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What is Left of Classical Philosophical Understanding of Space?

Abstract

This paper deals with the traditional philosophical understanding of space in comparison with the contemporary physical understanding of space, which is under the influence of Einstein's theory of relativity. As the first variant of the traditional philosophical understanding of space, an understanding of space as the property of existing beings (either as a coordinate associated to material bodies or as the all embracing superiority that comprehend all material bodies) is stated. This tradition takes us from ancient Greek philosophy (i.e. Leucippus, Democritus) to Descartes and Newton's understanding of absolute space. As the second variant of the traditional philosophical understanding of space, an understanding of space as the aprioristic intuition of mind, which enables us to perceive beings existing in absolute space, is stated. This tradition leads from Kant's philosophy to contemporary theories of the inborn aprioristic faculty of mind. The untenableness of these variants, which include the concept of absolute space, is shown with the help of proofs that confirm Einstein's theory of relativity, and with the help of non-Euclidean's geometries. With the help of examples from Stephen Hawking and Roger Penrose's discussion concerning the nature of space and time, it is shown that the contemporary physical understanding of space remains inside the frames of philosophical understanding of three-dimensional space. With the help of the ontological foundation of the rules of deductive logic, what is shown is the measure of actuality of the aprioristic variant of philosophical understanding of space.

Key words

traditional philosophical understanding of space, contemporary physical understanding of space, Einstein's theory of relativity, non-Euclidean geometries, deductive logic

1. Classical philosophical understanding of space

The fact is that during the long and theoretically very rich history of western philosophy we have a number of different ideas about the concept of space, and the mutually different variations within the scope of each of them. To answer the question: "Is there anything that we can consider 'classical philosophical understanding of space'?", we have to recognize a minimum of semantically meaningful "constants" which are common to different philosophical understandings of space. To this end philosophical attitudes Plato, Aristotle, Descartes, Leibniz and Kant can help us to better cope with the problem.

Plato develops his attitudes of the concept of space mainly in *Timaeus*.[1]

[1] "And they, being thus moved, were perpetually being separated and carried in different directions; just as when things are shaken and winnowed by means of winnowing – baskets and other instruments for cleaning corn, the dense and heavy things go one way, while the rare and light are carried to another place and settle there. In the same way at that time

The main idea is the ontological identification of the world of physical bodies with the world of geometric forms. Furthermore, the "elements" are endowed with geometrical spatial structures: fire with pyramid, earth with cube, etc. A physical body becomes a part of empty space, limited by geometric surfaces containing imperfect spatial realization of a prefect *ίδέα*. The reason why this physical realization is imperfect leads to the imperfect property of space. Imperfection of space belongs to the dimensionality of space. A physical body cannot be anything but the imperfect three-dimensional copy of the combination of the perfect non-dimensional ideas. As a result, matter is reduced to space, and physics is reduced to geometry. Plato's ontological identification of geometrical "entities" and physical bodies, or, in terms of later Neoplatonistic interpretations, of tridimensionality and matter, had a great influence throughout the Middle Ages.[2]

Being unsatisfied with the Plato's statement according to which the existence of geometrical spatial structures that limited the parts of empty space are the ontological fundamentals of really existing beings, Aristotle in his *Categories*, and as well as in *Physics*, develops his theory of "space" and "place". The main idea is that any kind of physical body is the union of form and matter (*ϋλη* and *μορή*), and space can be defined only as a function of the spatial/temporal really existing beings. "Space", under the category of quantity, is a continuous quantity as a purely geometric property of coherent matter. But as a function of the really existing beings, "space" is the sum total of all places occupied by the existing beings. Conversely, all places occupied by the existing beings are that parts of space whose limits coincide with the limits of the occupying existing beings.[3]

Places, occupied by the existing beings, show mutual temporal/spatial relations among existing beings, and in a sense of ontological foundations of substantial beings are only accidents having real existence only by mutual relations among existing beings – a reference system of a limited scope. The reality of space is possible to prove only by the changeability of mutual relations among existing beings.[4]

Pure possibilities (*δύναμις*) are conditioned by the dynamic influences intrinsic to space (moving spheres).[5]

Dynamic field structure, inherent in spherical space, is conditioned by the geometrical property of coherent matter that belongs to that spherically limited space. Celestial spherical coordinates: longitude (*μεκος*) and latitude (*ρλατος*) being the ideal two-dimensional system for Aristotle's cosmology of spherical symmetry. Aristotle's definition of spatial "place" also had a great influence in the Middle Ages.[6]

Stoics did not accept Aristotle's definition of space as the containing surface of the encircling body, maintaining the dimensional extension as the distance between the points of the containing surface. This alternative enables them to understand a void outside the material bodies as infinite continuum being qualitatively completely indeterminate with no possibility of any kind of influence on materiality. Furthermore, Euclid himself, investigating platonically understood material body as the spatial geometrical realization of the intelligible perfect unchangeable *ίδέα*, undoubtedly dealt with three-dimensional objects. But Euclidean three-dimensional geometric coordinate system with infinite lines and planes cannot fit into the finite and anisotropic Aristotelian cosmology. This realization had to wait until the seventeenth century and Rene Descartes' philosophy. In *Principles of philosophy* Descartes mostly develops his attitudes of the concept of space. The main idea is the ontological bifurcation

of existing beings owing to implicated definition of a human being. Namely, "*Cogito, ergo sum*", as the ontological *prius*, means confirmation of the reality of existence of a human being by the presupposed human essence. Logical consequence of this ontological priority statement is the logical impossibility

the four kinds where shaken by the Recipient, which itself was in motion like an instrument for shaking, and it separated the most unlike kinds farthest apart from one another, and thrust most alike closest together; whereby the different kinds came to have different regions, even before the ordered whole consisting of them came to be." – Plato, *Timaeus* 52d; translated by B. Jowett, ELPENOR – Home of the Greek Word, Παιδεία, 2004.

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"Moreover, as the Christians had no philosophy of their own to start with (i. e. in the academic sense of philosophy), they very naturally turned to the prevailing philosophy, which was derived from Platonism but was strongly impregnated with other elements. As a rough generalization, therefore, one may say that the philosophic ideas of the early Christian writers were Platonic or neo-Platonic in character (with an admixture of Stoicism) and that the Platonic tradition continued for long to dominate Christian thought from the philosophic viewpoint." – Frederic Copleston, *Medieval Philosophy*, Continuum, London – New York 2003, p. 14.

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"For the parts of a solid occupy a certain space, and these have a common boundary; it follows that the parts of space also, which are occupied by the parts of the solid, have the same common boundary as the parts of the solid. Thus, not only time, but space also, is a continuous quantity, for its parts have a common boundary." – Aristotle, *Categories* 5a; translated by E. M. Edghill, The Classical Library, HTML edition 2001.

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"Moreover the trends of the physical elements (fire, earth, and the rest) show not only that locality or place is a reality but also that it exerts an active influence; for fire and earth are borne, the one upwards and the other downwards, if unimpeded, each towards its own 'place', and these terms – 'up' and 'down' I mean, and the rest of the six dimensional directions – indicate subdivisions or distinct classes of positions or places in general." – Aristotle, *Physics* 208b; see trans. by P. H. Wicksteed and F. M. Cornford, Loeb Classical Library, Harvard Univ. Press, Cambridge 1929, p. 279.

Aristotle's mentioning of "six dimensional directions" must not be confused with the spatial dimensions. Until today it is possible to find this kind of confusion in a number of philosophical disputations. Allegedly, this paradoxical *n*-dimensionality is what differentiates "philosophical" understanding of space from mathematical understanding of space. Namely, there is a potential possibility (*δύναμις*) to move any physical body in an indefinite number of directions, but all of these potential translocations are possible to determine in tree-dimensional coordinative mathematical referential system. Confusion between the concept of "direction of movement" and the concept of "spatial dimensions" is out of deductive logical articulation of any consistent theory about the objectively existing time/space universe. Sometimes, it is present a philosophical confusion between the meaning of space as the objectively existing space/time universe, and the meaning of space as the place of cultural, spiritual, philosophical, scientific, etc. happenings of human civilization. Confusion between the concept of "space as the objectively existing space/time universe", and the concept of "space as the place of happening of human civilization" is out of semantically logical different meanings of those two different understanding of space. Namely, confusion between the space and the place means confusion between the space/time universe and the surface of the planet Earth. Moreover, sometimes, somehow, the meaning of the concept of time as the objectively existing property of space/time continuum is confused with the philosophical intuitive subjective Henry Bergson's concept of time as the property of state of human consciousness. This confusion means violation of the logical demand for consistency of a theory. Namely, it is not possible to violate scientific methodological demand for corroboration of a theory by experimental data, and not to violate the logical demand for consistency of a scientific theory. For example, it is not possible, by the state of Marcel Proust's consciousness, to proclaim his fictionally genial work of art *In Search of Lost Time - the Remembrance of Things Past* as the property of space/time continuum, and not to violate scientific methodological/logical demand for consistency of a scientific theory. Bergson's idea of time, which is on an admirable way applicable to aesthetical theories, has its philosophical routes that lead to Plato's *ἀνάμνησις*, but not to Plato's *χρόνος*.

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"It might be asked, since the center of both (i. e., the earth and the universe) is the same point, in which capacity the natural motion of heavy bodies, or parts of the earth, is directed towards it; whether as center of the universe

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of the existence of a human being as a human being, without higher mental activities (thinking, be consciousness, be self-consciousness).[7]

Ontological aspect of these psychological properties of a human being means definition of human being as *res cogitans*. This definition enables ontological bifurcation of really existing beings into *res cogitans* and *res exstensa*. Definition of physical bodies as *res exstensa* enables Descartes' identification of space and matter. Descartes' identification of space and matter through quantitative extension enables him to apply three-dimensional Cartesian geometrical coordinates to space. Despite the fact that Descartes did not allow the concept of empty space as the referential concept, despite the fact that he did not allow the application of the concept of force in physics because of the ontological properties of *res cogitans*, his identification of space and matter enables understanding of the homogenous "properties" of space and implicitly application of the concept of geometrical infiniteness in physics. Despite the fact that Newton's abstraction of matter as "mass-point" is proved in physics as more fruitful than Descartes' *res exstensa*, Descartes' identification of space and matter as quantitative extension was important philosophical suggestion for the Newton's understanding of the concept of absoluteness as a logical and ontological necessity.[8]

Namely, for Descartes, *res extensa* has an absolute significance of properties compared with the absolute significance of properties of *res cogitans* – mental properties are absolutely independent of the properties of quantitative extension. For Newton, the concept of absolute space has an absolute significance compared with the absolute concept of time – time is absolutely independent of the state of motion of the body of reference.

All of the three abovementioned philosophical attitudes understand the properties of spatial/temporal beings as the objective properties of the really existing universe which we can say represents a classical philosophical understanding of the concept of space. An exception concerning this classical understanding is represented by the Immanuel Kant's transcendental philosophy. In his *Critique of Pure Reason* Kant understands the properties of spatial/temporal beings as the subjective three-dimensional quantitative/qualitative images resulting from the apperceptive faculty of human mind that enables synthesis of sensible data. This attitude semantically reflects the meaning of his understanding of space as a three-dimensional absolute objective reality, of which we become aware under the directivity of apperceptive synthetical faculty of our mind.[9]

The main idea is the abstract ontological understanding of all really existing beings as *phaenomena/noumena*. In another words, being as phenomenon is our three-dimensional spatial reconstruction of the *noumena*. *Noumena* (*Ding an Sich*) are intelligible and transcendent cause of this spatial phenomenal image. The only exception concerning this metaphysical transcendent cause (under the Cartesian definition of human being, according to which the principal essence of human being corresponds with human mind) is human being. Namely, it is not possible to presuppose intelligible metaphysical transcendent *noumena*, which could cause a human mind as "phenomenon", without implying strict epistemological scepticism. But despite of this logical weakening of strict epistemological scepticisms, in terms of the contemporary philosophy of science, we can say that Kant's "scientific antirealism of some degree" has provoked criticism until today. Logically, metaphysically and/or ontologically we can suppose that existing beings are phenomenal beings that are conditioned by a transcendent noumenal "thing in itself". On an equal level we can suppose that existing beings are phenomenal beings that are conditioned e.g. by Leibnizian intelligible, "simple" and indivisible "monads", as

the substance of existing beings. It is a logical condition that a phenomenon must be a phenomenon of something, but it is only a matter of theoretical (metaphysical) choice to define this something as a transcendent noumenal "thing in itself". Namely, there is no logical equivalence between sentences:

(A) Phenomenon must be phenomenon of something different than phenomenon is.

(B) Phenomenon exists only if it is something different from what causes it.[10]

or of the earth. But it must be towards the center of the universe that they move, seeing that light bodies like fire, whose motion is contrary to that of the heavy, move to the extremity of the region, which surrounds the center. It so happens that the earth and the universe have the same center, for the heavy bodies do move also towards the center of the earth, yet only incidentally, because it has its center at the center of the universe." – Aristotle, *De caelo* II, 14, 296 b; Loeb Classical Library, Cambridge/Massachusetts 1986, p. 243.

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"Thus some say that place has two aspects, namely, that which is material in place, viz., the surface of the containing body; secondly, that which is formal in place, viz., its order with regard to the universe (*ordo ad universum*). This order in relation to the universe, however, is always immobile. For place, with regard to its formal aspect, cannot be moved either for itself or *per accidens*…" – William Occam, *Summulae in libros physicorum*, see in: F. Copleston, *Medieval Philosophy*, p. 71.

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"But how do I know that there is not something different altogether from the objects I have now enumerated, of which it is impossible to entertain the slightest doubt? Is there not a God, or some being, by whatever name I may designate him, who causes these thoughts to arise in my mind? But why suppose such a being, for it may be I myself am capable of producing them? Am I, then, at least not something? But I before denied that I possessed senses or a body; I hesitate, however, for what follows from that? Am I so dependent on the body and the senses that without these I cannot exist? But I had the persuasion that there was absolutely nothing in the world, that there was no sky and no earth, neither minds nor bodies; was I not, therefore, at the same time, persuaded that I did not exist? Far from it; I assuredly existed, since I was persuaded." – Rene Descartes, *Meditationes* II 3; see trans. by John Veitch, ed. By D. B. Manley and C. S. Taylor: *A Trilingual HTML Edition* 2005.

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"Absolute space in its own nature, without relation to anything external, remains always similar and immovable. Relative space is some movable dimension or measure of the absolute spaces; which our senses determine by its position to bodies; and which is commonly taken for immovable space; such is the dimension of a subterraneous, an aerial or celestial space; determined by its position in respect to the earth. Absolute and relative space is the same in figure and magnitude; but they do not remain always numerically the same. For if the earth, for instance, moves, a space of our air, which relatively and in respect of the earth remains always the same, will at one time be one part of the absolute space into which the air passes; at another time it will be another part of the same, and so, absolutely understood, it will be continually changed." – Isaac Newton, *Mathematical Principles of Natural Philosophy*, see Britannica Great Books *Newton – Huygens*, ed. by William Benton, *Encyclopaedia Britannica*, Chicago – London – Toronto 1952, p. 8.

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„Alle Versuche, jene reine Verstandesbegriffe von der Erfahrung abzuleiten, und ihnen einen bloß empirischen Ursprung zuzuschreiben, sind also ganz eitel und vergeblich. Ich will davon nichts erwähnen, daß z. E. der Begriff einer Ursache den Zug von Notwendigkeit bei sich führt, welche gar keine Erfahrung geben kann, die uns zwar lehrt: daß auf eine Erscheinung gewöhnlicher Maßen etwas andres folge, aber nicht, daß es notwendig darauf folgen müsse, noch daß a priori, und ganz allgemein daraus als einer Bedingung auf die Folge könne geschlossen werden." – Immanuel Kant, *Kritik der reinen Vernunft,* Suhrkamp Taschenbuch Verlag, Frankfurt am Main 1968, p. 171.

"Die Synthesis der Räume und Zeiten, als der wesentlichen Form aller Anschauung, ist das, was zugleich die Apprehension der Erscheinung, mithin jede äußere Erfahrung, folglich auch alle Erkenntnis der Gegenstände derselben, möglich macht, und was die Mathematik im reinen Gebrauch von jener beweiset, das gilt auch notwendig von dieser." – I. Kant, *Kritik der reinen Vernunft*, p. 207.

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For details, see Mirko Jakić, "Critique of Immanuel Kant's Criticism", *Disputatio Philosophica* (1/2004).

Kant established "thing in itself" as *noumena*. He did not declare that "thing in itself" was a simple substantial subject with powers of representation. He declared that "thing in itself" was over-sensible transcendent object, which is in fundament of any subjective sensible phenomenal reality. He did not deny to "thing in itself" anything like external relation. He warranted external relation to "thing in itself" by its establishment as the fundament of any image and its external composition or combination.

For the case of determination of qualitative properties of beings that are postulated purely metaphysically, a good example is Leibniz's "Monadology". In a high degree, "Monadology" deals with a theoretical determination of qualitative properties of beings (monads) that are postulated purely metaphysically.

Difference in logical steps of Kant's and Leibniz's procedure of establishment of their mutually different philosophical theories is of uncompromising importance. Exception is in the logical step of conclusion to over-sensibility. Kant's step is a metaphysical step, on the equal level as Leibniz's step is metaphysical too.

On the other hand, it is not difficult to refute possible objections on Kant's ontology of spatial/temporal beings from the point of view of natural scientific established existing beings, e.g. photons. It is for certain that it is not possible to have an image of photons, but a conclusion about the existence of photons is achieved from sensible macro effects to micro causes. So, photons are in the domain of the condition of sensibility. Similar situation was in Kant's time, when in physical paradigm Newton's corpuscular and Huygens's undulatory theory of the nature of light was present.

Now we are ready to answer previously raised question about the minimum of the semantically meaningful "constants", common to different philosophical understandings of space, which enable the concept of classical philosophical understanding of space. We can find the following: Space is an absolute three-dimensional reality, absolutely independent of time. So, we can put another question: "What is left of this, possible naïve, understanding of space?"

2. Einstein's attitude

Michelson's experiment from 1881 convincingly shows that there is no different velocity of light which could be dependent of the movement of Earth through space, or to presupposed ether. Namely, Cartesian concept of ether as a presupposed bearer of light, and its Lorentz's interpretation as somehow physical realization of absolute space, served as the system of reference under the absolute motionlessness. What followed was the Lorentz's thesis of contraction of distances in direction of movement – distances depend on the velocity of movement of the spatial/temporal entity. According to Stilwell's experiment from 1938, and later experiments, spectral lines of positive ions have the shift to the red part of the spectrum of light. This result is independent of the movement of Earth through space, or to presupposed ether, too. If experiments show that light have a greater length of wave, and proportionally smaller frequency, we have to conclude that events in the source of light are slow down. This physical "phenomenon" means dilatation of time. Furthermore, experiments show that the path of light is distorted in a gravitational field. Such experimental results together with the accompanied theoretical problems enable Einstein's theory of relativity. The main idea concerning space and time is the well known principle of relativity: Every transformation corresponds to the transition of one Gauss coordinate system into another.[11]

Space/time is invariant, but time is different for different observers, and space is different to different observers too. According to standard two-dimensional representation of the Minkowski's four-dimensional referent system, *y* and *z* spatial coordinates by Lorentz's transformations remains invariant. Invariability of a space/time event enables preservation of the physical core of that event.

Geometrical propositions and geometrical models have no truth validity that is separate from the really existing spatial/temporal entity. Properties of space and time depend of mass-energy quantities of material bodies in a really existing universe.[12]

There is no need for the presupposition of the really existing absolute motionless ether, because all materiality is in relative mutually motion. The concept of ether can serve only as a presupposed instrumental absolute motionless system of coordinates. Lorenz's transformation shows that it is possible to calculate spatial coordinates and time of any point that belongs to the system S_n as measurement shows in the system S, if analogous data are known in the system S_m. Namely, it is possible to express time as the fourth ordinate in the coordinative system in the sense of Minkowski's four dimensional space/time continuum.[13]

So, it is for certain that after Einstein's formulation of the general theory and the special theory of relativity, almost nothing is left of the classical philosophical understanding of space as the absolute three-dimensionality absolutely independent of time. The concept of absoluteness is shaken in the sense of absolute invariability of spatial dimensions, and in the sense of the existence of absolutely motionless system. It is shown that properties of space and time depend of the mass-energy quantity of any system of universe, and it is possible to locate any physically phenomenon by the help of four-dimensional coordinative system. But the three-dimensionality of space still remains, and time, as the fourth "dimension" is only a matter of mathemati-

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"According to the special theory of relativity, the equations which express the general laws of nature pass over into equations of the same form when, by making use of the Lorentz transformation, we replace the space-time variables *x, y, z, t* of a (Galilean) reference-body K by the space-time variables *x', y', z', t'*, of a new reference-body K'. According to the general theory of relativity, on the other hand, by application of arbitrary substitutions of the Gauss variables x_1, x_2, x_3, x_4, the equations must pass over into equations of the same form; for every transformation (not only the Lorenz transformation) corresponds to the transition of one Gauss co-ordinate system into another." – Albert Einstein, *Relativity*, Pi Press, New York 2005, p. 124.

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"If we are to have in the universe an average density of matter which differs from zero, however small may be that difference, then the universe cannot be quasi-Euclidean. On the contrary, the results of calculation indicate that if matter be distributed uniformly, the universe would necessarily be spherical (or elliptical). Since in reality the detailed distribution of matter is not uniform, the real universe will deviate in individual parts from spherical, i. e. the universe will be quasi-spherical." – A. Einstein, *Relativity*, p. 144.

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"It is to be found rather in the fact of his (Minkowski) recognition that the four-dimensional space-time continuum of the theory of relativity, in its most essential formal properties, shows a pronounced relationship to the three-dimensional continuum of Euclidean geometrical space. In order to give due prominence to this relationship, however, we must replace the usual time co-ordinate *t* by an imaginary magnitude $\sqrt{-1} \cdot ct$ proportional to it. Under these conditions, the natural laws satisfying the demands of the (special) theory of relativity assume mathematical forms, in which the time co-ordinate plays exactly the same role as the three space co-ordinates. Formally, these four co-ordinates correspond exactly to the three space co-ordinates in Euclidean geometry." – Ibid., pp. 74–75.

cal imaginary addition of the fourth ordinate to the spatial three-dimensional coordinate system.

It is for certain too that nothing is left of the Kant's understanding of space and time as *a priori* (i.e. independent of any kind of sensible data), absolute, mutually independent apperceptive synthetical faculties of our mind. Properties of space and time depend of the properties of objectively existing universe. Perceptive abilities of our senses, abilities of our mind, and our logical/mathematical abilities are only our epistemological "suppositions" for the knowledge about the objectively existing universe. Logical theoretical articulation of experiments deductively leads to knowledge. In the words of prevailed standpoints of the contemporary philosophy of science, deductive logic is the reliable epistemological tool (in Aristotelian sense of *όργανον*) because logic has no ontology.[14]

In narrow sense, we have to articulate theories in accordance to experimental results, and logic serves for deductive theoretical consequences. Now, we can ask the following question: "Is it so that sources of logical rules are completely independent of ontological properties of space?"

3. Logic and space

For illustration that logic serves for deductive theoretical consequences I will use the quotation from Hawking-Penrose debate from 1994 according that logical consistency of physical theory was restored when it was discovered that black holes are sending out radiation that was exactly thermal.[15]

It is for certain that Hawking's appeal on consistency means non-violation of the logical contradictory rule. So, logical rules serve as the reliable tool of articulation of theories. Understanding of the logical rules that serves as reliable epistemological tool for articulation of theories remains invariant through the whole history of science, apart of the different standpoints of the theories of philosophy of logic concerning possible ontological sources of the logical rules. But ontological/logical argumentations of various standpoints concerning possible source of the logical rules have an impact on evaluation of plausibility of the Kantian part of the classical philosophical understanding of space. Namely, if logic has no ontology it is no possibility to infer logical rules from the properties or from the mutual relations of spatial/temporal objectively existing beings. Ontology embraces physical entities and abstract geometrical entities. Logical rules serves only as the reliable tool of theoretical inferences. So, nothing contradicts a possibility of Kantian interpretation that logic is *a priori* apprehensive ability of our mind. In Kantian variant of the contemporary philosophy of language that means those logical rules are inborn ideas of our mind. On the other hand, it is possible to infer counterexamples by the definitions of logical operators that are unavoidable parts of symbolic expressions of the logical rules. For example, logical rule of identity contains logical operator of implication. Logical operator of implication is defined by its truth table. Truth table of logical implication is articulated under the properties of identity. Identity is ontological problem from the Aristotle's times. So, it is possible to argue that we infer identity from properties of spatial/temporal objectively existing beings.[16]

This problem of ontological/epistemological status of logic remains as an open scientific and philosophical problem. As Einstein shows on the example of geometrical ideas, we are lean to correspondence:

"It is not difficult to understand why, in spite of this, we feel constrained to call the propositions of geometry 'true'. Geometrical ideas correspond to more or less exact objects in nature, and these last are undoubtedly the exclusive cause of the genesis of those ideas. Geometry ought to refrain from such a course, in order to give to its structure the largest possible logical unity."[17]

4. Conclusion

After the Einstein's theory of relativity, classical philosophical understanding of space, as absolute and independent of time, becomes untenable. Space as three-dimensionality still remains, but we are talking of space/time "four-dimensional" continuity in the sense of coordinative system that enables space/time identification of physical phenomenon in a really existing universe. Mutual ontological relation between logic and space, in the sense of possible source of logical rules, remains as the open scientific and philosophical question.

Literature:

1. Aristotle: *Categories* 5a; translated by E. M. Edghill, The Classical Library, HTML Edition.
2. Aristotle: *Physics* 208b; translated by P. H. Wicksteed and F. M. Cornford, Loeb Classical. Library, Harvard University Press, Cambridge/Massachusetts 1929.

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"The idea that 'ontology' (i.e. the domain of the bound variables) in a mathematically true statement is a domain of sets or numbers or functions or other 'mathematical objects', and, moreover, that *this* is what distinguishes mathematics from other sciences is a widespread one. On this view, mathematics is distinguished from marine biology by the difference in the objects studied. This idea lives on in a constant tension with the other idea, familiar since Frege and Russell, that there is no sharp separation to be made between *logic* and mathematics. Yet logic, as such, has no 'ontology'! It is precisely the chief characteristics of the principles and inference rules of logic that *any* domain of objects may be selected, and that any expressions may be instantiated for the predicate letters and sentential letters that they contain." – Hillary Putnam, *Mathematics, Matter and Method*, Cambridge University Press, Cambridge 1975, pp. 1-2.

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"If black holes have entropy proportional to horizon area, they should also have a nonzero temperature proportional to surface gravity. Consider a black hole that is in contact with thermal radiation at a temperature lower than the black hole temperature. The black hole will absorb some of the radiation but won't be able to send anything out, because according to classical theory nothing can get out of a black hole. One thus has heat flow from the low-temperature thermal radiation to the higher-temperature black hole. This would violate the generalized second law because the loss of entropy from the thermal radiation would be greater than the increase in black hole entropy. However, as we shall see in my next lecture, *consistency* was restored when it was discovered that black holes are sending out radiation that was exactly thermal. This is too beautiful a result to be a coincidence or just an approximation. So it seems that black holes really do have intrinsic gravitational entropy. As I shall show, this is related to the nontrivial topology of a black hole. The intrinsic entropy means that gravity introduces an extra level of unpredictability over and above the uncertainty usually associated with quantum theory. So Einstein was wrong when he said, 'God does not play dice'. Consideration of black holes suggests, not only that God does play dice, but that he sometimes confuses us by throwing them where they can't be seen." – Stephen Hawking and Roger Penrose, *The Nature of Space and Time*, Princeton University Press, Princeton and Oxford 1995, pp. 25-26.

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For details, see Mirko Jakić, "Has Logic any Ontology?", *Synthesis Philosophica* 33 (1/2002).

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A. Einstein, *Relativity*, p. 7.

3. Copleston, Frederic: *Medieval Philosophy*, Continuum, London – New York 2003.
4. Descartes, Rene: *Meditationes*, translated by John Veitch, ed. by D. B. Manley and C. S. Taylor, *A Trilingual HTML Edition* 2005.
5. Einstein, Albert: *Relativity*, Pi Press, New York 2005.
6. Hawking Stephen, and Penrose Roger: *The Nature of Space and Time*, Princeton University Press, Princeton and Oxford 1995.
7. Kant, Immanuel: *Kritik der reinen Vernunft*, Suhrkamp Taschenbuch Verlag, Frankfurt am Main 1968.
8. Newton, Isaac: *Mathematical Principles of Natural Philosophy*, Britannica Great Books. *Newton – Huygens*, ed. by William Benton, *Encyclopaedia Britannica*, Chicago – London – Toronto 1952.
9. Plato: *Timaeus,* translated by B. Jowett, Elpenor, Παιδεία, 2004.
10. Putnam, Hillary: *Mathematics, Matter and Method*, Cambridge University Press, Cambridge 1975.

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Was bleibt von der traditionellen philosophischen Auffassung des Raumes übrig?

Zusammenfassung

Der Artikel befasst sich mit dem Vergleich zwischen der traditionellen philosophischen Raumauffassung und der zeitgenössischen Raumauffassung unter dem Einfluss von Einsteins Relativitätstheorie. Als eine erste Abwandlung der traditionellen philosophischen Raumauffassung wird die Vorstellung vom Raum als einer Eigenschaft existierender Wesen festgestellt, sei es als einer den materiellen Körpern zugeordneten eigenen Koordinate oder als einer alle materiellen Körper umfassenden Überordnung. Die Tradition geht von der altgriechischen Philosophie (z.B. Leukipp, Demokrit) aus und reicht bis zu Descartes' und Newtons Auffassung des absoluten Raumes. Als eine weitere Variante der traditionellen Raumvorstellung wird die Auffassung vom Raum als einer aprioristischen Intuition des Geistes angegeben, welche die Wahrnehmung der in einem absoluten Raum existierenden Wesen ermöglicht. Die Tradition reicht von Kants Philosophie bis hin zu den zeitgenössischen Theorien von den angeborenen aprioristischen geistigen Fähigkeiten. Die Unhaltbarkeit dieser Varianten, die den Begriff des absoluten Raumes enthalten, wurde sowohl aufgrund von Belegen zugunsten der Einstein'schen Relativitätstheorie erklärt als auch mit Hilfe der neueuklidischen Geometrien. An Beispielen aus Stephen Hawkings und Roger Penroses Abhandlungen über die Natur von Raum und Zeit wird gezeigt, dass die zeitgenössische physikalische Raumauffassung im Rahmen der philosophischen dreidimensionalen Raumauffassung erhalten bleibt. Am Beispiel der ontologischen Grundlage für die Regeln der deduktiven Logik (Identitätsprinzip) wird das Aktualitätsmaß der aprioristischen Variante der philosophischen Raumauffassung erörtert.

Schlüsselwörter

Traditionelle philosophische Raumauffassung, zeitgenössische Raumauffassung, Einsteins Relativitätstheorie, nicht-euklidische Geometrie, deduktive Logik

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Qu'est-ce qui reste de l'entendement philosophique traditionnel de l'espace?

Sommaire

Cet article compare l'entendement philosophique traditionnel de l'espace avec l'entendement physique contemporain de l'espace qui est influencé par la théorie de la relativité d'Einstein. La première variante de l'entendement philosophique traditionnel de l'espace est l'entendement de l'espace considéré comme une propriété des êtres existants soit en tant que coordonnées associées aux corps matériels, soit en tant que supériorité universelle qui comporte tous les corps matériels. La tradition mène de la philosophie de la Grèce ancienne (par exemple Leucippe, Démocrite) à l'entendement de l'espace absolu de Descartes et Newton. Une deuxième variante de l'entendement traditionnel de l'espace est l'entendement de l'espace considéré comme une intuition a priori de la raison ce qui permet de percevoir les êtres existant dans l'espace universel absolu. La tradition mène de la philosophie de Kant aux théories contemporaines sur l'inhérence a priori des facultés de la raison. La fragilité de ces variantes qui impliquent le concept de l'espace absolu est démontrée grâce aux preuves qui ont confirmé la théorie de la relativité d'Einstein et grâce aux géométries non-euclidiennes. Les exemples tirés de la discussion de Stephen Hawking avec Roger Penrose sur la nature de l'espace et du temps ont servi pour démontré que l'entendement physique contemporain reste dans les cadres de l'entendement philosophique de l'espace à trois dimensions. L'exemple des fondements ontologiques des règles de la logique déductive (le principe d'identité) est utilisé pour présenter quelle est la mesure de l'actualité de la variante a priori de la conception philosophique de l'espace.

Mots clés

Entendement philosophique traditionnel de l'espace, entendement physique contemporain de l'espace, théorie de la relativité d'Einstein, géométries non-euclidiennes, logique déductive