field than in its absence. Another system discussed early in the history of quantum mechanics is the negative hydrogen ion, H^-. H. A. Bethe first proved that it has a bound state, but until recently how many additional bound states it has was not settled. R. N. Hill gives an account of his proof that there is exactly one singlet bound state below the continuum and no triplet. Another eigenvalue problem, this suggested by the description of charmonium in particle physics, is treated by H. Grosse. Charmonium is a bound system of a charmed quark and a charmed antiquark. It has an interesting excitation spectrum, which can be described by a nonrelativistic model using a potential of the form $V(r) = A/r + Br + C$, where r is the separation and A, B, and C are constants. The problem is to show that the observed order of the levels is a consequence of qualitative properties of the potential and not a freak produced by a special choice. The remaining short contributions, which discuss the Efimov effect, the quasi-classical limit of scattering, the spectrum of a particle in a random potential, and a scattering problem in indefinite metric, are all interesting. The section ends with a review of some open problems about Coulomb systems; here are questions for the strong, ambitious, and patient.

Given the long history of statistical mechanics and the subtlety of its problems, one has a right to expect something intriguing from the 60 pages devoted to statistical mechanics, and I was not disappointed. O. E. Lanford reviews time-dependent phenomena in statistical mechanics, singling out three topics: classical mechanics of an infinity of particles according to Fritz and Dobrushin, the Vlasov limit according to Braun and Hepp, and the Grad limit according to van Beijeren *et al.* The paper can be regarded roughly as part of a program to derive transport theory from first principles—a serious business with many unsolved problems. Jimbo, Miwa, and Sato review an extraordinary family of ideas associated with their names, linking the deformation theory of differential equations with quantum field theory and statistical mechanics. The short contributions include a general proof of the thermodynamic instability of the interface between distinct phases in two dimensions by M. Aizenman and the application of topology to the characterization of defects in ordered media by G. Toulouse, as well as six other papers that it would take too long to describe.

The above should give some idea of the coverage of two of the seven subjects discussed at the conference. In the remaining subjects the talks were just as interesting and nontrivial. If I had to single out one among them, it would be J. Bros's magistral review of the analytic structure of Green's functions in quantum field theory.

This book is a useful tool for all those struggling to keep up with the exploding subject of mathematical physics.

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Geophysics

The Earth's Variable Rotation. Geophysical Causes and Consequences. KURT LAMBECK. Cambridge University Press, New York, 1980. xii, 450 pp., illus. $77.50. Cambridge Monographs on Mechanics and Applied Mathematics.

In the field of geophysics the study of the earth's rotation perhaps illustrates better than any other specialty how scientists can take a relatively innocent-looking topic and turn it into a whole discipline. I am sure no layperson could imagine the breadth and complexity of the discipline that students of this obvious and seemingly regular natural daily occurrence have been able to develop. The subject was first brought together in 1960 in the now classic book of Walter Munk and Gordon J. F. MacDonald titled *The Rotation of the Earth.* It was subtitled "A Geophysical Discussion" in recognition of the broad range of geophysical phenomena that either are reflected in or bear on the earth's rotation.

Two decades later the successor to Munk and MacDonald has been written. Although Lambeck has chosen to call his book *The Earth's Variable Rotation: Geophysical Causes and Consequences* he might, without undue pretension, have called it "The Earth's Rotation: A Textbook on Geophysics." Anyone completing a thorough study of all the topics Lambeck deals with would indeed have a considerable background in the whole of geophysics. He or she would also have gained a more than passing knowledge of positional astronomy and satellite dynamics and picked up some very interesting highlights from the history of science.

Overall Lambeck's book is a worthy successor to Munk and MacDonald's. It reflects well the maturity the subject has gained. Much of the earlier treatise was taken up with introducing the reader to topics through the development of governing equations and simplifications, the description of observations, and the establishment of orders of magnitude. Lambeck is able to move well beyond such introductory material, taking advantage of the many advances in the subject over the last two decades. His treatment of topics such as tides and meteorological effects to the understanding of which he himself has contributed is particularly masterly, although he gives thorough and informed accounts of other difficult topics too.

Geophysical specialists will nonetheless see shortcomings in the treatment of their own subjects. This is to be expected, however, in a treatise that sweeps such a broad portion of the geophysical spectrum, and the breadth of the book is its virtue. Though the subject has progressed considerably since 1960, the Lambeck book is still, like Munk and MacDonald's, a collection of geophysical puzzles. Nearly every topic treated opens doors to further research for both theoreticians and experts in precise measurement. No topic seems complete and absolutely settled, many remain centers of controversy.

In addition, there are some minor disappointments. New observational techniques that hold the promise of providing the stimulus to the next set of major advances in the subject are allotted less than three pages. Presumably this is because they have still not produced a large number of definitive results and Lambeck regards them as essentially unproven. Surprisingly, the deformational equations do not include the Coriolis term even though its importance is mentioned in a far too abbreviated discussion of core dynamics. Specialists will find it curious that a two-term differentiator applied to the polar motion data will not simply turn them into white noise. The more fastidious readers will find occasional blunders, such as an incorrect relation between the bulk modulus and the Lamé constants of elasticity and some problems with vector calculus in the representation of the displacement field in spherical coordinates. Nevertheless, for a first edition the book is relatively free of blunders and seems to have been subjected to reasonably careful proofreading.

Looking to the future, one can hope that, with the deployment of new measurement techniques and the advancement of theory, particularly that of the rotational and dynamical behavior of the liquid core, it will be necessary to write a successor to Lambeck in far less than two decades. Given the hoped-for time scale and the magnificent achievement evident in his first effort, one can only add the hope that Lambeck himself will take on the task.

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Solar Phenomena

Solar and Interplanetary Dynamics. Papers from a symposium, Cambridge, Mass., Aug. 1979. M. DRYER and E. TANDBERG-HANSSEN, Eds. Reidel, Boston, 1980 (distributor, Kluwer Boston, Hingham, Mass.). xx, 558 pp., illus. Cloth, $66; paper, $28.95. International Astronomical Union Symposium No. 91.

The study of the solar corona was revolutionized during the decade of the 1960's by in situ spacecraft observations of the coronal gas in the vicinity of 1 astronomical unit. Even the earliest spacecraft data revealed that the solar corona is not static but expands supersonically into interplanetary space. Observations of this "solar wind" confirmed the basic theoretical predictions made by E. N. Parker in the late 1950's, but it soon became apparent that the simple kinematic picture of Parker required modification. The observations revealed that the solar wind was highly structured over some six orders of magnitude of spatial scales, from a few hundred kilometers to a large fraction of an astronomical unit. Moreover, the solar wind was found to be highly variable in time, with temporal scales ranging from a few seconds to many months, and to even longer time scales associated with the solar cycle.

A similar revolution occurred in solar physics during the decade of the 1970's with the launching of sophisticated solar telescopes into space, most notably in the Skylab program. As a result of studies during this period it is now realized that the lower solar atmosphere is itself highly structured and dynamic. The structuring of the solar atmosphere occurs over a wide range of spatial scales, from a few hundred kilometers to about a solar radius. It has become apparent that the structuring is strongly controlled by the solar magnetic field, with the solar atmosphere being organized into loop-like structures that appear to follow magnetic field lines. Prominent exceptions to this rule are the "coronal holes," which have been shown to correspond to magnetic field lines that open out into the solar wind and contribute to some of the spatial and temporal structure of the wind. Moreover, the modern data reveal the lower solar atmosphere to be ever in a state of change and agitation on a wide variety of time scales.

As a result of these discoveries, the solar physics community has abandoned its quasi-static one-dimensional view of the solar atmosphere and solar wind. The solar physicist is now presented with a fascinating laboratory for exploring a great variety of nonlinear dynamic phenomena in a flowing plasma in the presence of gravity and a highly structured magnetic field. In addition, direct observations of the response of the solar wind to changes in the lower layers of the solar atmosphere demonstrated in a graphic way how closely the behavior of the solar wind is coupled to the underlying solar atmosphere. As a result, solar wind physics and solar physics have largely merged into one discipline.

This volume of proceedings consists of 12 invited review papers, 69 short contributed papers, and a brief summary by M. Kuperus. The overall approach is to consider what is known about the dynamic response of the solar atmosphere and solar wind to various changes occurring at some lower layer. A wide variety of phenomena are examined: spicules, surges, solar flares, coronal and chromospheric heating, filaments and prominences, solar wind streams, coronal and interplanetary shock waves, and related phenomena. However, two topics are recurring themes throughout the book. The first is the quasi-static response of the chromospheric, coronal, and interplanetary magnetic field structures to the dynamo activity in the subphotospheric solar layers. This topic is treated in several review papers; "Evolution of coronal and interplanetary magnetic fields" by R. Levine is particularly instructive. The second theme is the physical nature of the so-called "coronal transient"—a large-scale eruption of coronal mass (and perhaps magnetic field) into the solar wind. This topic is treated in several review papers; "MHD aspects of coronal transients" by U. Anzer stands out as a model of a critical review of the field. There are also several invited papers dealing with prospects for future developments.

The contributed papers are of varying quality. The editors have, however, restricted them to a nearly ideal length of two to three pages; more information is provided than in an abstract, but they do not substitute for publication in a properly refereed journal.

The one objection I have to the volume is its division into eight primary sections. I have been able to find very little correspondence between the section titles and the contents of the sections and recommend that the reader ignore the section divisions and peruse the entire table of contents for papers that may be of interest to him or her. (An index is also provided.) I also recommend that the paper by Kuperus be read first as an introduction to the volume.

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Bridges Past and Future

Long-Span Bridges. O. H. Ammann Centennial Conference, New York, Nov. 1979. EDWARD COHEN and BLAIR BIRDSELL, Eds. New York Academy of Sciences, New York, 1980. viii, 282 pp., illus. Cloth or paper, $54. *Annals of the New York Academy of Sciences*, vol. 352.

For many years, the United States was the leader in the design and construction of long-span bridges. However, after World War II, countries such as Germany, England, and Japan soon caught up. Appropriately, an international conference on long-span bridges was held in November 1979 in New York City to share ideas on the subject. The meeting commemorated the 100th anniversary of the birth of Othmar Hermann Ammann, a Swiss-born bridge engineer who practiced his profession in the United States and was the designer of the famed Verrazano suspension bridge across New York Harbor. Out of this conference came the present book. Although much of the information found in it is available elsewhere, the book does bring together in one package a considerable amount of useful material on long-span bridges.

Because of the wide range of subjects