

# Explaining Science Historically

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**Abstract:** The author brings out the many faces of explanation in history of science by commenting on the contributions to this Focus section. The essay starts by indicating several ways in which the term “explanation” is used in historiographical discourse. It then distinguishes the object of explanation from the process of explanation and points out common themes and points of contention among the thirteen contributions. It also discusses two of those points in more detail: the problems of causal explanation in history of science and the imperative of avoiding anachronism in historical interpretation. The essay concludes by suggesting a pluralist take on explaining science historically.

*History is an explanatory enterprise.*

—Thomas S. Kuhn (1977)

## THE PROBLEM OF HISTORICAL EXPLANATION

In ordinary parlance the word “explanation” is used in connection with different activities: deciphering the meaning of an obscure text; understanding a puzzling behavior or decision; elucidating the function, operation, and purpose of an artifact; specifying the causes of an event; developing a theory about a phenomenon; explaining away a paradox; narrating the unfolding of a process; accounting for the success or failure of a project; justifying an opinion; and so forth. Several of those meanings are at play in the contributions to this Focus section. John Steele’s piece aims at deciphering the meaning of a Babylonian astronomical text; the explanatory target of Robert Westman’s essay is Copernicus’s decision to put the Earth in motion; María Portuondo attempts to elucidate a sixteenth-century treatise with natural philosophical ambitions; John Heilbron tries to shed new light on Galileo’s misfortunes with the Catholic Church; John Schuster seeks to account for the origins of the mechanical philosophy in the work of Isaac Beeckman; J. B. Shank provides an analysis of the rise of mathematical physics in early eighteenth-century France, based on actor-network theory; Michael Bycroft and Nadine Weidman explain away some apparent contradictions in the historical record concerning, respectively, the eighteenth-century natural philosopher Charles Dufay and the twentieth-century anthropologist Ashley Montagu; Frans van Lunteren traces the complex process that led to the establishment of a meteorological law; Helen Curry drains the wonder from the *prima facie* surprising presence of a collection of seeds in an American preservation facility; Jeremy

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Vetter tells the story of an American family in the early twentieth century in order to highlight the possibilities and obstacles involved in “lay participation in field science”; Laura Stark suggests a complex account of the death of Frantz Fanon, which dispenses with simpleminded notions of historical causation; and Bert Theunissen undertakes to make sense of the failure of a large-scale public scientific project in the Netherlands.<sup>1</sup>

The many faces of explanation have been noted in the philosophical literature on scientific explanation, which, however, has focused exclusively on explanation as an activity of making sense of particular phenomena or general laws.<sup>2</sup> Contemporary philosophical discussions on scientific explanation originate from a classic article by Carl Hempel and Paul Oppenheim, which was published seventy years ago. That article had been preceded by another one, by Hempel, on historical explanation. The two articles shared a central idea: the methodological unity of all sciences, natural and social alike.<sup>3</sup> It followed that explanation should have the same form in the natural sciences as in history. Explanation, across all scientific fields, was supposed to be a deductive argument, the premises of which included natural or historical laws.

Hempel and Oppenheim’s model of explanation is, of course, outdated, and its flaws have been thoroughly analyzed.<sup>4</sup> For one thing, as regards history, the existence of historical laws is rather doubtful. Their basic terminology, however, has stood the test of time. They “divide an explanation into two major constituents, the *explanandum* and the *explanans*. By the *explanandum*, we understand the sentence describing the phenomenon to be explained (not that phenomenon itself); by the *explanans*, the class of those sentences which are adduced to account for the phenomenon.”<sup>5</sup>

In thinking about explanation in history of science it is, thus, helpful to distinguish the object of explanation, what we are trying to explain, and the process of explanation, how we are carrying out the explanation. The *explanandum*, as testified to by the contributions to this Focus section, can be various things. They include the beliefs, actions, and decisions of historical actors, as well as various sorts of change in every aspect of the scientific enterprise: in worldview, in methodology, in values, in institutions, in the relations between science and society, in the scale of scientific practice, and so forth. Furthermore, the *explanandum* can also be some obscure textual or material artifact, which a historian of science undertakes to make sense of.

The *explanans*—how we do the explaining—is often entangled with philosophical and sociological theories about science and its relative autonomy.<sup>6</sup> In any case, historical explanations are usually fleshed out via narratives. Historians of science explain by telling stories, which are constructed on the basis of methodological principles (e.g., to use actors’ categories) and em-

<sup>1</sup> I found all the contributions thoughtful and informative. It is only lack of space that prevents me from doing justice to each of them here. For the epigraph see Thomas S. Kuhn, *The Essential Tension: Selected Studies in Scientific Tradition and Change* (Chicago: Univ. Chicago Press, 1977), p. 5.

<sup>2</sup> See, e.g., James Woodward, “Scientific Explanation,” in *The Stanford Encyclopedia of Philosophy* (Fall 2017), ed. Edward N. Zalta, <https://plato.stanford.edu/archives/fall2017/entries/scientific-explanation/>.

<sup>3</sup> Carl G. Hempel and Paul Oppenheim, “Studies in the Logic of Explanation,” *Philosophy of Science*, 1948, 15:135–175; Hempel, “The Function of General Laws in History,” *Journal of Philosophy*, 1942, 39:35–48; and Fons Dewulf, “Revisiting Hempel’s 1942 Contribution to the Philosophy of History,” *Journal of the History of Ideas*, 2018, 79:385–406.

<sup>4</sup> Note, though, that their treatment of explanation continues to cast a long shadow over contemporary philosophical debates about explanation in history. See, e.g., Paul A. Roth, “Varieties and Vagaries of Historical Explanation,” *Journal of the Philosophy of History*, 2008, 2:214–226.

<sup>5</sup> Hempel and Oppenheim, “Studies in the Logic of Explanation” (cit. n. 3), pp. 136–137.

<sup>6</sup> See Theodore Arabatzis, “What’s in It for the Historian of Science? Reflections on the Value of Philosophy of Science for History of Science,” *International Studies in the Philosophy of Science*, 2017, 31:69–82; and Steven Shapin, “Discipline and Bounding: The History and Sociology of Science as Seen through the Externalism–Internalism Debate,” *History of Science*, 1992, 30:333–368.

body specific hypotheses (e.g., about the character traits of a historical actor) or general theories of science in action (e.g., the actor-network theory). The aim of the explanatory process is to render the *explanandum* comprehensible. Explanatory narratives should transform the *explanandum* from a surprising to an “expected outcome” (Curry).

#### SOME COMMON THEMES AND A FEW DISAGREEMENTS

All of the contributors consider explanation, in its various forms, as a legitimate, or even central, aspect of historiographical practice. Their essays provide a rich repertoire of explanatory strategies and tools. Not surprisingly, those strategies make no reference to any kind of historical laws, as would be demanded by a positivistic approach to historical explanation. Some of the contributors, though, advocate, as regards explanation, the methodological unity of history and physics. According to Heilbron, in history as in physics explanations are based on theories about the subject matter under investigation. Heilbron portrays the historian as a theoretician who, not unlike the physicist, explains by constructing theories. In the case of biography, those theories concern the personality of the biographee and include hypotheses about his or her motives.<sup>7</sup> Biographical theories are predicated on an assumption about “our common humanity” and are evaluated on the basis of the plausibility of the narrative that they engender.<sup>8</sup> The common humanity assumption is nontrivial and has been contested in the historical literature.<sup>9</sup> Notwithstanding its difficulties, however, it seems methodologically indispensable. Without it, it is hard to imagine how a historian could gain access to remote times, places, and cultures. Despite the often huge gap between historians and their subject matter, as shown strikingly in Steele’s essay, our ability to understand alien forms of thought and practice would not be possible if something like a common humanity assumption did not hold.

Stark’s relational approach to historical explanation also narrows down the methodological gap between history and physics. Drawing on Niels Bohr’s philosophy of physics, as interpreted by the feminist philosopher of science Karen Barad, Stark emphasizes the “emergence,” “entanglement,” and “relational” character of historical phenomena, which are constituted through their “observation” by the historian. This complex and, to me at least, not entirely clear approach to historical explanation enables her to give an account of Frantz Fanon’s death that does away with linear and one-dimensional conceptions of historical causality. Given the obscure workings of causality in history, this is an advantage of her account, which, however, as she herself points out, needs to be articulated and developed further.

#### The Perils of Causal History

The nature of historical causation is a sticky point in some of the other contributions too. Schuster, like Stark, is skeptical of the deployment of mechanical notions, such as “influence,” “imprint,” and “shape,” in historical explanation, because they go hand in hand with considering past scientists or natural philosophers as “cultural dopes.” The cultural context is important for understanding past scientific life, but it has to be conceptualized as a pool of resources that are “picked up, adopted, adapted, and deployed” by the historical actors. Thus, contextual factors affect historical actors in different ways. Schuster gives the example of Isaac Beeckman and Simon Stevin, who shared the same context but nevertheless developed very differently.

<sup>7</sup> See also van Lunteren’s contribution, where aspects of Buys Ballot’s personality (“highly ambitious”) and motivations (he “longed to make his mark in the natural sciences”) play an explanatory role in the narrative. The account of Buys Ballot’s personality and motivations is a theoretical construct, which makes it possible to give a plausible interpretation of his behavior.

<sup>8</sup> Cf. Kuhn’s assertion that “a plausible narrative . . . [involves] recognizable motives and behaviors”: Kuhn, *Essential Tension* (cit. n. 1), p. 17.

<sup>9</sup> See, e.g., Nick Jardine, “Uses and Abuses of Anachronism in the History of the Sciences,” *Hist. Sci.*, 2000, 38:251–270, esp. p. 263.

The particular choices made by each actor have to be explained via a “biographical reconstruction.” In this, Schuster and Heilbron are in agreement.

Other authors, while sharing an emphasis on the fruitfulness of a biographical approach, employ a stronger notion of historical causation. In explaining Benito Arias Montano’s *Magnum opus*, Portuondo mentions “the core reasons he gives for writing” it, but she finds those reasons wanting since they do not “explain why the *Magnum opus* makes the type of natural philosophical proposal it makes.” To fill this explanatory gap, Portuondo brings in biographical information (e.g., about Montano’s education and “the sites where he worked”) and claims that “the *Magnum opus* is the product of the Seville of the century of discovery, Arias Montano’s home for most of his life.” Now, this is a plausible claim, provided that we don’t take the term “product,” with its heavy causal overtones, literally. “The Seville of the century of discovery” may have enabled and constrained Montano’s work in several ways but did not “produce” it in the same sense that a factory produces a product.

Bycroft also deploys a strong conception of historical causality. One of his *explananda* is why Charles Dufay developed “the theory that metals behave like sponges.” The reason, according to Bycroft, is that Dufay “was part of a tradition of material-driven experimentation that had flourished at the Paris Academy of Sciences since the 1660s.” Furthermore, that “tradition, embodied in Réaumur, pushed Dufay in certain directions. And it kept pushing as Dufay went along—insights from Réaumur can be found in several of Dufay’s electrical papers.” Well, it seems to me that drawing on someone else’s insights does not amount to being pushed by him. Here I would side with Schuster, who insists—rightly, I think—that a tradition (or, more generally, a context) does not function as a mechanical cause with a predetermined effect but, rather, as a space of possibilities that enables and constrains the historical actors’ beliefs, actions, decisions, and the like.

An attenuated notion of causality is also suggested by van Lunteren, who associates the transformation of C. H. D. Buys Ballot’s “local rule of thumb . . . into what came to be known as Buys Ballot’s law” with a “change of context,” from the Netherlands to Britain, where his innovation was appreciated and established. Van Lunteren considers his “explanation . . . a largely causal one.” However, he understands causality as “forging meaningful connections between prior and later events,” without requiring that the former make the latter “inevitable or even probable.”

### Contextual Explanation and Actors’ Categories

One of the truisms in our field is that the past has to be understood and explained on its own terms. As Westman suggests, to explain an action or decision of a historical actor, we have to get clear on his or her project (“what basic question was . . . [he] trying to answer?”) and on the “intellectual and social context” of his or her inquiry. Furthermore, we should not “import current beliefs into the past that might prevent understanding of an actor’s motives—as, for example, that astrology is now considered a pseudo-science.” This abhorrence of anachronism is also expressed by two of the principles of historical interpretation advocated by Shank: first, to “deploy the categories of the actors [we] study as [our] analytical categories”; and, second, to “work to reconstitute the historical epistemologies present” at the time. Needless to say, these sound like eminently reasonable guidelines for historical explanation. Not all of the contributors stick by them, though.

Steele, for instance, attempts to interpret his *explanandum*, a Babylonian text, by situating it within its astronomical and wider context. His interpretation, however, includes a “technical” component, which involves “a modern astronomical and mathematical understanding of the observations, calculations, or theories presented [in the text].” The employment of modern knowledge compensates for the lack of sufficient information in the available textual material.

I am not able to evaluate the specifics of Steele's interpretation; this should be left to other specialists in the history of Babylonian astronomy. His interpretive strategy, though, does not strike me as illegitimate in principle. Modern knowledge about the phenomena investigated by our historical actors might be employed, even if with caution, provided that certain conditions for the application of that knowledge are in place.<sup>10</sup>

As indicated by Steele's piece, sticking to actors' categories and the information accessible to them may not always be the best way of understanding what they were up to. This is further suggested by Shank's illuminating explanation of the rise of French mathematical physics in the early eighteenth century. Despite his disavowal of retrospective and anachronistic "rationalizations" of that historical development, his own account of it is not limited to the concepts and categories that were available to the historical actors. Rather, it is based on a contemporary and widely used sociological theory (actor-network theory [ANT]), which would have been as baffling to his historical actors as any theory in modern mathematical physics. The ontology of ANT (actants, networks, etc.), in particular, goes well beyond anything that early eighteenth-century mathematicians and natural philosophers could have conceived.<sup>11</sup> My point here is not to denigrate ANT. On the contrary, I take its historiographical fertility to indicate the limitations of an unmitigated rejection of presentism. Our historiographical tools cannot (and should not) always be confined to those available to the subjects we study.

Some of the benefits of hindsight are indicated in Bycroft's and Weidman's essays and, in particular, in how they set up their *explananda*. Bycroft, for instance, asks why Dufay was not troubled by an experiment that looks paradoxical to us. Its paradoxical character, though, as Bycroft argues, derives from describing it using the modern concepts of conductors and insulators, which would have been alien to Dufay. If we redescribe the experiment with Dufay's conceptual apparatus, then the paradox disappears. The original *explanandum* has now been explained away through a conceptual reorientation.<sup>12</sup>

#### CONCLUDING REMARKS: THE MANY FACES OF HISTORICAL EXPLANATION

Given the variety of *explananda* in the essays under discussion, from the career of a book (Portuondo) to the troubles of a contemporary large-scale scientific project (Theunissen), it is, perhaps, a little surprising that the corresponding explanations are carried out in a similar way: by telling stories. Of course, the stories are of very different kinds, involving different historical subjects, ranging from Copernicus and Galileo to a seed (!), and different explanatory strategies, from detective-like tactics (Westman, Curry) to sophisticated theorizing about the nature of historical causation (Schuster, Stark).

What conclusions can we draw from all this variety? In explaining past scientific life, we may focus on individuals (particular actors, texts, and objects) or on communities. With a few exceptions (e.g., Shank, Theunissen), the contributors here focus on the former. They attempt to make sense of specific texts (Steele, Portuondo), particular objects and innovations (Curry, van Lunteren), and the behavior and decisions of individual actors (e.g., Westman, Heilbron, Schuster, Bycroft, and Weidman). In understanding human actors it is clear, I think, that we should avoid the Scylla of a sociology that portrays actors as mere puppets that are

<sup>10</sup> For details about these conditions see *ibid.*

<sup>11</sup> Cf. Shapin, "Discipline and Bounding" (cit. n. 6), pp. 355–357.

<sup>12</sup> This is very similar to Kuhn's method of interpreting older and apparently nonsensical scientific texts. See Thomas S. Kuhn, *The Road since "Structure": Philosophical Essays, 1970–1991, with an Autobiographical Interview*, ed. James Conant and John Haugeland (Chicago: Univ. Chicago Press, 2000), p. 59ff.

pushed around by overpowering social and cultural forces. Here I'm in full agreement with Schuster. At the same time, we should steer away from the Charybdis of portraying actors as free-floating individuals who can transcend the possibilities available to them. It still seems to me that a sensible middle way between these two extremes is suggested by Marx's well-worn dictum: "Men make their own history, but they do not make it just as they please; they do not make it under circumstances chosen by themselves, but under circumstances directly encountered, given and transmitted from the past."<sup>13</sup>

Those circumstances include the intellectual and material resources that are available to historical actors and the constraints faced by them (Vetter). Resources and constraints circumscribe the options that are open to them, without however necessarily forcing them to choose any particular one. Different actors, with access to similar resources and subject to similar constraints, may nevertheless act differently. This is illustrated by the case of physicists in Weimar Germany, made famous by Paul Forman. Even though Weimar physicists were subject to strong social and cultural pressures, as Forman strenuously argued, their responses to those pressures, *pace* Forman, were far from uniform.<sup>14</sup> Thus, cultural resources and constraints merely delineate a space of possibilities, within which the trajectory followed by a historical actor can be explained in light of his or her theorized personality and project of inquiry. In light of this picture of explanation, the prospects of causal explanation in history of science are rather dim. A cause determines, if only probabilistically, its effect. I doubt that anything of that sort can be found in history of science.<sup>15</sup>

The language of resources and constraints is also useful for understanding large-scale collective endeavors. For instance, a strong case can be made that the epistemic, financial, material, and organizational resources of the United States enabled the Manhattan Project and should thus be incorporated in the explanation of why the atomic bomb was developed there. On the other hand, the absence of some of those resources in Germany or Japan may help explain why the bomb was not developed (and could not have developed) in those countries.<sup>16</sup>

In closing, I would like to repeat a plea for pluralism in historiography that I have made elsewhere.<sup>17</sup> The rich variety of approaches to explanation in this Focus section attests to the pertinence of a pluralist historiographical vision for the future of our explanatory enterprise. Depending on a historian's interests, skills, sensibilities, and subject matter, her or his choices of *explananda* and explanatory strategies may legitimately differ.

<sup>13</sup> Karl Marx, *The Eighteenth Brumaire of Louis Bonaparte* (New York: International, 1963), p. 15.

<sup>14</sup> See some of the contributions in Cathryn Carson, Alexei Kojevnikov, and Helmuth Trischler, eds., *Weimar Culture and Quantum Mechanics: Selected Papers by Paul Forman and Contemporary Perspectives on the Forman Thesis* (London: Imperial College Press, 2011).

<sup>15</sup> Cf. Weidman's reflections on World War II as the context, and not the cause, of Ashley Montagu's change of opinion regarding the biological roots of human behavior.

<sup>16</sup> See, e.g., Andrew J. Rotter, *Hiroshima: The World's Bomb* (Oxford: Oxford Univ. Press, 2008).

<sup>17</sup> See Theodore Arabatzis, "Causes and Contingencies in the History of Science: A Plea for a Pluralist Historiography," *Centaurus*, 2008, 50:32–36.