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Pluralism as a New Framework for Integrated HPS†

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A kind of monism prevalent among philosophers of science was an important cause of the demise of the tradition of integrated history and philosophy of science (HPS). This monism assumed that there was one method common to all science, and that this method was the means of creating or selecting the one best possible theory about nature. Finding this perspective too narrow and unrealistic, many historians of science turned away from philosophy as a framework for history. I argue that the traditional HPS project can be re-founded on the basis of pluralism, which recognizes the co-existence of multiple systems of practice in a given field as a normal and healthy state of science. This opens the possibility of recognizing various valid developmental patterns in science, and of conceiving the historiography of science as the elucidation and collection of developmental patterns in science. Not only would such pluralism stop the philosophical alienation of historians wary of forcing the past into one ill-fitting mould, but it would also give every historical episode philosophical significance and interest. Thus we can bring back a venerable old idea, in a new way: philosophical ideas about how science develops provide appropriate frameworks for historiography.

【Key words】 Pluralism, Monism, Integrated history and philosophy of science, Developmental patterns

† This paper is based on the presentation I made at the third international conference on Integrated History and Philosophy of Science at the University of Indiana, Bloomington, on 23 September 2010.

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Introduction

In this paper I propose a natural history of developmental patterns in science. It is conceived as a way of giving new meaning and significance to the pursuit of history and philosophy of science (HPS) as an integrated subject. At the core of this research program is a strong pluralism, consisting in the assumption that scientific knowledge often develops in multiple directions, and that this plurality is worthy of careful description and cultivation. Such pluralism is not often found among scientists and philosophers of science, and usually not fully appreciated even by historians of science.

Let me start with Thomas Kuhn—there are a lot worse places to start. I am a great admirer of *The Structure of Scientific Revolutions*, but I think this great book starts off on the wrong foot. Look at the first word of the title: *The* Structure of Scientific Revolutions. Kuhn implied that there was one common structure to all scientific revolutions, and that was part of his view that all genuine scientific development followed the same pattern: namely, periods of monopolistic normal science punctuated by revolutions.

It is instructive to look back at the debate between Kuhn, Karl Popper and others captured in the classic collection *Criticism and the Growth of Knowledge*.[1] Popper and Kuhn were fighting over who had the right picture of scientific development, and with the exception of Paul Feyerabend, everyone commenting on the debate seems to have been agreed that there *was* one right picture. Stephen Toulmin and Imre Lakatos thought that Popper and Kuhn were both wrong, and proposed their own monistic theories of scientific change. L. Pearce Williams, the only "real" historian among the contributors to the volume, complained

[1] Lakatos and Musgrave (1970).

that Popper and Kuhn were relying on the history of science without having done extensive enough historical work ("neither has amassed sufficient hard evidence"). But even Williams agreed that the task at hand was to capture "the essence of the scientific quest" and concluded that "we need a lot more examples"[2]. I would certainly agree with Williams on the need for more examples, but looking back across the space of 40 years, it is difficult to see why people were so caught up in this monistic debate, based on the presumption that there was just one essential pattern of scientific development.

How Monism Poisoned Integrated HPS (Pluralism as an Antidote)

I believe that philosophical monism was one of the important causes for the demise of the traditional style of HPS, which famously declared that "history of science without philosophy of science is blind" (and "philosophy of science without history of science is empty"), a slogan attributed to Lakatos and also Norwood Russell Hanson. The monism I speak of was twofold: it assumed that there was one method common to all science, and that the ultimate aim of science was to find the one best theory (if not the perfect theory) in each scientific domain. In addition, it was taken for granted that the one scientific method was to lead us to the one best theory. This is, of course, an exaggerated caricature of the view that philosophers typically held; however, there is enough truth in that caricature, enough to put off historians in any case. Finding the monist vision too narrow and unrealistic, the majority of professional historians of science perhaps came to prefer philosophical

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2) Ibid., p. 50.

blindness! Bad philosophy poisoned the atmosphere of integrated HPS, and made so many historians turn away from philosophy altogether. If we abandon monism, it will be much easier to bring back a venerable old direction of thinking in a workable form: philosophical ideas about how science develops do provide an appropriate framework for the historiography of science.

The integrated HPS enterprise can be revitalized by replacing this underlying monism with pluralism, by which I mean a commitment to *recognize* plurality where it is present, and to *cultivate* it further where it is plausible and beneficial. So the pluralism I advocate is both descriptive and normative. Elsewhere I have given a detailed argument for normative pluralism, to the effect that it is beneficial to maintain multiple systems of practice in science, even within one discipline.[3] This is because each system will have a distinct set of contributions to make, and also because there are benefits arising from a productive interaction between the different systems. In this paper I will not repeat those arguments. Instead I will focus on the positive implications of descriptive pluralism for the practice of HPS. So, setting the normative dimension aside for the moment, the key point is to recognize the existence of multiple systems of practice in a scientific field when such plurality is present, and moreover not to neglect such pluralistic phases of science in our historiography.

By a "system of practice" I mean a coherent set of "epistemic activities" performed with a view to achieve certain aims.[4] Like a Kuhnian paradigm, a system of practice incorporates within it both the methods of science and the results of science. Therefore, the pluralism of systems opposes the twofold monism of methods and results at once. When we recognize that there are multiple systems that develop in

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[3] So far, the most complete presentation is in Chang (2012), chapter 5.

[4] Ibid., pp. 15-8.

interaction with each other, what we begin to see is a variety of possible patterns of development (or developmental patterns), many of which are recognized as valid and scientific. This should immediately reduce the alienation felt by anti-philosophical historians who are wary of forcing the past into an ill-fitting philosophical mould. If there are counter-examples to a pattern of scientific development that one starts by assuming, it is simply an indication that there may be another pattern at play. Therefore, such counter-examples should not lead to either philosophical despair or distortions of history. Pluralism gives positive philosophical significance and interest to every historical episode. (It is also important that pluralism recognizes plurality as a legitimate end-point of scientific inquiry, or even as its normal ongoing state. I will say more about that below.)

The Natural History of Developmental Patterns

The pluralist[5] integrated HPS that I advocate begins by conceiving the historiography of science as the elucidation of *various* developmental patterns in science. This is of course not the only way of doing the history of science, nor the only reason for doing it, but it is a significant and viable mode of historiography that should not be neglected. The notion of *developmental* pattern expresses a commitment to study science as a dynamic and progressivist enterprise, without

5) One could say “pluralistic” here, but I prefer “pluralist” because it has a clearer connotation of an ideology that provides guidelines for practice (rather than a value-neutral description). So, a “pluralistic” interpretation may be one that just happens to record any plurality that is present in the situation. In contrast, a “pluralist” interpretation of science would be one given by someone who subscribes to pluralism, who seeks to highlight and promote the plurality, or laments the lack of plurality.

making overly restrictive presumptions about progress.[6] Pluralism guarantees openness: there are many legitimate and viable developmental patterns, each of them more or less effective under particular types of circumstances. Pluralist philosophy of science can provide a wide conceptual space of developmental patterns, each of which can serve as a template for the writing of history.

Pluralistic historiography opens up an enormous *taxonomic* enterprise that I find exciting to contemplate, reminiscent of early modern natural history.[7] The bread-and-butter of such an enterprise is *collecting*. An open-minded and imaginative look at history will reveal all kinds of developmental patterns in past science. Historians can identify, describe and classify various specimens of each and every pattern. In this process, the discovery of previously unrecorded patterns should be greeted with the same enthusiasm as naturalists have shown on the discovery of new species. Historiographical collection is not a crudely inductive process, since it will be informed by philosophical ideas. There will be predictions of new patterns; disputes about how to classify anomalous cases; and abstract debates about the general principles of classification. There will also be normative debates, reaching into the present too, about which developmental patterns are most effective under which circumstances, and which kinds of patterns should be encouraged further and which ones reformed or even restrained. Philosophical pluralism will broaden our historiographical

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6) Concerning progress, I am only giving a description of scientists' intent, not making a claim that science is always or essentially progressive, judged by any particular standards. And there are degenerating developmental patterns, too.

7) I believe that one historian who has been putting this idea into practice, long before I articulated it, is Klaus Hentschel. This is obvious from his research output, and at Göttingen University in 2000 he gave a course on "Models and Patterns of Historical Development in the History of Science".

minds, and enrich our store of history, which will in turn enable a better-informed philosophical pluralism.

Are Historians Already Pluralists?

In the remainder of this paper, I would like to describe some of the developmental patterns that I have identified so far, and some of the specimens of each pattern. Before coming to that, however, there is one general methodological point that I should address. Almost every time I present an argument that a better philosophy of science can bring benefits to history of science, some historian objects and says that *good* historians should be able to do all the things I am talking about without any help from philosophy. So here historians may feel that they have already been putting pluralism into practice - deconstructing grand narratives, deflating scientific claims of cognitive superiority, and renouncing the worship of heroes and geniuses. So, what further lesson is there for historians to take from the Johnny-come-lately philosophers who have finally discovered pluralism? My answer is twofold.

First, there is a kind of monism that runs deep even among today's historians. Many phases of past science have been neglected because they did not lead to a tidy closure. Consider, for example, early electrochemistry; it was probably one of the most exciting developments in all of 19th-century science and technology, but even professional historians of physics and chemistry who are not particular experts on this topic tend to draw a blank about the whole period between Humphry Davy and Svante Arrhenius, except for a superficial awareness of Michael Faraday's work. (And there are not many who have paid sufficient attention to this topic to become experts on it.) Or how about

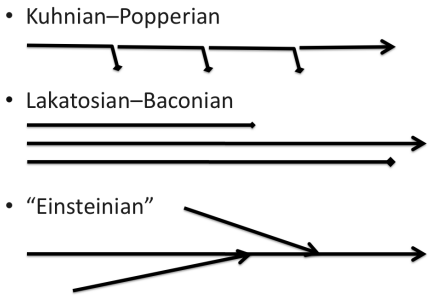
the theories of rain up to the end of the 18th century, and theories of evaporation before the kinetic theory of gases? Or the great challenge and excitement of hypsometry (the measurement of the height of mountains, and of elevation in general) up to the late 18th century? Or pre-Newtonian theories of tides, or theories of animal heat before modern biochemistry, or theories of cohesion through the ages? These are just a few examples from areas that I happen to know about, in which a number of past scientists at the time spent a great deal of time and mental energy researching and debating a topic, and later historians ignore this work because it "did not lead anywhere."

Secondly, I contend that historians' pluralism has typically been purchased at the price of blindness. These days we are swamped by histories of science that do not even entertain the question of the progress of science or the development of knowledge in any serious sense. This philosophical blindness in currently fashionable historiography is actually a great opportunity for integrated HPS. Developmental patterns can serve as a basis for a review, classification and epistemological enhancement of the great number of stories produced by unphilosophical or even anti-philosophical historians. This way, almost any historical work can interest philosophers, and philosophizing about developmental patterns can stimulate and guide further historical work. I am not denying the importance, interest or independence of historical work that is carried out without philosophical concerns in mind. I am only saying that such historical work creates opportunities for philosophers to add and stimulate new dimensions of research on the same topics.

Some Developmental Patterns

Although I cannot give a detailed description of a large number of developmental patterns in this paper, I would like to give a skeletal illustration of what kinds of things we are likely to find if we start looking seriously. First of all, even when we are considering scientific episodes with tidy endings, it is important to recognize that there are

Figure 1. Monistic (one-endpoint) developmental patterns

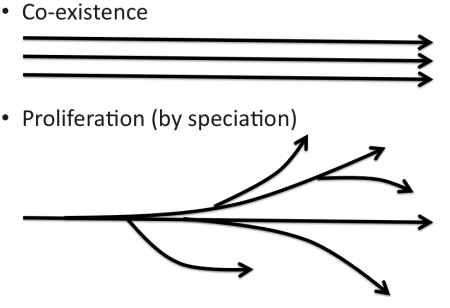


many different ways in which tidy endings can be achieved. Figure 1 gives a schematic representation of some of the well-known developmental patterns with monistic end-points. These include the Popperian sequence of "conjectures and refutations", and the Kuhnian series of successive paradigms. These two are actually quite similar to each other, so I represent both here with one schema.[8] The Lakatosian pattern is pluralistic in its process, but monistic in the end-point: a competition between multiple research programs ends with the survival

[8] I owe this insight to an undergraduate student at University College London who commented during my introductory philosophy of science course that the picture of scientific development presented by Popper was actually just like Kuhn's picture, only fast-forwarded. Unfortunately I cannot remember which student this was, but his idea has stayed with me.

of the most progressive one; there is a structural similarity here with what is achieved by Baconian crucial experiments. And then there is the pattern of unification so well-loved by physicists and reductionists, which I will call "Einsteinian" for lack of a better figurehead. In the diagrams here, each line represents not just a theory, but a distinct system of practice that continues and develops for some time. By a "system of practice" I mean a coherent set of epistemic activities (including theoretical practices) with some identifiable aims).[9] Kuhnian paradigms and Lakatosian research programmes can be seen as types of systems of practice. My pictures are only meant to be heuristic; they are schematic (or even metaphorical) expressions of some key features of the developmental patterns under consideration.

Figure 2. Pluarlistic (many-endpoint) developmental patterns



To the monistic patterns shown in Figure 1, we need to add those that end with a plurality of systems. This should begin to give us an appreciation of the variety of patterns (see Figure 2). First of all, there are situations in which competing systems co-exist for a long time: for

9) For a further elaboration of this idea, see Chang (2012), section 1.2.1.1 (pp. 15-8) and Chang (2011), pp. 247-68.

example, the competition between the particle theory and the wave theory of light; the co-existence of catastrophism and uniformitarianism in geology; the 19th-century dispute between the contact and chemical theories of the battery; or the multiple theories and models of high-temperature superconductivity today. There are also situations in which a system of practice splits into two or more, in a process that has been compared to speciation in biological evolution. Much of what is at work in such splitting is specialization, akin to isolation in evolution. The proliferation of sub-disciplines in today's science is a testimony to the importance of this developmental pattern, whether we like it or not. Today's scientists are very familiar, and comfortable, with long-established divisions such as organic, inorganic and physical chemistry groups within any large chemistry department, or several departments of biology within the same university. The first schema shown in Figure 2 (co-existence) can be refined further, by noting that multiple systems may remain even after the initial weeding-out of obviously dysfunctional ones, and that the proliferation of systems in a domain can happen by the addition of entirely new ones as well as speciation from existing ones (see Figure 3).

Figure 3. More complicated patterns of co-existence

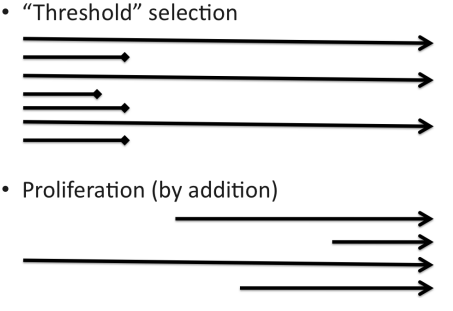
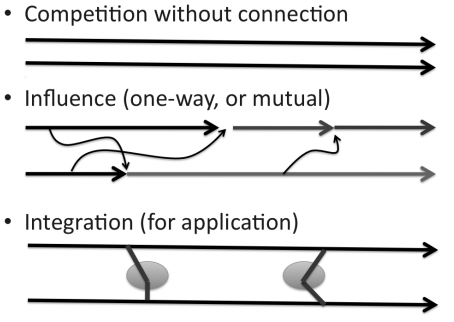


Figure 4. Inter-system interactions (lasting)



In many developmental patterns the *interaction* between co-existing systems of practice plays an important role. Figure 4 shows some of the most basic patterns of interaction. When we talk about "competing" theories, we often don't think about any active interaction between them. Although it is sometimes the case that there is an absence of any interesting interaction, more often competing systems of knowledge do influence each other by sharing facts, techniques, materials and ideas, or by posing problems for each other. And sometimes distinct systems are brought together in order to address particular problems; this is the view of the sciences of complex systems advanced by Sandra Mitchell in her "integrative pluralism", especially through the example of the biology of social insects. Otto Neurath had proposed a similar view long ago, but concerning the integration of different fields of science for practical applications, rather than the integration of different systems within a given field.[10)]

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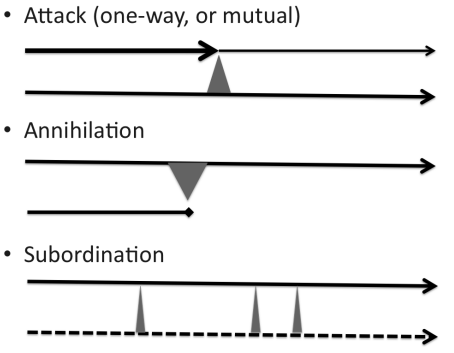
10) For more detailed thoughts on some modes of inter-system interactions in the context of "interactive pluralism", see Chang (2012), *Evidence* (2012), section 5.2.3 (pp. 279-84). References to Neurath's and Mitchell's works can be found there, too.

Figure 5. Inter-system interactions (hostile)



There are also more hostile interactions (see Figure 5). Often one system will launch an active attack on another, which may be killed off, or may carry on in a diminished way afterwards. Sometimes a vanquished system will live on like the "un-dead", and continue to launch its own feeble attacks on the dominant system. This sort of scientific interaction persisted for a long time between mechanism and vitalism in biology, and it is still carried out by opponents of relativity and proponents of homeopathy, for example (if we take a liberal view of what qualifies as physics or medicine).

Figure 6. Inter-system interactions (unifying)

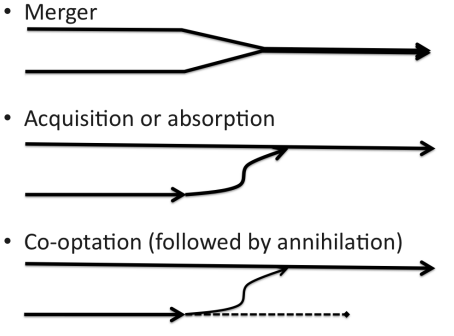
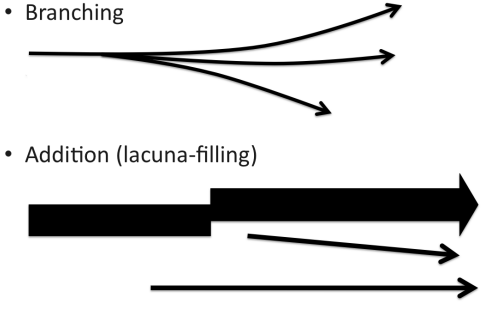


Figure 6 shows another set of elementary interactive patterns: it is important to note that the number of systems in play may get reduced through interactions that are less hostile than annihilation. There are *mergers* in which two systems both change in order to come together (for example, in the synthesis of radical theory and type theory in organic chemistry in the 1850s and 60s). If one has mergers, one can have acquisitions, too, in which one system is the dominant one absorbing another into it. And then there are more treacherous cases, which I have called "co-optation" here, which may be a bit like asset-stripping (to continue with the business metaphor): the dominant system claims for itself the key achievements of a competitor, and then leaves the competitor to die; for example, I think this was basically the character of Lavoisier's victory over the phlogiston theorists. (Co-optation may also be a mode of a more productive and pluralist interaction, in which one system benefits from borrowing something from another, and the latter system is not thereby harmed.)

Figure 7. Inter-system interactions (diversifying)

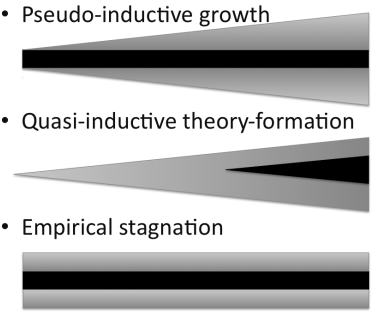


There are diversifying interactions, too (see Figure 7). I have already

spoken about the branching of one system into two or more. What is also important is the pattern in which an existing system changes its emphasis, abandoning some important problems and issues. In that case another system can arise to fill that gap; for example, through the excitement about the new organic structural theory, and the rejection of Jöns Jakob Berzelius's old orthodoxy of electrochemical dualism, the mainstream of chemistry in the second half of the 19th century abandoned questions about the causes and explanations of chemical bonding; these questions were picked up by the new field of physical chemistry instead.

So far, I have painted very large-scale pictures. To gain a better appreciation of how these kinds of patterns are produced, we need to dig deeper to find smaller and more finely described elements within each system that work together to generate the developmental patterns. What is particularly important here is the interaction between theory and fact (see Figure 8). Sometimes facts do accumulate, in connection with a stable body of theory that is pre-determined; I have called this pattern "pseudo-inductive", as the theory is not generated inductively and its evidential base rests on the framing of observations by the theory in question. Sometimes facts do come first in a relatively theory-free way, and theory grows up in such a fact-rich environment; this is a pattern that I call "quasi-inductive". Or we may have a pattern of "empirical stagnation", in which there is not much growth in either fact or theory, but the system continues in a steady state of theory-fact harmony (for example, this is what Kuhn says about geometric optics, a system so perfect and complete that it died as a field of research science).

Figure 8. Intra-system developments (theory–fact interaction)



Often the fact-theory relation is more complex, as noted by Galison, for example (see Figure 9).[11] Theory can undergo revolutionary change while facts continue to accumulate on an unchanged basis; or, theory may continue unfazed while new technology or culture changes the facts. And of course I am saying "fact" and "theory" merely as a shorthand here, and the whole situation is much more complex. From Lakatos there is a reminder that facts are rolled in with theory into the auxiliary assumptions constituting the "protective belt" of a research program, and will be changed in order to maintain the "hard core" theoretical assumptions.

I have only scratched the surface in the natural history of developmental patterns. There is much more to say and do, but I hope that my preliminary remarks here are sufficient to give the sense of an important and plausible historiographical research program. I predict that we will be able to discern many more developmental patterns and many more subtleties in them by engaging in a more extensive and in-depth pluralist historiography, or even by just remembering what we already know about various parts of the history of science.

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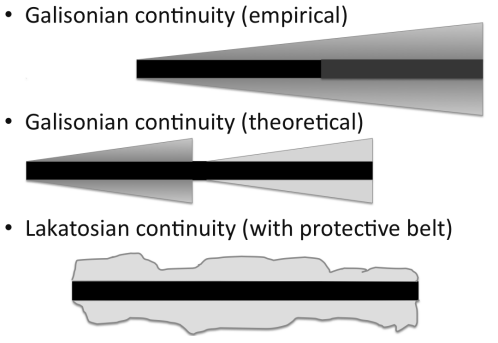
11) Galison (1997), chapter 9.

Figure 9. More intra-system developments



The Uses of Developmental Patterns

What can we do with all the developmental patterns that we may collect? Going beyond the nerdy pleasures of taxonomy itself, what kind of questions can we effectively tackle by means of the taxonomy of developmental patterns? (Very practically, I would ask myself what I could suggest to an ambitious PhD student or postdoc that they might do in this line of work.)

First of all, even if we do not really apply the results in any particular way, engaging in this taxonomic work will change the discourse in history and philosophy of science fundamentally. It will encourage us to avoid fruitless debates searching for *the* essence of science, and also to recognize due merits of *various* conceptions of scientific development. So at least our thinking would be freed up quite a bit.

More deliberately, there are several promising areas of work in HPS that can be stimulated by the taxonomy of developmental patterns. On the side of philosophy, the grand old topics of scientific change and

scientific progress will once again become tractable areas of research, for both historians and philosophers. Having seen all kinds of different developmental patterns, we can productively re-open the question about what progress in science means, and to what extent it has been achieved. Many other classic topics in the philosophy of science will also receive a fresh formulation and urgency: most of all, theory-choice, confirmation, reduction, discovery, and demarcation.

On the side of history, our pluralistic taxonomy can bring to life a great deal of past science that has been unjustly neglected for not being monistic; for that reason, there is also an opportunity here for us to come to better grips with current science, much of which actually does not fit very well into the traditional philosophical models. The overall profile of the collection of developmental patterns in science, and the diachronic changes in that profile, will add a whole new dimension to our description of the evolution of science. Once the description is enriched sufficiently, new and better explanatory questions would also arise: what are the epistemic, psychological, and institutional drivers of particular developmental patterns, and of their developments and fortunes?

Good descriptions and explanations will also enable proper normative assessments. When results are not satisfactory, we can ask if it would be helpful to try for a different pattern of development. Scientific development should not just be a matter of scientists “following their noses”. And having a good working taxonomy of developmental patterns will facilitate integrated HPS. In particular, a tension between the philosophical framework and the historical content can become a productive thing. Against the background of recognized standard patterns, it will become possible to identify unusual or anomalous episodes as such, and investigate them in a focused way. The outcome may be the discovery of a new developmental pattern, or the revision of a

recognized pattern, or a modification in the description of the episode in question.

In closing, I hope that everything I have said in this paper sounds obvious, now that I've said it. All of my points follow very naturally and effortlessly from the simple recognition that there isn't just one pattern of development in science. It is a mundane insight, but it is worth pursuing.

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다원주의: 융합된 과학사-과학철학의 새로운 틀

장 하 석

과학철학자들 사이에 팽배한 일원주의는 융합된 과학사-과학철학 ("과사철") 전통의 몰락을 불러일으키는 한 주요한 원인이 되었다. 이 일원주의는 과학에는 단 한가지의 방법이 있다고 가정했고, 또 이 방법은 자연에 대한 하나뿐인 최선 이론을 낳을 것으로 가정했다. 이러한 관점이 너무 편협하고 비현실적이라 느낀 많은 과학사학자들은 역사의 틀로서 철학을 버리게 되었다. 저자는 전통적 과사철을 다원주의에 기반해서 새로 정립할 수 있다고 주장한다. 이 다원주의는, 한 분야에서 다수의 실천 체계가 공존하는 것을 과학의 정상적이고 건전한 상태로 간주한다. 과학을 그렇게 볼 때, 우리는 여러 가지 타당한 발달 형식이 있으리라는 가능성을 인지하게 되고, 과학사를 이러한 발달 형식들을 명료하게 밝히고 수집하는 과업으로 볼 수 있다. 이러한 다원주의는 과거를 잘 맞지 않는 하나뿐인 틀에 처넣기를 꺼리는 사학자들이 보이는 철학기피를 막아줄 수 있으며, 또 한편으로는 어떠한 역사적 에피소드라도 철학적 중요성과 흥미를 가지게 해 줄 것이다. 그리하여 아주 전통적인 아이디어를 새로이 부활시킬 수 있다: 과학의 발전에 대한 철학적 개념들은 적합한 과학사의 틀을 마련해 준다.

주요어: 다원주의, 일원주의, 융합된 과학사-과학철학, 발달 형식