Research methods using atomic and molecular beams

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G. Scoles (Ed.) Atomic and Molecular Beam Methods. V. 1 Oxford University Press I, 1988 pp. 721.

The two-volume book "Atomic and Molecular Beam Methods" published under the general editorship of Professor G. Scoles is a review of an encyclopedic type of the latest achievements in this field (the appearance of the second volume is planned for the second half of 1990). According to its position among physics investigations research with molecular beams should be regarded as a synthetic field of experimental physics encompassing the interests of atomic and molecular physics, of gas and chemical kinetics, of surface physics, of spectroscopy (including laser spectroscopy) and of other fields. Realistically it provides the experimental basis for those fields the objects of which are either individual properties of atomic particles, or macroscopic properties of gases and condensed media determined by the interaction of atomic particles.

The impetus for the development of systematic investigations based on the method of molecular beams was provided in the 1920's by such prominent people as Frisch, Stern, Gerlach, Esterman, and others in Germany and N. N. Semenov and Yu. B. Khariton in our country. In the following decades and particularly after 1950's truly gigantic process was achieved in realizing the possibilities of this method. To a great extent this is due to the achievements of methodological and instrumental nature. The instrumental base for these investigations has accumulated in recent decades the best achievements of the technique of physics experimentation-vacuum technique, supersensitive detecting technique, electronics (including digital electronics), laser technique, etc. A convincing confirmation of the leading position of these investigations is also the award of the Nobel Prize in physics to N. Ramsey and others.

The material included in the book "Atomic and Molecular Beam Methods" is divided into two parts-the methodology of investigations and its application to problems of the study of collision interactions in the gas phase (volume I), and also to problems of interactions with the surface and spectroscopic investigations discussed in the second volume. Seventeen chapters of the first volume written by leading investigators and reflecting the level of achievements up to 1987 are devoted to an examination of the methodological problems. The aspects discussed here encompass a detailed analysis of the methods of obtaining continuous and pulsed beams of atoms, molecules and clusters, the principles and practical realizations of the detecting systems, including spectroscopic and laser systems, methods and practical achievements in the technique of preparation of states (translational, internal energies, spin) of the colliding particles. A very valuable addition to this methodological part is the discussion of the application of the technique of molecular beams in problems of epitaxy and the production of flowing targets for research in high energy physics.

Of particular value for the reader of this part of the book are the more than 200 diagrams and circuits of concrete devices included in the text. In the section devoted to studies of molecular scattering numerous instrumental realizations of experiments on the measurement of total and differential cross sections of elastic scattering and the theoretical bases for treatment and interpretation of measurements are discussed in detail. Problems of investigations of inelastic (with the excitation of molecular and electronic degrees of freedom and change of the spin state) interactions and collisions accompanied by a chemical transformation—reaction are discussed separately.

Presentation of the material "at first hand" provided by leading specialists is characterized by clarity and a high level of detail. It is sufficient to note that the first volume that has been published includes approximately 700 pages of text and over 300 diagrams. The last item is of considerable importance for readers who are entering the field and for future research workers—undergraduate and graduate students. For the latter readers the book can be regarded as a universal reference for mastering this rapidly developing field which enables one to see clearly the genesis, the current state and the future prospects both of the methods being used and of investigations underway.

The availability of such a book guarantees the maintenance of a high level of an experimenter forced, in order to solve a problem in his work, frequently to rummage in a sheaf of disconnected and elusive publications.

Of undoubted interest and highly instructive is the nontraditional review of problems arising in creating a laboratory devoted to research with molecular beams. Even keeping in mind the differences in the administrative and bureaucratic structures in science in our country and abroad the experience of creating dozens of laboratories summarized in the chapter written by the editor of the book, Professor G. Scoles, is of obvious interest also for our reader.

In summarizing this necessarily "telegraphic" review I would like to note that the book under discussion enters naturally into the series of monographs on theoretical and experimental investigations of atomic-molecular interactions being systematically published abroad. It is specifically such publication that guarantees that "cultivation of the soil" which guarantees obtaining stable and high-yielding—in this case scientific—harvests. It has to be said that in this sense our publishers owe a great debt. It is sufficient to note that the last translation of the book "Research with Molecular Beams" by our publishing house Mir is dated 1969 (with the original dated 1966).

Translated by G. M. Volkoff