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Y. Itikawa

Molecular Processes in Plasmas

Collisions of Charged Particles with Molecules

With 84 Figures

 Springer

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Preface

When I was a graduate student, I studied plasma physics. My thesis for D.Sc. was concerned with transport properties of plasmas. This study needed information of elementary collision processes in the plasma. Since the plasma considered was a fully ionized, hydrogen plasma, collisions were only the Coulomb scattering among plasma particles (i.e., electrons and protons). Therefore, no atomic physics was involved in the study. After my graduation, I started a theoretical study of atomic collisions. Among a variety of collision processes, I was particularly interested in electron–molecule collisions. Molecules are much more complicated than atoms. A detailed study of electron–molecule collisions was somewhat behind the study of electron–atom collisions. At first, my study of atomic collisions had no relation to plasma physics. Eventually, however, I realized that the electron–molecule collision is a fundamental elementary process in gaseous discharges. In fact, scientists engaged in the research of gaseous discharges, or more generally weakly ionized plasmas, are very much interested in electron–molecule collisions. I began to contact those scientists.

Then came an era of plasma processing. In the 1990s, a weakly ionized plasma found a wide range of applications. Requests of information of electron–molecule collisions and related subjects have arisen from industry. Personally, I have been asked to give a talk of atomic collisions to the community of application fields. They often want to have a text book on atomic collisions they can refer to. The present book is my answer to the request.

Many text books on plasma physics include sections for atomic collision processes, but usually they give only a general feature of the processes. On the other hand, many text books are available on the atomic and molecular collisions. Usually, however, they are too much detailed to be referred for application problems. This book has been written from the stand points of atomic physics. Nothing is mentioned about plasma physics. But the examples shown have been selected with an intension to the application in molecular plasmas. The description of atomic physics is as much compact as possible. But, if anyone wants to know more details, he/she is directed to a proper reference. In this sense, this book serves as a guide to atomic physics that is

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necessary to understand the molecular processes in plasmas. From the side of applications, the items sought after are cross-section data. Considering that situation, this book would also serve as a guide for cross-section data on molecular processes.

During the preparation of this book, many scientific colleagues in the world provided the results of their theoretical and experimental research on atomic collisions. I am very much grateful, particularly, to Professor H. Tanaka of the Sophia University, Tokyo. He not only made available the detailed results of the experiments of his group, but also kindly offered me technical help for the preparation of the manuscript.

Tokyo, March 2007

Yukikazu Itikawa

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