Cambridge University Press & Assessment
978-1-108-49911-8 — Fundamentals and Applications of Heavy Ion Collisions
Below 10 MeV/ Nucleon Energies
R. Prasad , B. P. Singh
Frontmatter
More Information

Fundamentals and Applications of Heavy Ion Collisions

Experiments with accelerated heavy ion beams of energy less than 10 MeV per nucleon require an understanding of the basic concepts of reaction dynamics as well as of experimental technique and methods of preparing samples for irradiation, accurate measurement of sample thickness, sample irradiation, selection and calibration of detectors etc. In depth discussion of models like, promptly emitted particles model (PEPs), breakup fusion model (BUF), hot spot model, Harp Miller and Berne (HMB) and geometry dependent hybrid model etc., offer a comprehensive and up-to-date discussion to the theory and applications of heavy ion collisions at lower energies.

Experimental details of sample preparation, irradiation by HI beams, post irradiation analysis, measurement of recoil range distribution (RRD) and angular distribution of heavy residues in off-beam experiments and of spin distribution in the in-beam experiments are all covered in detail in this monograph. The application of heavy ion interactions including the study of highly rotating neutron deficient nuclei, production of super heavy nuclei and production of specific isotopes of medical applications etc. is presented for the benefit of readers.

R. Prasad is a retired Emeritus Professor of Physics from Aligarh Muslim University, Aligarh, India. He has more than 40 years experience in teaching courses on nuclear physics, electronics, thermal physics, quantum mechanics and modern physics at undergraduate and graduate levels. His field of specialization is experimental nuclear physics in which he has published more than hundred research papers. He has also authored the book *Classical and Quantum Thermal Physics*.

B. P. Singh is a Professor of Physics at Aligarh Muslim University, Aligarh, India. He has more than 25 years teaching and research experience. He has taught courses on nuclear physics, heavy-ion physics, mechanics, electronics, electricity and magnetism, thermal and statistical physics at undergraduate and graduate levels. His areas of research include experimental nuclear physics with special interest in pre-equilibrium emission in nuclear reactions and incomplete fusion reactions in heavy ion interactions, on which he has published more than hundred research papers.

Fundamentals and Applications of Heavy Ion Collisions

Below 10 MeV/ Nucleon Energies

R. Prasad
B. P. Singh

CAMBRIDGE
UNIVERSITY PRESS

CAMBRIDGE
UNIVERSITY PRESS

Shaftesbury Road, Cambridge CB2 8EA, United Kingdom

One Liberty Plaza, 20th Floor, New York, NY 10006, USA

477 Williamstown Road, Port Melbourne, VIC 3207, Australia

314–321, 3rd Floor, Plot 3, Splendor Forum, Jasola District Centre, New Delhi – 110025, India

103 Penang Road, #05–06/07, Visioncrest Commercial, Singapore 238467

Cambridge University Press is part of Cambridge University Press & Assessment, a department of the University of Cambridge.

We share the University's mission to contribute to society through the pursuit of education, learning and research at the highest international levels of excellence.

www.cambridge.org
Information on this title: www.cambridge.org/9781108499118

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

ISBN 978-1-108-49911-8 Hardback

Additional resources for this publication at www.cambridge.org/9781108499118

Cambridge University Press & Assessment
978-1-108-49911-8 — Fundamentals and Applications of Heavy Ion Collisions
Below 10 MeV/ Nucleon Energies
R. Prasad , B. P. Singh
Frontmatter
More Information

Contents

Cambridge University Press & Assessment
978-1-108-49911-8 — Fundamentals and Applications of Heavy Ion Collisions
Below 10 MeV/ Nucleon Energies
R. Prasad , B. P. Singh
Frontmatter
More Information

Figures

Cambridge University Press & Assessment
978-1-108-49911-8 — Fundamentals and Applications of Heavy Ion Collisions
Below 10 MeV/ Nucleon Energies
R. Prasad , B. P. Singh
Frontmatter
More Information

Cambridge University Press & Assessment
978-1-108-49911-8 — Fundamentals and Applications of Heavy Ion Collisions
Below 10 MeV/ Nucleon Energies
R. Prasad , B. P. Singh
Frontmatter
More Information

Tables

Preface

The study of incomplete fusion (ICF) reactions in heavy ion (HI) interactions at energies below 10 MeV per nucleon is a topic of resurgent interest. At such low energies, near and/or just above the fusion barrier, the complete fusion (CF) of the interacting ions is expected to be the most dominant process; however, experiments carried out during the last decade or so have indicated that a significant part of the interaction proceeds through ICF process. Some theories have been proposed to explain the process of incomplete fusion but none of them could successfully reproduce the experimental data at energies < 10 MeV/A. In order to understand the dynamics of such low energy ICF processes and to develop a viable theoretical frame work, our group carried out extensive and complementary experiments on the topic during the last decade or so. The monograph presents the details of these experiments and the analysis of the data.

The presentation has five chapters; Chapter-1 gives a historical background of the subject and discusses the motivation for the work. Chapter-2, entitled 'Theoretical Tools, Reaction Mechanism and Computer Codes' is intended to develop a sound theoretical background of the subject. Important features of computer codes available in the market for theoretical simulation are discussed in this chapter. All experimental details, including the methodology, experimental setups, formulations used for data reduction etc., are given in Chapter-3. The Chapter-4, entitled 'Measurements' contains the details of the measurements of Excitation Functions (EFs), Recoil Range Distributions (RRDs), Angular Distributions (ADs), Spin Distributions (SDs) and Feeding Intensity Profiles (FIPs) of reaction residues. Each measurement is discussed in detail and the recorded experimental data is presented both in tabular form as well as in graphical form. Chapter-5, is 'Results and Conclusions' which provides a detailed discussion of the results obtained from the critical analysis and evaluation of the data obtained in the present set of experiments. Conclusions regarding the dependence of ICF component on various entrance channel parameters, presented in this chapter may be of considerable value in developing a theoretical frame work for HI reactions at energies below 10 MeV per nucleon. The experiments detailed in this document were carried out by our research group at the Physics Department, Aligarh Muslim University, Aligarh, India, in collaboration with members of the Nuclear Physics Group of the Inter University Accelerator Centre (IUAC), New Delhi, India. The Appendix provides a list of some of the important research publications on the subject published by our research group.

During our interaction with fresh graduates desirous of having a career in accelerator based physics in general and experimental nuclear physics in particular, it was realized that they need a document that may spell out most details for carrying out experiments using accelerated beams. These details, such as, designing an experiment, preparation of samples for irradiation, their thickness measurement, choice of detectors, calibration of detectors, data acquisition and analysis etc., are generally available only in research publications and that too in brief. The present document is written with the view to provide young entrants a detailed description for carrying out experiments with accelerated beams. Details of four different types of experiments mentioned above are provided in this document. As such, the monograph is expected to serve as a handbook, a ready reference for beginners in the field. It is hoped that the monograph will be of interest both to new entrants as well as to experienced researchers in the field of low energy heavy ion interactions.

Acknowledgements

The research work reported in this book is based on the experiments carried out by our research group at the Physics Department, Aligarh Muslim University, Aligarh, India in collaboration with members of the Nuclear Physics Group, Inter University Accelerator Centre (IUAC), New Delhi, India. We wish to put on record our sincere thanks to our collaborators from IUAC, Dr Ranjan K. Bhowmik, Dr R. P. Singh, Dr S. Muralithar, Dr Rakesh Kumar, Mrs K. S. Golda, Mrs Indu Bala and Dr Ajit K. Sinha (presently, the Director General, Inter University Centre for Department of Atomic Energy Facilities, Indore, India). We appreciate, very much, the cooperation extended by you all, individually and collectively. Thank you very much.

Thanks are due to the members of our research group as well; in particular to Dr H. D. Bhardwaj, Dr (Mrs) Sunita Gupta, Dr M. M. Musthafa, Dr (Mrs) Unnati, Dr Manoj Kumar Sharma, Dr Pushpendra P. Singh, Dr Devendra P. Singh, Dr Abhishek Yadav, Dr Vijay Raj Sharma and Mr Mohd. Shuaib. Each member of the group participated, designed, and successfully carried out some part of the experimental work. We thank them all from the bottom of our hearts.

All experiments reported in this document were carried out at the IUAC, New Delhi, India using the accelerated heavy ion beams provided by the 15 UD Pelletron accelerator of the centre. We wish to put on record our heartfelt thanks to Professor Amit Roy, ex-Director and Dr Dinakar Kanjilal, the present Director of IUAC, New Delhi, for their kind cooperation and for extending all facilities required during these experiments. We thank the Pelletron crew, who provided the beams of desired ions of required energy and fluence.

Authors also wish to thank the Department of Physics and the Aligarh Muslim University, respectively for extending departmental facilities and administrative support required to successfully complete the research projects that facilitated these investigations.

Financial support in the form of research projects sanctioned by the University Grants Commission (UGC), Council for Scientific and Industrial Research (CSIR) and Department of Science and Technology (DST), Government of India is thankfully acknowledged.

We both wish to say a big thank you to Mr Gauravjeet Singh Reen, the young, smart, prompt and extremely polite but firm commissioning editor at Cambridge University Press, India for his continued cooperation in communicating with the publishers.

Though last but not the least, we wish to thank our families for their continued support.