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INTRODUCTION

Feyerabend and the Philosophy of Physics, Part II

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Paul K Feyerabend's engagement with physics started before his engagement with philosophy, and he continued to think about new developments in physics until the end. To understand Feyerabend's philosophy, therefore, it is crucial to understand his views on physics, many of which have remained unpublished until now. Doing so pays off, not only in helping us to understand the history of philosophy of science, but also insofar as it opens up new resources for contemporary philosophy of physics. The papers collected in this special issue demonstrate just how impactful such a project can be.

This special issue arrives in two parts, each collecting four papers. The first half was published online in 2022 (introduction here, Shaw and Stuart 2022). This is the introduction for the second half.

The first two papers revisit contemporary issues in the philosophy of quantum mechanics through a Feyerabendian lens. These are: 'Tightrope-Walking Rationality in Action: Feyerabendian Insights for the Foundations of Quantum Mechanics' by Daniele Oriti, and 'Realism with Quantum Faces: The Leggett-Garg Inequalities as a Case Study for Feyerabend's Views' by Elise Crull. The third and fourth papers shed new light on Feyerabend and the history of philosophy of physics. These are 'The Challenge of Quantum Mechanics to the Rationality of Science: Philosophers of Science on Bohr' by Marij van Strien, and 'From Quantum Holism to the Disunity of Science and Social Activism: The Cat-Feyerabend Correspondence' by Jordi Cat and Jamie Shaw. Together, these papers reveal the variety of ways in which Feyerabend's thought and philosophical issues in physics interrelate and can be resources for modern philosophy.

'Tightrope-Walking Rationality in Action: Feyerabendian Insights for the Foundations of Quantum Mechanics' by Daniele Oriti aims to reconstruct Feyerabend's attempt to walk several tightropes, to use Farrell's (2003) metaphor. This meant recognising compelling arguments for contradictory positions on fundamental theories in quantum mechanics: realism vs. instrumentalism, philosophical vs. physical arguments, and hidden variables vs. complementary. This wavering back and forth between viewpoints, Oriti argues, is a part of Feyerabend's anti-dogmatic approach reminiscent of the Sophists, who Feyerabend praises, for making the 'weaker case the stronger' and thereby 'sustaining the motion of the whole' (Feyerabend [1975] 1993, 21). Similarly, recalling Einstein's contention that a 'good joke (such as the considerations leading to the special theory of relativity) should not be repeated too often' (fn. 6 138), Feyerabend insists that dogmatism can come in any guise, and any particular perspective one chooses

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might become sterile if taken as conclusive. This, for example, happened to the 'Copenhagen' school which began with Bohr's admirable pluralism and open-mindedness and degenerated into positivistic slogans, on Feyerabend's account. Oriti goes on to suggest that modern ideas in relational quantum mechanics are anticipated by Feyerabend's appraisal of Bohr, showing how a partial realism and 'relational objectivity' remains possible without the dogmatism or finality often associated with realism. Further, this position can explain away the EPR paradox without sacrificing locality or the completeness of quantum mechanics. Oriti goes on to continue Feyerabend's account of the transformation of Bohr's ideas via the Copenhagen school to contemporary research, including QBism and some approaches to quantum information theory, showing how they really lead to a kind of realism rather than the instrumentalism or positivism associated with the Copenhagen school during the mid to late twentieth century. Oriti further draws parallels between Feyerabend's earlier work (i.e. pre-1981) and contemporary work on perspectival pluralism (e.g. Massimi 2022). Overall, Oriti's paper provides a *tour de force* on Feyerabend's methodological arguments on a wide variety of topics and relates them to historical and contemporary issues in the interpretation and development of modern quantum theory.

Elise Crull's paper ('Realism with Quantum Faces: The Leggett-Garg Inequalities as a Case Study for Feyerabend's Views') revisits Feyerabend's stances on realism, pluralism, and anarchism in light of the Leggett-Garg inequalities (LGIs). The LGIs were explicitly constructed as temporal analogies to Bell's inequalities, and new work in physics continues to raise philosophical questions about what violations of these inequalities might imply, and how we should think about that analogy. Crull adopts Chang's (2021) reading of the later Feyerabend as both pluralist and realist, and shows how the state-of-the-art concerning the LGIs would have vindicated Feyerabend, as it profits from being both pluralist and realist. Specifically, there are different ways of understanding the inequalities, and different ways of setting up experiments to test them, which we might interpret as motivating separate realisms and separate methodologies. Crull points to three central lessons for the modern Feyerabendian. First, beyond indicating the live possibility of quantum realism, the LGIs suggest novel experiments that increase testability, a feature of science which Feyerabend thought was characteristic and crucial. Further, despite their original intention, the LGIs do not rule out an entire class of realist theories, but provide a more modest qualification for quantum realism. This, Crull suggests, favours Feyerabend's brand of falsificationism over Popper's. It further sharpens the definition of measurements to be more sensitive to temporal considerations than Bell's inequalities. This increased testability, Crull further claims, is heightened by the theoretical and methodological pluralism enabled by the LGIs. Interdisciplinary methodological pluralism is the third lesson, where the LGIs motivate sharper experimental tests of classes of realism, and raise novel challenges for classical causality.

Marij van Strien, in her 'The Challenge of Quantum Mechanics to the Rationality of Science: Philosophers of Science on Bohr', zooms out to consider the impact Bohr's work had not only on Feyerabend but other pivotal figures in twentieth century philosophy of science, including Kuhn, Popper, and Lakatos. She specifically reconstructs Popper's grievances about the seeming subjectivism and anti-realism inherent in Bohr's approach. The accusation of subjectivism in particular is grounded in Popper's contention that Heisenberg's uncertainty relations were interpreted via a Pascalian notion where probability

reflects ignorance, rather than objective propensities in nature. Despite Popper's personal appreciation of Bohr's personality and his insecurity about being a philosopher dictating to physicists from the armchair, he continued to denounce various aspects of Bohr's approach even accusing his response to the EPR paradox ad hoc. Building off of the work of others (e.g. Kuby 2021), van Strien covers Feyerabend's changing attitudes towards Bohr. While Feyerabend began as more of a Popperian, his approach was more methodological—focusing on the increased testability afforded by realist approaches to quantum mechanics. Feyerabend eventually turns his back on Popper and claims we should go 'back to Bohr', arguing that Bohr's complementarity principle was not a philosophical dogma—as Popper contended—but the result of good physical arguments. This shines light on Feyerabend's increasing dissatisfaction with purely philosophical approaches, seeing scientific practice as something that contains its own rationality that can only be disturbed if understood in detail. Lakatos was less talkative about Bohr, but he certainly did not appreciate Feyerabend's ad hominem arguments in his paper criticising Popper and defending Bohr. He did have an in-depth case study of Bohr's atomic theory, showing how Bohr fruitfully used inconsistent theories, *pace* Popper. Treading a path in between the overly strict Popperian norms, insisting on consistency through-and-through, and the chaos Feyerabend promoted to give up on consistency altogether (Lakatos maintained that the inconsistency must *eventually* be removed, cf. Seselja 2017). Finally, van Strien comments on the 'remarkable' silence of Kuhn in *Structure* on quantum mechanics despite Kuhn completing his PhD in physics. While Kuhn-the-historian wrote extensively on historical issues in the development of quantum mechanics (specifically on blackbody radiation research at the turn of the twentieth century (Kuhn 1978) and his ambitious interviewing project of many pioneers of quantum mechanics), Kuhn's normatively tinged *Structure* says nothing precisely because Kuhn saw 'outside' philosophical criticisms as fruitless distractions. With regards to Bohm's approach in particular, Kuhn's sympathies did not lead him to defend it but saw it as bound to fail precisely because it didn't help physicists solve technical puzzles. While Kuhn and the later Feyerabend shared the preference for scientific arguments over philosophical ones, they continued to disagree about what this meant for the normative role of philosophy in science.

Cat and Shaw's paper ('From Quantum Holism to the Disunity of Science and Social Activism: The Cat-Feyerabend Correspondence') includes a previously unpublished correspondence between Jordi Cat and Feyerabend from the late 1980s up until a few weeks before Feyerabend's death in 1994, and a commentary placing the content of this correspondence in light of Feyerabend's later thought on quantum mechanics, reductionism, pluralism, and social activism. This is important, because while Feyerabend's early works are dominated by technical issues in the philosophy of physics and his mature works contain many historical and (then) contemporary examples from the physical sciences, Feyerabend's later works involve sparser references to physics. The Cat-Feyerabend correspondence published here reveals how Feyerabend continued to be interested in ongoing developments in physics in the 1980s and 1990s. Specifically, we see his admiration for the logical-algebraic approach developed by his Swiss colleague Hans Primas (1984). This provided, for Feyerabend, a window for thinking about broader issues about reductionism, inter-theory relations, and even the place of science in society. Primas' approach is used to model general philosophical issues about the disunity of

science and the political implications for science-society interfaces. Additionally, the commentary provides original analyses of the philosophical bases of these letters to better understand Feyerabend's position with regards to logical empiricism, especially the works of Otto Neurath, and John Dupré's (1983, 1993) work on the disunity of the sciences.

Overall, these four papers, together with the four from the first part of this special issue, help paint a more complete picture of the Feyerabend-physics relationship, and move philosophy of science forward in a number of ways. They bring to light previously unpublished historical texts (Collodel 2022; Feyerabend 2022; Kuby and Fraser 2022; Cat and Shaw 2024). They draw on these and other recently published historical materials to provide fresh new accounts of the history of philosophy of science (Del Santo 2022). They offer new historical perspectives on Feyerabend (e.g. via dadaism, Kent 2022). They unearth and analyse Feyerabend's only technical contribution to physics (Kuby and Fraser 2022). They mine Feyerabend's work for insights applicable to issues in contemporary philosophy of physics (Crull 2024; Oriti 2024). And they place Feyerabend's engagements with quantum mechanics in dialogue with other historically significant philosophers (Van Strien 2023). Despite the insight of these contributions and more recent scholarship (e.g. Heilbron 2024), it is becoming increasingly clear that we are just scratching the surface.

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