Heavy Elements and Related New Phenomena

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Heavy Elements and Related New Phenomena

Volume I

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World Scientific

Singapore • New Jersey • London • Hong Kong

Published by

World Scientific Publishing Co. Pte. Ltd.

P O Box 128, Farrer Road, Singapore 912805

USA office: Suite 1B, 1060 Main Street, River Edge, NJ 07661

UK office: 57 Shelton Street, Covent Garden, London WC2H 9HE

Library of Congress Cataloging-in-Publication Data

Heavy elements and related new phenomena / editors, Walter Greiner,
Raj K. Gupta.

p. cm.

Includes index.

ISBN 9810233353 (set : alk. paper). -- ISBN 9810239572 (v. 1 :

alk. paper), -- ISBN (invalid) 981023958X (v. 2 : alk. paper)

1. Nuclear physics. 2. Superheavy elements. I. Greiner, Walter,
1935-- II. Gupta, Raj K. (Raj Kumar), 1938--

QC770.H4 1999

539.7'234--dc21

99-21157

CIP

British Library Cataloguing-in-Publication Data

A catalogue record for this book is available from the British Library.

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Printed in Singapore by Uto-Print

PREFACE

This book consists of four parts, covering both the experimental and theoretical details. The new developments in the field of heavy and superheavy elements and the very related new phenomena of fission and cluster radioactivity are reviewed in the first three Parts I, II and III, respectively. Also, the very new extensions of the Nuclear Chart in new directions of nuclei at the proton and neutron drip-lines, the astrophysical regime and the strange matter are included in Part IV. Some of these considerations could also be of use for future studies of the heavy elements. The contributors were allowed full liberty to give all possible details of the experiments and/or theory so that the book could serve both the post-graduate students in physics as well as the researchers of low energy heavy-ion physics.

Recently, the experiments for the production of heavy/superheavy elements and the related new phenomena have reached a stage of high precision and confidence and the theory, though given out much earlier (two decades or more), is able to explain the underlying physics much better. We have observed not only the “cold fusion” but also the “hot fusion” phenomena, signaling a complete success of the quantum mechanical concept of probability. Similarly, fission is observed both as cold and hot fragments of very high and very low total kinetic energy, respectively. In each case, the cold process is found to be more probable (with larger cross-section) than the hot one, predicted as early as in 1974–75 by the authors and collaborators. Also, the simultaneous occurrence of both cold and hot fission fragments, the bimodal fission, and deformed and/hyper-deformed fission phenomena are observed and understood on quantum theory. Both the cold fission and cold fusion processes are rare processes since cold fission is masked by fragments of various kinetic energies and cold fusion by their specific choice of target-projectile combinations and incident bombarding energies and angular momenta. Only one or a very few atoms of new heavy elements are thus produced, whose chemistry is now also made possible by the development of new methods. Finally, the very rare process of cluster radioactivity, due to the very large number of competing α -decay events, and the availability of radioactive nuclear beam (RNB) facilities for studying the very neutron-rich or neutron-deficient nuclei at the drip-lines, or the possible nuclear astrophysical processes in nature and the possibility of strange matter (hyper matter) are very interesting new aspects of heavy-ion physics study. The prediction of cluster radioactivity, also as a cold phenomena, once again prior to experiments, establishes beyond doubt the presence of (large amplitude) coherent collective motion, best described by a quantum mechanical theory. This book provides an in-depth study of all these phenomena which are very much related to one another.

Initially, this book was planned as a single volume of five-, six-hundred pages but the overwhelming response of the contributors has made it grow presently into two volumes. The authors are highly thankful to all the contributors for their valuable contributions and support. Volume I deals with the superheavy elements and fission studies, and Volume II comprises the cluster radioactivity and the very new extensions to regions of drip-line nuclei, the nuclear astrophysics and other new directions. We are conscious of the missing one Chapter on experimental details of RNB facilities and their recent new data. Unfortunately, this could not be procured within the time scale set out for the preparation of these two volumes. Lastly, the authors appreciate very much the keen interest and cooperation of the Publishers, particularly for modifying the agreed size of the book as 8.5 inches by 6 inches to an impressive 9.75 inches by 6.5 inches.

Walter Greiner
Raj K. Gupta

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