

Landolt-Börnstein

Numerical Data and Functional Relationships in Science and Technology

New Series / Editor in Chief: W. Martienssen

Group I: Elementary Particles, Nuclei and Atoms

Volume 19

Nuclear States from Charged Particle Reactions

Subvolume A

Tables of Proton and α -Particle

Resonance Parameters

Part 2

$Z = 19 - 83$

S.I. Sukhoruchkin

Z.N. Soroko

Edited by H. Schopper



Springer

ISSN 1615-1844 (Elementary Particles, Nuclei and Atoms)

ISBN 3-540-23109-9 Springer Berlin Heidelberg New York

Library of Congress Cataloging in Publication Data

Zahlenwerte und Funktionen aus Naturwissenschaften und Technik, Neue Serie

Editor in Chief: W. Martienssen

Vol. I/19A2: Editor: H. Schopper

At head of title: Landolt-Börnstein. Added t.p.: Numerical data and functional relationships in science and technology.

Tables chiefly in English.

Intended to supersede the Physikalisch-chemische Tabellen by H. Landolt and R. Börnstein of which the 6th ed. began publication in 1950 under title:

Zahlenwerte und Funktionen aus Physik, Chemie, Astronomie, Geophysik und Technik.

Vols. published after v. 1 of group I have imprint: Berlin, New York, Springer-Verlag

Includes bibliographies.

1. Physics--Tables. 2. Chemistry--Tables. 3. Engineering--Tables.

I. Börnstein, R. (Richard), 1852-1913. II. Landolt, H. (Hans), 1831-1910.

III. Physikalisch-chemische Tabellen. IV. Title: Numerical data and functional relationships in science and technology.

QC61.23 502.12 62-53136

This work is subject to copyright. All rights are reserved, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, reuse of illustrations, recitation, broadcasting, reproduction on microfilm or in other ways, and storage in data banks. Duplication of this publication or parts thereof is permitted only under the provisions of the German Copyright Law of September 9, 1965, in its current version, and permission for use must always be obtained from Springer-Verlag. Violations are liable for prosecution act under German Copyright Law.

Springer is a part of Springer Science+Business Media

springeronline.com

© Springer-Verlag Berlin Heidelberg 2005

Printed in Germany

The use of general descriptive names, registered names, trademarks, etc. in this publication does not imply, even in the absence of a specific statement, that such names are exempt from the relevant protective laws and regulations and therefore free for general use.

Product Liability: The data and other information in this handbook have been carefully extracted and evaluated by experts from the original literature. Furthermore, they have been checked for correctness by authors and the editorial staff before printing. Nevertheless, the publisher can give no guarantee for the correctness of the data and information provided. In any individual case of application, the respective user must check the correctness by consulting other relevant sources of information.

Cover layout: Erich Kirchner, Heidelberg

Typesetting: Authors and Redaktion Landolt-Börnstein, Darmstadt

Printing and Binding: AZ Druck, Kempten

SPIN: 1093 2315 63/3020 - 5 4 3 2 1 0 – Printed on acid-free paper

Editor

H. Schopper

CERN, CH-1211 Geneva 23, Switzerland
e-mail: herwig.schopper@cern.ch

Contributors

S.I. Sukhoruchkin

Z.N. Soroko

Petersburg Nuclear Physics Institute
188350 Gatchina, Leningrad District, Russia
e-mail: sergeis@mail.pnpi.spb.ru

Landolt-Börnstein

Editorial Office

Gagernstr. 8, D-64283 Darmstadt, Germany
fax: +49 (6151) 171760
e-mail: lb@springer-sbm.de

Internet

<http://www.landolt-boernstein.com>

Preface

Nuclear resonance parameters for levels created in reactions with incident protons and other light charged particles are of great interest for nuclear spectroscopy, astrophysical models, thermonuclear calculations and other applications. In the Landolt-Börnstein volume I/19A the parameters have now been compiled. No systematic compilation for such data has been performed so far. Parameters for nuclear levels produced in reactions with incident neutrons were published in volumes I/16B and I/16C.

There is such an abundance of experimental data, a large part of it produced during the last 10 years, that it had to be distributed over two subvolumes. Subvolume I/19A1 contains the data for nuclei up to $Z = 18$ and the present subvolume I/19A2 those for nuclei with $Z = 19$ up to $Z = 83$.

In agreement with the Publisher's general effort to make the data available to users by modern methods each subvolume is delivered with a CD-ROM which contains all the data of the printed volume, however, in view of the large amount of data some of the information is given on the CD-ROM only.

The compilation was prepared as usual by eminent experts in the fields. One of the characteristics of Landolt-Börnstein is that data are evaluated before they are accepted for compilation. The idea is to present 'best values' which can be used with confidence by non-experts. Preparing such best values also implied making corrections necessary because of different energy calibrations in various publications.

I should like to thank the authors for their careful work and their flexibility to comply with the wishes of the editor and publisher. Thanks are also due to the members of the Landolt-Börnstein editorial staff who have made major contributions to the successful production of this volume.

Geneva, January 2005

The Editor

Contents

1	Introduction	1
1.1	General remarks	1
1.2	List of notations	5
1.3	Acknowledgements	5
2	Tables	6
19-Pottasium		
K-37	6	
K-39	8	
K-41	15	
20-Calcium		
Ca-40	27	
Ca-42	46	
21-Scandium		
Sc-41	60	
Sc-42	66	
Sc-43	69	
Sc-44	80	
Sc-45	82	
Sc-47	115	
Sc-49	123	
22-Titanium		
Ti-44	126	
Ti-46	130	
23-Vanadium		
V-47	133	
V-48	145	
V-49	147	
V-50	183	
V-51	185	
24-Chromium		
Cr-52	194	
25-Manganese		
Mn-51	196	
Mn-53	216	
Mn-54	245	
Mn-55	252	
26-Iron		
Fe-56	264	
27-Cobalt		
Co-55	272	
Co-57	287	
Co-58	308	
Co-59	311	
28-Nickel		
Ni-58	315	
Ni-60	315	
29-Copper		
Cu-59	317	
Cu-61	329	
Cu-63	348	
Cu-65	359	
30-Zinc		
Zn-62	363	
Zn-64	363	
Zn-66	365	
31-Gallium		
Ga-65	367	
Ga-67	371	
Ga-69	375	
Ga-71	377	
33-Arsenic		
As-71	378	
As-73	379	
As-75	380	
As-77	382	
34-Selenium		
Se-76	383	
35-Bromine		
Br-75	383	
Br-77	384	
Br-79	384	
Br-81	384	
Br-83	385	
37-Rubidium		
Rb-85	385	
Rb-87	386	
38-Strontium		
Sr-88	386	
39-Yttrium		
Y-85	387	
Y-87	387	
Y-88	388	
Y-89	388	
40-Zirconium		
Zr-90	389	
41-Niobium		
Nb-91	390	
Nb-92	391	
Nb-93	391	
Nb-95	392	
Nb-97	392	
42-Molybdenum		
Mo-94	393	

43-Technetium	51-Antimony	61-Promethium
Tc-93 393	Sb-113 411	Pm-143 422
Tc-95 399	Sb-115 411	Pm-145 422
Tc-96 400	Sb-117 411	Pm-147 422
Tc-97 400	Sb-118 412	Pm-149 422
Tc-98 401	Sb-119 412	Pm-151 423
Tc-99 401	Sb-120 412	
Tc-101 402	Sb-121 413	63-Europium
	Sb-123 414	Eu-145 423
45-Rhodium	Sb-125 414	Eu-149 423
Rh-97 402		Eu-151 424
Rh-99 402	52-Tellurium	
Rh-101 403	Te-124 414	65-Terbium
Rh-102 403		Tb-159 424
Rh-103 403	53-Iodine	
Rh-105 403	I-123 415	69-Thulium
	I-125 415	Tm-167 424
47-Silver	I-126 416	Tm-169 424
Ag-103 404	I-127 416	
Ag-105 404	I-129 416	71-Lutetium
Ag-107 404	I-131 417	Lu-171 424
Ag-109 405		Lu-173 425
Ag-111 405	55-Caesium	Lu-175 425
	Cs-137 418	Lu-177 426
48-Cadmium		
Cd-108 406	57-Lanthanum	73-Tantalum
Cd-110 406	La-131 418	Ta-179 426
	La-133 419	
49-Indium	La-135 419	81-Thallium
In-107 406	La-137 419	Tl-205 426
In-109 407	La-139 420	
In-111 407		82-Lead
In-112 408	58-Cerium	Pb-204 427
In-113 408	Ce-140 420	Pb-206 427
In-114 409		
In-115 409	59-Praseodymium	83-Bismuth
In-117 410	Pr-141 421	Bi-205 427
	Pr-143 421	Bi-207 428
		Bi-208 428
		Bi-209 429
3 References		430
Supplement (complete sets of resonance parameters)		CD-ROM