FRAGMENTATION PROCESSES

Revolutionary advances in experimental techniques and spectacular increases in computer power over recent years have enabled researchers to develop a much more profound understanding of the atomic few-body problem. One area of intense interest has been the study of fragmentation processes.

Covering the latest research in the field, this edited text is the first to provide a focused and systematic treatment of fragmentation processes, bringing together contributions from a range of leading experts. As well as tackling the more established coincident study of electron-impact ionization, the (e,2e) process, this book also guides the reader through topics such as molecular fragmentation, ion–atom collisions and multiphoton processes.

Combining a broad range of topics with an equal mix of theoretical and experimental discussion, this is an invaluable text for graduate students and researchers in atomic collisions, laser physics and chemistry.

COLM T. WHELAN is a Professor of Physics and an Eminent Scholar at Old Dominion University, USA. He received a Ph.D. in Theoretical Atomic Physics from the University of Cambridge in 1985 and an Sc.D. in 2001. He is a Fellow of both the American Physical Society and the Institute of Physics (UK). He has edited five previous books and has written over 150 research papers, mostly on atomic collision physics.

FRAGMENTATION PROCESSES

Topics in Atomic and Molecular Physics

Edited by

COLM T. WHELAN
Old Dominion University

CAMBRIDGE
UNIVERSITY PRESS

CAMBRIDGE UNIVERSITY PRESS
Cambridge, New York, Melbourne, Madrid, Cape Town,
Singapore, São Paulo, Delhi, Mexico City

Cambridge University Press
The Edinburgh Building, Cambridge CB2 8RU, UK

Published in the United States of America by Cambridge University Press, New York

www.cambridge.org
Information on this title: www.cambridge.org/9781107007444

First published 2013

Printed and bound in the United Kingdom by the MPG Books Group

A catalogue record for this publication is available from the British Library

Library of Congress Cataloguing in Publication data
Fragmentation processes : topics in atomic and molecular physics / edited by Colm T. Whelan,
Old Dominion University.
pages cm
Includes bibliographical references and index.
ISBN 978-1-107-00744-4
1. Few-body problem. 2. Ion-atom collisions. 3. Nuclear fragmentation.
I. Whelan, Colm T., editor of compilation.
QC174.17.P7F72 2012
530.14 – dc23 2012035049

ISBN 978-1-107-00744-4 Hardback

Contents

Contributors

Lorenzo Avaldi *CNR-Istituto di Metodologie Inorganiche e dei Plasmi, Area della Ricerca di Roma 1, CP10, I-00015 Monterotondo Scalo, Italy*

Philip L. Bartlett *ARC Centre for Antimatter-Matter Studies, Murdoch University, Perth 6150, Australia*

Itzik Ben-Itzhak *James R. Macdonald Laboratory, Cardwell Hall, Kansas State University, Manhattan, KS 66506-2604, USA*

S. J. Brawley *Department of Physics and Astronomy, University College London, Gower Street, London WC1E 6BT, UK*

D. A. Cooke *Department of Physics and Astronomy, University College London, Gower Street, London WC1E 6BT, UK*

I. A. Ivanov *Research School of the Physical Sciences and Engineering, The Australian National University, Canberra ACT 0200, Australia*

Á. Kövér *Institute of Nuclear Research of the Hungarian Academy of Science, (ATOMKI), Debrecen, Hungary*

A. S. Kheifets *Research School of the Physical Sciences and Engineering, The Australian National University, Canberra ACT 0200, Australia*

G. Laricchia *Department of Physics and Astronomy, University College London, Gower Street, London WC1E 6BT, UK*

Julian Lower *Institut für Kernphysik, Max-von-Laue-Str. 1, 60438 Frankfurt am Main, Germany*

Andrew James Murray *Photon Science Institute, School of Physics and Astronomy, University of Manchester, Manchester M13 9PL, UK*

M. McGovern *Department of Applied Mathematics and Theoretical Physics, The Queen's University, Belfast, BT7 1NN, UK*

Giovanni Stefani *Dipartimento di Fisica and CNISM Universitá Roma Tre, Via della Vasca Navale 84, I-00146 Rome, Italy*

Andris T. Stelbovics *ARC, Center for Antimatter-Matter Studies, Curtin University, Perth, WA 6102, Australia*

Masahiko Takahashi *Institute of Multidisciplinary Research for Advanced Materials, Tohoku University, 2-1-1 Katahira, Sendai 980-8577, Japan*

H. R. J. Walters *Department of Applied Mathematics and Theoretical Physics, The Queen's University, Belfast, BT7 1NN, UK*

Colm T. Whelan *Physics Department, Old Dominion University, Norfolk, Virginia, USA*

Masakazu Yamazaki *Institute of Multidisciplinary Research for Advanced Materials, Tohoku University, 2-1-1 Katahira, Sendai 980-8577, Japan*

Preface

In the past few years, revolutionary advances in experimental techniques and spectacular increases in computer power have offered unique opportunities to develop a much more profound understanding of the atomic few-body problem. One area of intense effort is the study of fragmentation processes – break-up processes – which are studied experimentally by detecting in coincidence the collisional fragments with their angles and energies resolved. These experiments offer a unique insight into the delicacies of atomic and molecular interactions, being at the limit of what is quantum mechanically knowable; the fine detail that is revealed would be swamped in a less differential measurement. The challenge for the theorist is to develop mathematical and computational techniques which are of sufficient ingenuity and sophistication that they can elucidate the Physics observed in existing measurements and give direction to the next generation of experiments. Fragmentation processes are studied by those interested in electron and photon impact ionization, heavy particle collisions, collisions involving antimatter, as well as molecular collisions.

Colm T. Whelan
31 January 2012