Book Reviews

Units of Matter

Atomic Physics 4. Proceedings of a conference, Heidelberg, Germany, July 1974. G. zu Putlitz, E. W. Weber, and A. Winnacker, Eds. Plenum, New York, 1975. xvi, 780 pp., illus. $59.

The fundamental physical principles governing atomic structure, as well as collision and radiation processes, were laid down some 50 years ago. The field is now passing through a remarkably vigorous middle age. The continued vitality of atomic physics is due, in part, to its relevance in areas of applied physics, such as space physics and the studies of plasmas and lasers, that are of current interest. Beyond this, however, one can point to an intrinsic richness of subject matter and an intellectually stimulating interrelation among the various subfields. Since 1968 there have been four international conferences set up to review the state of fundamental research in atomic physics. *Atomic Physics 4* is a compilation of more than 30 invited papers delivered at the latest of these conferences. The papers give authoritative summaries of recent advances and indicate possibilities for future developments and applications.

A very nice example of the intimate connections that may exist between apparently unrelated subfields appears in the paper by Berndt Müller, R. K. Smith, and Walter Greiner, who discuss the possibility of positron production in heavy-ion collisions. If the subject is viewed as a problem in quantum electrodynamics, the interest lies in the study of electronic states that disappear into the negative-energy continuum when the binding potential is strong enough. Fields of sufficient strength may be realized through the temporary formation of superheavy molecules in heavy-ion collisions. The positron production analysis depends critically on a knowledge of the probability that a K-shell vacancy will be produced in the collision. One is led then to a study of the quasi-molecular model of atomic collisions and an analysis of radiative transitions in quasi molecules. This is a subfield of interest in its own right; several reviews, covering different aspects of the subject, appear in this volume.

The traditional method for testing the validity of quantum electrodynamics is by comparison of measured and predicted energy levels in light atoms. Such tests become more stringent, and therefore more interesting, as experimental techniques are refined. At the same time they provide increasingly precise values for the fundamental constants. Theo W. Hänsch reports a new measurement of the Rydberg constant, of dramatically improved accuracy. This is made possible by recent advances in high-resolution spectroscopy with tunable lasers, a subject reviewed extensively elsewhere in the volume.

Lasers are now also being used in atomic collision physics, thus opening up a new area of investigations. As described by I. V. Hertel, atoms, prior to their collision with a beam of electrons, can be prepared in states of definite spin projection by allowing them to interact with laser light of the proper frequency. By eliminating the need to average over spin projections in the analysis of the experiment, information (such as the phases of the scattering amplitudes) hidden in conventional experiments can now be revealed.

Atomic collision theory has developed in parallel with experimental refinements. Currently, multiple scattering methods of the Glauber type are under intensive study. One wants to know why they work as well as they do, and where precisely they fail. F. W. Byron, Jr., gives a clear introduction to the subject and indicates the connection between the Glauber approach and conventional perturbation theory.

This somewhat random sampling of topics covered in the book cannot properly indicate its scope. Taken as a whole it provides a comprehensive overview of the present status of basic atomic physics research; it will be a useful reference work for expert and nonexpert alike.

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Magnetospheric Science

Physics of the Hot Plasma in the Magnetosphere. Proceedings of a symposium, Kiruna, Sweden, Apr. 1975. Bengt Hultqvist and Lennart Stenflo, Eds. Plenum, New York, 1975. x, 370 pp., illus. $25. Nobel Symposium No. 30.

In April 1975, some 40 magnetospheric scientists met in Kiruna, Sweden, to discuss some basic problems of their field. Their meeting resulted in this book, a collection of 16 highly specialized papers on a variety of relevant subjects. It is not a book for beginners, nor can it be regarded as a textbook or a review.

The 16 papers are only loosely coupled, but two groups can be discerned among them. First, there are studies of waves and fluctuations in the magnetospheric plasma, by Ashour-Abdalla and Kennel, Galeev, Scarf, and Hultqvist, the first three of them having a distinctly theoretical-mathematical flavor. Secondly, there are papers on outstanding puzzles of the magnetosphere, on observed features that fit neither prediction nor accepted theory, such as the energetic oxygen ions described by Johnson *et al.* or the low-altitude acceleration processes reviewed by Evans. This group may also include the heretical but cryptic introductory paper by Alfvén and the contributions of McIlwain and Block: they all seem to imply that, contrary to naive plasma theory, electrical potential differences do sometimes develop along magnetospheric field lines, in ways we still do not understand. The remaining chapters deal with miscellaneous magnetospheric topics and regions, such as the boundary layer, the plasma sheet, Birkeland currents, and plasmas near synchronous orbit.

Although most papers deal with timely subjects, this collection also has many flaws. It consists of facsimile typescripts, which gives it an unfinished appearance, the chapters are disjointed, and some of them lack key illustrations or summary sections. There is no record of the discussions (which, one participant told me, were an important part of the symposium), nor is there any overall review of the meeting. Most important, perhaps, much of the material has the nature of reports on individual research rather than reviews of various subjects of interest.

Thus, I would recommend the book to any major scientific library, but at the same time I cannot help thinking that much of this material should have appeared in regular journals—in particular those papers (such as McIlwain's) that