DISSOCIATIVE RECOMBINATION OF
MOLECULAR IONS

Dissociative recombination (DR) of molecular ions with electrons is a complex, poorly understood molecular process. Its critical role as a neutralizing agent in the Earth’s upper atmosphere is now well established and its occurrence in many natural and laboratory produced plasmas has been a strong motivation for studying the event. For the first time, theoretical concepts, experimental methodology, and applications are united in one book, revealing the governing principles behind the gas-phase reaction. The book takes the reader through the intellectual challenges posed, describing in detail dissociation mechanisms, dynamics, diatomic and polyatomic ions, and related processes, including dissociative excitation, ionpair formation and photodissociation. With the final chapter dedicated to applications in astrophysics, atmospheric science, plasma physics, and fusion research, this is a focused, definitive guide to a fundamental molecular process. The book will appeal to academics within physics, physical chemistry, and related sciences.

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DISSOCIATIVE RECOMBINATION OF
MOLECULAR IONS

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We would like to dedicate this book to Sheldon Datz, who was responsible for introducing us to this interesting area of physics.
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Preface

This research monograph provides a single-volume description of the dissociative recombination of molecular ions with electrons. Since this is one of the most complex gas-phase processes, its study is a challenge to theorists and experimentalists alike. The theory, experiment, and applications of dissociative recombination are scattered in the scientific literature as original research articles, conference proceedings, and review articles. This book brings this information together in a single work for the first time.

The book is intended for researchers and Ph.D. students in the fields of atomic and molecular physics, chemical physics and physical chemistry, molecular astrophysics, atmospheric physics, and other areas of science where electrons and molecular ions are important.

This book was written during a period when each of us had several other commitments which slowed down the writing. One of us (AEO) was department chair at UC Davis essentially during the entire writing process, and ML chaired committees for the Swedish Space Board and the Swedish Research Council.

We are grateful for the hospitality of the Institute for Atomic and Molecular Physics (ITAMP) at the Harvard-Smithsonian Center for Astrophysics and Harvard University Physics Department (Kate Kirby, Hussein Sadeghpour), the Cluster Research Laboratory, Toyota Technological Institute, Tokyo (Tamotsu Kondow), and the University of Chicago (Takeshi Oka), all of which provided excellent working conditions for us when we needed to get away from our home institutions to focus on writing.

Several people have assisted us in reading part of the book and making valuable suggestions: Alex Dalgarno, Shirzad Kalhori, Holger Kreckel, Åsa Larson, Valery Ngassam, Takeshi Oka, Jeanna Royal, Albert Viggiano and Vitali Zhaunerchyk. We offer them our sincerest thanks for their help.

Finally we would like to thank Rainer Johnson, Brian Mitchell, Ioan Schneider, Andreas Wolf, Chris Greene, and the members of our research groups for access to material prior to publication.
Dissociative recombination studies of other molecular ions in the interstellar medium and in cometary and planetary atmospheres are covered. Ionization is an important competitive process to dissociative recombination and its competition with predissociation and its role in the reverse process of the association of neutral species is presented. Dissociative attachment, in which an electron attaches to a neutral molecule, has many similarities to dissociative recombination. The topics covered include the accurate calculation of electron affinities, attachment to molecules, clusters, and to specific research on the dissociative recombination of electrons e- and molecular ions XY+ in an external electromagnetic field is important to the theory of radiative collisions and also in connection with the development of laser methods for stimulating elementary processes involving atoms and molecules. There is particular interest in the case of monochromatic IR light under limitations on the frequency ωf and amplitude f of the external field such that this field affects the e- +XYt system only in the stage in which intermediate Rydberg complexes XY** form (such complexes are known to play an important role in Cambridge University Press, 2008, 380 pages. Dissociative recombination (DR) of molecular ions with electrons is a complex, poorly understood molecular process. Its critical role as a neutralising agent in the Earth's upper atmosphere is now well established and its occurrence in many natural and laboratory produced plasma has been a strong motivation for studying the event. For the first time, theoretical concepts, experimental methodology and applications are united in one book, revealing the governing principles behind the gas-phase reaction.