Strange Glow: The Story of Radiation FREE

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engineers at Langley and JPL faced incredible odds in pursuing personal and professional goals simultaneously, but I never got a sense of what either set of women meant to the programs for which they worked. What is quite apparent is the remarkable strength of the communities the women built to support each other inside and outside the workplace.

Although neither Holt nor Shetterly engages with the breadth of existing scholarship on race and gender issues at NASA or its predecessors, they forge new pathways for additional investigations. Taking a multibiographical approach does complicate their narratives, but those complications are necessary to relate the stories. The female technical experts, well aware of their uniqueness in their fields and in their places of employment, played important roles in human and robotic spaceflight, despite decades of being hidden from public view. Uncovering and telling such stories will hopefully lead to deeper scholarly examinations that will enrich our understanding of what women of all backgrounds meant to NASA and what NASA continues to mean to young women interested in careers in science, technology, engineering, and mathematics.

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Group Theory in a Nutshell for Physicists

A. Zee

Princeton U. Press, 2016. $90.00 (632 pp.).
ISBN 978-0-691-16269-0

Many books have been written about group theory's applications to physics. Some have an arid, mathematically rigorous style that often obscures physical insight. Other, less formal presentations usually cannot deliver the necessary know-how for practical applications. In *Group Theory in a Nutshell for Physicists*, Anthony Zee, a physicist at the University of California, Santa Barbara, combines clarity of presentation with mathematical detail at a level of rigor acceptable to physicists. The result is a tour de force that guides readers through the universe of group theory and leads them to recent applications in particle physics, cosmology, and condensed matter.

The book is unique in its laid-back presentation. It is peppered with colorful stories about famous mathematicians and physicists and includes frequent interjections from fictitious characters. Particularly helpful are the mutterings of Dr. Feeling, who supplies intuitive understandings of formal definitions or theorems, and the observations by Confusio, who (not surprisingly) points out issues of possible confusion. The book is ideally suited to accompany a graduate course on symmetries in physics because of its pedagogical approach, the detail of its illustrative examples, and its many exercises. Readers need to be familiar with the basics of quantum mechanics, but little other advance knowledge is required since the book starts with a brief review of linear algebra and a reminder of the properties of matrices.

After its mathematical refresher, the book turns to a detailed presentation of the representation theory of finite groups and the introduction of Lie groups. Early on, Zee introduces Lie algebras by way of three-dimensional rotations; the classification of those algebras by roots, weights, and Dynkin diagrams comes later. The book's mathematically detailed material is interspersed with group theoretical applications to physical systems. Given the author's distinguished career in particle physics, it is not surprising that most of the examples come from that field, but Zee occasionally ventures out to other areas with examples relevant to condensed-matter and atomic physics.

The book makes only a single mention of group theory applied to atomic nuclei (my field of expertise), and that appears as a footnote when Zee discusses the Elliott model. James Philip Elliott's application of $SU(3)$ is admittedly of less fundamental importance than the application of that group to particle physics, but the mathematics behind Elliott's application is more sophisticated. After reading about how the finest minds in the particle-physics community struggled to get the eightfold way right, I can only admire Elliott's achievement even more, as he developed the $SU(3)$ model of nuclei essentially by himself.

The book does not comprehensively discuss the representation theory of the symmetric group of permutations, and the author even advises readers to stay clear of the diagrammatic machinery of Young tableaux. That may be sensible advice when one is dealing with low-dimensional representations. However, as the dimension of the representation increases, as is the case, for example, in quantum many-body physics, Zee's treatment in terms of either totally symmetric or totally antisymmetric tensors rapidly becomes cumbersome, and Young tableaux are called for.

Eugene Wigner, who introduced group theory into quantum mechanics and is therefore one of the heroes of the book, famously wrote about the "unreasonable effectiveness" of mathematics. In the final chapters of his text, Zee forcefully makes the case for the unreasonable effectiveness of group theory and buttresses his case with many compelling examples. Group theory can generate everything from the Dirac equation for the electron to the equations that describe the expanding universe. Indeed, all known particles can be unified within the framework of the Lie group $SU(5)$.

With *Group Theory in a Nutshell for Physicists*, Zee convincingly demonstrates that group theory governs the physical universe, and he gives aspiring physicists the tools to understand its applications to their work.

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Strange Glow

The Story of Radiation

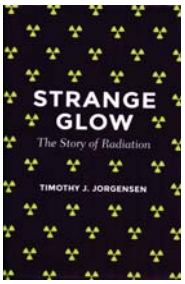
Timothy J. Jorgensen

Princeton U. Press, 2016. $35.00 (512 pp.).
ISBN 978-0-691-16503-5

Timothy Jorgensen's *Strange Glow: The Story of Radiation* has two purposes: to educate the lay public about the various real and imagined health risks radiation poses to humans and to tell "the story of radiation," as his subtitle has it, from x rays to mobile phones. An accomplished radiation biologist, Jorgensen succeeds as a communicator of the current state of the fraught and fluid field in which he works. *Strange Glow*'s historical account is less adept, however. General audiences will likely struggle with an overabundance of detail, while histori-

ans of science will recognize their discipline's original sin of presentism—using modern standards to judge the quality and value of historical scientific work.

The final third of the book, in which Jorgensen lands on his own professional turf, is the strongest. Jorgensen discusses how to evaluate radiation's risks and rewards using examples drawn from contemporary accounts of Fukushima, the discovery of environmental radon, nuclear medicine, and dirty bomb threats. The anxieties and aspirations that those events have revealed in the contemporary zeitgeist are then further explored through his patient and clear explanation of how the prepared mind should evaluate risk.



Jorgensen's approach has real value because people tend to reckon poorly with phenomena that span as many orders of magnitude as the variables involved in calculating radiation risks. He properly resists the temptation to simply instruct his audience not to fear the many sorts of radiation they may encounter and offers instead straightforward lessons in how to make calculations that will generally result in unfrightening conclusions about the dangers of cell phones or the abundant supply of uranium-bearing minerals in Earth's crust.

The anecdotal approach applied to more distant times and places in the first two-thirds of the book, however, is not always as effective. Jorgensen uses vignettes on familiar topics related to radiation to loosely follow the evolution of scientific thought on the subject, from x rays and radioactivity to nuclear weapons and fallout, and perhaps to too many points in between. *Strange Glow* is ostensibly about the intersection of radiation and human health, and a firmer editorial hand could have profitably cut a number of passages tangential to that subject—for example, on the death of Topsy the Elephant, the development of radar, or the trigonometry used to calculate the release point for the *Enola Gay* bomb.

Furthermore, because of a persistent tendency to evaluate his actors by contemporary standards, Jorgensen's narrative occasionally goes astray. Why were the charter generation of radiologists so cavalier in the face of the seemingly obvious dangers their machines presented to their own health? Even a partial answer requires a fairly deep dive into the martyr-venerating professional culture that arose among them, the persistent and plausible belief that most radiation-related symptoms actually came from ozone discharge, and the decades-long use of radiation burns on patients as an impromptu dosimeter during treatments.

Jorgensen, however, concludes that "common sense" was unevenly distributed among early radiation workers, and that these researchers were hurt "more [by] negligence than ignorance." He acknowledges, in a section titled "Cutting the Pioneers Some Slack," that fin de siècle scientists should be "forgiven" for not understanding their discoveries as clearly as we do. Yet he is willing to retrospectively grade Herman Muller's political acumen, Marie Curie's management of her laboratory, and the critics of radium-therapy pioneer Howard Kelly—all cases for which *Strange Glow*'s indulgence in presentism causes it to miss the complexity of the historical record.

At the outset, Jorgensen declares his intention that *Strange Glow* be "useful in practical ways" for nonscientists wishing to make sense of their irradiated world. The book's careful and readable treatment of radiation's risks and rewards will certainly succeed in tamping down tendencies toward unwarranted ray-phobia in contemporary culture. It's probably safe to assume that lay readers looking for accessible information about radiation will not be especially bothered by Jorgensen's departures from historians' best practices. But neither will they profit from his retellings of radiation history as much as they would from reading some of his sources, like Bettyann Kevles's *Naked to the Bone: Medical Imaging in the Twentieth Century* (Rutgers U. Press, 1997) or Spencer Weart's recently reissued classic *The Rise of Nuclear Fear* (Harvard U. Press, 2012).

Strange Glow is flawed as a history, but accessible and useful as an intervention in the public's practical understanding of radiation in the modern world.

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