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Reflections on *Light* and *Time* in the Philosophy of Franciscus Patricius and in the 1905 Paper of Albert Einstein “The Electrodynamics of Moving Bodies”**Abstract**

The philosopher Frane Petrić (Franciscus Patricius, Francesco Patrizi 1529–1597), particularly in his major works, Discussiones peripateticae and Nova de universis philosophia, devoted a significant part of his studies in ontology and cosmology to a highly original study of light and of time, two of the same concepts that play such an important part in Einstein’s paper of 1905, “The electrodynamics of moving bodies”. By juxtaposing these concepts in the two thinkers, it becomes clear that there is an affinity between the concepts in each of the thinker’s systems. For Patricius, as for Einstein, light has a unique, unchanging function in the universe. And in his analysis of time and related concepts such as duration, Patricius developed a conceptual structure dynamic enough to find consistency with Einstein’s analysis of time and of simultaneity.

Key words

electrodynamics of moving bodies, light, time, simultaneity, principles of Special Relativity, absolutes, Franciscus Patricius, Albert Einstein

Introduction

In a paper entitled, “Substances and Space-Time: What Aristotle Would Have Said to Einstein”, an American scholar has attempted to offer help in untangling the dispute about space-time as a substance or as a relation by making what seems to be the unlikely move of appealing to Aristotle’s account of substances in Book Zeta of the *Metaphysics*. The author of the paper, Tim Maudlin, analyzes the

“... difficulty (that) arises from asserting that *the substantialist must regard space-time as represented by the bare topological manifold*”. (Maudlin, 1990: 545)

He argues:

“The solution to this dilemma is just that which, I have argued, Aristotle saw. Not all predicates of a subject are accidental features of the subject.” (Maudlin, 1990: 545).

And from all of this he derives the moral:

“Since the ontological structure of the physical universe does not mirror the ontological structure of the mathematical object representing it, the mathematics must be supplemented with a *metaphysical commentary*.” (Maudlin, 1990: 545).

According to Maudlin, Aristotle’s study of substances can provide such a cogent and consistent metaphysical commentary.

Now since the present conference is part of what is called *The Days of Frane Petrić*, and is taking place on the enchanting island where Frane Petrić (Franciscus Patricius, Francesco Patrizi) was born, and since Patricius is a philosopher who devoted a significant part of his studies in ontology and cosmology to two of the concepts that play such an important part in Einstein's papers of 1905, whose centenary we are commemorating, it seemed fitting to me to consider some of the possible affinities between the thought of Einstein and that of Patricius. It is not my aim to emulate Maudlin by analyzing some way in which Patricius might have brought added clarity or even deeper insight to the thought of Einstein. Much less is it my claim that in the philosophy of the scholar from Cres there can be found correctives of some of the misunderstanding or paradoxes that may arise from what has become known as the Special Theory of Relativity. My aim is much more modest. In studying the 1905 paper of Albert Einstein, *Zur Elektrodynamik bewegter Körper* (The electrodynamics of moving bodies), it seemed clear that there are indeed some affinities between the author's theories and two essential concepts of the 16th century philosopher. The two concepts are those of *light* and of *time*. It also seemed to me that by juxtaposing these concepts as found in the work of the two scholars it would be possible to come to a more perspicacious understanding of the insightfulness of the philosopher, and perhaps even to clarify some of the philosophical dimensions of the concepts themselves. What I will endeavor to do, then, will be to present a brief analysis of each concept in the philosophy of Patricius, and then attempt to approach the Einstein paper from the point of view of Patricius, to outline what might be called an appreciation of some of Einstein's insights from the philosopher's point of view. I understand that Einstein later went on to develop further these concepts in ways that were perhaps not even hinted at in the 1905 paper I am considering. But since it is the centenary of this paper, along with the two others from what has been called "The Miraculous Year", it seemed to me reasonable to restrict my Patrizian appreciation of the concepts to this one paper.

Lux and lumen: Patricius on Light

One of the most striking features of the *magnum opus* of Franciscus Patricius, *Nova de universis philosophia*, is the fact that light comprises one of the foundation concepts of the whole system formulated in the first part of the work. It was always the intention of Patricius, in undertaking the work, to develop a new method of demonstrating the existence of a supreme being, and the relationship between that being and all other entities, and to do that, in part by following the lead of Aristotle and the method the Stagyrite used in the *Metaphysics*, but now instead of appealing to motion or change as the basic given, as Aristotle had done, to appeal to *lumen* or *lux*, light, as the basic given. It was from this given that the entire framework of the first part of his extraordinary work was derived. That first part carried the name, *Panaugia*, a name indicating the central role light played in it. We recall the now familiar distinction that Patricius drew between the Latin terms *lux*, meaning the source of light, *lumen*, the illumination resulting from that source, and *radii*, or rays, the entity that made possible the propagation of light. It was on the basis of the existence of *lumen*, the effect of *lux*, that it was possible to argue to the necessary existence of *lux*, and indeed of the First Light, the *Prima lux*, a First Light that then the philosopher would go on to analyze as the source not only of all light, but of all being, all beauty, all mind, all intelligibility.

As we read the very first pages of the *Panaugia*, we come upon the following passage in which Patricius is going to great lengths to emphasize the importance of light:

“A luce igitur, et lumine, quae nos maxime admiramur, exordium sumamus. A luce inquam, quae Dei ipsius, eiusque bonitatis est imago. Quae omnem supramundanam, omnem circummundanam, omnemque mundanam, illustrat regionem. Quae sese per omnia extendit. Per omnia se fundit. Per omnia permeat. Omnia permeando format, et efficit. Omnia vivificat. Omnia continet. Omnia sustinet. Omnia congregat. Omnia unit...” (1 v.)

“Therefore let us take our start from light, which we admire in the highest degree. From light, I say, which is the image of God himself and of his goodness. Which illumines every supermundane, every circummundane, and every mundane region. Which extends itself to all things. It pours itself out through everything. It permeates through everything. Permeating, it forms and makes everything. It vivifies everything. It contains everything. It sustains everything. It joins all things together. It unifies all things...”

After continuing in this vein for some lines, he writes:

“Omnia conservat: et ne in nihilum abeant, efficit. Omnia rerum est, et numerus et mensura. Lux rerum omnium purissima. Inalterata, inalterabilis: Impermista, impermiscibilis: Indomita, indomabilis. Nullius indiga. Dives omnium.” (1 v.)

“It (light) conserves all things, and brings it about lest they fall into nothingness. It is the number and the measure of all things. Light of all things is the most pure. Unchanged, unchangeable. Unmixed, unmixable. Not surpassed, unsurpassable. In need of nothing. Rich in all things.”

Clearly in the lines quoted above, the philosopher was coming close to waxing poetic in his paean to light, as he describes its power, its beauty, its all-pervasiveness. But it seems clear that he was not so carried away in his enthusiasm that he neglected to recall that his purpose was philosophical. As he went about his project of demonstrating the existence of the First Light, it was clearly necessary to have an accurate perspective on what made up the necessary steps in that demonstration. Most of all it was necessary to have an accurate perspective on the nature of light itself. So let us look back at the lines that have just been quoted, and try to analyze what they are claiming about the nature of light. What we see, I believe, are the following components of the basic theory of light:

- Light permeates every region that exists, whether as part of the world (*regio mundana*), as somewhat beyond the world (*regio circummundana*), or as extending beyond the world and with no relationship to it (*regio supramundana*).
- Light is a factor in the very existence of all things.
- Light has a unifying function to perform.
- Light has a function of sustaining things in existence.
- Light is the number and measure of all things.
- Light is absolutely pure.
- Light is unmixed and unmixable.
- Nothing has the power to dominate light.

This list establishes beyond doubt that light is of fundamental importance in the philosophy of Patricius. Light's position in this philosophy seems to give rise to two critically important questions: (1) What precisely is it about light that endows it with such a privileged place in the existence of everything? (2) What can it mean to claim that light is "the number and measure of all things" (*omnium rerum numerus et mensura*)? By attempting to face these questions and, even if not answering them fully, by giving some reasonable and consistent response to them we can, I believe, come closer to grasping the core of what Patricius maintained about light. Why then does light hold such a unique place in the philosophy of Patricius? The reason seems to be that light is a *datum*, a given that makes it possible for first the senses and then the mind to comprehend entities that are associated with light in its manifestations in our experience, and at the same time makes it possible for the mind to surpass those entities of our experience to arrive at some understanding of what lies behind them. One reason it does that is that light in its different manifestations, *lux*, *lumen*, *radii*, uniquely spans those four levels of existence postulated as one of the basic tenets of the New Philosophy. By leaving behind the dichotomy materialism/dualism, it becomes possible to introduce a new, more refined classification of entities: incorporeal, corporeal incorporeal, incorporeal corporeal, and corporeal. It is an analysis of light in its different manifestations that furnishes the evidence for this more sophisticated categorization. And it is light in its different forms that, as it spans these categories, serves as the basis for the mind's comprehension of them. With regard to the second of our two questions, What can it mean to claim that light is "the number and measure of all things?", in a sense we have already answered it: precisely in spanning the four levels of existence, light is the unique element among existing things, and this gives it the unique function of being the reality against which all other beings are measured and numbered.

***Tempus*: Patricius on time**

While Patricius's treatment of time does not have the same systematic character as his treatment of other topics such as space, nonetheless time is a subject that was important for the philosopher from Cres. One reason for its importance is that the understanding of time served as one more platform from which to criticize the shortcomings in the philosophy of Aristotle. (Whether this criticism of Aristotle was justified or not is not my concern here, since I am simply concerned with understanding the ultimate position of Patricius.) Among the points where Patricius found Aristotle's theories wanting due to the lack of evidence offered in support of them, were the following:

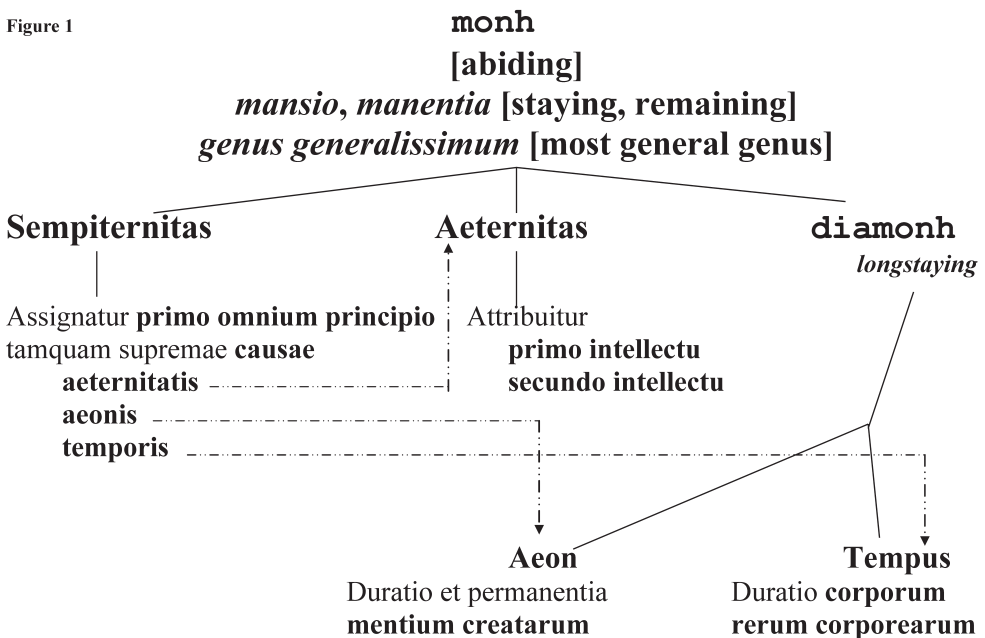
- rejected: that time is infinite
- rejected: that time is continuous or eternal
- rejected: that time is the measure of motion
- rejected: that time is dependent for its existence on reason or soul.

The first two of these tenets are closely related. If time has no beginning or no end, then it must be continuous, eternal, and infinite. And it will be these if it is related inseparably to motion, which in turn is claimed to be eternal. Further, if time is a measure or a counting, then it must be dependent on some entity that can carry out these functions. In sum, these views of Aristotle concerning

time assume that time is an entity that in a sense can be understood in its own terms without placing it in any wider context and without raising any question about the ontological status of the entities that are measured by time.

But more important than simply rejecting what Aristotle had asserted about time was the need to analyze time in terms of the New Philosophy of Patricius himself. When we turn to the positive position of Patricius concerning time, we find a complex and sophisticated analysis of the terminology related to *enduring* in its different manifestations. In an earlier paper on time in Patricius, I presented a diagram reflecting this analysis, and I shall do so again simply to indicate the complexity with which Patricius regarded the whole question of time and its relationship to other related concepts.

Figure 1



Without going into excessive detail with regard to the diagram, it is noteworthy that it reflects the fact that time, or *tempus*, is defined as “the duration of bodies and of bodily things” (*duratio corporum seu rerum corporearum*). It is clear from the diagram that *duration* is the basic underlying concept not only of time, but of all the related concepts, whether *eternity*, or *sempiternity*. The important thing to note is that what distinguishes the different species and subspecies under the genus *abiding* or *duration* is the ontological status of the entities that are abiding or enduring. This seems to be a very important point, and let me elaborate on it briefly. As the diagram makes clear, the relationship between “abiding” and that of “sempiternity”, “eternity”, and “longstaying”, is that of genus to species. That is, these three species are not related simply by a figure of speech, but they share the same genus. Analogously, the subspecies *eon* and *time* share the same species and consequently also the same higher genus. What establishes the difference between all of them is precisely the entity that is abiding, and what I have called the *ontological status* of the entity. If the entity is incorporeal the duration will be in one species, while if it is corporeal the duration will be in a different species. There is a complex argument in support of this position that time is duration, and it seems to be something like the following:

1. Time is either
 - (a) the measure of motion or change, or
 - (b) duration, that is, simple persistence without the requirement for motion or change.
2. But if time is the measure of motion or change (a), then it is dependent upon motion or change (c), and it is dependent on a cognitive process recognizing or being aware or, indeed, numbering that motion (d).
3. But time is not dependent upon motion or change (not c).
4. Time is not dependent upon a cognitive process (not d).
5. Therefore time is not the measure of motion or change (not a).
6. Therefore time is duration (b).

After offering a series of subordinate arguments in support of the premises of the above argument, the philosopher concludes:

“Tempus ergo aliud non est quam monh[–],
permanentia et duratio, corporum rerum
corporearum.”

“Time therefore is nothing other than monh[–],
the persistence and duration of bodies and of
bodily things.”

What is perhaps a somewhat surprising corollary of this thesis is the claim that in the analysis, bodies or bodily things include both rays (*radii*) and *lumen*. Thus Patricius writes:

“Corpora ergo radii sunt. Sed corpora non
elementaria, non antitypa, nec quale spacium
est. Sed corpora sunt, spacio quidem densiora,
rariora tamen rarissimis, aereo, aethereoque...
Si sol lucis suae sit materia, radii autem sint
imateriales prorsus.” *Panaugia* III (6v)

“Therefore rays are bodies. But they are not
bodies that are elemental, nor resistant (to
other bodies), nor the kind that space is. But
they are bodies, denser indeed than space,
but rarer even than the most rare items, air
and ether... If the sun is the matter of its
light, rays on the other hand are straightway
immaterial.”

And again: That *lumen* is a body is made clear in Book IV of the *Panaugia* (*De lumine*) where Patricius writes:

“... Dicimus lumen esse corpus incorporeum
et immateriale, trine dimensum.”

“... We say that *lumen* is an incorporeal and
immaterial body with three dimension.”

We seen, then, that this is an illustration of the tenet that duration in its different forms, including that of time, is instantiated in a wide range of entities, and that the nature of the entities determines the nature of the duration or time instantiated.

To sum up: according to the analysis of Patricius, time is a subspecies under the species of *longstaying* which in turn is a species under the genus of *abiding*, or *duration*, the most general genus in this whole taxonomy of entities and their related concepts. And it is essential to note that the taxonomy is based on the differences of the entities that endure. In the instances considered so far, these have arisen from the ontological status of the entity. Still it seems reasonable to claim that analogous differences might also account for different durations, and not simply those differences that are ontological. As

I shall argue below, by creating this possibility of different durations, the system of Patricius becomes open to the positions about time and duration that would be alien to the thought of other philosophers.

Turning to Einstein

Now that we have reviewed, even if in a very condensed manner, some of what seem to me to be the main views of Patricius on light and time, I would like to turn to Albert Einstein's paper of 1905, *Zur Elektrodynamik bewegter Körper* (The electrodynamics of moving bodies), and to consider these same items, and to do so precisely from the standpoint of the earlier work of Patricius. As I have already mentioned in the introduction, it is not my aim to correct any of the interpretations of Einstein, nor to offer new interpretations, but rather to show what appears to be some affinity between the two thinkers, not of course in the sophisticated mathematical physics of the modern thinker, but in the epistemological and ontological terrain they seem to have shared.

Einstein: Light

One of the most striking things that appears to a non-physicist in reading Einstein's 1905 paper on the electrodynamics of moving bodies is the importance of light. At the very beginning of the paper, Einstein lays down a postulate about light that has the most fundamental implications for the universe we live in. The postulate is so well-known, and is one of the two basic postulates of what has become known as the Special Theory of Relativity, that it is hardly necessary to repeat it. Even so it bears repeating as we seek to understand what might be the appreciation of the philosopher Patricius of the postulate:

„... sich das Licht im leeren Raume stets mit einer bestimmten, vom Bewegungszustande des emittierenden Körpers unabhängigen Geschwindigkeit V fortpflanze.“ (Einstein, 1905: 892)

“...that light always propagates in empty space with a definite velocity V that is independent of the state of motion of the emitting body.” (Einstein, 1998: 124)

And later essentially the same principle is enunciated as follows:

„Jeder Lichtstrahl bewegt sich im ‘ruhenden’ Koordinatensystem mit der bestimmten Geschwindigkeit V , unabhängig davon, ob dieser Lichtstrahl von einem ruhenden oder bewegten Körper emittiert ist.“ (Einstein, 1905: 895)

“Every light ray moves in the ‘rest’ coordinate system with a fixed velocity V , independently of whether this ray of light is emitted by a body at rest or in motion.” (Einstein, 1998: 128)

For a philosopher like Patricius, a question could well arise about the epistemological basis for the claim about the constancy of the speed of light, and of the lack of any relationship between the velocity of light and the velocity of the emitting body. But apart from this consideration, the postulate of the constancy of the speed of light, and of the role this constancy plays in the universe would be conceptually welcome. There are a number of reasons why this postulate and its accompanying conceptual structure would be greeted by Patricius with alacrity. Perhaps most important of all is the fact that the

postulate establishes light and its velocity as a basic given. It is a given that has never changed, that will never change, a given that is absolute. In such an absolute given, a philosopher like Patricius would find reinforcement, or perhaps even more strongly, a vindication of some of the most basic tenets of his ontology and his epistemology. Essential to the ontology of Patricius is the existence of an absolute, or a number of absolutes that are impervious to change. And essential to his epistemology is the capability of the human mind or intellect to grasp such absolutes. Thus the fact that the speed of light is an absolute reinforces not only the claim that there are such absolutes that are impervious to the mutability conditions of material entities, but reinforces as well the claim that there is order in the universe, that the universe is not simply a random collection of divergent forces and processes, but that underlying it is at least one absolute. In addition, our understanding of this absolute, the constant velocity of light, serves to validate the claim that the human mind can, and does, apprehend reality, a reality that is not the concoction of the human imagination, but one that truly exists, neither a figment of the intellectual realm nor yet totally independent of that realm. The existence of the absolute and our comprehension of it establishes and reveals the link between the intellectual realm and the universe of our experience.

In the ontology of Patricius as represented by the conceptual grid of the *Pan-*augia**, light in its various manifestations is of fundamental importance. In a very real sense it forms the universe, and as we have seen from the words of Patricius, *Omnium rerum est, et numerus et mensura* (“It /light/ is the number and measure of all things”). Thus this conceptual frame of the philosopher is rendered eminently reasonable by the position of light in Special Relativity theory.

It should be pointed out that while at times Patricius mentions the ether, it seems to play no essential role in his ontology since light can and does move through a vacuum. Thus it seems that Patricius would have posed no objection to the following words of Einstein:

„Die Einführung eines ‚Lichtäthers‘ wird sich insofern als überflüssig erweisen, als nach der zu entwickelnden Auffassung weder ein mit besonderen Eigenschaften ausgestatteter ‚absolut ruhender Raum‘ eingeführt, noch einem Punkte des leeren Raumes, in welchem elektromagnetische Prozesse stattfinden, ein Geschwindigkeitsvektor zugeordnet wird.“ (Einstein, 1905: 892)

“The introduction of a ‘light ether’ will prove to be superfluous inasmuch as the view to be developed here will not require a ‘space at absolute rest’ endowed with special properties, nor assign a velocity vector to a point of empty space where electromagnetic processes are taking place.” (Einstein, 1998: 124)

Finally with regard to light we have seen that Patricius attributes corporeal characteristics to *lumen* and *radii*. While it would make no sense to think that this somehow foreshadows Einstein’s words about the energy and force of light rays, it would be reasonable, I believe, to see at least an affinity between the views of the two groundbreaking thinkers.

Einstein – Time

Some of the lines a non-physicist finds most striking in the 1905 papers of Einstein I have been discussing are found in the section of the paper that analyzes *simultaneity* (*Gleichzeitigkeit*) and the related topic of *time* (*Zeit*) in an

analysis of the motion of particles. And I now would like to consider some of the concepts relating to time and simultaneity from the paper where that discussion is carried out. I will then discuss these from the standpoint of the earlier treatment of time in the philosophy of Patricius. Einstein points out that in describing the motion of particles, “we give the values of its coordinates as functions of time”. He continues:

„Es ist nun wohl im Auge zu behalten, dass eine derartige mathematische Beschreibung erst dann einen physikalischen Sinn hat, wenn man sich vorher darüber klar geworden ist, was hier unter ‚Zeit‘ verstanden wird.“ (Einstein, 1905: 892)

“However, we must keep in mind that a mathematical description of this kind only has physical meaning if we are already clear as to what we understand here by ‘time’.” (Einstein, 1998: 125)

At this point Einstein argues that our judgments about time always involve judgments about the simultaneity of events (*Ereignisse*). To back up this point he gives the simple and well-known example of a judgment about events that involve such a judgment: a train arriving at the place where I am waiting at 7 o’clock. He claims that such a judgment “means, more or less, ‘the pointing of the small hand of my watch to 7 and the arrival of the train are simultaneous events’”. Consequently, he continues, we might be able to solve any of our difficulties about the definition of time if instead of referring to “time” we were to refer to the “position of the small hand on my watch”. So we see how Einstein recognizes the classic difficulties inherent in any attempt to define time and suggests a simple way to get around these difficulties. We might simply reduce time to the data furnished by clocks without attending to the more subtle issues involved in the concept. In his first endeavor to establish the meaning of time, Einstein sees as essential to that meaning the concept of simultaneity. In other words, when we talk about the time of an event, we seem to be implying some sort of comparison, a comparison between two actual events or between a particular event and the movement of the hands of a watch. Einstein describes this comparison between events as being based on the fact that the events are “linked temporarily” or are being “evaluated temporarily”. He points out that a difficulty arises when we are dealing with a series of events that are at different locations. That is, the situation becomes more complex when, instead of something like the arrival of a train where I, the observer, am, and my checking my watch, which again is also where I am, we must make a judgment about events that are significantly distant from each other. In that case our simple definition of simultaneity and by extension that of time will not be adequate.

„Eine solche Definition genügt in der Tat, wenn es sich darum handelt, eine Zeit zu definieren ausschließlich für den Ort, an welchem sich die Uhr eben befindet; die Definition genügt aber nicht mehr, sobald es sich darum handelt, an verschiedenen Orten stattfindende Ereignisreihen miteinander zeitlich zu verknüpfen, oder – was auf dasselbe hinausläuft – Ereignisse zu werten, welche in von der Uhr entfernten Orten stattfinden.“ (Einstein, 1905: 893)

“Such a definition is indeed sufficient if a time is to be defined exclusively for the place at which the watch is located; but the definition is no longer satisfactory when series of events occurring at different locations have to be linked temporally, or – what amounts to the same thing – when events occurring at places remote from the clock have to be evaluated temporally.” (Einstein, 1998: 125, 126)

Two solutions to this complicating factor seem to offer themselves:

Solution 1: Have the observer with a clock at the point of origin of the coordinates who would receive a light signal through empty space from the event and on the basis of the signal assign a time to the event and so for the others in the series.

Problem with solution 1: “we know from experience that such a coordination has the drawback of not being independent of the position of the observer with the clock”. (Einstein, 1998: 126)

The reason why this problem arises is clearly due to the fact that the light signals will have to travel different distances, and since they do, the interval it takes for the signal to arrive from the observer at the different events will not be the same in all cases. Consequently such a procedure will not furnish the basis for making a judgment about simultaneity of events. Thus we must look for an alternative solution.

Solution 2: The second proposed solution would be to have two observers, A and B, with two clocks, A clock and B clock, resembling each other “in all respects”. Each of them will be able to determine the time of the events in their immediate vicinity, resulting in an A time and a B time. But now it will be necessary to determine a “common time”:

„Die letztere Zeit kann nun definiert werden, indem man *durch Definition* festsetzt, dass die ‚Zeit‘, welche das Licht braucht, um von A nach B zu gelangen, gleich ist der ‚Zeit‘, welche es braucht, um von B nach A zu gelangen.” (Einstein, 1905: 894)

“The latter can now be determined by establishing *by definition* that the ‘time’ required for light to travel from A to B is equal to the ‘time’ it requires to travel from B to A.” (Einstein, 1998: 126)

This point can be illustrated by the following:

„Es gehe nämlich ein Lichtstrahl zur ‚A-Zeit‘ t_A von A nach B ab, werde zu ‚B-Zeit‘ t_B in B gegen A zu reflektiert und gelange ‚A-Zeit‘ t'_A nach A zurück. Die beiden Uhren laufen definitionsgemäss synchron, wenn

$$t_B - t_A = t'_A - t'_B$$

(Einstein, 1905: 894)

“... suppose a ray of light leaves from A for B at ‘A-time’ t_A , is reflected from B toward A at ‘B-time’ t_B , and arrives back at A at ‘A-time’ t'_A . The two clocks are synchronous by definition if

$$t_B - t_A = t'_A - t'_B$$

(Einstein, 1998: 126)

This reasoning process has brought us to the point where we can formulate more refined definitions both for *simultaneity* and for *time*:

„Die ‚Zeit‘ eines Ereignisses ist die mit dem Ereignis gleichzeitige Angabe einer am Orte des Ereignisses befindlichen, ruhenden Uhr, welche mit einer bestimmten, ruhenden Uhr, und zwar für alle Zeitbestimmungen mit der nämlichen Uhr, synchron läuft.” (Einstein, 1905: 894)

“The ‘time’ of an event is the reading obtained simultaneously from a clock at rest that is located at the place of the event, which for all time determinations runs synchronously with a specified clock at rest, and indeed with the specified clock.” (Einstein, 1998: 127)

And it is essential to note that the time so defined is in fact “the time of the rest system”. In such a system, then, the fundamental importance of the concept of time seems to be that it is a factor in comparing two events, to determine whether indeed they are simultaneous or not simultaneous. This determination is to be made by two clocks which by definition are synchronous in the sense of showing the same time and running at the same rate.

But up to this point we have considered only part of the picture, and indeed the less significant part. In the second section of the paper, Einstein turns to a

consideration of “the Relativity of Lengths and Times” (*Über die Relativität von Längen und Zeiten*). This consideration is predicated on two principles. One of these is the well-known enunciation of the constancy of the velocity of light. The other, the Principle of Relativity, is now enunciated as follows:

„Die Gesetze, nach denen sich die Zustände der physikalischen Systeme ändern, sind unabhängig davon, auf welches von zwei relativ zueinander in gleichförmiger Translationsbewegung befindlichen Koordinatensystemen diese Zustandsänderungen bezogen werden.“ (Einstein, 1905: 895)

“If two coordinate systems are in uniform parallel translational motion relative to each other, the laws according to which the states of a physical system change do not depend on which of the two systems these changes are related to.” (Einstein, 1998: 128)

On the basis of these two principles, Einstein considers two systems, the one at rest, the other in motion relative to the first. He argues that in such a situation, observers in the moving system would take a different view of two clocks from the judgment of the others in the system at rest. To observers in the moving system the clocks would not be running synchronously, but to the observers in the system at rest the clocks would be running synchronously. Thus it is that in systems in uniform parallel translational motion, the time of one may be different from the time of the other. Einstein writes:

„Wir sehen also, dass wir dem Begriffe der Gleichzeitigkeit keine *absolute* Bedeutung beimessen dürfen, sondern dass zwei Ereignisse, welche, von einem Koordinatensystem aus betrachtet, gleichzeitig sind, von einem relativ zu diesem System bewegten System aus betrachtet, nicht mehr als gleichzeitige Ereignisse aufzufassen sind.“ (Einstein, 1905: 897)

“Thus we see that we cannot ascribe *absolute* meaning to the concept of simultaneity; instead two events that are simultaneous when observed from some particular coordinate system can no longer be considered simultaneous when observed from a system that is moving relative to that system.” (Einstein, 1998: 130)

Einstein’s paper continues on into the next section with a discussion of the “Theory of Transformations of Coordinate and Time from the Rest System to a System in Uniform Translational Motion Relative to It”, but I would like to bring to a close at this point my review of the concepts of time and simultaneity in the paper before turning to what I am suggesting might be a Patrizian appreciation of these concepts as presented.

One might come away from this brief overview of the sections of the paper I have been considering with a cluster of concepts all having some temporal aspect. Chief among those, obviously, are those of *time* and *simultaneity* and the relationship between the two. It is suggested that we may be able to avoid the complexities of the concept of time by simply relating it to the determining process of a clock, or better, two clocks. That is, the paper seems not concerned with determining any further the nature of time or even with categorizing it in some way. The principal concern is to link the concept of *time* with that of *simultaneity* in order to thus lay the basis for a comparison between two events. But the concept of simultaneity does not lend itself to such a simple reduction, and consequently, so the argument goes, we are unable to give an absolute account of *simultaneity*, nor an absolute account of what the paper describes as events being “linked temporarily” or “evaluated temporarily”.

As I return to my Patrizian appreciation of this paper of Einstein, and now in particular with regard to the concept of time and simultaneity there enunciated, it might be worth noting that, at first sight, from a philosophical point of

view, as well as from one of common sense, the analysis of the concepts may seem quite counterintuitive, or indeed paradoxical. And of course in the years intervening since the ideas were first formulated, many puzzles have been generated. After all, we might say or think, time is time, and if two events are simultaneous then they are simultaneous.

Let me try to formulate what might be thought of as some Patrizian questions and possible insights that could arise from the study of the sections of the paper in question. Before doing so, it might help clarify our investigation if we recall briefly here the major points of the theory of Patricius regarding time. We recall that he rejected what he took to be Aristotle's view of time:

- rejected: that time is infinite,
- rejected: that time is continuous or eternal,
- rejected: that time is the measure of motion,
- rejected: that time is dependent for its existence on reason or soul.

As far as his own theory was concerned, it was encapsulated in the following claim:

- time is the duration of bodies and of bodily things.

In view of this thesis that time is the duration of bodies or of bodily things, one question that might arise would be this: If time is relative to the observers in different systems, then is one claiming that event A and event B from one standpoint are simultaneous, or having the same duration, and from another standpoint not simultaneous, or having different durations? Is one claiming that the durations are different or rather that the durations are the same but measured in different ways? Or must one simply abandon the attempt to make some meaningful comparison between the duration of event A and of event B?

In response to these questions, it seems to me that Patricius might very well say something like the following: In my general theory concerning duration the significance of event A and of event B both depend on the ontological status of the entities involved in the events. That is, the entities will fit into one of the four ontological categories I have established and argued in support of. The entities might be incorporeal, corporeal incorporeal, incorporeal corporeal, or simply corporeal. Just as an entity that is entirely incorporeal differs profoundly from one that is entirely corporeal, so an event involving an entity that is incorporeal will differ profoundly from an event involving an entity that is entirely corporeal. One significant difference between these events will be precisely the nature of their durations. (Recall the scheme presented earlier that illustrated these differences.) But on this reasoning there is no reason in principle why, in an analogous way, two events that have the same ontological status could not be attributed duration of a different nature, as for example if one event is in a system at rest and the other in a system in motion relative to the system at rest. We see many suggested examples of this happening. One of them is found in Einstein's thought experiment in the 1905 paper that has been alluded to earlier. Modern physics textbooks abound with other examples of things like trains running at half the speed of light with an observer on board conducting an experiment with light, while on the ground beside the tracks is another observer. The point of this example is to show that the time of the two events or the duration of the period for the ray of light to move from point A to point B will differ for the observer on the train and for the observer on the ground.

Thus what I have been arguing is that Patricius might very well claim that his analysis of time as duration, with duration having many parameters, seems to

be harmonious with the arguments about time and simultaneity presented by Einstein in the texts under consideration. And we might very well maintain that the philosopher would find the claims of Einstein not only not paradoxical but rather as fitting in very well with his analysis of time. As we have already seen, time is not a measure (remember that light is the measure for Patricius and the speed of light for Einstein). Time in the analysis of Patricius is simply one aspect of the multifaceted entity that can be labeled generically as *duration*, and as I hope may have been made clear from the earlier diagram that I presented. *Duration*, then, can have many different parameters depending on the nature and circumstances of the items that endure. The most obvious determining circumstance will be the ontological status of the entity that is to endure. But again there is no reason in principle why a different, analogical circumstance might not also have an impact on the nature of the duration. Thus it might very well seem that the relativity of time and simultaneity is not only not problematical for Patricius but even quite in accord with what he argued in favor of.

It might be pointed out that in an earlier paper on time in Patricius, the claim was made, and made quite independently of any reference to Einstein or Special Relativity, that the concept of simultaneity was one that would have provoked difficulties for Patricius: it does not seem to make sense to claim that item A, which has a duration independent of item B, is simultaneous to item B.

Concluding remarks

This paper has been an attempt to show some affinity between the thought of Franciscus Patricius in his works *De Rerum Natura*, *Discussiones Peripateticae*, and *Nova de universis philosophia*, as these treat of *light and time*, and the thought of Albert Einstein in his paper *Zur Elektrodynamik bewegter Körper* (On the electrodynamics of moving bodies), as it treats of *light and time*. It would, of course, be a fool's errand to try to claim that in some real sense Patricius was a precursor, or that we can correct some of the difficulties with the theory of Special Relativity by appealing to the works of Patricius. Rather I hope to have shown in a very limited way, that Patricius had intellectual concerns which, if not identical to those of Einstein, had an affinity with them, and that system of thought of Patricius is open and flexible enough to welcome the insights of Einstein regarding *light and time* in his groundbreaking paper.

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Eugene E. Ryan

**Reflexionen über die Begriffe *Licht* und *Zeit* in der Philosophie von
Franciscus Patricius und in Albert Einstein Schrift
„Zur Elektrodynamik bewegter Körper“ aus dem Jahr 1905**

Zusammenfassung

Der Philosoph Frane Petrić (Franciscus Patricius, Francesco Patrizi 1529–1597), widmet einen bedeutenden Teil seiner Studien über Ontologie und Kosmologie, insbesondere in seinen Hauptwerken Discussiones peripateticæ und Nova de universis philosophia, einer höchst originellen Untersuchung des Lichtes und der Zeit, zwei Konzepten, die auch in Einsteins „Zur Elektrodynamik bewegter Körper“ (1905) eine wichtige Rolle spielen. Bei der Gegenüberstellung der Konzepte dieser zwei Philosophen kommt ihre Verwandtschaft in jedem der erwähnten Systeme zum Ausdruck. Sowohl für Patricius, als auch für Einstein besitzt das Licht eine einmalige, unveränderliche Funktion im Universum. In seiner Analyse der Zeit und mit ihr verwandter Konzepte, beispielsweise der Dauer, entwickelte Patricius eine konzeptuelle Struktur, dynamisch genug, um ihre Konsistenz mit Einsteins Analyse von Zeit und Simultaneität erkennbar zu machen.

Schlüsselwörter

Elektrodynamik bewegter Körper, Licht, Zeit, Simultaneität, Prinzipien der speziellen Relativität, Absolute

Eugene E. Ryan

**Réflexions sur les concepts de *lumière* et de *temps* dans la philosophie de
Franciscus Patricius et dans l'ouvrage d'Albert Einstein
« Electro-dynamiques des corps en mouvement » de 1905**

Sommaire

Le philosophe Frane Petrić (Franciscus Patricius, Francesco Patrizi 1529–1597) a consacré, surtout dans ses œuvres principales Discussiones peripateticæ et Nova de universis philosophia une grande partie de ses recherches sur l'ontologie et la cosmologie à une étude originale de la lumière et du temps, deux concepts ayant un rôle important dans l'ouvrage d'Einstein « Electro-dynamique des corps en mouvement ». La confrontation de ces concepts des deux penseurs fait apparaître leur affinité dans chacun des systèmes. Pour Patricius, de même que pour Einstein, la lumière est une fonction unique, constante dans l'univers. Dans son analyse du temps et des concepts relevant du temps comme la durée, Patricius a développé une structure conceptuelle suffisamment dynamique pour que soit révélée sa consistance avec l'analyse du temps et de la simultanéité d'Einstein.

Mots clés

Electrodynamique des corps en mouvement, lumière, temps, simultanéité, principes de la relativité restreinte, l'absolu