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A Study Concerning the Nature of the Relation Between Successive Scientific Theories

FOURTH EDITION

by

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“Free of unnecessary ballast, and written with didactical aptitude, this book gives a complete overview of how the different views of scientific progress have developed since the time of the Vienna Circle. It is a suitable introduction to a complex period in contemporary theory of knowledge. In later chapters the author present his own standpoint, so that the work can also be used as a source of new impulses in this direction. …

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Evandro Agazzi, *University of Genoa*

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ACKNOWLEDGEMENTS

This study has been presented in a number of versions since its central ideas first appeared in a short essay 'Incommensurability and Scientific Progress' in 1975. Since that time it has received the helpful criticism of very many people, and to all of them I here express my thanks. Lennart Nordenfelt has discussed with me in detail versions appearing in 1976 and 1977. Those whose contributions are more recent include Rainer Carls, Paul Feyerabend, Mats Furberg, Lars Hertzberg and Dag Prawitz, each of whom has made valuable suggestions concerning my 1978 paper 'On the Nature of the Relation Between Successive Scientific Theories,' from which the last six chapters of the present work have been developed. More specialised comments have been offered by Staffan Nilsson (Chapter 10), and by Peter Gärdenfors and Włodzimierz Rabinowicz (Chapter 11). And for reading and commenting on the whole of this work just before it went to press, I express my gratitude to Ingvar Johansson and Giovanni Sommaruga.

Very special thanks are due to Prof. Stig Kanger, for his support and guidance during my years as a graduate student at Uppsala, and to Prof. Evandro Agazzi, who has done everything possible to help see this work through to completion.

FRIBOURG
March 1981

C. D.

PREFACE TO THE SECOND EDITION

This edition has been supplemented by two appendices. The first, which has also appeared as an independent essay in *Erkenntnis* **21** (1984), is a deepening of the discussion of theoretical terms which runs through Chapters 4, 10, and 11 of the book. The second is a paper written in response to a number of comments on the book, and focuses on the relation between the Gestalt Model and the Perspectivist conception of science. Its content slightly overlaps that of the main text, but this repetition may itself be of some use in that it involves the presentation of the central ideas of the book in a somewhat different form. This paper was read at the History and Philosophy of Science Conference in Veszprém, Hungary in 1984; and it will also appear separately in a forthcoming volume of the *Boston Studies in the Philosophy of Science* devoted to the proceedings of that conference.

Apart from these appendices, this edition also includes some minor corrections and a number of typographical improvements.

STOCKHOLM
January 1986

C. D.

PREFACE TO THE THIRD EDITION

This edition incorporates four new appendices (III–VI). The first was written shortly after the completion of the first edition of the book, and has appeared in Swedish in *Vår Lösen* **72** (1981). Intended for an audience of nuclear physicists, it includes the application of the Perspectivist conception to the phenomenon of nuclear modelling in physics. Appendix IV is a further development of the discussions in Chapter 10 and Appendices I and III on the nature of laws and theories, and has previously been published in *Zeitschrift für allgemeine Wissenschaftstheorie* **XX** (1989). Appendix V was written in response to a challenge to apply the Perspectivist conception to the Mach-Newton controversy concerning the nature of space, and has appeared in the anthology *Changing Positions*, Uppsala, 1986. And the last appendix, which has just been completed, involves the application of the Perspectivist conception to a central issue in ecological economics concerning the attainment of development in an environmentally sustainable way. An expanded version of Appendix VI will be appearing in *Population and Environment* **15** (1993–1994). Funding for research on this topic was provided by the Swedish Environmental Protection Agency.

As in the previous edition, minor changes and typographical improvements have also been made.

STOCKHOLM
November 1993 C. D.

PREFACE TO THE FOURTH EDITION

It is of course gratifying to see this book come out in another edition more than twenty-five years after its first publication, thereby bringing it to the attention of a potential new readership. On the other hand it is disheartening that since the book's first publication it seems that very few of my academic colleagues have been able to benefit from it, or, for that matter, even to understand it. That this is so is ironic, considering the many remarks my reviewers have made as to the clarity of the book's presentation. What I have come to realise, however, is that this inability stems at least in part from the novelty of the view I am presenting: that in order to understand it professional philosophers of science simply have had to take too great a step outside the logico-linguistic framework in which they have been educated. Confounding this shortcoming, perhaps abetted by the influence of this same framework, is the apparent inability of the majority of my commentators to appreciate the nature of philosophical theorising, such that they have been unable to distinguish it from the provision of a general description or analysis, and realise that what is presented in this book is in fact a theory.

For this edition of the work, apart from removing some repetitive text from Appendices III, V and VI, I have replaced the original Appendix II, and added two other new appendices. The original Appendix II was intended to function as both an alternative presentation of the book's central ideas and a reply to criticism of the first edition, while its replacement is intended only to perform the latter function, and this with direct reference to my critics. A similar reply to criticism of the second and third editions of the book may be found in Appendix III of the second edition of my other major work in the philosophy of science, *The Metaphysics of Science*.

The first of the other new appendices, Appendix VII, takes a look at the nature of the empirical aspect of science in different terms than those of its treatment in Appendices I and IV, and from a more historical point of view. And the second, Appendix VIII, presents a theory that, like the Perspectivist conception of science, is intuitively based on the Gestalt Model, but which concerns rather the topic of identity and reference in the philosophy of language.

This edition of the work has been completely reset; and, apart from the changes mentioned above, there have been many typographical and other minor improvements.

STOCKHOLM
April 2007 C. D.

INTRODUCTION

For the philosopher interested in the idea of objective knowledge of the real world, the nature of science is of special importance, for science, and more particularly physics, is today considered to be paradigmatic in its affording of such knowledge. And no understanding of science is complete until it includes an appreciation of the nature of the relation between successive scientific theories – that is, until it includes a conception of scientific progress.

Now it might be suggested by some that there are a variety of ways in which science progresses, or that there are a number of different notions of scientific progress, not all of which concern the relation between successive scientific theories. For example, it may be thought that science progresses through the application of scientific method to areas where it has not previously been applied, or, through the development of individual theories. However, it is here suggested that the application of the methods of science to new areas does not concern forward progress so much as lateral expansion, and that the provision of a conception of how individual theories develop would lack the generality expected of an account concerning the progress of science itself.

In considering the nature of scientific progress through theory change, a particular feature of the relation between theories presents itself as requiring explanation. This feature is the competition or rivalry that exists between successive theories in their attempts to explain certain aspects of reality. We note then that an adequate account of scientific progress should include a conception of the conflict that arises in the case of successive scientific theories.

In its treatment of the notion of scientific progress, this study begins with a critical analysis of the logical empiricist and Popperian conceptions of the nature of the relation between successive theories, and the basis from which these conceptions are derived. The analysis is structured via the reconstruction of the empiricist and Popperian conceptions in terms of the Deductive Model, which is formally identical to the covering-law model of explanation. This reconstruction is intended to show in detail what the empiricist and Popperian views consist in, and in so doing demonstrate how they are in fact conceptually dependent on the Deductive Model, which thereby determines both their capabilities and their limitations.

The major criticisms based on the reconstruction are of three kinds. The first of these concerns the inability of the Deductive Model, as employed by the empiricists and Popper respectively, to *formulate* conceptions of important aspects of science. The most important of these criticisms are that the empiricist view affords no notion of theory conflict, and that the Popperian view fails to provide a notion of scientific progress. The second type of criticism concerns the problem of *applying* the Deductive Model to actual science. Thus, for example, it is shown that while the empiricists have given us a notion of scientific progress (as involving deductive subsumption), actual scientific advance does not take this form. The third kind of criticism, directed mainly at Popper, suggests that a number of claims considered to be integral to his view are actually quite ad hoc, in that they are not at all suggested by the Deductive Model, on which his conception of science depends.

The study then moves on to consider the important claims of Thomas Kuhn and Paul Feyerabend, that in certain cases, succeeding theories might well be ‘incommensurable’ with their predecessors. These claims, in their negative aspect, are viewed as essentially being criticisms of the second sort mentioned above. That is, they are seen to concern the applicability of the empiricist and Popperian conceptions of the relation between theories, and to suggest the relinquishment of the model underlying these views. And, in their positive aspect, they are taken to suggest that in actual science theories are often related in the same sort of way, as are the different aspects of a gestalt-switch diagram.

Following this lead, a model which is fundamentally different from that of the empiricists and Popperians is introduced. This model – the Gestalt Model – is intended to provide a positive intuitive understanding of incommensurability, and to afford notions both of conflict and of progress.

Taking the Gestalt Model as an intuitive basis, the Perspectivist conception of science and scientific progress – which constitutes the heart of the book – is then presented. On the Perspectivist conception, scientific theories are seen not to be entities of the sort which are either true or false, but to be structures which are more or less applicable depending on the results of certain measurements.

Following this, the Perspectivist conception is developed further in the context of its application to the kinetic theory of gases. In this development the role of *models* in theoretical science, while not treated by the empiricist and Popperian views, becomes of central importance.

A critique is then made of the set-theoretic or structuralist conception of science, in which a notion of model also plays a role. An examination of the reconstruction of Newtonian particle mechanics in terms of intuitive set theory, and the attempted extension of these methods to the case of theory change, finds them not to have provided adequate conceptions either of theory conflict or of scientific progress.

Finally, the Perspectivist conception is applied to the views of Newton, Kepler, and Galileo concerning the motions of material bodies. Here the opportunity is also taken to compare the Perspectivist conception with its alternatives, thereby further demonstrating its relative superiority.

CHAPTER 1

THE DEDUCTIVE MODEL

As will be shown in this study, the Deductive Model constitutes the formal basis upon which both the logical empiricist and Popperian conceptions of science and scientific progress are built. It is here introduced in its most familiar form: as a model of explanation and prediction.[1]

1. THE DEDUCTIVE MODEL AS A MODEL OF EXPLANATION

Popper formulates the model in his *Logic of Scientific Discovery*[2] as a model of causal explanation consisting in universal or general statements and singular statements, the conjunction of which entails some particular prediction. The model takes its more classic form as the covering-law model of deductive-nomological explanation in an article by Carl Hempel and Paul Oppenheim entitled 'Studies in the Logic of Explanation' (1948). It is there summarised in the following schema:

(1)

Logical deduction	$L_1, L_2, ..., L_r$	General Laws	Explanans
	$C_1, C_2, ..., C_k$	Statements of antecedent conditions	
→	E	Description of the empirical phenomenon to be explained	Explanandum

[1] While the Deductive Model – which is being made explicit for the first time in this book – has the same logical form as the covering-law model, and may be seen as first having been expressed as that model, its function is different and its scope is greater. Where the covering-law model is to function as a model of explanation and prediction, the Deductive Model, which includes the covering-law model, is to afford a template for the reconstruction of the whole of the empiricist and Popperian philosophies of science.

[2] Popper (1934), pp. 59f.

Taken to its simplest extreme, the model may be schematised as follows:[3]

(2) $A \vdash B$,

where "A" is to denote the conjunction of general laws and statements of antecedent or initial conditions, and "B" is to denote the explanandum. The deductive relation is to go from A to B so that the truth of A is sufficient for the truth of B, and the truth of B is necessary for that of A.

The model may also be presented in a slightly more complicated form thus:

(3) $L \wedge C \vdash E$.

Here "L" denotes the conjunction of general laws, "C" the conjunction of statements of initial conditions, and "E" the explanandum.

In the model general laws are taken to be unrestricted universal statements; and statements of initial conditions and the explanandum may be conceived as restricted or specific statements. (Unrestricted statements are to be applicable at any place at any time, while restricted statements are to relate only to specific times and places. For example, on this line of thinking 'All swans are white' and 'There exists a black swan' are unrestricted; and 'This swan is black' is restricted.)

The formally deductive nature of the model can be captured by its being formulated directly in terms of the first-order predicate calculus. Here only one law and one statement of initial conditions will be taken to be present:

(4)	L	$\forall x\,(Fx \rightarrow Gx)$	(unrestricted)
	$\underline{C}$	$\underline{Fa}$	(restricted)
thus,	E	Ga	(restricted).

And an example of the application of the above might go as follows:

(5)	$\forall x\,(Fx \rightarrow Gx)$	All copper expands when heated
	$\underline{Fa}$	<u>This is copper being heated</u>
thus,	Ga	This (copper) expands.

[3] Cf. ibid., p. 76.

Here "*F*" stands for: 'is copper being heated,' and "*G*" stands for: 'expands.'

It is of some interest to note that the model, as given in (4) and (5) above, not only bears a close affinity to the Aristotelian syllogism,[4] but is in fact a Stoic syllogism of the same form as: All men are mortal; Socrates is a man; thus, Socrates is mortal.[5]

As presented by Popper and by Hempel and Oppenheim the model can function in two different ways: it can serve either as a model of explanation or as a model of prediction. In applying it as a model of explanation it is supposed that those receiving the explanation are aware of the truth of *E*, and are being informed that *L* and *C* are the case. In its application to prediction, *L* is assumed true, and, following the establishment of *C*, the truth-value of *E* is to be empirically determined.[6]

2. A CRITICISM OF THE MODEL AS A MODEL OF EXPLANATION

As presented above, the Deductive Model is to afford the linguistic form that a line of reasoning ought ideally to have in order to count as an explanation or prediction. In this guise it has been the recipient of a number of criticisms, most of which concern either the existence of seemingly adequate explanations (or predictions) not having the form suggested by the model (e.g. teleological explanations), or the fact that certain lines of reasoning have the deductive form, and yet are not explanations (e.g. conventional generalisations).

All the same, it is believed by many that the rigorous explanations made in deterministic branches of science do in fact have the deductive form, and that in this way it constitutes a sort of ideal, deserving of emulation. But it is suggested here that explanations in science do not have this form, and that those cases to which the model actually has been applied do not constitute instances of explanation.

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[4] Cf. *An. Pr.* 26[a] 24–27: "Let all *B* be *A* and some *C* be *B*. Then if 'predicated of all' means [that no instance of the subject can be found of which *B* cannot be asserted], it is necessary that some *C* is *A*. ... So there will be a perfect syllogism."

[5] Concerning the Stoic origin of syllogisms having this form, see Bocheński (1961), p. 232&n.

[6] Cf. e.g. Hempel (1962), pp. 118–119.

If we consider the (paradigmatic) example given above, and suppose someone to witness the expansion of some particular material under certain conditions and to seek a scientific explanation of this phenomenon, it is not at all clear that his being told that the material is copper being heated, and that all copper expands when heated, would provide him with what he is seeking. In other words, his knowing that *all* copper behaves in this way under these conditions does not tell him why this particular piece does so; it only tells him that, in being constituted of copper, if this piece were replaced with another, also constituted of copper, the substituted piece would behave in the same way. And this would still leave him without an explanation as to why this material, which he now knows to be copper being heated, should expand under these circumstances.[7]

This problem will be seen later in this study to stem from the fact that explanations are here viewed as being based on scientific laws, rather than on theories. But of greater interest at this point is the fact that, as will now be shown, not only can both the empiricist and Popperian conceptions of science and scientific progress be derived from the Deductive Model, but both their capabilities and limitations are bound to it.[8]

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[7] For a similar criticism, see Scriven (1962), p. 203; concerning the applicability of the Deductive Model to the case of laws being explained by higher-level theories, see Chapter 4 below.

[8] The present reconstruction of the logical empiricist and Popperian conceptions in terms of the Deductive Model may be seen as a presentation of what has recently come to be called 'the statement view.' Cf. e.g. Stegmüller (1973), p. 2, and Feyerabend (1977), p. 351.

CHAPTER 2

THE BASIS OF THE LOGICAL EMPIRICIST CONCEPTION OF SCIENCE

1. VERIFIABILITY

Logical empiricism is an outgrowth of logical positivism, in which the verifiability principle was put forward as a criterion for distinguishing meaningful statements from meaningless pseudo-statements. For logical positivism, if any proposition or statement were not in principle conclusively verifiable by experience, it was to be considered meaningless, or, at best, tautological. Along this line then it was intended that meaningful statements include the pronouncements of science, while excluding those of metaphysics, ethics, and theology.

With the realisation that on this criterion scientific laws would themselves be meaningless, a first step towards the logical empiricist position was taken by extending the status of meaningfulness to any proposition from which an empirically verifiable proposition could be logically derived. In such derivations, the meaningfulness of the consequent was to imply that of the antecedent.

But this view too suffered problems, a major one of which centres on the fact that no universal statement or law by itself entails an observation statement. What more is required is a statement of the conditions under which the observation is being made.

In this way then alterations in the logical positivist criterion of meaningfulness give rise to the basis of the logical empiricist conception of science, in which scientific laws, in conjunction with statements of initial conditions, are to entail particular observation statements. Here we see that lying behind these developments is the conception of laws, statements of conditions, and observation statements as having the form suggested by the Deductive Model: $(L \wedge C) \vdash E$.

Unfortunately, for logical reasons, the above attempt to include scientific laws among meaningful assertions while excluding metaphysical sorts of statements has proved unsuccessful.[1] But more important here is the introduction of the Deductive Model at the basis of the empiricist conception of science.

2. INDUCTION AND CONFIRMATION

As well as affording a structure for explanation and prediction, and for the above criterion of meaningfulness, the Deductive Model can be seen to form the basis of the empiricist conception of induction. Where in applying the model to explanation the starting point taken is the truth of the explanandum, and in the case of prediction it is the truth of the laws and statements of conditions, in its application to induction one takes the statements of conditions and explanandum, i.e. $(C \wedge E)$, or $(Fa \wedge Ga)$, to be true. Thus while we should not say that scientific laws, as conceived on the model, are logically derivable from statements of conditions and explananda, we may say that they can be related to the latter by means of induction.

A point not always recognised in discussions concerning (empirical) induction is that the term has two distinct applications. In one, induction may be thought of as a possible means by which we come to realise that there exist certain regularities in nature on the basis of an acquaintance with their instances. In the other, induction may be considered the method employed to afford rational support for the claim that some particular regularity does in fact exist. As conceived on the Deductive Model, both of these applications are fundamental to logical empiricism, the latter (called 'confirmation') defining its position in the context of justification, and the former (here termed simply 'induction') in the context of discovery.

The main problem with the empiricist conception of *induction* as being the means by which new laws are discovered, as has been noted by others, is that it provides no hint as to why attention is focused on certain particular phenomena as providing the basis from which the inductive step is taken. The scientist seldom simply amasses quantities of data, sifting through them hoping to find a regularity. Rather, he usually works in the context of some theory

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[1] For a discussion of this problem see Ch. 4 of Hempel (1965). For a presentation of the view being reconstructed in the present chapter, see e.g. Ayer (1936).

which, as will be discussed later in this study, is not itself a regularity of the same sort as that being sought.

In various forms the problem of *confirmation* has received a great deal of attention in empiricist writings. The heart of this problem lies in the fact that the truth of the conclusion of a logical deduction does not imply the truth of the premises. In terms of the Deductive Model the problem is that the truth of the explanandum and statements of conditions, i.e. the truth of statements of the form ($Fa \wedge Ga$), does not establish the truth of the law. And not only this, but since the law is conceived as an unrestricted universal statement, no one finite number of true statements of the above form provides any more support for it, or makes its truth any more probable, than does any other. But it may be pointed out that, if we do grant scientific laws as conforming to the model, then this problem of induction is not a problem for the empiricist, but for the scientist, for all that is demanded of the empiricist is that he provide a conception of science as it is actually practised.

But then it may be asked whether scientific laws do in fact have the form suggested by the Deductive Model. An examination of the nature of scientific laws, at least in the exact sciences, reveals that, rather than being expressed by statements having a truth-value, they are most often expressed as *equations* suggesting a numerical relationship among the values of certain parameters. And, where on the Deductive Model it is difficult to see how a statement discovered to be false might nevertheless continue to function as the expression of a law of nature, in science we find that laws expressed by equations are often retained even when it is realised that they have only a limited range of application.

While a positive account of the nature of scientific laws which is in keeping with the above observations will be given later, for present purposes it suffices to point out that the empiricist conception of science may be seen as being conceptually based on the Deductive Model, and that in this way it thus begins with a conception of scientific laws, rather than theories. In the next chapter the basis of the Popperian conception of science will be treated, and it too will be found to rest on the Deductive Model.

CHAPTER 3

THE BASIS OF THE POPPERIAN CONCEPTION OF SCIENCE

1. FALSIFIABILITY

The considerations of the previous chapter indicate that the logical positivist and logical empiricist views can be seen as attempting to demarcate (meaningful) science from (meaningless) non-science on the basis of verifiability and confirmability respectively. Popper's demarcation between science and non-science, on the other hand, is on the basis of falsifiability. For Popper, if there is no conceivable way that a statement can be shown to be false, while it might still be considered meaningful, it is not scientific but 'metaphysical.'

Seen most simply, on the empiricist conception the confirmation of scientific laws consists in the verification of observation statements entailed by them. On Popper's view, in its simplest form, laws or theories may be falsified via the determination of the truth of observation statements that contradict them. Thus where we can represent the empiricist conception by $A \vdash B$, where A is to include a general law, and B observational evidence, Popper's conception can here be represented by the formally equivalent:

(6) $\neg B \vdash \neg A$.

Here we see that the Popperian view lays stress on the idea that, while no amount of true observation statements of the sort B could verify the universal statement in A, the truth of one observation statement $\neg B$ should suffice to falsify A.[1]

The fact that at this primitive stage the schematisation of Popper's view is formally equivalent to that of the logical empiricist conception is worthy of note, for it suggests that the difference between the bases of the two views is more one of emphasis than of substance.[2]

[1] On this point, see Feyerabend (1974), p. 499.
[2] Cf. a similar remark by Carnap cited in Popper (1962), p. 254n.

Where the empiricist directs himself to the problem of what justifies our believing certain general claims of science to be valid, Popper points to a criterion – capable of being formulated within the empiricist conception – which should suffice to show them to be invalid. Of course the refutability of general claims in science was generally recognised before Popper made falsifiability his criterion of demarcation,[3] and, as will be seen below, Popper's main contribution beyond his demarcation criterion is his attempt to develop this idea in terms of laws (and theories) conceived of as general statements, i.e. in terms that can be represented by the Deductive Model.

The basis of the Popperian view as outlined to this point, in emphasising the falsifiability of general or universal claims, can be seen to have two serious shortcomings in comparison with a similarly simple presentation of the empiricist view. It affords a conception neither of the discovery of new laws (context of discovery), nor of the support of claims that certain laws exist (context of justification).[4] If it is viewed as providing a conception of discovery, such discovery is the discovery of mistakes; and granting that it affords a conception of justification (in a broad sense), such justification is the justification one might have in saying that something is wrong.

2. BASIC STATEMENTS AND BACKGROUND KNOWLEDGE

A first step in rendering Popper's conception more sophisticated parallels a move made by the empiricists in their development of the confirmability criterion of meaningfulness. It is the recognition that – in keeping with the conception of laws suggested by the Deductive Model – a universal statement entails an observation statement only when the former is conjoined with certain statements of initial conditions. In the case of the empiricist view this may be schematised by: $(L \wedge C) \vdash E$. In Popper's case the formulation is again equivalent,

[3] Cf. e.g. Poincaré (1902), pp. 150ff., Duhem (1906), pp. 180ff., and Campbell (1920), pp. 109 and 131.

[4] Lakatos would almost certainly have disagreed with this. On p. 375 of his (1968) he claims Popper to have focused attention on the problem of the discovery of hypotheses, when he has in fact focused attention on their refutation. But Lakatos' conception of the 'logic of discovery' is rather unusual – he sees it as the discipline of the rational *appraisal* of theories: in this regard see his (1970), p. 115.

but in keeping with the $\neg B \vdash \neg A$ schematisation in (6), it might first be presented as follows:

(7) $\neg E \vdash \neg (L \wedge C)$.

This formulation of the basis of Popper's philosophy of science in terms of the Deductive Model makes it clear that his notion of falsification is not so straightforward as one might have hoped. Here, where we begin with the 'basic statement' $\neg E$,[5] we find that it does not entail the negation of the law or theory L, but rather entails the negation of the conjunction of L and the statement(s) of conditions C. Thus the determination of the truth of $\neg E$ would not suffice to falsify L.[6]

In order to obtain a situation in which L *is* falsified, Popper employs a line of thought that can best be represented by:

(8) $(C \wedge \neg E) \vdash \neg L$.

In this formulation, which is still formally equivalent to the basis of the empiricist conception – i.e. to the Deductive Model – $(C \wedge \neg E)$, or, in the predicate calculus $(Fa \wedge \neg Ga)$, is the 'falsifying basic statement' deductively subsuming the negation of the law.[7] But it is obvious that this does not avoid the problem, for it is still the case that, just as the empiricist conception requires the truth (or confirmation) of C in order to confirm L, Popper requires the truth of C in order to falsify L.

Now, where the empiricists might want to say that statements of the sort C, e.g. 'This is copper being heated,' are capable of being observationally verified (or at least confirmed), Popper, in a move away from logical empiricism (logical positivism), argues that since such statements contain universal notions such as 'copper,' which themselves are based on certain theoretical presuppositions, they *cannot* be verified.[8] He suggests, in fact, that like general laws themselves, such statements can be falsified, but can be neither confirmed

[5] Cf. Popper (1959), p. 85n.

[6] For a similar point, see Duhem (1906), p. 185.

[7] Cf. e.g. Popper (1934), pp. 102 and 127, and (1959), p. 85n.

[8] Popper (1934), pp. 94–95; (1959), pp. 423–424&n. It may be noted that Carnap also adopts this stance in his (1936), pp. 425ff. In this regard cf. also Campbell (1920), p. 43.