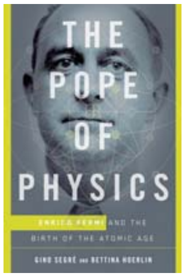
wrote an essay as part of a series of highly competitive exams that earned him entry as a physics student into the Scuola Normale and a reputation for genius.



After conducting research aimed at applying general relativity to the motion of charged particles, Fermi received a physics doctorate magna cum laude in 1922. In the early 1920s, as Benito Mussolini was gaining power, the apolitical Fermi was taken under the wing of politically connected physics professor Orso Mario Corbino. With Corbino's help, Fermi received fellowships at the University of Göttingen, where he met Werner Heisenberg, Wolfgang Pauli, and Paul Dirac, and at the University of Leiden, where he met Albert Einstein.

In 1926, as quantum mechanics was emerging, Fermi was appointed to a position Corbino had created for him and became the University of Rome's first professor of theoretical physics. There, he established a world-renowned physics group that included Franco Rasetti, Edoardo Amaldi, and Emilio Segrè. In that informal, productive, and creative atmosphere, he was sometimes jokingly called the Pope because of his apparent infallibility. In 1928 he married Laura Capon, who came from a well-to-do assimilated Jewish family.

After Fermi achieved fame for his work on the theory of beta decay, his group brought new distinction to Italy by using a small radioactive neutron source to irradiate numerous materials with neutrons. That meticulous work led to Fermi's being awarded the 1938 Nobel Prize in Physics.

With the advent of anti-Semitic laws in Italy and the growing alliance between Mussolini and Adolf Hitler, the Fermis surreptitiously emigrated to the US after the Nobel ceremony in Stockholm. Within weeks of arriving in New York and starting his position at Columbia University, Fermi learned of the discovery of fission. As World War II began, he undertook his crucial wartime work, which built on his prewar neutron-physics expertise. By 1942 he had moved to the University of Chicago where, on a former squash court, he built the first reactor and created the first sustained neutron chain reaction. He provided advice for the construction and operation of the Manhattan Project's first plutonium production reactors in Hanford, Washington, and later moved to Los Alamos, New Mexico, to become a group leader with the bomb design project.

After the war the Fermis returned to Chicago, where Enrico headed the Institute for Nuclear Studies. At his urging, computing facilities and a cyclotron were built there, which opened the way for groundbreaking research in the new field of elementary-particle physics. After nearly a decade in productive postwar research, Fermi died of stomach cancer in late 1954.

Authors Gino Segrè, the nephew of Fermi's colleague Emilio Segrè, and Bettina Hoerlin, whose father Hermann Hoerlin was an industrial physicist and group leader at Los Alamos National Laboratory, are wonderful writers with a deep sense of the personalities, science, historical backdrop, and locales of Fermi's story. Although the book told a familiar tale, I literally could not put it down once I started it. Its account nicely complements Emilio Segrè's *Enrico Fermi: Physicist* (University of Chicago Press, 1970), which contains more scientific detail, and Laura Fermi's classic *Atoms in the Family: My Life with Enrico Fermi* (University of Chicago Press, 1954), with its lively and charming first-person narrative.

The book also contains new insights that paint a poignant picture of a human genius. For example, as he lay dying, Fermi calmly measured the flux of his intravenous nutrients, counting drops with his stopwatch. The story brings to mind his legendarily calm calculation of the detonation power at Trinity. The book also contains an extraordinary essay arguing that Fermi's approach to physics "combined a breadth of knowledge, mathematical acumen, a strong dose of intuition, and mental agility." That essay alone, perhaps alongside a description of Einstein's much more visual approach, would be wonderful for a course on variants of scientific creativity.

I strongly recommend *The Pope of Physics* for anyone who wants to know more about Fermi or to use his example in teaching.

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Applied Thermodynamics for Meteorologists

Sam Miller

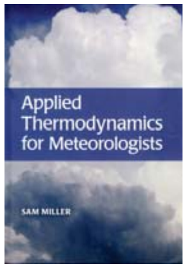
Cambridge U. Press, 2015. $84.99 (392 pp.).
ISBN 978-1-107-10071-8

Thermodynamics, a subject essential to meteorology, can be a bit of a puzzle for undergraduates—and not a few of their instructors. Some key topics in the subject, such as entropy, challenge or upend intuition. Others, such as moist thermodynamics, are essential for understanding the circulation of the atmosphere and the chance of severe weather but are usually not addressed in introductory physics classes. As a result, meteorology students confront the mysteries of water and energy all at once in their undergraduate thermodynamics class while they gasp for air and grasp for practical ways to apply their knowledge.

Striking the right balance between theory and application is a challenge for instructors and for the authors of the textbooks they use. During the past two decades, several authors have attempted to find that balance. Craig Bohren and Bruce Albrecht, in their *Atmospheric Thermodynamics* (Oxford University Press, 1998), say they aspire to provide "rollicking good literature" for students, but the book's digressions and wealth of detail make it the text that instructors should read before teaching the subject. Judith Curry and Peter Webster's *Thermodynamics of Atmospheres and Oceans* (Academic Press, 1999) uses a broad multidisciplinary approach but deals only briefly with applications. Anastasios Tsonis's *An Introduction to Atmospheric Thermodynamics* (Cambridge University Press, 2002) targets the one-semester undergraduate course in thermodynamics in departments of meteorology or atmospheric science, at the cost of meteorological applications. Grant Petty's *A First Course in Atmospheric Thermodynamics* (Sundog Publishing, 2008) opts for less detail on the more obscure or philosophical aspects and more focus on observations and severe-weather indices. After some trial and error, our program at the University of Georgia has settled on Petty's book.

Into this mix comes Sam Miller's *Applied Thermodynamics for Meteorologists*.

The author is an associate professor of meteorology and department chair at Plymouth State University, a department with a respected undergraduate-focused meteorology program. Miller's background with the US Air Force and National Weather Service, coupled with his position in a teaching-intensive department, bodes well for a textbook that emphasizes the applied aspects of atmospheric thermodynamics. The result, however, is a mixed bag, with more good than not good, and with some of the blame for the latter resting on the publisher.



First, the positives. Miller's book is conversational and down-to-earth. He pays more attention to derivations than do most other authors. As he leads the student through the material, he notes assumptions carefully, while successfully avoiding the annoying "it can be shown" tone of too many textbooks. Miller also provides data tables of key thermodynamic values for various substances, as I found to my delight while working on a research paper; the information is not easy to locate elsewhere. His treatment of entropy is clearer and more detailed than the discussion in Petty's book. Numerous inclusions of real-life weather data, from surface weather maps to radiosonde soundings, relate the concepts to atmospheric observations. Petty's text covers some of the same ground, but Petty's illustrations are more often photographs of phenomena or instruments.

However, there are some glaring missteps that should not have made it through to the finished product. The most cringeworthy: The "Clausius" in "Clausius–Clapeyron equation" is misspelled as "Classius" every single time in the book, and that's a lot of occurrences given the importance of that equation to moist thermodynamics! At the time of writing, that had not yet been corrected in the errata on the publisher's website. Second, the copious weather data graphics in the book are confusing and difficult to read. They were obtained from the Plymouth State Weather Center's website, which offers low-resolution GIF files that reproduce poorly. End-of-chapter questions are too often perfunctory assignments of the "list this" or "name and describe" variety. It's also surprising that Miller doesn't reference many earlier texts on atmospheric thermodynamics, particularly Bohren and Albrecht's book or Petty's. The latter omission is especially odd because Petty's book, with its applied approach to atmospheric thermodynamics, is by far the nearest kin to Miller's.

Price is a final consideration in this era of spiraling educational costs. Miller's text lists for $84.99, which is reasonable compared to the multi-hundred-dollar cost of many introductory-level science texts. However, Petty's book, printed by his own Sundog Publishing, currently sells for $33.60. If Cambridge had provided a significantly more polished and vetted product with higher-quality graphics, then the additional $51 cost could be rationalized. But the differences between Miller's and Petty's books are relatively minor, and in at least some respects the cheaper book is also the better book. As a result, I will recommend that we continue to use Petty's book in our program—but I also await a revised second edition of Miller's text.

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