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EXPLAINING SCIENTIFIC PROGRESS: LAKATOS'  
METHODOLOGICAL ACCOUNT OF KUHNIAN PATTERNS OF  
THEORY CHANGE

Theory choice decisions were at the focus of the debate on theory change that dominated the philosophy of science in the 1960's and 1970's. Comparative evaluations of competing theoretical approaches were supposed to form the nucleus of scientific progress and, at the same time, the nucleus of scientific rationality. A theory choice decision singles out the methodologically most qualified alternative from among a set of rival theories. A sequence of such decisions is supposed to generate a series of theories with increasing methodological virtue; and a series of this kind constitutes scientific progress. Moreover, scientific rationality is tied to the nature and justification of the criteria brought to bear on theory choice decisions. Rational theory choices are made relying on objective and epistemically significant criteria. The intertwinement of rationality, theory change and theory choice is among the outstanding commitments underlying the entire debate on "theory dynamics"; in particular, it is constitutive of the methodological approaches of Larry Laudan and, above all, Imre Lakatos. The backdrop, against which this debate unfolded, is provided by the methodological challenge involved in Thomas Kuhn's philosophy of science. My objective is to elucidate more clearly Lakatos' attempt to neutralize methodological threats he assumed to be inherent in some of Kuhn's claims on theory change.

I begin by giving a brief sketch of Kuhn's model of scientific change and continue by highlighting the limitations it entails for any account of theory choice decisions appealing exclusively to objective and epistemically significant methodological criteria. Subsequently, I outline Lakatos' methodology and elaborate the criteria of theory choice involved in it. Finally, I develop the implications of Lakatos' model for scientific change and address, in particular, its bearing on those features of scientific change, which Kuhn thought defied the grip of systematic methodology. It is well-known that Lakatos attempted to provide a sort of rational reconstruction of some of Kuhn's allegedly descriptive generalizations about scientific change. My aim is to spell out the nature and import of this endeavor.

# I. SOME BASICS OF KUHN'S "PARADIGM THEORY"

Kuhn introduced a distinction between two levels of scientific theorizing that was retained in all later conceptions; the distinction, namely, between an overarching theoretical framework, on the one hand, and its more specific elaboration, on the other. This framework he called "paradigm"; it was supposed to embrace theoretical principles, methodological or metaphysical commitments, and a collection of exemplary solutions to problems (whence derives the appellation "paradigm"). For example, the paradigm of 19th-century wave optics proceeded from the assumption that light is to be conceived as a state of elastic oscillation of a pervasive medium. Specific versions of the paradigm consisted in more elaborate explanations of optical phenomena such as refraction, diffraction or interference. A scientific discipline that is dominated by one particular paradigm has entered the stage of "normal science." The shared commitment to an overarching framework relieves the scientists from the need to defend their basic orientation and thus allows them to focus on more productive, technical work. In normal science, a paradigm rules monopolistically and unquestioned. Its principles are not liable to empirical testing. If an application of a paradigm fails unexpectedly, i.e. if an anomaly emerges, the blame is not attributed to the paradigmatic principles themselves. Rather, additional unrecognized influences or lack of ingenuity on the part of the scientists are held responsible. That is, either the situation is considered more complex than anticipated, or the scientists' creativity and technical skill are found to be wanting. The paradigm is maintained, in spite of empirical counterinstances. In sum, Kuhnian normal science is characterized by *paradigm monopoly* and *paradigm immunity* (Kuhn, 1970a, pp. 77–80; Kuhn, 1970b, p. 6).

It is obvious that the central traits of Kuhn's normal science stand in marked contrast to Popper's methodological advice to heed counterinstances. Scientists informed by Popper's falsificationism must not ignore empirical problems. Rather, they are called upon to either modify the theory in a methodologically acceptable fashion or to drop it entirely. A theory is improved in an acceptable way if the anomaly is resolved and at the same time the theory's empirical content (i.e. the number of possible observations conflicting with the theory) is expanded (Popper, 1935, §§ 20, 31). Nothing of the kind is required from Kuhnian normal scientists. They are licensed to shelve unsolved problems and go ahead undauntedly. The difference between Popper and Kuhn cannot be traced back to the ubiquitous contrast between lofty normative principles and sloppy practice. Kuhn, namely, gives epistemological reasons for the nonchalant attitude toward anomalies he assumes to be characteristic of normal science. The chief reason is based on the historical observation that no theory ever gets rid of anomalies. This Kuhnian tenet of the "omnipresence of anomalies" rules out assessing each of them as a serious threat to the theory. Taking – in the Popperian spirit – each anomaly to be a potential refutation amounts to closing down the

business of scientific theorizing altogether (Kuhn, 1970a, pp. 79–82). By contrast, the immunity conferred to paradigms in normal science provides a basis for the tenacious pursuit of theories, which is in turn a necessary precondition for overcoming recalcitrant difficulties.

However, when anomalies pile up and the paradigm proves incapable of guiding a successful tradition of normal science, commitment to the fundamental principles is increasingly weakened and finally lost. In the course of such a “crisis,” alternative theoretical options are considered and pursued. The emergence of a crisis follows from the principles of Kuhn’s account. As a result of the sophisticated and highly specialized work done in normal science, anomalies are bound to turn up (barring the extremely improbable eventuality that a theory gets everything right). As unsolved problems pile up, each tradition of normal science sooner or later slides into crisis. Such crises frequently result in a “paradigm shift” that is characteristic of a “scientific revolution.” It is one of Kuhn’s central historical claims that a theory is never given up, unless it can be replaced by an alternative approach. Abandoning a paradigm is tantamount to adopting a new one. In contrast to the smooth development of normal science, Kuhnian cataclysms amount to a wholesale substitution of the former conceptual framework. This means, in particular, that revolutions are non-accumulative, in that they involve taking back problem solutions that were formerly accepted as correct. What counted as trustworthy scientific knowledge before, is at least drastically reinterpreted and frequently rejected as misleading or false.

The non-accumulative character of scientific revolutions becomes manifest in four features, namely, in changes: of the relevant concepts, of the problem-situations, of the criteria for evaluating theoretical achievements and, finally, in the occurrence of so-called “Kuhn-losses.” The assumed conceptual change constitutes the notorious doctrine of meaning variance, which grows out of the assumption that meaning is determined by the pertinent theoretical context. Drastic alterations of this context lead to significant changes in the meaning of the concepts involved, which in turn may vitiate the translatability of concepts from different theories. This result constitutes the “incommensurability thesis,” which denies that the substantive claims of disparate theories can be translated into one another (Kuhn, 1983). I won’t go into this matter here. The reason is, first, that addressing this contentious issue deserves a full-scale treatise in itself, and that, second, it is of no relevance for the methodological problems I wish to discuss. The latter problems arise irrespective of any potential further aggravation generated by the breakdown of translation. Thus, I proceed from the assumption – as Lakatos does – that the substantive content and the empirical consequences of rival theoretical approaches can be compared.<sup>1</sup>

The second major shift occurring during a revolution concerns the change of problems. This is unsurprising at first sight. After all, it conforms well to the traditional picture of scientific progress that old problems are solved and new problems crop up. Kuhn does not deny that problem changes of this kind

appear in the course of a revolution; on the contrary, the solution of long-standing anomalies within the new framework constitutes one of the chief reasons for the shift of allegiance. However, as Kuhn stresses, an additional pattern of problem change turns up which amounts to “dissolving” a problem rather than solving it. That is, the legitimacy of the problem is rejected by the alternative approach (Kuhn, 1970a, p. 103). Around 1770, for instance, one of the major challenges in chemistry was to explain the role of phlogiston in the release of hydrogen from the solution of metals in acids. The claim of the rival oxygen theory was that phlogiston doesn’t exist at all, and that it consequently plays no role whatsoever in these processes. Accordingly, the question wasn’t answered; it was rejected as misguided, instead.

The third important alteration refers to the criteria invoked for judging problem solutions. Such criteria are frequently tied up with – and specific to – a given paradigm, and thus change upon paradigm substitution. One of Kuhn’s examples is again taken from the Chemical Revolution. Within the phlogistic framework, it was considered the chief task of chemical theories to account for the properties of chemical substances (such as hardness, combustibility, volatility and the like), along with their changes during chemical reactions. Consequently, chemical explanations are to be judged according to their capacity to afford such an account. In the course of the switch to the oxygen theory, these problems were shifted into the background, whereas the challenge of accommodating reaction weights was moved to center stage. Chemical theories are to be assessed according to their ability to meet this challenge. As a result of the paradigm shift, the standards for judging the adequacy of theoretical achievements are altered as well (Kuhn, 1970a, p. 107; Kuhn, 1977, pp. 335–336).

Fourth, scientific revolutions frequently go along with what is now called Kuhn-losses. A new paradigm may be accepted in spite of the fact that some of the former explanatory achievements are thereby lost. More specifically, some of the phenomena accounted for previously are re-transformed into open problems. Already explained data once again become anomalous. To be sure, Kuhn-losses are only tolerated as long as they do not exceed a low-level threshold. But the salient point is that they do occur, and that their mere existence vitiates any claim to the effect that the new paradigm reproduces all the explanatory achievements of the old one. One of Kuhn’s favorite examples of a Kuhn loss again refers to the Chemical Revolution. In the phlogistic framework, a metal was regarded as a compound of a specific component (the “calx”) and phlogiston. Since phlogiston was assumed to be present in all metals, the theory could explain why they resembled one another to a much greater extent than the corresponding calces (the oxides, in modern terminology). The oxygen theory, by contrast, considered metals to be elementary, and thus lacked any resources to account for their similarity. The adoption of phlogiston theory thus reopened an empirical problem that had been considered settled before (Kuhn, 1977, p. 323; Kuhn, 1970a, pp. 132, 157, 170; Kuhn, 1970b, p. 20).

On the whole, then, and due to these four features, revolutions are characterized by a fundamental theory change, which admits of no reconstruction to the effect that the earlier theory is approximately retained by the later. The contrast between theories separated by a revolution are far-reaching and unbridgeable (Kuhn, 1970a, pp. 5–6, 97–110).

## 2. KUHN'S ACCOUNT OF THEORY CHOICE DECISIONS

Within the framework of the paradigm theory, theory choice decisions are only made in the course of revolutions. Naturally enough, Kuhn's account of such decisions focuses on such cataclysmic periods. The central claim is that the best choice is not fixed by appeal to the available facts and to standards of evaluation traditionally deemed "rational." Rather, there is room left for subjective factors, and their supplementary influence is not detrimental to scientific progress, but constitutes a methodological virtue.

The first contention is that the evaluation of theories cannot be made by relying solely on the data. This claim follows directly from the basics of Kuhn's paradigm theory. On the one hand, the old paradigm is afflicted with a particularly large number of anomalies; otherwise a crisis wouldn't have occurred in the first place. On the other hand, the new paradigm has, due to its nascent state, not yet reached a level of elaboration and articulation comparable with the former monopolist. A freshly invented approach inevitably suffers from gaps and lacunae, most of which are unlikely to appear in the older competitor. The conclusion is that both rival approaches are anomaly-ridden, so that the evidential situation fails to give unique preference to one of them. Empirical adequacy cannot be the sole criterion for theory choice.

Second, this shaky empirical ground necessitates the invocation of additional, non-empirical standards. However, the catch is that these standards depend on – and vary with – the paradigm candidates at issue. As mentioned above, the contenders typically provide different standards for judging the appropriateness of problem solutions. As a result of these disparate criteria, each competitor appreciates its own assets and its rival's liabilities, drawing on its own specific measures of adequacy. Naturally enough, the adherents of the contrasting paradigms will fail to convince one another (Kuhn, 1970a, pp. 109–110).

Third, not all criteria of appraisal are tied to one of the rival candidates. There are shared methodological values, including explanatory power, precision, consistency or simplicity. The problem is, though, that these standards are imprecise, and can be made precise in disparate ways. If the simplicity of a given theory is to be assessed, different results are likely to turn up. Moreover, the application of more than one of these standards to a specific case may easily engender conflicts among them. One of the candidates may have a wider scope, while the other may furnish more precise

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