rise to intellectual activities that go far beyond merely reproducing and varying traditional doxographical accounts in the domains of astronomy and natural philosophy. Rather, these now become the starting points for intense speculation and being expanded with the help of excerpts taken from newly translated Arabic treatises. All in all, these developments favor the use of more diversified types of demonstrations and corresponding cosmological visual figures. William of Conches and Adelard of Bath are among the first authors that testify to these developments. When distinguishing between probable and necessary demonstrations, (William of Conches 1997, bk. I, chap. 6, par. 1; bk. II, chap. 2, par. 7), the author of the *Dragmaticon philosophiae* holds that the former are quite sufficient in the domain of physics. But he resorts to necessary demonstration with regard to the question of the relative sizes of the sun and the earth. However, William of Conches' mathematical culture remains very modest and he reproduces in a purely descriptive manner the traditional geometrical demonstrations made with the help of figures of shadows projected by spherical objects of differing sizes. His demonstrations are simplified versions of those transmitted by Calcidius in his *Commentary on the Timaeus*, which includes large translated and paraphrased sections of Theon of Smyrna's astronomy. Accordingly, William of Conches—or, rather, his immediate source—omit the letters of the text and of the corresponding visual figures (William of Conches 1997, bk. IV, chap. 6-10). Thus, while showing his willingness to explore new domains and subjects, William of Conches' arguments and the corresponding figures ultimately testify once again to a process of schematization. He reproduces demonstrations from his recently translated Arabic source, *De orbe* by Māshā'allāh which show that the progressions, stations, and retrogressions of Saturn are mere visual phenomena that can be reduced to a regular circular movement. In Conche's work these demonstrations are of a rhetorical nature: first he gives the example of a turning wheel and then turns to the description of an actual visual figure. Provided with letters, this figure accompanies the account as to how the visual rays of the terrestrial observer lead to the erroneous impression that there are irregular movements in the heavenly sphere (Obrist 2009; 2011).

In short, during the twelfth century authors of cosmological and cosmographical treatises became increasingly aware that their expositions and visual figures were ultimately derived from geometrical models of the universe. They were, however, unable, or unwilling—the latter being the case with Adelard of Bath's introduction to his treatise *On the Astrolabe* (ca. 1150)—to go into any detailed geometrical demonstrations. Robert Grosseteste's early thirteenth-century introductory chapter to his *On the Sphere* emblematically sets the tone for a new, specialized type of cosmology that reunites mathematical astronomy and Aristotelian physics: not content with introducing the Euclidean definition of a sphere, he gives corresponding instructions for drawing the visual figure of the *machina mundi*. This figure is, moreover, provided with inscriptions specifying its quintessential nature in a number of manuscripts. Yet, the relatively recent critical edition of the text is not accompanied by any visual figure (Grosseteste 2001).

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