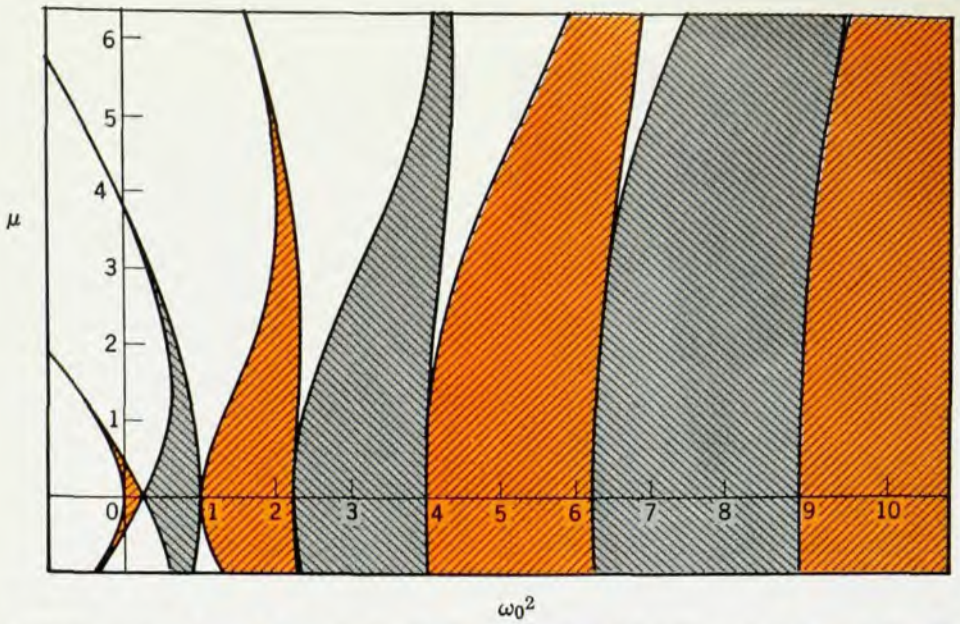

Stability regions for solutions to the Mathieu equation $(d^2x/dt^2) + (\omega_0^2 + \mu\cos t)x=0$. The solutions are well behaved for ω and μ parameters that fall within the shaded areas, but blow up elsewhere. Applications are to periodically focussed beams, alternating-gradient accelerators, and ion traps (mass filters). From *Phase-Space Dynamics of Particles* by Allan Lichtenberg (reviewed on this page).

others in these fields, he is conscious of the large and untapped body of literature that tends to be circulated among acquaintances at accelerator laboratories and that rarely becomes generally available; unlike them, he has done something about it. He has undertaken, very successfully, the task of bringing to the surface in a coherent format much of the content of this underground press and of material from conference proceedings. Many highly inventive pieces of work are often developed in a special context and never published by the authors; see for example, H. G. Hereward's "impedance" concept in beam-transfer optics, which is well summarized by Lichtenberg. Of great value, also, is the way he has selected problems that have been treated independently in the plasma-physics literature and in the accelerator literature and then has presented them in a unified treatment.

The utility of phase-space concepts in treating the dynamics of particles was well recognized in the work of Hamilton, Liouville and, later, Poincaré in the last century. It is only in the last two decades, however, that physicists have made widespread use of this powerful technique to attack a wide variety of problems in plasma and accelerator physics. Many of the complex situations involving the motion of particles in electric and magnetic fields have yielded elegant and useful solutions when dealt with in terms of phase-space concepts, and there is expectation that it will continue to be very fruitful in coming years.

The subject matter is divided into five substantial chapters. The first chapter is a brief conspectus of the basic principles and theory—Hamiltonian mechanics, constants of the motion, the theorems of Poincaré and Liouville, the properties of oscillators and the reduction from $6N$ dimensions to 6 dimensions. Chapter 2 deals with the important topic of adiabatic invariants and goes on to consider the systems that depart from adiabaticity to either small or great degree. The linear phase-space transformations of beams, familiar to beam designers, is described in chapter 3 with some extensions to the effects of nonlinearities, space charge and coupling between degrees of freedom. The application of the basic material thus far developed to two major fields of interest is the subject of the two final (and major) chapters. The first of these is particle accelerators; Lichtenberg provides an excellent treatment, not just of the betatron and synchrotron coupled-motion problems, but also of the transverse and longitudinal matching and multiturn injection. Finally, he gives an elegant description of the containment and heating of plasmas and discusses the several solutions that have been proposed and are under experimental investigation.

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Shell-Model Approach To Nuclear Reactions

By Claude Mahaux, Hans A. Weidenmüller
347 pp. Wiley (North-Holland), New York, 1969. $16.00

Without stretching credulity too far, one can argue that during the past half decade the sense of urgency and competition in developing the *Shell Model Approach to Nuclear Reactions* has rivaled that found in elementary-particle theory (or in a tennis match between middle-aged physicists). This monograph is about one of the places where the action is in theoretical nuclear physics; its authors have been among the leading players.

In prefacing the title of the book with the definite article, as above, I had in mind the unity in the physical model underlying the entire development, rather than the multiplicity of mathematical approximations introduced in specific applications. The model emerges from the confluence of two ideas. Of these, the conception of bound states embedded in the continuum (BSEC) is at least as old as the Wigner–Weisskopf theory of radiative decay of atomic states (1930). All the so-called "bound states" of hydrogen above the ground state are of this type: *As soon as we turn on the coupling* to the radiation field they become narrow resonances in photon scattering.

The application of the BSEC concept to nuclear physics had to wait, however, until it could be grafted on to the idea that shell-model calculations of excited states, within a limited configuration space, could be usefully extended to the calculation of cross sections. All the physical states in this model are described as limited superpositions of Slater determinants of single-particle functions in a "realistic" shell-model potential. The limitation is to those configurations in which, at most, one particle is in a continuum orbit. These restricted continuum channels are coupled by the "residual interaction" of the shell model to BSEC and turn these into resonances. For a problem such as the elastic scattering $^{15}N(p,p)^{15}N$, which has served as a touchstone of the reaction model, one finds that properly defined BSEC retain more or less distinguishable identities as well separated resonances and that agreement with experiment, though far from perfect, is encouraging.

In describing the various schemes for solving the equations of the model, the authors lean, naturally enough, on their own very extensive contributions, but reasonable effort and space is devoted to precursors and competitors. Overall, as the writers admit, the ratio of theory to application is rather heavy, but this is a function of where matters rest at the moment. One finds most instructive accounts of the analytic properties of the S-matrix of the model, of the connection with such older formal theories as R-matrix theory, of the optical model and the distorted-wave Born approximation for inelastic scattering. There is a thorough description of the shell-model approach to the theory of isobaric analogue resonances, which must be accounted one of its major successes.

During a period when everyone is writing more and reading less (or so it

seems), the authors of this monograph have done a great deal of both in producing a work of exceptionally thorough scholarship. This book, however, is not easy to dip into. It can only be read slowly, carefully, and sometimes painfully, because notations and derivations are so explicit and detailed. The writers argue with some justice, however, that increased use of symbolic manipulation would only gloss over the real subtleties of the subject, which they have strived, successfully, to expose.

Thus, if one wants to learn the subject rather than to review a book, one *will* slow down, one will look up a few more references, and one will refresh oneself more thoroughly about some of the details of scattering theory that are only briefly presented as introductory materials. This volume will join my two-foot shelf of indispensable reference and *lehrbüche* on nuclear physics, and I will urge its study upon any student (they're *all* serious) of nuclear-reaction theory. The latter will learn not only about closed problems, but also about open ones; some of these won't remain so for long.

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Synchrotron Radiation

By A. A. Sokolov, I. M. Ternov
202 pp. Pergamon, New York, 1969. $16.00

Synchrotron radiation has become a very important subject for those dealing with large modern accelerators, as well as those studying radiation from galaxies. It also serves as a "known source" of photons for studies in the far ultraviolet range down to the one-Ångstrom range for investigations on the interaction of electromagnetic radiation with matter.

Synchrotron radiation, sometimes known as magnetic bremsstrahlung, is the radiation emitted from electrically charged particles (with or without spin) when accelerated in a magnetic field. One can consider this system—charged particle and magnetic field—as a macroatomic system, where both classical and phenomena may be studied. The authors have also written a book on quantum mechanics and have many publications in this field.

In this book they treat the classical and quantum theories of the behavior of charged particles with a magnetic field. Spin and polarization effects as well as inhomogeneities and fluctuations in the magnetic fields are also considered. Although this book is primarily devoted to the theoretical investigation of the subject, a chapter is devoted to the experimental investigations with some suggestions for applications.

About 150 references are quoted with a very large fraction being the authors' works and many being other works in Russian, as is the case of most books written by the Russian school. I suppose the same implied criticism applies to Westerners writing reviews. An important Western contributor who was not cited was H. Olsen, who wrote a fairly comprehensive theoretical (classical and quantum) treatment in the early 1950's. Despite this flaw, the work is very comprehensive and presented in a rather orderly fashion. It will be of much value to those working in this field and to those who want to be introduced to it.

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De l'imaginaire au Réel: Essai sur le Temps dans la Théorie de la Relativité

By William Rivier
86 pp. Dunod (Editions du Griffon, Switzerland), Paris, 1969. 14 F

When I was first asked to review *From the Imaginary to the Real: An Essay on Time in Theory of Relativity*, I eagerly accepted. I was fascinated by the title, which is suggestive of important contemporary problems regarding imaginary masses, counterdirected time and causality. I found nothing of the kind. What I found is well characterized by the author's discussion of the twin paradox. He bases his discussion on the following "principle" (page 70):

> "If two processes begin simultaneously at the same point and terminate simultaneously at the same point, these two processes are of equal duration no matter what the observer's reference system may be."

Common sense, no? Ergo, no difference can arise in the ages of the twins, implies the author, because both start from the same point and end up at the same point.

The above should take care of his physics. What about his philosophy? Again I will let the author speak for himself. Here is a gem (page 60):

> "Each philosophy which considers itself nonmaterialistic should rebel against Einstein's idea of assimilating the duration with a dimension of space . . . Einstein has rendered science more materialistic . . . by refusing or neglecting to recognize that duration is a necessary and sufficient condition of all existence."

Need I say more?

OLEXA-MYRON BILANIUK
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Wave Interactions in Solid State Plasmas

By Martin C. Steele, Bayram Vural
285 pp. McGraw-Hill, New York, 1969. $15.50

Solid-state plasma—nearly a contradiction in terms, after all—consists of mobile charge carriers (plus their neutralizing ionic background) as they coexist in a semiconductor, semimetal or metal. The study of such a system from the plasma viewpoint is a relatively recent discipline whose practitioners have come from both gaseous plasma and solid-state physics and are driven by interest in modeling controlled thermonuclear reactors in the small, or by potential device applications or perhaps by the sheer good physics of it all.

Martin C. Steele and Bayram Vural, whose origins at RCA Laboratories betray their biases in this respect, have rendered the rest of us a valuable service by undertaking the onerous task of reducing the research literature in the field to an advanced monograph of high quality. The primary emphasis of their book is on wave propagation and interactions in such a charged-particle ether, especially as regards the existence of unstable solutions.

The approach is summarized by the dielectric response tensor for electrokinetic waves in a magnetic field and encompasses passive and growing waves; their interactions with phonons, spin waves, and external circuits; negative resistance, and pinch effects. In level and content, and in its mix of both theory and experiment, the book serves as a connection between textbook and journal. Its primary lack is in photon–plasma interactions in solids at infrared through ultraviolet frequencies; but then this leaves something for others to do.

JOHN R. APEL
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Mecanique Des Milieux Deformables

By Gerard Gontier
580 pp. Dunod, Paris, 1969.

What could possibly be interesting about another text on continuum mechanics? This one follows a familiar pattern. It proceeds from the algebra and calculus of tensors through general principles of kinematics and dynamics to the construction of some general constitutive equations, elasticity, Stokesian fluids and plasticity; it concludes with some applications.

What, then, is noteworthy about this book? Well for one thing, it is French. With Gallic precision the book makes clear, for example, the distinction between the transpose of a tensor and the