well written, and I found only one important slip: the velocity potential for the subsonic flow past the flat-plate airfoil depicted on page 53 is *not* "an analytic function of x and y throughout the flow" (it is singular at both the leading and trailing edges and discontinuous across the wake extending downstream from the trailing edge). The exercises are ample in number and are closely coordinated with the exposition. I conclude that anyone intending to give an elementary course on Green's functions would do well to consider Greenberg's book; however, I am far from convinced that such a course is appropriate.

JOHN W. MILES
University of California
San Diego

Electronic and Ionic Impact Phenomena Vol. III: Slow Collisions of Heavy Particles

H. S. W. Massey, E. H. S. Burhop and H. B. Gilbody
819 pp. Oxford U. P., Oxford, 1971.

The high-power gas dynamic laser developed by AVCO was publicly described in the spring of 1971. This technological achievement marked a threshold where laser development ceased to be a trial-and-error practice and became a branch of engineering, in which design can be based at every step on a thorough knowledge of the collision cross sections and radiative processes involved. A construction of this magnitude could only be justified if its performance could be reliably predicted, but the reactions were too complex for any simple scaling. Consequently, all the relevant cross sections had to be known and used. It is a testimony to the accuracy and completeness of the body of knowledge available on the carbon-dioxide system that actual performance was within a factor or two of design predictions.

Lasers do not appear in Volume III of Sir Harrie Massey, Eric Burhop and Brian Gilbody's *Electronic and Ionic Impact Phenomena* except as a tool for exciting specific states in measuring cross sections. Indeed, the numerous applications of collision physics in technology or in other sciences such as aeronomy are not the subject of this book. This impressive volume of a monumental work does, however, provide a rich and authoritative description of the state of atomic-collision science at the beginning of the 1970's and will provide anyone who glances at it with reason to believe that this science is now capable of supplying in manageable form much of the information that practical men like the physicists and engineers at AVCO may need.

Massey has been publishing authoritative textbooks on atomic collisions, both theoretical and experimental, since 1933, and the present volume (the third of four) is part of the almost five-fold expansion of Massey and Burhop's book by the same title published in 1952. The new edition, like its predecessor, is a rich storehouse of information on a great variety of collision processes. In it information can be found on the most important experimental techniques and on the most important theoretical principles applicable to the understanding and prediction of various cross sections. The primary focus of the work is experimental, and a more detailed view of theory and calculational techniques is left to be found in other places, notably in Mott and Massey's *Theory of Atomic Collisions*, which has been a bible of the field since 1933.

The new edition of this work continues to follow the successful pattern of its predecessor, providing a well-balanced mixture including straightforward descriptions of the essential features of various experimental techniques, a very large (but not encyclopedic) presentation of information obtained from these measurements, and frequent descriptions of the appropriate theory and interpretation. This volume on heavy-particle collisions at low energies (mostly near thermal) is largely self-contained, and those who wish to can use it as such, although it occasionally refers back to volumes I and II (devoted to electron collisions with atoms and molecules) for descriptions of an experimental technique or a theroretical principle. Volume IV will be devoted to collisions of heavy particles at higher energies. Unlike the situation twenty years ago, when electron collisions dominated the first edition, Volume III is much fatter than volume I or II, and volume IV should follow its example. This reflects the great and rapid growth in the understanding of heavy-particle collisions that the last few years have brought; the effort that has been devoted so fruitfully to their measurement and understanding has been largely motivated and funded because of their technological importance in many fields.

During World War II, when Massey worked for the British Admiralty, eventually as Chief Scientist in the Mine Design Department, and before he went to Berkeley to work on other explosives, it is said that he and his long-time associate, David Bates, used their long commuting journeys to study, for recreation, a subject that was safely outside the range of military and security restrictions, namely, the collisional and radiative processes going on in the upper atmosphere and ionosphere. To the conditions of commuting in wartime Britain we can thus attribute the fact that Massey and Bates retained their active and productive interest in collision phenomena and in their application in atmospheric physics, and did not succumb to the pressures that, in the US, converted practically all collision physicists to the nuclear or high-energy fields. The great centers of research in collision physics under Massey at University College London, and under Bates at Belfast, which have been the strongholds for work in this field for fully 25 years, thus exist largely because of tenuous historical, social and economic accidents.

The very subject of atmospheric physics, which was so innocent and impractical in World War II, of course came to have much importance to military and space science in the last 20 years, and this relevance was one of the forces that led to the great regrowth of collision physics in the US in that period. In this growth, Massey has notably participated as a senior advisor as well as scientist. Since 1959, he has been the Chairman of the British National Committee for Space Research and an important and influential advisor to the space program in the US as well.

Atomic and ionic collisions have found increasing applications in many other fields, including radiation and nuclear effects in materials and in living organisms, astrophysics, plasma physics and diagnostics, aerodynamics and shock waves, and laser and quantum electronics. These and many other applied needs have been largely responsible for the enormous growth in this subject reflected in the growth of Massey and Burhop's book since its first edition in 1952. As the references in this book show, the activity in this field has been particularly great in the US, especially on the experimental side, but major and important efforts have also been mounted in the Soviet Union, in Western Europe, especially West Germany, and in the UK. The British effort has tended to emphasize theory, largely under the influence of the leadership of Massey and of Bates, and in this respect it has made up for the relative weakness of the US on the theoretical side of this undertaking during much of the last twenty years. The American effort on the theoretical side has been increasing in the past few years, especially in response to the availability of effective computer support, and a highly desirable interaction between theory and experiment is more and more to be seen. In this type of interaction, Massey himself has set the example, not only by combining experimentalists and theoreticians in the department he built up at University College London, but also in the great interest he has shown in assimilating and reporting the results of an enormous number of experimental works in books such as the one under review.

Until now the field of heavy-particle collisions has been characterized by a rather spotty distribution of knowledge with only isolated points where full theoretical understanding existed that could be matched satisfactorily with experiment. We now appear to be well into a period of transition in which these previously isolated regions are rapidly joining into a firm network of consistent and interrelated information, both experimental and theoretical. As this process occurs one subfield after another tends to crystallize rapidly once the really effective organizing principles have been discovered and confirmed by a variety of tests. To this process Massey himself has contributed greatly. He approaches the field as one of the leading architects of its theoretical framework and has an unrivalled knowledge and interest in the experimental information as well.

Just as the first edition of this book has been one of the chief sources to which we have all turned for almost 20 years when seeking orientation into an unfamiliar corner of the field of collision physics, I expect the new edition will provide the same vital service for many years to come.

FELIX T. SMITH
Stanford Research Institute
Menlo Park, Calif.

An Introduction to Mössbauer Spectroscopy

Leopold May, ed.
201 pp. Plenum, New York, 1971. $15.00

The development of Mössbauer spectroscopy has proceeded rapidly since the discovery in 1957 of recoil-free gamma radiation. The history of the technique is not unlike that of other discoveries in physics, particularly that of nuclear magnetic resonance. The initial discovery was in nuclear physics, and it rested quietly for a time. There followed a swift, even hysterical surge of interest in and exploitation of the phenomenon until, by 1962, it had been utilized in many different areas of physics, and the groundwork for the elaboration of the technique had been laid. The history of this period along with the early experimental and theoretical developments was well summarized by Hans Frauenfelder in his lecture-note and preprint volume published at that time. Since then the development of the technique has proceeded at a calmer, but still vigorous, pace. One still finds an occasional conference given over in its entirety to Mössbauer spectroscopy and indeed there continue to be developments that warrant such conferences. On the whole, however, the results of experiments using the technique are more likely to be discussed at conferences on the subject under investigation than in special technique-centered sessions.

Mössbauer spectroscopy is thus, at fourteen years of age, a mature research tool, and the range of its utility is wide indeed. It has found application in many branches of solid-state physics: magnetism, metallurgy, lattice dynamics, phase transitions and critical phenomena and relaxation effects, to give an off-hand list. It is still of use in nuclear physics, and the applications to chemical problems continue to increase. There has also been application to biochemical systems and indeed, some of the most exciting possible uses of variants of the technique lie in this area.

The purpose of this book, edited by Leopold May, is to provide an introduction, for graduate students and research workers, to a number of the current applications of Mössbauer spectroscopy. The nine chapters of the book consist of lectures delivered at Mössbauer Spectroscopy Institutes held at the Catholic University of America from 1967 to 1969, and the authors are all active workers in the fields they discuss. Unfortunately, as with many collections of lectures, the book suffers from a lack of uniformity of quality and viewpoint in the different chapters, of repetition of some subjects and inadequate discussion of others. Thus, the nuclear-quadrupole-interaction formulae are derived in three of the nine chapters, and there are almost no cross references from one chapter to another. The latter would not be a fault in a research monograph but it does reduce the utility of an introductory work.