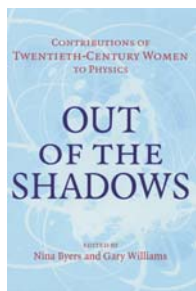


UCLA; Williams's research is in low-temperature physics, and he is a professor in the department of physics and astronomy, also at UCLA. The physics they cover in the book is quite broadly defined; included are women who have worked in areas as diverse as biophysics, crystallography, geophysics, mathematical physics, cosmic-ray physics, and physical chemistry. Essays are arranged chronologically, and each were written by a practicing scientist or science historian familiar with the specific subject. In several cases the writer is a family member of the woman being profiled. Each essay is divided into three parts: science, biography, and bibliography. It is admirable and distinctive to first cover the stories of important physics discoveries whose provenance has in many cases been forgotten. Yet the book's separation of science from biography may be why several of the essays are redundant in the scientific and biographical parts: The work one does is not neatly separable from the social conditions under which that work is produced. Gender is hardly irrelevant when considering what these particular physical scientists were able to accomplish.

The collection of essays begins with science historian Joan Mason's description of the innovative work of Hertha Ayrton (1854–1923) with carbon arc lamps. Ayrton's groundbreaking text, *The Electric Arc*, was published in 1902, the same year in which the Royal Society “pronounced that a married woman was not a ‘person’ eligible for fellowship under the Charter” (page 21).

Similarly fascinating is Jean-Pierre Adloff and George B. Kaufman's story behind the discovery of francium in 1939 by Marguerite Catherine Perey (1909–75). It was not until 1962 that Perey was elected to the Paris Academy of Sciences. She was the first woman to be elected; even Nobel laureates Marie Curie and her daughter, Irène Joliot-Curie, had been denied admission. Those facts speak volumes about the attitudinally challenged conditions under which Perey worked.

David Cline's essay on prominent particle physicist Sau Lan Wu, a professor of physics at the University of Wisconsin–Madison, is the final profile in the book. Wu was admitted to Harvard graduate school in 1963, but she was not permitted to enter the men's dorm, where she might have joined her classmates in study sessions. She was the only woman in her entering class. Wu was permitted to attend commencement



ceremonies when she received her master's degree the following year; she was not, however, allowed to attend the celebratory lunch afterwards. Tradition simply did not permit such a thing. Despite the affront, Wu returned to Harvard to complete her PhD.

The women described in the essays are nothing if not persistent. Several express reluctance—perhaps necessary to their successes—to dwell on the barriers they faced: Bertha Swirles Jeffreys (1903–99), about whom Ruth Williams writes, “quite emphatically” stated that she would have preferred to be profiled “in a book entitled ‘Contributions of *People* to Twentieth-Century Physics’” rather than in one emphasizing work done by women (page 189).

Although barriers to women's work in physics did erode during the 20th century, physics lags behind other sciences in the percentage of women attaining degrees in the discipline. For example, the American Institute of Physics has statistics that show that in 2001 approximately 46% of high-school physics students were female (<http://www.aip.org/statistics>). Four years later, only about 23% of bachelor's degrees in physics went to women.

As an incentive for young women to pursue physics, and for their instructors to encourage them, *Out of the Shadows* could be more useful in a key area: It needs a collective bibliography. The insights provided by the essayists are crucial in explaining succinctly—occasionally too succinctly—the major accomplishments of each of the women profiled. However, the bibliographies associated with the essays are uneven and generally lack familiarity with the work of historians of science. The book features no women who were born after 1950. Clearly, the question “What challenges are going to face me when I go to graduate school?” did not cease to be relevant for women physicists in 1976.

Students whose interests are piqued by *Out of the Shadows* would benefit from references to other sources, in print and on the Web, that would bring the story of women in physics into the 21st century. The book does cover a lot of ground. Some readers might be surprised to find a few names missing—perhaps Rosalind Franklin, for one; on the other hand, many stories of women physicists whose contributions have not been adequately profiled elsewhere are in the book. Despite its ambivalence in addressing the issue of gender in the scientific community, *Out of the Shadows*

is a worthwhile contribution to the overall story of the rise of modern physics.

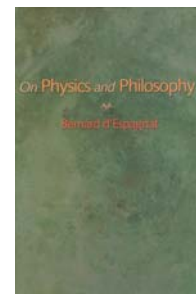
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On Physics and Philosophy

Bernard d'Espagnat
Princeton U. Press, Princeton, NJ,
2006. \$35.00 paper (503 pp.).
ISBN 978-0-691-11964-9

Bernard d'Espagnat is well known for his work, principally from the 1970s, on the foundations of physics and his subsequent attempts to construct a philosophical edifice on top of those foundations. If his *Veiled Reality: An Analysis of Present-Day Quantum Mechanical Concepts* (Addison-Wesley, 1995) represents the basic frame of that construction, then his latest book, *On Physics and Philosophy*, can be seen as an elaboration of the galleries and French doors that link the edifice's philosophical rooms and alcoves. Some of those rooms and alcoves are open-sided; others are closed off and apparently lead nowhere.

The first half of d'Espagnat's book surveys the physical foundations, the standard bricks and mortar of philosophical discussions: Bell's theorem, nonlocality and nonseparability, decoherence and de Broglie-Bohm theory, Erwin Schrödinger's cat curling round the feet of Eugene Wigner's friend who performs the famous thought experiment, and so forth. What is missing, however, are the iron rods of mathematical equations. Although the attempt to make the book accessible to a general audience is admirable, the rococo curlicues of d'Espagnat's discursive style snag one's progress through his argumentation. The conclusion that d'Espagnat reaches is that although instrumentalism and idealism are too cheap and thin to be taken seriously as appropriate philosophical attitudes, “standard” realism, with its objective, mind-independent world informed by a classical metaphysics of individual objects and local action, cannot sit comfortably on the piles driven down by the physics. The piles are shaped by entanglement, the concomitant notion of nonseparability, quantum statistics, and the often-drawn implication that



the fundamental objects of the world are nonindividual.

D'Espagnat's core notion of a "veiled reality" is proposed as fitting snugly on top of those physical foundations; the second half of the book is devoted to articulating that proposal further by comparing it with related positions, and defending it from criticism. The basic idea is reminiscent of Kantian views in that the central purpose of science is gaining knowledge not of "the Real" but of "phenomena." The Real, according to the author, lies beyond the phenomena and cannot be approached quantitatively, nor is it embedded in a spatiotemporal framework because that would imply nonlocality; it nevertheless exerts an influence on the phenomena. The grand laws of physics are "highly distorted reflections . . . of the great structures of 'the Real'" (page 455). The Real, although impossible to conceive, is non-separable; from it, both consciousness and empirical reality "co-emerge." Putting it crudely, what d'Espagnat proposes is a kind of transcendental realism grounded in quantum holism and hence fit for the modern age.

The ambitious reach of the book is impressive, and the tour of d'Espagnat's philosophical mansion is often illuminating and thought provoking. But

running through the edifice are cracks, papered over by the erudite language. He mentions "influence" and "reflection," words that have to carry a heavy, philosophical weight. And with d'Espagnat demoting the truth to the realm of "empirical" reality only, the relationship between laws and reality in particular needs shoring up with an appropriate notion of representation. In addition, other constructs, with cleaner lines and easier-to-grasp blueprints, can be built on the foundations of physics. Although central to his arguments, d'Espagnat's analysis of nonseparability and nonlocality fails to mention various resources that the realist can draw on. Paul Teller's "relational holism," for example, is driven by a similar feeling that object-oriented metaphysics is simply incapable of handling quantum entanglement, but by couching the quantum entanglement in familiar relational terms, Teller declines to place a veil between us and the world in the way d'Espagnat does.

Likewise, a number of realist-inclined philosophers have recently advocated approaches that focus on the structural aspects of reality, some of which have been explicitly designed to accommodate quantum phenomena. But d'Espagnat is perhaps too quick to

dismiss such views; he focuses on Henri Poincaré, whose work in the early 20th century was an early precursor of those approaches but has been superseded by recent developments in the philosophy of science (pages 370–373). The point is, metaphysically cheaper and simpler constructions are on the market, and neither philosophically inclined physicists nor scientifically aware philosophers need to mortgage themselves to the hilt by buying into such an elaborate structure as the author presents.

On Physics and Philosophy contains interesting aperçus and thoughtful commentaries suitable for both parties. Nevertheless, the philosophical inclinations of the physicist will have to be powerful indeed to push him or her through this often dense and, dare I say, entangled text.

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Acoustical Imaging. Vol. 28. M. P. André, ed. Proc. symp., San Diego, CA, Mar. 2005. Springer, Dordrecht, the Netherlands, 2007. \$229.00 (477 pp.). ISBN 978-1-4020-5720-5, CD-ROM

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