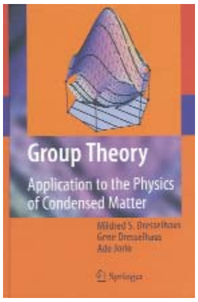
already have some idea of the physical applications.



Group Theory: Application to the Physics of Condensed Matter, by Mildred S. Dresselhaus, Gene Dresselhaus, and Ado Jorio, has had enormous consumer testing in the way it steers around those obstacles: It was developed for a graduate course taught mostly by Millie Dresselhaus at MIT for more than 30 years, with many revisions of lecture notes. Very much a graduate text or specialist monograph, the book covers a wealth of applications across solid-state physics. In fact, the only two topics I could not find covered in its pages were selection rules for Raman transitions in solids and lines of accidental degeneracy when electron energy bands cross, both somewhat esoteric.

Following a four-chapter introduction to the mathematics—with more math promised for later—and another two chapters on its applications to quantum systems, two chapters on electronic states and vibrations in molecules (including Raman activity) introduce the basics of group theory in molecular systems. The authors use crystal-field effects to show how to treat the perturbative splitting of degenerate energy levels. Nearly half the book is taken up with the space-group symmetry of solids, its application to phonons and electron energy bands, and the use of double groups to account for spin. The authors give detailed discussions of effective-mass tensors, g-factors in a magnetic field, and other topics. Three more chapters cover time-reversal symmetry, tensors in elasticity and nonlinear optics, and the permutation group. The point of including the last subject is not clear. The authors use the permutation group to derive the spectroscopic terms (which denote the total angular momentum L and total spin S) in various orbital configurations such as p^5 or d^5, but that can be done much more simply with John Slater's scheme, which originally introduced Slater determinants. That approach is not mentioned, perhaps because it is assumed known from atomic theory.

The book takes a how-to approach throughout. For example, the authors introduce irreducible representations of the full rotation group from spherical harmonics, assumed to be familiar, and they write the extension to spin representations by analogy. Even so, the background mathematics covers the first 70 pages, though the authors provide examples from physics to illustrate concepts. A novice would be advised to have a guide through that early material, because, of course, not all the mathematics is needed for many simple applications.

In one or two places, where the ideas are a matter of physics and not of mathematics, the authors' how-to approach left me a bit dissatisfied. The most basic points of the subject are that quantum energy levels have associated group representations and that those representations are "normally" irreducible, as stated on page 58. But why should they be irreducible? The fact is that they are irreducible only if the group includes all the symmetries of the system and if neither quirky mathematical symmetries such as those inherent in the hydrogen atom's simple $1/r$ potential nor "accidental" degeneracies such as the band crossings mentioned above are present, while keeping in mind that time-reversal symmetry treated afterward as an add-on can also produce degeneracy. The authors include those ideas, of course, but in a conversational way without a crisp formulation of where the irreducibility comes from. I noticed only one small typo, and found the index satisfyingly complete.

The book can be warmly recommended to students and researchers in solid-state physics, either to serve as a text for an advanced lecture course or for individual study, preferably with an instructor to help select mathematical background and applications of interest. But even if one is never going to use the detailed machinery of group theory, the concepts give a precise way of thinking about symmetry and degeneracy in physics.

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Panofsky on Physics, Politics, and Peace

Pief Remembers

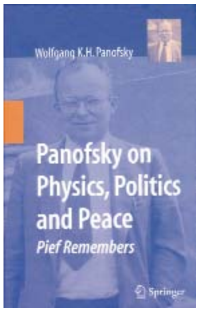
Wolfgang K. H. Panofsky
Springer, New York, 2007. $69.95 (191 pp.). ISBN 978-0-387-69731-4

Wolfgang Kurt Hermann Panofsky (1919–2007), nicknamed "Pief," was a man of small physical stature but one of the intellectual giants of 20th-century experimental physics. His memoir, *Panofsky on Physics, Politics, and Peace: Pief Remembers*, is not an autobiography in the usual sense. It contains little about his family life; instead, it is a personal account of his professional activities—his outstanding scientific research in the early part of his career, his founding and leadership of a great national laboratory, and his extensive work throughout his career advising the government at various levels. The book also has numerous photographs, mostly showing Pief involved in his various activities but also including his wife, Adele, and their five children.

Born in Berlin, Germany, Pief was the son of distinguished art historians. In the early chapters of the book, he discusses his childhood; his family's move to Princeton, New Jersey, in 1934; and his university studies from his days as a 15-year-old freshman at Princeton University to the completion of his PhD in physics at Caltech in 1942. After his work for the war effort at Caltech and the Los Alamos laboratory, he joined the University of California Radiation Laboratory (UCRL) at Berkeley, also known as the Rad Lab, and pursued outstanding particle-physics research. Pief's recollections provide an excellent glimpse into the atmosphere and research directions in the Rad Lab under the leadership of Ernest Lawrence and Luis Alvarez after World War II. They also indicate that Pief, in a short time at Berkeley, became a particle-accelerator expert. As he notes, "at UCRL there was no distinction between particle physicists and accelerator physicists" (page 26). In 1951, the "loyalty oath" imposed by the University of California system prompted Pief to leave Berkeley for Stanford University. Faculty were expected to take an oath of allegiance to the US and California constitutions and disavow membership in the Communist Party. Unfortunately, Pief gives only a brief account of the feelings and considerations that led him to that momentous decision.

The next part of the book is devoted to Pief's work at Stanford prior to his drafting the SLAC proposal. He covers the development of electron linear accelerators (linacs) and their application to a high-quality program of exploratory high-energy physics, with energies on the order of 1 GeV and the beams comprising electrons or photons.

In his fascinating discussion of the development of the SLAC proposal, Pief details many of the scientific, technical, and administrative issues that he encountered before its approval. He describes interacting with the Stanford administration, the physics department, the Atomic Energy Commission, and the outside physics community while, at the same time, working to satisfy the technical requirements of the project. However, I would have liked more discussion of what motivated the important choice of linac energy, which set the scale of the SLAC construction project. As history later proved, that choice, like most of Pief's other decisions, was remarkably wise.



Moving beyond approval of the SLAC construction, Pief details its organization and the many challenges—mostly technical, but also political and administrative—that were encountered in the building of the accelerator and the large spectrometers needed for the research. He managed to attract an outstanding staff of not only accelerator builders but also research scientists. He clearly took a highly active role in solving some of the technical problems. In later chapters, Pief discusses some important results of SLAC research, which led to several scientists receiving Nobel Prizes. Topics include a detailed recollection of the electron–positron collider SPEAR and the exciting observations of the charm quark and the tau lepton. The book also contains recollections of the higher-energy SLAC colliders—the Positron–Electron Project (PEP) and the Stanford Linear Collider (SLC). Going beyond the SLAC experiences, Pief also briefly recalls the rise and fall of the Superconducting Super Collider project in which he participated as chair of the SSC Board of Overseers. His reflections on all those topics are illuminating.

Interspersed among the chapters on the science and organization of SLAC are chapters detailing Pief's work advising government over the course of his career. He evaluated high-energy physics programs for government funding agencies and, more significantly, played a major role on national committees, including the now-defunct President's Science Advisory Committee, advising the government on policies related to the control of nuclear weapons. He discusses a list of potential problems in the advisory process, such as conflict of interest, accountability, access, and so forth. After his retirement as SLAC's director, Pief chaired the Committee on International Security and Arms Control of the National Academy of Sciences for eight years. The final chapter recounts in some detail many of the issues he encountered in his efforts toward a sensible nuclear weapons policy.

A few minor errors appear in Pief's account, but that is not surprising, given all the detail he supplies. For example, on pages 125 and 138 Pief refers to the "tau meson," even though it should be the "tau lepton." Also, some of the discussions of experiments and their results are probably too technical for general readers. Such slight limitations do not detract significantly from the overall story. Pief gives us a truly panoramic narrative of both the history of US electron-accelerator-based, high-energy physics and the development of the country's nuclear weapons control policy. He contributed enormously to both endeavors and has a remarkable, fascinating tale to recount.

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Volcanism on Io

A Comparison with Earth

Ashley Davies
Cambridge U. Press, New York, 2007. $133.00 (355 pp.).
ISBN 978-0-521-85003-2

Io, the innermost Galilean satellite of Jupiter, is an enigma. A little larger than the Moon, it has a richly colored surface of sulfur compounds and silicates