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The Pessimistic Induction and Space-Time Theories*

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【Abstract】This essay attempts to evaluate the pessimistic induction within the case of the historical development of space-time theories, which are claimed to undergo a radical ontological change providing evidence for the pessimistic induction. In my view, this claim misleads us to see the discontinuity of the structure of classical and relativistic space-time by means of a doubtful interpretation of space-time theories, which holds that space-time causally explains the phenomena of motions.

【Key Words】Pessimistic Induction, No Miracle Argument, Space-Time Theories, The Ontology of Space-Time, Interpretation.

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1. Introduction.

Realists' interpretation of the success of science that the truth of theoretical claims provides the most plausible explanation of its success is severely challenged within the context of the historical study of scientific change. Laudan (1977) claims that it should be acknowledged that even the most successful theories in the past have been discarded as false theories. Therefore, the no miracle argument is undermined by the pessimistic induction from the failure of past successful theories. Since historical cases, especially within current philosophy of science, are regarded as the most important test ground, realists have the burden of explaining away the conflict between the success and apparent falsehood of scientific theories.

This essay attempts to evaluate the pessimistic induction within the case of the historical development of space-time theories, which are claimed to undergo a radical ontological change providing evidence for the pessimistic induction. In my view, the argument misleads us to see the discontinuity of the structure of classical and relativistic space-time by means of a doubtful interpretation of space-time theories, which holds that space-time causally explains the phenomena of motions.

2. The Structure and the Strategy of the Pessimistic Induction.

Laudan (1977) points out that considering the historical development of scientific theories, we can observe that even the most successful theories in the past have been discarded as false theories. His argument purports to criticize one of the crucial arguments for scientific realism, the ‘no miracle argument’, which asserts that a theoretical claim should be true for the success of science not to be a miracle. (Putnam 1975) The strategy of the argument is basically to adopt the success of scientific practice as evidence of the reality of theoretical claims. Hence, Laudan’s counterarguments are to show that although a certain theory has been considered as successful in the past, its theoretical terms are at last proved as not referring to real things. Therefore, the realists’ position seems to be severely weakened by the pessimistic induction, since it attempts to argue that the no miracle argument is not tight enough in that their success, while it may be a necessary condition, cannot be said to be sufficient for scientific theories to be true. Given that Laudan provides evidence from the history of science in rejecting the intuition of the no miracle argument[1)], it is now the realists’ burden to refute evidence exhibiting a conflict between the success and truth of theories within realists’ intuition.

It is necessary to examine and clarify the key strategy of Laudan’s pessimistic induction before we discuss the case of space-time theories. The main point that Laudan attempts to show

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1) As evidence for the pessimistic induction, Laudan provides a set of theories that were “once successful and well confirmed, but which contained central terms which (we now believe) were non-referring.” (Laudan 1981, p. 33) The evidence against the no miracle argument involves the crystalline sphere of ancient and medieval astronomy, the phlogiston theory of chemistry, the caloric theory of heat, the vibratory theory of heat, the theory of circular inertia, and the electromagnetic and optical ether theories.

in the example of history of science is that two important aspects in the no miracle argument, which are (1) the success and (2) the truth of theories, do not necessarily go together. Laudan is arguing that his examples from scientific change, which exhibit cases against the no miracle argument, can be formulated as the conjunction of (1) and ¬ (2).[2] Hence, first of all, realists can respond to the threat of Laudan's examples by examining whether or not (1) and ¬ (2) are undisputedly satisfied in his cases. They can rely on either one or both to deal with the pessimistic induction. First of all, the individual requirement of the pessimistic induction, that is either (1) or ¬ (2), can be considered to evaluate whether or not each example can be legitimately characterized as the conjunction of (1) and ¬ (2). By checking whether each example can be said to satisfy (1) (i.e. is it really a successful theory?), as Psillos has done, we can eliminate certain cases unnecessary to consider. (Psillos 1994) But to check individual elements that consist of the pessimistic induction is not an effective way to attack Laudan's argument, because the success of certain theories can be vague since they consist of both successful and unsuccessful elements. Then, what is important to see the validity of Laudan's argument is to check whether or not the specific example's successful components really turn out to be false. Furthermore, the element of truth is

[2] In Laudan's own words, "Because [most past successful theories] have been based on what we now believe to be fundamentally mistaken theoretical models and structures, the realists cannot possibly hope to explain the empirical success such theories enjoyed in terms of the truth-likeness of their constituent theoretical claims." (Laudan 1984, pp. 91-92)

also unclear in Laudan's argument, since one theory can be composed of both true and untrue elements. Hence, what we need to consider carefully is whether successful elements are proven to be false elements, rather than whether overall successful theories are proven to be false theories.

With this clarification, we can now inquire into the question whether each of Laudan's cases still works as he intends it to. The cases that fail to satisfy the requirement of the elements of (1) and ¬ (2), can be categorized as follows. First, certain theories, such as the case from the pre-Scientific Revolution era (the crystalline sphere of medieval astronomy), can be easily eliminated from legitimate evidence since they cannot be qualified as successful theories. In the same spirit, we can see that the pessimistic induction, in some cases, makes an illegitimate trick of using unsuccessful elements within a successful theory, and then claims that it has been proven to be false. And another possibility misleading the debates is to highlight only false aspects of theories, which is necessary for the argument to work, and to neglect other true elements of theories.

Then, the task for realists is to pick out the significant aspects that make the theories successful due to its truth.[3] This filtering can be achieved by the interpretation of theories, which specifies

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[3] A set of similar strategies entitled the "*divide et impera*" strategy have been suggested in order to undermine Laudan's argument by Kitcher (1993), Hardin and Rosenberg (1982) and Psillos (1999). According to this line of thought, one can learn a different lesson from Laudan's lists, which does not necessitate Laudan's conclusion. What we can learn from the pessimistic meta-induction, according to Psillos, is that realists need the 'right kind' of the explanatory connection between success and truth of theories.

essential aspects of the theories. Interpretation can decide which theoretical structure takes the ontological priority within given theories. (Belot 1995) By taking into account this new means of understanding the reality of theories, we can develop a more detailed way of looking at how theoretical components within space-time theories encounter the reality of the world. This puts us in a better position to examine whether or not the pessimistic induction is employing the theoretical elements that can be interpreted as essential to space-time theories.

3. The Pessimistic Induction in Space-Time Theories

Given that *the difference between the structure* of classical and relativistic space-time seems to be manifest, the pessimistic induction can employ *the difference between their ontological statuses* to make their argument for the discontinuity of theories work. The argument focuses on its difference by pointing out that while space and time in classical mechanics are separate entities (that are represented by 3-dimensional Euclidean manifolds, which correspond to simultaneous spaces, and an 1-dimensional manifold representing time), in relativity space and time are treated simply as the spatial and the temporal aspects of a single theoretical entity *space-time* (that is represented by a 4-dimensional manifold). Minkowski's statement that “space by itself, and time by itself, are doomed to fade away into mere shadows, and *only a kind of union of the two will preserve an independent reality*” (Minkowski 1908, p. 75) can be read as providing an *ontological* *significance* to a single four dimensional manifold, which is clearly distinct from its classical counterpart. Given this historical case that shows the radical change of ontology, the pessimistic induction seems to provide a convincing case refuting the reality of space-time structure.

However, it can be argued that space-time structure represented by a single four dimensional manifold is *not* the only characterization in the relativistic case. Stein and Norton point out that both classical and relativistic space-time can be defined within the framework of four dimensional space-time.[4] (Stein 1991, Norton 2000) What is novel about relativistic space-time is not that its event can be placed in a container of four dimensional space-time, but *how space-time can be decomposed into temporally spontaneous spaces*. While in classical theory the way that space-time is decomposed into simultaneous spaces is unique, in relativity simultaneous events that consist of simultaneous spaces are different with respect to the speed of inertially moving observers. Although there is a difference in the slicing of spatial and temporal structure of space-time between classical and relativistic theory, it does not necessarily mean that this difference results in a difference in the ontological status of space-time. Given that space-time in both cases is posited as a

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[4] In other words, by emphasizing inertial structures that are essentially four-dimensional concepts, we can see the commonality in the dimensionality between Newtonian space-time and Minkowski space-time. An inertial structure is a four-dimensional affine space-time. Only four-dimensional space-time has enough structure to capture the inertial structure of Newtonian dynamics, i.e. symmetries.

single four dimensional manifold, and classical space-time is considered as a special case of the relativistic one, it seems that the continuity between the two space-times override their discontinuity. In the same spirit, Bell states, “I would emphasize the continuity with earlier ideas. Usually it is the discontinuity which is stressed, the radical break with more primitive notions of space and time. Often the result is to destroy completely the confidence of the student in perfectly sound and useful concepts already acquired.” (Bell 1987, p. 67) It can be said, then, that the filter extracting ontological bases, on which the pessimistic induction depends, provides an unfair portrayal that shows how space-time theories make themselves successful. Therefore, based on this interpretation of space-time, we cannot say that the pessimistic induction presents convincing evidence demonstrating the tension between success and truth.

Although one may admit the commonality of the dimension of space-time structure, a more crucial aspect of structural discontinuity between classical and relativistic theories can be evidenced in their ontological discontinuity. The theory change in the relation between space-time and the dynamics of material bodies can be employed as supporting the pessimistic induction. The structure of space-time in classical theories can be characterized as absolute in the sense that its spatial and temporal structures can be decided *independent of the dynamics of material bodies*. In general relativity, the absoluteness of space-time is significantly eliminated except for topology and continuity structure. The structure of space-time in general relativity is represented as a four dimensional differential manifold M, which is equipped with a semi-Riemannian metric tensor $g_{\mu\nu}$ of signature (1, 3). And the distribution of material things is encoded in its stress energy tensor $T_{\mu\nu}$. Then the dynamics can be specified by Einstein field equations (EFE) $G_{\mu\nu} = R_{\mu\nu} - 1/2g_{\mu\nu}R = 8G\pi/c^4T_{\mu\nu}$, which associates the curvature of space-time, the function of $g_{\mu\nu}$ and its first derivatives, with $T_{\mu\nu}$. What is notable in this equation is that the metric tensor $g_{\mu\nu}$ occurs not only in the left hand side of EFE which decides the spatio-temporal structure, but also in the right hand side of EFE which encodes matter distribution. And this correlation between the two metric tensors in EFE shows the way that space-time directs the motion of material bodies, and the mass-energy distribution can in turn influence spatio-temporal structure. In this way the geometric structure of the metric, which encodes spatial and temporal aspects of space-time, is now determined *in terms of dynamics that is specified by Einstein field equations*. Einstein in *the Meaning of Relativity* maintained, "*absolutum* means not only 'physically real,' but also 'independent in its physical properties, having a physical effect, but not itself influenced by physical condition.'" (Einstein 1922, pp. 55-56) This objectionable absoluteness is one of the motives to develop general relativistic space-time in that "it is contrary to the mode of thinking in science to conceive a thing (the space-time continuum) which acts itself, but which cannot be acted upon." In this way, considering the extreme change of the role of space-time within dynamical theories, it can be argued that the ontological status of space-time is radically altered through theoretical development. It seems, then, that the pessimistic induction secures its key witness for the case of space-time theories.

However, it seems that the validity of this witness can be questioned by considering alternative interpretive filters. Although we agree that the role of a specific theoretical structure within one theory is different from the one within its succeeding theory, it does not necessarily follow that its ontological status is also different. For the functional relation between spatio-temporal structure and matter distribution does not automatically provide an answer to the question of what the ontological status of space-time is. The problem of the argument comes from the fact that *we read off the ontology of space-time directly from the mathematical formalism of general relativity*. We should keep in mind that a different mathematical structure can be adopted to represent the same ontology, while the same mathematical structure can be used to represent distinct ontological features.[5)] At this point, we need the *interpretation* of theoretical structures to understand their ontological status. Given that an interpretive work provides a putative picture that shows which aspects of the world mathematical frameworks capture, reading off ontology *without its interpretation* can be said to presuppose its ontological

5) We need to consider our case by differentiating these three elements within a given theory: (1) mathematical and formal structures constituted by meaningless symbols, (2) theoretical models whose mathematical structure acquires its physical meaning within a theoretical framework, (3) ontological schemes that elucidate the mode of existence of the elements which constitute the model.

commitment. In this context, we can still question the argument of the ontological discontinuity between classical and relativistic space-time by examining major attempts to interpret the structure of space-time in general relativity.

The conclusion that the ontological difference between classical and relative space-time originates from the three theoretical considerations can be summarized as follows: (1) space-time can be *identified* with the gravitational field since we can see the direct influence of the latter to the former in physical equation. “Newton’s background spacetime was *nothing but* the gravitational field! The stage is promoted to one of the actors. ⋯ any measurement of length, area or volume is, in reality, a measurement of features of the gravitational field.” (Rovelli 2001, p. 107) (2) The gravitational field has the same theoretical role as the electromagnetic field has; “the gravitational field is represented by a field on spacetime, $g_{\mu\nu}$, just like the electromagnetic field A_μ. They are both *concrete entities*: a strong electromagnetic wave can hit you and knock you down; and so can a strong gravitational wave.” (ibid.) (3) Space-time is relational in that general relativity “describes the world as a set of interacting fields including $g_{\mu\nu}$, and possibly other objects, and motion can be defined only by positions and displacements of these dynamical objects relative to each other.” (ibid.)

The first claim is less problematic than the others since it is supported by ‘the equivalence principle,’ which states that gravitational force is identified with the transformation of space-time coordinates that represent spatio-temporal structure. But claiming that the transformations of space-time coordinates can be identified with gravitational field by no means provide a definite clue of the ontological status of space-time, because the gravitational field is generally admitted as unique comparing with other physical fields.[6] Hence, we need an additional argument that clarifies the ontological status of the gravitational field. In this context, the second claim plays its role.

When it comes to the second claim, its problem becomes obvious since it is based on the reading off ontology *without its interpretation*. The reason for the is based on the fact that the electromagnetic field and the gravitational field are represented by the identical mathematical expression. However, although admitting that the metric field $g_{\mu\nu}$ is represented by the identical mathematical structure as the electromagnetic field A_μ, we need not conclude that they have the same ontological status. Firstly, if the argument is based on the fact that the metric field has causal

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6) This claim stems from the interpretation of the principle of equivalence. This is well reflected within Einstein's thought experiment concerning a freely falling person in an elevator, who cannot decide whether she is uniformly accelerating downward, or she is experiencing a gravitational field. The equivalence principle states that acceleration in Minkowski space-time is equivalent to experiencing the gravitational field, such that "in a sufficiently small area, inertia and gravitational forces cancel to any accuracy in a freefalling reference frame." (Rovelli 2004, p. 60) At this point, Rovelli provides two alternative interpretations of the principle: "1. as the discovery that the gravitational field is nothing but a local distortion of space-time geometry; or 2. as the discovery that *spacetime geometry is nothing but a manifestation of a particular physical field*, the gravitational field." (Rovelli 1997, p. 194, my italics) Rovelli prefers the latter interpretation. So it seems that he considers the principle as implying that space-time structure can be reduced to the property of gravitational interaction.

effects in that a gravitational wave can knock you down, it can be a bad analogy since even Newtonian absolute space-time may be also interpreted as having casual effects, because it can accelerate material objects. (Belot 1995) Secondly, if we think that the conclusion follows from the commonality of mathematical structures that represent both the metric and the mater, it is a typical case of reading off ontology *without its interpretation*. The metric is labelled as the 'field,' since it is represented by second rank tensors as is genuinely material field $T_{\mu\nu}$. But we should not forget that the same mathematical structure can be applied to totally different situations which play distinct roles in theories. Hoefer also claims that we cannot consider the metric and the electromagnetic field as having the same ontological status only because they are represented as the same mathematical structure, that is, a tensor field. Instead, he draws our attention to different theoretical roles of both theoretical entities within their background theories. (Hoefer 1998, p. 459) While the classical field exists *in* space and time, the metric is itself space-time. Whereas the electromagnetic field can be removed from space-time, space-time does not exist if the metric field is eliminated. Einstein in his 1920 Leiden lecture makes this point: "if we consider the gravitational field and the electromagnetic field from the standpoint of the ether hypothesis, we find a remarkable difference between the two. There can be no space not any part of space without gravitational potential [the $g_{\mu\nu}$]; For these confer upon space its matrical qualities, without which it cannot be imagined at all. The existence of the gravitational field is inseparably bound up with the existence of space. On the other hand a part of space may very well be imagined without an electromagnetic field ⋯ (Einstein 1923, pp. 21-23)" We cannot then claim the ontological commonality between the metric and the electromagnetic field solely on the basis of the fact that both theoretical entities use the same mathematical machinery. Hence, if one wants to prove the ontological difference between classical and relativistic space-time, the claim (2) is not enough and more arguments are necessary.

In the interpretations of EFE, we can distinguish different approaches depending on which parts in EFE are treated as ontologically prior. Interpretations elucidate the *structure of certain classes of models* satisfying a given mathematical structure of space-time. Hence different interpretations select different structures that capture the reality represented by mathematics. First of all, dynamical interpretations have been proposed by admitting only the existence of material bodies. Typical cases are based on Mach's principle, which attributes the structure of space-time exclusively to the distribution of material objects in the universe. According to this interpretation, space-time does not have its own existence, which can be reduced to the distribution of material bodies. Hence, the left hand side in EFE, the curvature of space-time, has no physical meaning whatsoever and provides only an instrument to calculate intended phenomena, i.e., the trajectories of material bodies. It is well known that Einstein, by pointing out epistemological defects of absolute space-time, attempted to realize Mach's principle in the early stages of developing the general theory of relativity. Then the pessimistic induction seems convincing here since the difference in the ontology between classical and relativistic space-time is manifest enough to argue that there exists a significant discontinuity in the development of space-time theories. For whereas classical space-time is absolute in the sense that it is ontologically independent of material objects, a counterpart in the general theory of relativity is actually an entity reducible to material objects.

However, this so-called star witness appears from nowhere. It is less well known but the truth is Einstein himself, despite having the initial motive to construct general relativity, admitted that Mach's principle is not necessary and even inconsistent with general relativity. (Hoefer 1994) We can find a set of problems of Mach's principle including the fact that there exist non-flat solutions of EFE even when the energy momentum tensor is zero; that is, when there is no matter in the universe.[7] (Earman 1986,

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[7] If Mach's principle were correct, in famous case of 'Newton bucket' the effect of the shape of water surface would be identical whether the bucket or the shell is set rotating: the shape of water surface become concave in both cases. On the other hand, Newton's theory predicts that the rotating shell will have not any effect on the shape of the water surface. When Einstein attempted to determine the metric field of a rotating shell at its center, he calculated a shell which is rotating in Minkowski space-time. Although a tiny deviation from the metric field of Minkowski space-time is generated by the rotation of the shell, it was not enough to change the shape of water surface into concave one. (Janssen 2004) Another problem occurs in a boundary condition. When Einstein calculated the metric field generated by the rotating shell around its center, he employed Minkowski space-time as a boundary condition of the situation. But at this point, he

Sklar 1976, Janssen 2004) Given that there is still no significant success to this day in realizing Mach's principle by modifying its definition, one can doubt the ontological conclusions based on such an interpretation.

But it seems that the dynamical interpretation is not running out of its witness lists. Another dynamical approach is to interpret the ontological status of both sides of EFE as certain microscopic entities or causally interacting entities. This approach is attempted within the tradition of quantum field theories, in which the research project seeks to describe gravitation, i.e. space-time, as an interaction between certain microscopic entities. (Butterfield and Isham 2001) In quantizing gravity, the metric field is treated as a physical field, that is, the quantum field of massless spin-2 gravitons, which exists in a flat background Minkowski space-time. In this approach called linearized gravity, the metric is split into a classical flat background $\eta_{\mu\nu}$ and a perturbation field $h_{\mu\nu}$ that need to be quantized. If this theory is successful, $\eta_{\mu\nu}$ + $h_{\mu\nu}$ is supposed to determine the trajectories of material things by means of interaction with all forms of matter. This interpretation is also modified by positing the concept of a metric which is derived from perturbations of certain fine grained structure such as strings or knots. However, despite success in explaining *phenomenological aspects of gravitation*, it is still admitted that

brought the assumption of absolute space-time back. For the boundary condition states that as the values of the metric field as we go to spatial infinity, space-time becomes flat. In this way, Mach's view is undermined by the fact that rotation is considered with respect to absolute space-time rather than other matter. (Sklar 1974).

these approaches, even string theories, still fall short of understanding the nature of space-time, especially the symmetry of space-time called general covariance. (ibid.) Considering these attempts are based on perturbative approaches, which is a kind of approximation, what we can expect from these theories are only incomplete ontological pictures.[8)] Although these attempts in fact have the future prospect, the ontological interpretations based on incomplete theories, whose ontological foundation might be based on some other theories, can be controversial. Accordingly, since we can only conclude the ontological sameness of space-time and material things up to approximation, we cannot say that this interpretive work is completely settled.

Although one might admit that the above perspective emphasizing dynamical interpretations are not mature enough to provide decisive cases for the pessimistic induction, one could provide another interpretive scheme to argue for the discontinuity between classical and relativistic space-time. Instead of the above somewhat far-fetched interpretive works, we can attempt a more cautious interpretation that deals only with *the general features of dynamics* of space-time theories, *without regard to a detailed underlying mechanism*. Newtonian space-time can be said to be absolute in the sense that it is posited as a non-dynamical object. On the other hand, space-time in the general theory of relativity is relational in that the theory can be formulated only by

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8) Some critiques such as Smolin (2006) and Woit (2006) claim that these attempts are comparable to “epicycle on epicycle.” Given this lack of empirical support, it is not unreasonable to doubt that these super-microscopic theories can be regarded as legitimate empirical science.

relational properties such as positions and displacements of dynamical objects, i.e., a set of interacting fields, which can be defined only relative to each other. In this way, we can see that the two space-time theories adopt significantly distinct conceptual schemes, within which both theories can be interpreted as being based on distinct ontology. We may conclude then that with this interpretation the pessimistic induction seems to have material evidence.

However, we cannot say that the above evidence is conclusive, because the absolute vs. relational dispute is not settled within the context of the general theory of relativity. First of all, we have seen that without a decisive version of Mach's principle that embraces general relativity as a relational theory, whether or not general relativity is a truly relational theory is still controversial. Moreover, the interpretation of space-time in the general theory of relativity is not so favourable to relationism. Hoefer (1998) points out that the metric, which represents space-time in general relativity, should be viewed as analogous to Newtonian absolute space-time. For the metric gives rise to a definite three dimensional geometry on any spacelike hypersurface in manifolds. So, the metric has the same role of Newtonian space-time in that it "determines the spacelike-timelike distinction, determines affine connection or inertial structure of spacetime (i.e. defines which motions are accelerated and which are not), and determines distances between the points along all paths connecting them." (Hoefer 1998, p. 459) In these ways, he claims that the metric can be considered as 'the representor of substantival space-time.'

At this point, relationists might argue that relationism is not concerned with how to characterize space-time or metric, but with *the description of the motions* of material bodies. From this perspective, one can assert that within general relativity *the relationism of motion* can be maintained, since there exists no absolute reference frames. But although there are no absolute reference frames, *inertial trajectories,* which can make an absolute distinction between inertial and non-inertial motion, are still meaningful just as in earlier theories. (Friedman 1983) Accordingly, a privileged subclass of frames, the local inertial frames, can be still claimed within the context of general relativity. Given the existence of such a subclass of privileged frames, the theory does not realize a complete relativity of motion. Since acceleration and rotation have basically the status equivalent to ones in previous theories, the principle of general covariance does not achieve the general principle of relativity. Considering the status of space-time and motion, we can see that general relativity does not accomplish a complete break with Newtonian theory. It can be concluded then that the evidence supporting the pessimistic induction is inconclusive since it is based on questionable interpretations. So, we can see that both dynamical and general interpretation fail to show a complete break between Newtonian mechanics and Einstein's general theory of relativity.

4. The Lesson from the Difficulty in the Pessimistic Induction

What we can learn from my critique against the pessimistic induction of the development of space-time theories is the importance of interpretation of space-time theories in considering scientific realism. Given that what is relevant in our case is the interpretations of space-time theories, which select significant aspects as playing essential role in their explanation, we can see that the pessimistic induction based on space-time theories is based on a rather strong sense of scientific realism. For the argument to hold, one should consider controversial interpretations of space-time theories as real aspect of the theories. I think that this rather problematic interpretation regarding reality in theories is the key element to the success of the pessimistic induction. Laudan's tactic is tricky in that his image of science emerges from placing the microscope at the place where conflict between success and truth is most extreme. In doing so, however, he should be careful to consider whether or not this magnified part can still represent the whole picture. When one attempts to characterize the philosophical aspects of a scientific image such as realism, one should consider the constraint upon the real practice of science before making a priori conceptual analysis.

Hence, realists can respond to the pessimistic induction by claiming that Laudan distorts the real practice of science by exaggerating partial elements not entitled to represent the overall theories. In response to anti-realists' unfair portrayal of realism about theoretical parts, realists can chose a similar, though opposite, strategy in dealing with the pessimistic induction. Realists should instead provide appropriate forms of modified realism that selects essential elements contributing to its empirical success. (Kitcher 1993, Hardin and Rosenberg 1982, Worrall 1989) Just as anti-realists attempt to describe realism in the weakest form, by magnifying the parts of theories exhibiting tension between the truth and success, so realists can highlight theories' components that make its success possible due to the truth of theories, and show that they are actually the central elements of the theories. In doing so, the modified realists should be careful not to make the same mistakes of neglecting the real practice of science.

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ARTICLE ABSTRACTS

비관적 귀납과 시공간 이론

양 경 은

본 논문은 시공간 이론의 역사적 발전 사례를 통한 비관적 귀납 논증을 비판적으로 고찰한다. 시공간이란 이론적 존재자는 역학이론 발전과정에서 급격한 존재론적 변화를 경험했다는 점에서 비관적 귀납 논증에 대한 증거로서 제시된다. 필자는 이러한 주장이 시공간이 운동현상을 인과적으로 설명한다는 시공간이론에 대한 잘못된 해석에서 기인한다고 주장한다. 이러한 해석은 고전역학과 상대론 구조들 사이의 차이점만을 부각하기 때문이다.

주요어: 비관적 귀납, 기적 논증, 시공간 이론, 시공간의 존재론, 해석