Physics Today

Interfaces in Crystalline Materials and Surfaces and Interfaces of Solid Materials

Adrian P. Sutton, Robert W. Balluffi, Hans Lüth, and J. Murray Gibson

Citation: Physics Today 49(9), 88 (1996); doi: 10.1063/1.2807772
View online: http://dx.doi.org/10.1063/1.2807772
View Table of Contents: http://scitation.aip.org/content/aip/magazine/physicstoday/49/9?ver=pdfcov
Published by the AIP Publishing

five other books, all records of lectures he presented on different occasions. *General Theory of Relativity*, first published in 1975, represents a lecture course he gave after he moved to Florida State University. Dirac was a man of few words, and this little book—with 35 sections spanning 69 pages—exhibits the concise, direct style that was his trademark. Seasoned physicists will appreciate the book as an elegant, well-organized introduction to the basic mathematics and physics of curved space, but students approaching the subject for the first time—the intended audience for the book—will probably have their needs met better by one of the more detailed standard introductory texts. Dirac is not necessarily for the beginner in any of the subjects on which he wrote. As Schrödinger once said of his own problems in reading Dirac, "[H]e has no idea how *difficult* his papers are for the normal human being."

R. Corby Hovis
Valparaiso University
Valparaiso, Indiana

Interfaces in Crystalline Materials

Adrian P. Sutton
and Robert W. Balluffi
Oxford U. P., New York, 1995.
819 pp. $165.00 hc
ISBN 0-19-851385-2

Surfaces and Interfaces of Solid Materials

Hans Lüth
Springer-Verlag, New York, 1995.
$49.00 pb ISBN 3540-585-761

According to the *Oxford English Dictionary*, an interface is "a surface lying between two portions of matter or space and forming their common boundary." *Interfaces in Crystalline Materials*, and *Surfaces and Interfaces of Solid Materials*—two valuable but different texts—cover generally different portions of the science of solid interfaces and are aimed at two different communities. Hans Lüth aims at the surface scientist, who studies the vacuum–solid interface; Robert Balluffi and Adrian Sutton aim at the interface materials scientist, who looks at internal solid interfaces.

In my opinion, surfaces have been studied in more detail because they are easier to approach experimentally, but internal interfaces are more important for practical reasons. I can claim to be one of the small number of people who have published in both fields. Thus I have an interest in both books, but I find that Sutton and Balluffi's fills a more pressing need.

Besides their different emphases, the books also have different aspirations. Lüth provides a broad, well-crafted overview of a field in which there are already several other—although more specifically course-related—books. Sutton and Balluffi provide one of the few detailed expositions of a complex and important field.

Sutton and Balluffi are both highly regarded scientists in the field of grain boundaries, the former an experimentalist and the latter a theorist. In writing their book, they have used their experience well and have covered the extensive and challenging field of internal interfaces as well as we could hope, producing a wonderful addition to the literature of internal interfaces. But it is not light reading! Its 800 exhaustive pages contain hundreds of references and logical and detailed coverage of all the essential material. It will be useful not only for students, but also for scientists in any field who need a better understanding of strained-layer epitaxy, for instance.

Sutton and Balluffi also cover the general complex crystallography of interfaces, known as bicrystallography, which is particularly important in understanding interfacial dislocations. They describe in detail the methods by which theorists calculate the structure and properties of internal interfaces. They discuss both heterophase and homophase (grain boundary) interfaces. They cover interface thermodynamics (such as faceting and phase transitions as well as segregation), along with kinetics (such as diffusion and interface motion). The book concludes with a broad description of interface properties, including electrical and mechanical, with many examples.

Lüth's book comes from the complementary direction of surface science—the study of the vacuum–solid interface. It provides a very good introduction to this subject but is not as exhaustive as the Sutton and Balluffi book. Lüth covers ultrahigh-vacuum technology, surface structure (including electronic and vibrational), diffraction and scattering from surfaces, adsorption and metal–semiconductor interfaces. His book is well annotated for use as a student text. It focuses on the complex techniques used to examine surfaces, whereas Sutton and Balluffi focus on the underlying science of internal interfaces, using experimental data only as illustrative evidence.

This reinforces my original prejudice: Whereas the elegant techniques to probe surfaces are driving surface science, internal interfaces are a more challenging and important problem. Lüth's book, extensively revised in 1992, is certainly not without merit. But the obviously great efforts of Sutton and Balluffi in preparing their book have enormously aided the materials community.

J. Murray Gibson
University of Illinois at
Urbana–Champaign

Atom Optics with Laser Light

Victor I. Balykin and Vladilen S. Letokhov
Harwood, Newark, N.J., 1995.
115 pp. $45.00 pb
ISBN 3-7186-5697-3

During the last 20 years there has been enormous growth in the science concerned with the manipulation of matter with light. An important subfield is atom optics, which investigates "atom-optical" elements that focus, reflect, split and polarize atoms just as conventional lenses, mirrors, beam splitters and polarizers affect light. Atom–field interactions can also extend beyond the possibilities of conventional optics. For example, laser cooling can compress the atomic phase space in apparent violation of Liouville's theorem, and there is no limit to the lowest temperature that can be achieved by laser cooling. Ideas that were once confined to thought experiments have become routine laboratory exercises. Nanokelvin temperatures have already been achieved, as have Bose–Einstein condensation and the confinement of atoms in traps much smaller than an optical wavelength. Cold atoms are now used for rotation sensing and nanolithography, as well as for such more traditional applications as clocks and frequency standards. This appears to be only the beginning: I believe that atom optics is now at the same stage as conventional optics was in the early 1960s, when lasers were just becoming common.

In *Atom Optics with Laser Light*, Victor Balykin and Vladilen Letokhov have written a wonderfully clear book that presents an overview of all but the most recent results in the field.

They establish the context for atom optics right in the first chapter, with comparisons to neutron and electron optics as well as the conventional optics of photons. The first chapter also includes a nice short discussion of atom–matter and atom–static-field interactions.

The second chapter explains the basic forces that permit light to control atoms. It begins with a discussion of the validity of the classical approximation, which may be a bit off-putting to