Permanent Revolution
In Science: A Quantum Epistemology

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Abstract
This article is the preface to the Russian translation of my Kuhn vs Popper. I use it as an opportunity to re-examine the difference between Kuhn and Popper on the nature of ‘revolutions’ in science. Kuhn is rightly seen as a ‘reluctant revolutionary’ and Popper a ‘permanent revolutionary’. In this respect, Kuhn sticks to the original medieval meaning of ‘revolution’ as restoration of a natural order, whereas Popper adopts the more modern meaning of ‘revolution’ that comes into fashion after the French Revolution, which suggests a radical renewal. A key to understanding this difference in revolutionary mentalities lies in Kuhn’s and Popper’s respective treatment of the ‘Gestalt switch’ phenomenon. Kuhn sees the ambiguous Gestalt figure from the standpoint of the subject, and Popper from that of the experimenter. Behind this difference lies alternative interpretations of the significance of quantum mechanics for scientific epistemology, a preoccupation that Kuhn and Popper shared with the original Gestalt psychologists and is beginning to engage the interest of social scientists.

Keywords
Gestalt, Kuhn, Popper, quantum, revolution

What follows is the preface to the Russian translation of my Kuhn vs. Popper: The Struggle for the Soul of Science (Fuller 2003), which has now been published in eight languages and nine editions. The Russian translation,

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Karl Popper and Thomas Kuhn were the two most influential theorists of science of the 20th century. However, given that more than a generation has passed since they died (1994 and 1996, respectively), it is worth quickly recalling some of their many differences. To be sure, both lived in the shadow of two World Wars and survived the Cold War. This was the period when science’s long-promised capacity to transform the human condition was finally realized—for both good and ill. Against this common backdrop, Popper, roughly a generation older than Kuhn, had a less discipline-based—and perhaps even less professional—understanding of science. For him, “science” was the name of a potentially universal attitude rather than a set of socially specific techniques. For Kuhn, the opposite was the case. Whereas Popper basically saw the scientific attitude and liberalism as alternative expressions of the “open society,” Kuhn traced science’s unique epistemic strength to its authoritarian if not totalitarian structure, which commits to a line of inquiry until it fails on its own terms. Both admired Einstein but for different reasons. For Popper, Einstein was the great falsifier of Newton; for Kuhn, he was the great replacer of Newton. Behind these contrasting judgments lay radically different sensibilities about the “revolutionary” dimension of science. Popper made the Trotskyite slogan “permanent revolution” his own, whereas Scientific American editor John Horgan (1991) got the measure of Kuhn toward the end of his life by calling him a “reluctant revolutionary.”

Popper was clearly a more radical thinker than Kuhn, but that point never seemed to break through in the debates in which they and their proxies participated—even though Popper’s followers (e.g., Paul Feyerabend, Imre Lakatos, Joseph Agassi) were also more radical than Kuhn’s followers, who are the underlaborers and ethnographers of science who nowadays dominate the fields of philosophy of science and science and technology studies. An important reason for Popper’s rhetorical misfiring is relatively mundane. Beyond a logically trivial statement of “falsifiability” (i.e., *modus tollens*), he never really proposed a “template” for his view of science. As in the case of many other philosophers, Popper’s readers were simply meant to infer his positive position from his many examples and discussions. In striking contrast, perhaps because *The Structure of Scientific Revolutions* was commissioned to be part of an encyclopedia, Kuhn ([1962] 1970) quite explicitly identified science with what he called a “paradigm,” which has certain intrinsic qualities and is subject to a specific developmental process. Indeed, much to Kuhn’s own horror, many traditionally nonscientific disciplines saw in *Structure* a “recipe” for turning their activities into sciences.

It is worth lingering over the term “revolution” because Kuhn’s followers saw him as “revolutionizing” our understanding of science, even though he
intended no such thing. However, Kuhn’s conception of “revolution” was true to the word’s Latin roots in meaning a return to the starting point, a restoration of the natural order, offered in the spirit of a cyclical view of historical change. This was how Thomas Aquinas and other medieval political thinkers had understood the meaning of “revolution.” Indeed, Kuhn’s first book—on the so-called “Copernican Revolution” in astronomy—attempted to tease out the extent to which Copernicus’ own appeal to “revolution” to describe the planetary orbits was modern or ancient. The sensibility informing Popper’s appropriation of Trotsky’s “permanent revolution” could not be more different. That phrase originated not with Trotsky but with someone who reveals Popper’s and Trotsky’s common intellectual ancestry: the French classical liberal publicist Charles Comte (1782-1837), who should not be confused with Auguste Comte, the founder of positivism and sociology—though their paths did cross, when Auguste as a young follower of Saint-Simon published in Charles’ periodical.

When Charles Comte referred to “permanent revolution,” he meant the 1789 French Revolution as a profound failure on its own terms while still providing the basis on which something similar should be attempted in the future—now equipped with the knowledge provided by that failure. The conservative political theorist Eric Voegelin (1974) rightly identified Comte as a linchpin between liberalism and what Voegelin demonized as the “gnostic” sensibility that aims to overturn all established orders, which in the 20th century eventuated in both Communism and Fascism. However, true liberals would regard Comte more benignly as expressing the sentiment, “If at first you don’t succeed, try, try again.”

Nevertheless, in light of the Kuhn–Popper debate, this sentiment has not been received among philosophers of science quite as benignly as one might have hoped. I refer here to the preoccupation with avoiding “ad hoc hypotheses,” namely, the rather minimal corrections that a scientific theory’s proponents are inclined to make in the wake of falsification in order to continue promoting the theory. Historically, this practice is associated with Ptolemaic astronomy, which was maintained for 1,500 years by adding mathematical devices (“epicycles”) that accounted for predictive discrepancies while keeping Ptolemy’s geocentric model intact, because it had been deemed to be correct in general and perhaps even in principle. In retrospect, the ultimate triumph of the Copernican worldview was seen as having taken too long to arrive, which in turn suggested the presence of some sort of mental bias that prevented people from abandoning their cherished Ptolemy to embrace a radical alternative that nevertheless fit the facts better. This style of diagnosis suited the “science vs. religion” narrative of the history of science that emerged in the third quarter of the 19th century in the wake of Darwin’s *Origin of the Species* and the Vatican’s release of the transcripts of Galileo’s trial. To be sure, Ptolemy had continued to be promoted in some Roman
Catholic science teaching as late as the 18th century, while the followers of Copernicus—himself a Catholic cleric—had felt compelled to present his work as a “mere” hypothesis when it was originally published in the 16th century in order to avoid persecution. Yet, interestingly, Copernican astronomy was promoted by 17th-century Jesuit missionaries to China, even though it had yet to be accepted in their European homeland!

The liberal policy that “If at first you don’t succeed, try, try again” has been subverted by this narrative of the Copernican Revolution, which is told exclusively from the standpoint of present-day science. Accordingly, the defenders of Ptolemy occupy the role of those trying “too hard” to succeed, which is based on the simple fact that notwithstanding their efforts they were eventually replaced by the Copernicans. More to the point, the Ptolemaists are portrayed as having been destined to fail, supposedly because they resorted to “ad hoc hypotheses,” signifying the limited nature of their adjustment to empirical failure. And while there is a large grain of truth to that diagnosis, if we left the matter there, we would fail to appreciate that theories facing falsification often adjust well to failure, carry on, and sometimes achieve paradigmatic domination. Indeed, this point epitomizes the contribution of Popper’s student Imre Lakatos, who staged the original Kuhn–Popper debate in London in 1965, which provided the pretext for my *Kuhn vs. Popper* (Fuller 2003). Lakatos’ (1970) core intuition was that every theory is born “always already” refuted insofar as its evidence base is initially parasitic on whatever happens to be the dominant theory in that field at the time. In that respect, the upstart is simply reinterpreting the orthodoxy, however radically. This was certainly true of Copernican astronomy, which mainly reinterpreted the already existing evidence. It was only with Galileo’s, Kepler’s, and Newton’s modifications and supplementations that Copernicus’ theory began to be seen as a clear successor to Ptolemy’s.

A big part of that shift involved changing the rules of the game of science. It became easier to see Copernicus as superior to Ptolemy once astronomy was no longer seen as simply a navigational device (in which case starting with oneself on Earth as the center of calculations makes sense) but as a branch of physics, understood as a universal science of material motion. This move is comparable to the trigger moment in the famous Gestalt switch experiments, whereby the experimenter induces the subject to see an ambiguous figure as, say, a duck rather than a rabbit. Historically speaking, the relevant “inducement” involved relaxing the religious proscriptions against astrology, which was ultimately an attempt to unify human understanding of material motion in the Heavens and on Earth by imagining that whatever happens in the former has some direct impact on the latter, hence the preoccupation with the “star sign” of one’s birth.
It is easy nowadays to forget the significance of the Gestalt movement in psychology in the middle third of the 20th century, including on the theories of scientific change put forward by both Kuhn and Popper. Popper’s PhD in Vienna was supervised by the Gestalt psychologist Karl Bühler, and Kuhn credits Jerome Bruner’s Harvard experiments for his understanding of “theory-laden observation.” The big difference between them was that Popper saw matters from the standpoint of the experimenter and Kuhn from that of the subject in one of those Gestalt experiments (Fuller 2000, chapter 6). This difference in perspective reflected the latent liberal versus conservative bias in their respective understandings of science. Whereas Popper stressed the need to try to break the established paradigm, Kuhn was more impressed by the sheer fact that such paradigms have existed and persisted.

While undoubtedly the Kuhn–Popper debate does not loom as large now as it did when I was a student of the history and philosophy of science 40 years ago, the terms of the debate continue to resonate throughout the intellectual arena, which is probably why Kuhn vs. Popper was such an initial success. In this spirit, I would like to extend the discussion of “ad hoc hypotheses” discussed above from particular scientific theories to entire sciences, if not science itself.

When people want to dismiss failed scientific theories as “religious” or “cult-like” in their continuation, they often imagine the treatment of “ad hoc hypotheses” along the lines of the social psychologist Leon Festinger’s seminal When Prophecy Fails, which recounts a millenarian religious group that manages to survive its prediction of the world’s end (Festinger, Riecken, and Schachter 1956). However, philosophical readers of this book have not necessarily drawn the right lessons. Once the group failed to predict the end of the world, it resorted to neither of the usual philosophical strategies: the group neither abandoned its core beliefs nor simply offered another date for the end of the world. Instead, it used the prophetic failure as an opportunity to rethink its core beliefs, including a reorientation of its relationship to God. In the end, the group chastised itself for having second-guessed what only God can decide, so they stopped making predictions.

Of course, those lacking sympathy for the group might prefer that it had given up its beliefs altogether, perhaps even with Popper’s blessing. This is what Lakatos called “naïve falsificationism.” Nevertheless, on Festinger’s telling, the group members came to a deeper understanding of those beliefs, which enabled them to operate more effectively in what remained a hostile world. Festinger coined the phrase adaptive preference for this sort of response, as it involves a bending of what is desirable to what is feasible. In short, hopes were proportioned to expectations, resulting in a more “realistic” attitude to the world, which was expressed in the group’s new doctrine. Festinger regarded this case as a vivid but normal instance of his famed
“cognitive dissonance” theory, which he took to be a general feature of human psychology.

To be sure, adaptive preferences are normally classed as “rationalizations,” but we should understand this phrase ambiguously until sufficient time has passed to see the consequences. Radical scientific and technological change has involved adaptive preference formation on a mass scale, as most objections to new theories and practices were known before they became dominant. However, over time, those negatives were discounted in light of the positives they registered for those who adopted them. And unless one holds that the history of science and technology has been one gigantic mistake, this pattern of response would seem to vindicate the classical liberal view as updated by Trotsky and Popper: “If at first you don’t succeed, try, try again.” Indeed, this view may also provide an implicit answer to an obvious question that can be asked about the aftermath of the Second World War: why did not the Holocaust and Hiroshima spell the end of research into human genetics and nuclear physics? After all, it is generally agreed that these unprecedented atrocities would not have been possible without the relevant scientific backing and technological capability.

To be sure, these events triggered an enormous literature on evil in the second half of the 20th century. Moreover, the United Nations Universal Declaration on Human Rights was drafted as a significant response. And although the Declaration has been effective in motivating the prosecution of war-related “crimes against humanity” over the past 70 years, it has left the original offending sciences untouched. More to the point, the likelihood of human genetics or nuclear physics becoming outlawed decreases over time simply because their benefits to us have increased to such an extent that we may end up having to rely on them for health and energy. As Festinger might have predicted, we have deemed the worst effects of these sciences to have already happened. They are treated as “sunk costs,” as economists say. Moreover, much of the sciences’ original “evil” resulted from a failure to anticipate their potential for evil. Thus, their “evil” is treated as the occasion for a deep learning experience rather than a simple expression of malice or even negligence on the part of the relevant scientific communities. And while human genetics or nuclear physics may still cause disasters for humanity in the future, such harms would need to be on a much larger scale and under conditions very much unlike the Second World War to result in a termination of those fields.

Interestingly, the histories of both human genetics and nuclear physics tend to be told with a strong distinction between the overriding “internal” factors that have driven their development and the “external” factors that have periodically interfered with that development. Internal factors are presented as “cognitive,” which means that they are primarily about understanding some aspect of reality, while external factors appear as “socioeconomic,” “political,” or simply “affective,” all implying some sort of partisan if not
malign influence. Thus, the Holocaust is presented not as a natural outgrowth of human genetics research but as the result of “eugenics,” which nowadays refers to little more than the rogues’ gallery of genetics. Similarly, in the case of the Hiroshima, one downplays the fact that one of the greatest contributors to nuclear physics, Werner Heisenberg, probably inspired the Nazis to develop an atom bomb, in response to which Einstein and other anti-Nazi major scientific contributors persuaded the United States to follow suit. Instead, historians focus on the role played by U.S. scientist-administrators, such as Kuhn’s mentor, Harvard president James Bryant Conant, and second-generation contributors to nuclear physics who turned into Cold War hawks, such as Edward Teller. Yet, to the dispassionate eye, such distinctions between what lies “inside” and “outside” the proper development of a science are self-serving—which is to say, serving the interests of those of who draw upon the science’s legitimacy.

In 2019, on the occasion of the 150th anniversary of arguably the world’s leading scientific periodical, *Nature*, I remarked on the historically shifting boundary of the popular version of the internal/external distinction—namely, “science” and “scientism,” where the latter implies a misuse of science (Fuller 2019). Both Kuhn and Popper were very much exercised by this boundary, but from opposed standpoints, which perhaps serves best to characterize their ultimate differences. In light of the very innovative work of the U.S. international relations theorist Alexander Wendt (2015), I would now characterize this difference in terms of *quantum epistemology*, by which I mean not the epistemology of quantum mechanics but epistemology as conceptualized from the standpoint of quantum mechanics (Fuller 2018a). More specifically, I mean that the world is taken to be “underdetermined” with regard to both the past and the future until a decisive event serves to stabilize the causal pathways that lead both backwards and forwards from the event, at which point it becomes “overdetermined” (Fuller 2015, chapter 6). What we call “reality” is the result of this “stabilization,” which once institutionalized creates barriers to the conduct of another such “decisive event” in the future.

Nevertheless, such events do continue to happen, and hence reality’s set point is continuously recalibrated. No “realism” worth its salt can ignore this fact, a point on which Hegel and Popper are in secret agreement. Thus, Popper regarded the agreed state of play in science at any moment as no more than a “convention” that is always ripe to be overturned and replaced. In contrast, Kuhn welcomed science’s consolidation around an agreed state of play as a “paradigm.” In a more recent book, *Post-Truth: Knowledge as a Power Game*, I discuss this matter in terms of modal power, which is not about mastery over the facts as such but what metaphysicians call their “modality” (Fuller 2018b). Modality is epitomized in a set of questions that might be asked of the facts: did they have to be as they are? Do they need to continue as they are? How else could they be? The original Gestalt experiments were predicated on just such a modal sensibility to reality. This is
perhaps unsurprising, given that one of the school’s founders, Wolfgang Köhler, had been a student of the founder of quantum mechanics, Max Planck. Moreover, both Popper and Kuhn demonstrated a sustained interest in quantum mechanics. The books that Popper published late in his career that he described as “postscripts” to his first book, *The Logic of Scientific Discovery*, are largely about explicating the “open world” that he believed quantum mechanics made possible (Popper [1935] 1959, 1982). As for Kuhn, his only major historical work after the publication of *The Structure of Scientific Revolutions* was on the late 19th- and early 20th-century origins of quantum mechanics (Kuhn 1978).

But more to the point, Kuhn’s and Popper’s interest in the epistemology of quantum mechanics turned them into quantum epistemologists. Both Popper’s preoccupation with the active construction of “crucial experiments” and Kuhn’s remarks about the scientific establishment’s “Orwellian” approach to its own history are symptomatic of this mentality. Understood in quantum epistemological terms, the main difference between them is that Popper looks at things from the standpoint of the prospective revolutionary and Kuhn from that of the successful revolutionary: put another way, Schrödinger’s cat before and after the conduct of his fabled experiment. Whereas Kuhn explained the conditions under which the cat, say, died (i.e., the actual conduct of the experiment), Popper explained the conditions under which the cat need not have died (i.e., the design of the experiment before it was conducted). Moreover, the more that subsequent events are predicated on the cat’s death, the more likely that it will appear to have been necessary. That sums up how a decisive achievement in the history of science—such as Newton’s *Principia Mathematica*—became the basis of a Kuhnian paradigm, in terms of which the next 200 years of physics were determined. This is Kuhn’s revisionist “Orwellian” historiography in action. In contrast, the Popperian aims to deconstruct that historiography by returning its apparent “necessity” to its contingent origins by staging another “crucial experiment” that forces the paradigm to reestablish itself once again. That is the essence of Popper’s “falsifiability” principle, the basis of the “permanent revolutionary” approach to science.

From this perspective, Paul Feyerabend’s *Against Method* can be understood as an attempt to falsify the positivist metanarrative of science—to which Popper himself still somewhat adhered. According to this metanarrative, science progresses by following methodological principles such as testing hypotheses against empirical evidence. Feyerabend (1975) notoriously proposed Galileo as a counterexample to this conception of progress, namely, someone who basically overstated his knowledge claims and perhaps even fabricated evidence—all in violation of the methods of both his times and ours. Nowadays, he would be judged a “fraud.” Even in his own day, he was caught by the Papal Inquisition, who sentenced him to house arrest. Yet,
Galileo is celebrated today as one of the great heroes of science because we regard his claims as largely correct—but less due to his own work than to subsequent work, especially by Newton, who managed to incorporate Galileo’s unproven insights into the first truly modern universal theory of physical reality. However, from a Popperian standpoint, it is entirely possible that a future “Grand Unified Theory of Everything” might not be so beholden to the legacy of Newton (as, say, Einstein still was) and hence not require what Newton had identified as Galileo’s contributions. After such a scientific revolution, the hero might return to his original status of a fraud. Such are the vicissitudes of the quantum struggle for the soul of science that the original struggle between Kuhn and Popper began to highlight.

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