

frequency f . Esteve discusses the prospects of using these devices for metrology. Although the precision of such frequency-to-current converters is still too crude, they might eventually eliminate the kilogram—from which the ampere is presently derived—from our set of standards.

I expect that single-electron tunneling will continue to be a subject of much attention for the next few years. To my knowledge there are no other monographs on this subject, so those who intend to become experts will find this book quite valuable.

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Interfacial Transport Processes and Rheology

David A. Edwards,
Howard Brenner and
Darsh T. Wasan

Butterworth-Heinemann,
Boston, 1991. 558 pp. \$75.00 hc
ISBN 0-750-69185-9

As this review is being composed, thousands of gallons of light crude oil are spewing into the ocean from a tanker marooned off the Shetland Islands. In a distant time under less disturbing circumstances, Pliny the Elder observed that "divers sprinkle oil from their mouth because it calms the rough element and carries light down with them." Situations that evoke very different emotions often involve the exact same physics. Those currently interested in soft condensed matter, especially complex fluids such as liquid-liquid emulsions and gas-liquid foams, follow Lord Kelvin, J. A. F. Plateau, Lord Rayleigh and Josiah Willard Gibbs by engaging the physics of the interfacial region separating two fluids.

Interfacial Transport Processes and Rheology is a comprehensive graduate-level textbook concerned with the theory, measurement and application of interfacial hydrodynamics. The text is divided into two complementary parts. Part I occupies most of the book and adopts the classical, macroscopic view of fluid interfaces as idealized, two-dimensional singular surfaces. The adsorption of molecular or macromolecular surfactants imparts intrinsic rheological properties to the interface such as interfacial shear and dilatational viscosities (which are two dimensional counterparts of the three dimensional viscosities possessed by bulk-phase fluids) and Gibbs elasticity, which indicates the change in interfacial tension with

area. Gradients in surfactant concentration and temperature cause interfacial tension gradients that produce Marangoni phenomena such as the "tears" of strong wine. This text focuses successfully on predicting and understanding the separate and coupled roles of these intrinsic and extrinsic mechanisms of interfacial response.

The first two chapters of Part I include an illuminating introduction to interfacial phenomena, a short historical review, a qualitative discussion of the physicochemical aspects of interfacial behavior and an overview of important applications. The next three chapters provide a mathematical foundation and develop the field equations that govern the bulk and interfacial transport of momentum, mass, chemical species, energy and so on. These chapters provide deep insight into the physical and mathematical roles of the interface in supplying boundary conditions for the neighboring bulk phases. The text draws parallels and emphasizes differences between the interface and the bulk. The book includes numerous worked examples, questions and suggestions for additional reading at the end of each chapter. (A solution manual for instructors is available from the publisher.)

The next four chapters are devoted to the measurement of interfacial rheological properties. A balanced view is provided of the successes and problems, direct and approximate experimental techniques, and absolute and apparent physical properties that are associated with the condition of interfacial stress. Some highlights of the experimental sections include discussions of light-scattering techniques and the deep-channel viscometer for measuring interfacial shear viscosity. The last five chapters in Part I cover important applications such as Rayleigh and Bénard instabilities, interfacial turbulence, thin-liquid-film hydrodynamics and stability, and the rheology and stability of foams and emulsions. The discussion of the role of disjoining pressure and the use of Derjaguin-Landau-Verwey-Overbeek (DLVO) theory to understand the metastability (as opposed to the retarded but inevitable demise) of complex fluids are of interest to scientists and technologists alike, and they illustrate the broad appeal of the applications chapters.

Part II pursues a more detailed microrheological view of a three-dimensional interfacial region: It uses rigorous perturbation techniques to develop a generic surface-excess theory for nonmaterial interfaces that is

consistent with the classical approach. This theory may elucidate the molecular origins of interfacial phenomena and ultimately unify statistical mechanical and continuum mechanical approaches. The presentation parallels that on field equations in Part I and concludes with a chapter on the three-phase contact line (not covered in Part I but described by the Neumann-Young equation in the classical approach).

I highly recommend this textbook to serious students, teachers, technologists and researchers in this field.

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Exploring Music: The Science and Technology of Tones and Tunes

Charles Taylor

IOP, Bristol, UK (US dist.,
AIP, New York), 1992. 255 pp.
\$35.90 pb ISBN 0-7503-0213-5

The foreword of this book advises us that "Every year, ever since 1826, the Royal Institution has invited an eminent scientist to deliver a course of lectures at Christmastide in a style 'adapted to a juvenile auditory,' to use the words of Michael Faraday, who initiated the tradition." In practice the audience may range in age from under 10 to over 80.

Charles Taylor, a physicist who is an expert in crystal and optical phenomena, author of ten other musical books, and sometime professor of physics at the University of Wales, delivered the Christmas lectures in 1971 and again in 1989. The first series of lectures was published by the BBC as *Sounds of Music*. The book reviewed here is an expanded version of the 1989 lectures.

The book is charming in its descriptions of demonstrations by great men of the past and for illustrations of the apparatus they used. These include three used by John Tyndall, one demonstrating that sound will not travel through a vacuum. It is chastening to be reminded that effective acoustical and musical experiments predated electronic gadgets and computers. But electronics and computers also have their place in this wide-ranging book.

The variety of material covered would challenge the powers of any author. My reading is that Taylor is best in the physics of traditional musical instruments. He refers often to the work of the late Arthur Benade,

an outstanding expert on instruments, calling him "the great musical physicist." The chapters on instruments seem clear and effective. They include some more unusual instruments such as the tabor and the crwth.

Taylor fares less well in some other areas. In one figure he notes the visual similarity of oscillographic traces of audience noise, an orchestral performance and of white noise. However, we don't hear with our eyes, (except in lip reading), nor is it noted that oscillograms *can* give important clues in identifying utterances.

In connection with harmony and dissonance, the author mentions that Hermann von Helmholtz calculated the degree of roughness of violin tones as a function of frequency separation, but he does not say that the calculation is based on the beating of closely spaced spectral lines. There follows a complicated discussion of the properties of pairs of sinusoids (pure tones) of various frequencies. This is essentially irrelevant to music. If the frequency ratio of two sinusoids is roughly greater than a major third or a fourth, the two tones are heard separately, and the interval-dependent dissonance so important in harmony is absent. Also, while Taylor discusses various scales in admirable detail, he does not mention the fact that if you go up and down by exact consonant intervals, you often can't get back to the pitch on which you started. There *can't be* an ideal scale: In any scale some of the intervals must depart from the ratios of small whole numbers.

The book includes much more. The material on architectural acoustics is clear and good but somewhat limited. The difficulty of building satisfactory halls for larger and larger audiences is not mentioned. Electronic synthesis is another problematic topic; whatever its merits, the author's account wouldn't be mine. There is material on sequencers and on Music Instrument Digital Interface (MIDI), but not on the programming language Max, which has made computers accessible to many musicians.

Who is the plausible audience for this book? For casual readers interested in knowing more about musical phenomena, there are some rather difficult technical sections. For someone laying a basis for further knowledge, there is good material as well as, in my view, somewhat misleading material about important matters. What other books are there? Benade's books *Fundamentals of Musical Acoustics* (Oxford U. P., 1976) and *Horns, Strings, and Harmony*

(Doubleday, New York, 1979[1960]) are certainly good, as is Johan Sundberg's *The Science of Musical Sounds* (Academic, San Diego, 1991). Taylor also lists my book, *The Science of Musical Sound* (Freeman, New York, 1992).

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Introduction to Percolation Theory

Dietrich Stauffer and
Amnon Aharony
*Taylor and Francis, Bristol,
Pa., 1991. 181 pp. \$66.00 hc
ISBN 0-7484-0027-3*

Percolation describes the geometrical transition between a disconnected phase and a connected one as the concentration of bonds (or sites) in a lattice is increased. This phenomenon underlies the physical properties of many disordered systems, such as the mechanical properties of gels and the conductivity of metal-insulator composites. Percolation is a problem that is easily defined and visualized, but for which answers are nontrivial. These factors spawned considerable interest in percolation over the past 30 years.

The phenomenon is nicely introduced in the second edition of *Introduction to Percolation Theory* by Dietrich Stauffer and Amnon Aharony. The authors are eminently qualified for reviewing percolation: Both have made seminal contributions to the field. The first edition, authored by Stauffer and published in 1985, was a pleasantly idiosyncratic, brief and accessible introduction. Its primary strength was the presentation of a relatively concise yet complete scaling theory for the cluster-size distribution. This first edition served as a valuable starting point for beginners and a handy reference for practitioners. The revised edition maintains the informal style of the original but is more complete in several respects. There is a new emphasis on fractals and on the crossover between critical and homogeneous behavior for nonthreshold systems. The second edition also provides a better historical perspective and a more logical order of presentation for a variety of fundamental topics.

Larger-scale changes in the second edition include a substantial enlargement of Chapter 5, while new material on dynamic effects and applications to thermal phase transitions are presented in Chapters 6 and 7. Chapter 5 is a coherent discussion of the conductivity of random networks and its

relation to cluster structure and multifractality of the distribution of bond currents in a random resistor network. Novel aspects of conductivity in continuum percolation systems are also mentioned. Unfortunately, the section on elastic networks is too short to be useful. A logically complete treatment of random walk dynamics on percolation clusters is presented in Chapter 6, as well as new sections on fractons, diffusion fronts, hulls and invasion percolation. The latter two would be better placed elsewhere in the book. Chapter 7 is devoted to phase transitions in dilute magnets. This application is a welcome addition. There is, however, a gratuitous mention of spin glasses; this topic should have been omitted or else discussed more fully.

Given the slower pace of the field in recent years, it might have been appropriate for the authors to consider a more comprehensive revised edition. Topics that would have greatly added to the utility of the book include the connection between percolation and the Potts model, directed percolation, biased diffusion on percolation clusters, frequency-dependent conductivity and a more complete discussion of random elastic networks. The appendix on numerical methods could have been augmented by alternative depth-first-search cluster number algorithms, as well as recent backbone-finding algorithms. It might also have been useful to describe techniques for solving conductivity problems more completely, and to use a better random number generator.

As an introduction for the uninitiated or as a convenient reference, this book is still a great success. I highly recommend it on this basis. Unfortunately, the \$66 price is unjustified for a 180-page book with the above mentioned omissions. A modestly priced paperback volume would have been preferred.

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NEW BOOKS

Acoustics

Acoustic Resonance Scattering. Proc. Conf., Washington, D. C., May 1989. H. Hüberall, ed. Gordon and Breach, Philadelphia, 1992. 341 pp. \$78.00 hc ISBN 2-88124-513-7

Exploring Music: The Science and Technology of Tones and Tunes. C. Taylor. IOP, Bristol, UK (US dist., AIP, New York), 1992. 255 pp. \$35.90 hc ISBN 0-7503-0213-5