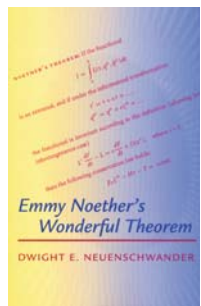


Emmy Noether's Wonderful Theorem

Dwight E. Neuenschwander
Johns Hopkins U. Press, Baltimore,
2011. \$75.00, \$30.00 paper
(243 pp.). ISBN 978-0-8018-9693-4,
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In his attractively titled book, *Emmy Noether's Wonderful Theorem*, Dwight Neuenschwander writes that his intended reader may be "a senior undergraduate physics major or a physics graduate student" with whom he wishes to share his passion for "the elegance and wonder of the relationship between symmetries and conservation laws." In a flowery preface, he asserts that "Noether's theorem deserves to be more widely known among physics students." The result of Neuenschwander's attempt is a text-



book that contains a large amount of valuable information but that disappoints in other regards. And it only partly succeeds in illustrating the "universal importance and unsurpassed elegance" of what is commonly known as Noether's theorem (there were actually two theorems and their converses) contained in her 1918 article, "Invariant variational problems."

Emmy Noether's Wonderful Theorem, written in a direct, informal style, provides detailed explanations and motivations for each topic it treats. It contains accessible accounts of the calculus of variations, a statement of Noether's first theorem, and a large number of its applications to mechanics and field theory, an exposition of the gauge theory of electrodynamics and a short section on non-abelian gauge theory, Hamilton's equations and the Hamilton-Jacobi equation, and elements of the theory of invariance in quantum mechanics. Each chapter offers "Questions for Reflection and Discussion" and challenging exercises.

The second theorem that Noether proved, not featured in this book, was prompted by problems that arose in connection with Einstein's 1915 general theory of relativity. That theorem shows that general covariance implies the existence of "dependencies"—or what are now called "Noether identities" in gauge theories. In fact, the book fails to

represent even Noether's first theorem in all its powerful generality. Readers never learn that Noether treated not only first-order Lagrangians but also higher-order ones such as those that appear in the theory of integrable systems, or that she introduced infinitesimal transformations of a very general nature that were rediscovered some 50 years later.

The author's desire to make himself understood by physics students leads him to avoid the most elementary mathematical notions from linear algebra and group theory that would have clarified his exposition. He often obscures the phenomena he describes by insisting that transformations only act on coordinates and never on intrinsically defined quantities such as scalars, vectors, and tensors. The title of section 5.2, "The Inverse Problem: Finding Invariances," is surprising since "the inverse problem" usually refers to the search for a Lagrangian whose Euler-Lagrange equations are given differential equations. The section presents a meager part of the theory of symmetries of variational problems; it should have mentioned the use of differential invariants and should have at least hinted at the existence of algorithms and software for the determination of symmetries.

In addition to the misprints and errors that mar this book, much of the biographical material concerning Noether is inaccurate. For example, Noether's doctorate was obtained in Erlangen in 1907, not in Göttingen where she was awarded the *habilitation* years later, in 1919; her thesis adviser was Paul Gordan of the Clebsch-Gordan coefficients, not Walter Gordon of the Klein-Gordon equation; she proved "Noether's theorem" in 1918, not 1915; her collected papers were published in 1983, not 1993; and despite being considered the pre-eminent algebraist in Göttingen in the 1920s, she was never named editor of the prestigious journal *Mathematische Annalen*.

Physics students, for whom this book is intended, have no luck. Sixty years ago, in an eight-page article, Edward L. Hill claimed that Noether's article, albeit important, was too difficult. He then offered a description of the mathematics of conservation laws "adapted to the needs of the student of mathematical physics." For decades, students and even research physicists took his overly simplified account to be the totality of Noether's contribution to elucidating the relationship between invariance and conservation. *Emmy*

Noether's Wonderful Theorem includes a useful compendium of results and applications to a large number of problems in physics, but it is still inadequate as a guide to Noether's essential work.

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The Physics and Technology of Radiation Therapy

Patrick N. McDermott and Colin G. Orton
Medical Physics Publishing, Madison, WI, 2010. \$125.00 (856 pp.).
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Having taught medical physics courses for several years now, I was curious to learn what advantages Patrick McDermott and Colin Orton's text, *The Physics and Technology of Radiation Therapy*, offered over the ones I've been using. So when I first picked it up, I immediately searched for a presentation of the Bragg-Gray cavity theory. I didn't find one, nor did I find the usual detailed description of the current algorithms for treatment planning. A little confused, I turned to the introduction, where I discovered my error.

This book breaks from the traditional "straddle the fence" compromise of trying to educate all the personnel in a radiation oncology department. Understandably, most authors produce textbooks that aim to provide broad working knowledge of a particular field to all its members, regardless of their role. However, for medical physics, that leaves behind those with insufficient math or physics backgrounds and makes more work for those who don't need that much detail.

What *The Physics and Technology of Radiation Therapy* successfully achieves is an accurate and thorough overview of radiation-therapy medical physics at the appropriate technical level for its intended audience—radiation oncologists, radiation-therapy technologists, and medical dosimetrists, not graduate students in medical physics. The authors accomplish that by drawing on

