International Atomic Energy Agency

INDC(NDS)-250
Distr. G,ND

INDC **INTERNATIONAL NUCLEAR DATA COMMITTEE**

Co-ordination of the International Network of Nuclear Structure and Decay Data Evaluation

SUMMARY REPORT

of a Consultants' Meeting
organized by the International Atomic Energy Agency and
held at the Kuwait Institute for Scientific Research

Kuwait, 10-14 March 1990

Edited by

H.D. Lemmel

November 1991

IAEA NUCLEAR DATA SECTION, WAGRAMERSTRASSE 5, A-1400 VIENNA

ABSTRACT

The IAEA Nuclear Data Section convened the ninth meeting of the international nuclear structure and decay data network at Kuwait, 10-14 March 1990. The meeting was attended by 19 scientists from 9 Member States and two international organizations, concerned with the compilation, evaluation, and dissemination of nuclear structure and decay data.

Reproduced by the IAEA in Austria
November 1991

INDC(NDS)-250
Distr. G,ND

Co-ordination of the International Network

of Nuclear Structure and Decay Data Evaluation

SUMMARY REPORT

of a Consultants' Meeting
organized by the International Atomic Energy Agency and
held at the Kuwait Institute for Scientific Research

Kuwait, 10-14 March 1990

Edited by

H.D. Lemmel

November 1991

CONTENTS

FOREWORD

The international nuclear structure and decay data (NSDD) network, consisting of numerous evaluation groups and data service centres, aims at a complete and continuous nuclear structure data evaluation of all isobaric mass-chains on a six-year cycle, the continuous publication of these evaluations and their dissemination to the scientific community. The evaluated mass-chain data resulting from this concerted international effort are published in Nuclear Physics A and the Nuclear Data Sheets, and comprise the currently recommended "best values" of all nuclear structure and decay data. The international NSDD network has evolved from the pioneering work in the late fourties and early fifties by physicists from the California Institute of Technology (Pasadena), the Rijksuniversiteit at Utrecht (Netherlands) and the Nuclear Data Group (Washington and Oak Ridge). The united States effort is presently coordinated by the US National Nuclear Data Center at the Brookhaven National Laboratory.

Periodic meetings of this network have the objectives to maintain the coordination of all centres and groups participating in the compilation, evaluation and dissemination of NSDD, to maintain and improve the standards and rules governing NSDD evaluation, and to review the development and common use of the computerized systems and data bases maintained specifically for this activity.

LIST OF ABBREVIATIONS

CAJaD	Centre for Data on the Structure of the Atomic Nucleus and Nuclear Reactions of the USSR State Committee on the Utilization of Atomic Energy, located at the Kurchatov Institute in Moscow.
CBNM	Central Bureau for Nuclear Measurements, located at Geel, Belgium.
CNDC	Chinese Nuclear Data Center, located at the Institute of Atomic Energy (IAE), Beijing.
CODEN	International code for the abbreviations of titles of scientific periodicals.
CPND	Charged Particle Nuclear Data.
EBCDIC	Extended binary-coded decimal interchange code.
ENSDF	Computer-based Evaluated Nuclear Structure Data File.
EXFOR	Computer-based system for the compilation and international exchange of experimental nuclear reaction data.
FIZ	Fachinformationszentrum Energie, Physik, Mathematik GmbH, Eggenstein-Leopoldshafen, FRG.
IAEA/NDS	Nuclear Data Section of the International Atomic Energy Agency.
INDC	International Nuclear Data Committee.
INIS	International Nuclear Information System, operated by the IAEA.
JAERI	Japan Atomic Energy Research Institute.
KACHAPAG	Karlsruhe Charged Particle Group.
KISR	Kuwait Institute fo Scientific Research.
LIYaF	Leningrad Institut Yadernoy Fiziki: Data Centre of the Leningrad Nuclear Physics Institute of the USSR Academy of Sciences.
NDP	Nuclear Data Project located at the Oak Ridge National Laboratory.
NDS	Nuclear Data Sheets, a journal devoted to ENSDF data.
NDS	IAEA Nuclear Data Section.
NNDC	National Nuclear Data Center, located at the Brookhaven National Laboratory, USA.
NSDD	NSD data = Nuclear Structure and Decay Data.
NSR	Nuclear Structure References, a bibliographic file related to ENDF.

M i n u t e s

The ninth meeting of the Network of Nuclear Structure and Decay Data Evaluators was hosted by the Kuwait Nuclear Data Group of the Kuwait Institute for Scientific Research (KISR). It was sponsored by KISR, the Kuwait Foundation for the Advancement of Sciences, and the Kuwait University. The participants enjoyed a most generous hospitality and excellent meeting conditions.

The meeting was opened by Dr. Ahmad Ali Al Jassar, Director General of KISR and H.D. Lemmel on behalf of the IAEA. A reception was given by the Minister for Higher Education, Dr. Abdulla Al-Shamlan. Dr. I. Kondurov was elected as the chairman of the meeting.

The Evaluated Nuclear Structure and Decay Data File (ENSDF) together with its bibliographic file Nuclear Structure References (NSR) is the internationally recognized database for nuclear level schemes, half-lives, decay gamma ray spectra, etc, of all the known nuclear isotopes (more than 2500). In addition to the main regular ENSDF publications in the journals Nuclear Data Sheets and Nuclear Physics A, there are other publications based on ENSDF. In particular, a new edition of the well-known handbook "Table of Isotopes" by the Lawrence Berkeley Laboratory, USA, which serves a large user community (10 000 copies are being printed), is planned.

The input to the ENSDF database is contributed by presently 18 nuclear data evaluation groups in 11 countries. A list of these groups is given in <u>Annex 1</u>, together with the work distribution as of 1989.

Despite the large user community, which illustrates the importance of this database, there is significant lack of support in several countries. Two groups in UK and India have discontinued their co-operation. Another group in Germany has announced its temporary discontinuation due to lack of funding.

The amount of new measurements of nuclear structure and decay data in a large number of institutes is such, that the level scheme of each nuclide should be re-evaluated every 5 to 6 years. This goal has not yet been reached. Evaluations for about one tenth of the nuclides are more than eight years old, indicating that some part of the database is known to be outdated due to lack of support.

Consequently, some time of the meeting had to be devoted to the question of priorities of data evaluation and to the work re-distribution among the available groups and their co-workers. The fact that the work of three groups was discontinued, will lead to a further increase of the evaluation cycle period, so that the number of outdated evaluations in the database is expected to increase further.

Guidance to the evaluation work is given primarily by the National Nuclear Data Center (NNDC) at BNL, USA, and the Nuclear Data Project (NDP) at ORNL, USA.

For the agenda see Annex 2. The list of participants is given in Annex 3. Of the 19 participants 7 received a lump sum payment by the IAEA covering only part of the travel and subsistence costs. The meeting could be held only with the generosity of the Kuwait hosts who gave full financial support to one participant and free accommodation to others. One participant attended completely at his own personal cost.

Since the last meeting three very active members of the network have retired, i.e. F. Ajzenberg-Selove, for many years head of the Light-Nuclei Energy Levels Evaluation Project at the University of Pennsylvania, S. Igarasi, head of the JAERI Nuclear Data Center, and A. Lorenz, deputy head of the IAEA Nuclear Data Section. The meeting participants expressed sincere thanks for all they had contributed to the network and wished them the very best for their future.

The meeting welcomed the announcement that Prof. D.R. Tilley and Prof. H.R. Weller of the Triangle Universities Nuclear Laboratories (TUNL), USA, joined the network with the new evaluations of the A=3 and A=4 systems. They have also assumed responsibility for the evaluation of A=5-20 formerly assigned to Prof. F. Ajzenberg-Selove.

It was noted with great regret and concern that the German network participant, the Fachinformationszentrum (FIZ) Karlsruhe, announced the discontinuation of its participation in the mass chain evaluation. During 14 years as a network member FIZ had produced for 20 mass chains 23 evaluations with recognized good quality. As a consequence of the discontinuation of this work the FIZ share of mass-chains had to be redistributed among the other groups as listed in Annex 4. Regrettably, the discontinuation of FIZ as an active network member will undoubtedly lead to a further increase in the average evaluation cycle period. FIZ requested to continue to receive copies of the ENSDF database for customer services, and the meeting agreed to keep FIZ on the distribution list for the time being.

It will be an important task for the IAEA Nuclear Data Section to find additional nuclear data groups that could join the network of nuclear data evaluators; this may involve fellowships for training at one of the established data evaluation groups.

H.D. Lemmel reported on a letter by Dr. Huo Junde, Department of Physics, Jilin University, Changchun 130023, China, who expressed interest to participate but who could not attend the Kuwait meeting for financial reasons.

Working through the items of the Agenda (see Annex 2), a number of actions were agreed as given in Annex 5.

Status reports by the participants are given in Annex 6.

Among the main achievements of the eeting the following items shall be mentioned:

- As the nuclear structure data evaluation activities originated from three roots (i.e. A=3-20 by TUNL, A=21-44 by Utrecht, and

A=45-266 by the ORNL Nuclear Data Group and other members of the NSDD network), a common database for all nuclides was still missing. The TUNL group has plans to provide future complete evaluations in ENSDF format. This will be an essential step towards a uniform file for all data (though for A=21-44 there will only be a subset of evaluated data in ENSDF).

- The need for an evaluation cycle time of 5 to 6 years was reiterated though only an average cycle period of 8 to 9 years could be achieved so far.

- Progress was reported in the programming of user-friendly access to the ENSDF system on the VAX computer at the NNDC (USA). A copy of the same system is used at the NEA Data Bank. A user's guide for the on-line access to nuclear data files at NNDC is reproduced as Annex 7. The meeting recognizes the significant achievements of on-line services at NNDC and NEA Data Bank.

- A PC version of a gamma-ray catalogue extracted from ENSDF had been produced by P. Ekström et al., Lund University, Sweden. This can be requested from the author; it is now also available at the IAEA Nuclear Data Section for distribution to member states. The database system is described in Annex 8.

- Various details on the ENSDF system and on the publication format in Nuclar Data Sheets were discussed and agreed.

- The Lawrence Berkeley Laboratory and the Brookhaven National Laboratory intend to publish handbooks from the ENSDF database aimed at defined user groups.

Agenda item C.3 was devoted to a presentation by F. Chukreev (Annex 9) about guidelines for evaluators. In this connection the network recognized the importance of the CAJaD activity on ambiguities in the authors' interpretation of experimental data. The CAJaD efforts in writing computer programmes in this field is supported. The network recommends CAJaD to transform its codes for non-unique analysis to run on IBM-PC and VAX-compatible computers.

For consistency of evaluations it was recommended to continue to use the Wapstra 1985 mass tables, except for a few new nuclides which are included only in the 1988 issue. F. Chukreev explained that the mass tables must be accompanied by their covariance matrix which is needed for calculating the uncertainties of the Q-values obtained from the mass differences. He requested NNDC to try to obtain the Wapstra covariance matrix.

Attention was drawn to the rules for achieving a consistent presentation of ENSDF data. The guidelines by R.R. Kinsey of 1988 are reproduced here again as Annex 10.

Under agenda item D.2 concerning the publication of NSDD, J. Tuli presented a detailed report on the publication procedures of the Nuclear Data Sheets, including some new arrangements. Several new format proposals are given in Annex 11. In this connection the meeting formulated the following conclusion:

The proposal fo interleaving (and later intermixing) of tables and drawings in the NDS was accepted. It was pointed out that the radiation tables which are currently (and traditionally) given under the parent nuclide, will be moved to the data section for the daughter nuclide. The necessary cross reference will be given under the parent nuclide.

A proposal for reformatting the adopted levels into four sections, the general comments, level properties, half-life table and spin/parity arguments was presented. It was suggested to explore if it was possible to give BAND information in a separate column in analogy with XREF. It was also suggested that it would be sufficient to give a nominal energy without uncertainty for levels in various tables (other than the level properties table). It was proposed to give reduced transition probabilities in a separate table under the Adopted Gammas section. It was also suggested that it would be sufficient to give E(gamma), MULT and one or two transition strengths in tabular form.

The meeting continued in discussing the needs for additional publications addressed to specific nuclear data user communities. NNDC (J.K. Tuli) was preparing a new issue of the "Nuclear Wallet Cards" of which the previous issues (1971 by F. Ajzenberg-Selove and C.L. Busch, 1979 by the LBL Isotopes Project, 1985 by NNDC) have been very popular. Of the 1990 issue about 10.000 copies will be printed. The proposal by NNDC for a "Nuclear Data Digest", which would offer enhanced online retrievals from ENSDF including drawings and concise tables, is given in Annex 12.

The proposal for an 8th edition of the "Table of Isotopes" planned by R.B. Firestone, E. Browne, and the Isotopes Project Staff at LBL is included as Annex 13.

The network strongly supports the continuing efforts of the LBL group in publishing the Table of Isotopes (Nuclides?) as outlined in the proposal. The book if of proven use to a broad community of mainly applied users, and thus also enhances the visibility of the network.

It is understood that the eighth edition

- will involve minimal additional evaluation, since the data will be taken from ENSDF,
- will absorb 3 man years at the cost of A-chain evaluation; the network considers this a reasonable investment of manpower.

The network also endorses the BNL proposal for a handbook of data taken from ENSDF and directed towards the nuclear structure community, with the recommendation that the decay drawings be deleted. The handbook would then consist of an index, a skeleton level scheme, and adopted levels, gammas in the spirit of the summary of data for A=45-250 previously published by the Nuclear Data Project. This handbook has been widely used by the research community. The production of this handbook would involve a commitment of approximately 0.5 man year.

Anyone responsible for the production of a handbook should make sure that the latest evaluation of the mass range 3-44 is in ENSDF.

V. Vukolov presented a book by V.G. Aleksankin, C.V. Rodichev, P.M. Rubcov, P.A. Ruzhanskij, F.E. Chukreev on "Beta and Antineutrino Emission by Radioactive Nuclei", Energoatomizdat Moscow 1989. Requests for this book can be addressed to CAJaD.

Technical matters of the ENSDF data exchange were discussed with the following conclusions:

- NNDC will redistribute the last version of the ENSDF physics codes, and all participants should verify that they use the most up-to-date versions of codes.

- NNDC will take initiative to review, who receives ENSDF tapes in what intervals.

- Recipients should not send back packages of tapes as freight which cause customs problems; they should rather send single tapes in normal mail.

J. Tuli presented the recent enhancements of the NNDC online services (see Annex 7) which have been made available also to European users through the NEA Data Bank. The participants confirmed that these services are extremely useful and thanked NNDC for the development of the codes. It should be noted that copies of the NUDAT file can be sent only to users that have DATATRIEV.

An advertisement pamphlet of the Kuwait Nuclear Data Group is reproduced in Annex 14. In addition to contributing nuclear structure evaluations to the ENSDF file, the group also serves as a national and regional nuclear data center offering data retrievals to various institutes in the Arabic region. The main interest for the application of nuclear data relates to radioactive methods in petroleum chemistry, ground water research and agriculture.

Subsequent to the meeting A. Farhan, P. Endt and H.D. Lemmel participated in a press conference given by the Director of the Kuwait Institute for Scientific Research Dr. A.A. Al Jassar. The article is reproduced as Annex 15.

Several participants presented scientific lectures related to the topics of the meetings. The lectures are listed in Annex 16. One of these lectures is appended in full length, see Annex 17.

Nuclear Structure and Decay Data (NSDD) Evaluated Nuclear Structure and Decay Data File (ENSDF)

DATA EVALUATION CENTERS 1989

a. National Nuclear Data Center
Brookhaven National Laboratory
Upton, NY 11973, U.S.A.
Contact: J. K. Tuli

b. Nuclear Data Project
Oak Ridge National Laboratory
Oak Ridge, TN 37831, U.S.A.
Contact: M. J. Martin

c. Isotopes Project
Lawrence Berkeley Laboratory
Berkeley, CA 94720, U.S.A.
Contact: E. Browne/R. B. Firestone

d. Idaho National Engineering Laboratory
E.G. and G. Idaho, Inc.
P.O Box 1625
Idaho Falls, ID 83415, U.S.A.
Contact: C. W. Reich

e. Physics Department
University of Pennsylvania
Philadelphia, PA 19174, U.S.A.
Contact: F. Ajzenberg-Selove

f. Center for Nuclear Structure and Reaction Data of the U.S.S.R.
State Committee on the Utilization of Atomic Energy U.S.S.R.
46 Ulitsa Kurchatova
Moscow, D-182, U.S.S.R.
Contact: F. E. Chukreev

g. Data Centre
Leningrad Nuclear Physics Inst.
Gatchina, Leningrad Region
188350, U.S.S.R.
Contact: I. A. Kondurov

h. Fysisch Laboratorium
Princetonplein 5, Postbus 80.000
3508 TA Utrecht, The Netherlands
Contact: C. van der Leun

i. Fachinformationszentrum Energie, Physik, Mathematik GmbH
Kernforschungszentrum
D-7514 Eggenstein-Leopoldshafen 2
F.R.G.
Contact: H. Behrens

j. Centre d'Etudes Nucleaires
DRF-CPN
Cedex No. 85
F-38041 Grenoble Cedex, France
Contact: J. Blachot

k. Nuclear Data Center
Tokai Research Establishment
JAERI
Tokai-Mura, Naka-Gun
Ibaraki-Ken 319-11, Japan
Contact: Y. Kikuchi

l. Institute of Physics
University of Lund
Sölvegatan 14
S-223 62 Lund, Sweden
Contact: P. Ekström

m. Nuclear Data Project
Kuwait Institute for Scientific Research
P.O. Box 24885
Kuwait, Kuwait
Contact: A. Farhan

n. Laboratorium voor Kernfysica
Proeftuinstraat 86
B-9000 Gent, Belgium
Contact: D. De Frenne

o. Tandem Accelerator Laboratory
McMaster University
Hamilton, Ontario L8S 4K1
Canada
Contact: J. A. Kuehner

p. Institute of Atomic Energy
P.O. Box 275 (41), Beijing
People's Republic of China
Contact: Cai, Dunjiu

EVALUATION RESPONSIBILITY

A-Range	Center	A-Range	Center	A-Range	Center	A-Range	Center
1-4	f	65-73	a	136-148	a	195-198	p
5-20	e	74-80	a	149,151	o	199-237	b
21-44	h	81-100	i	150,152	a	238-244(even)	f
45-50	a	101-110	j	153-162	d	239-243(odd)	b
51-56	p	111-117	n	163,165	a	245-263	b
57,58	a	118-129	k	164,166	f		
59-64	l	130-135	g	167-194	c		

DATA EVALUATION CENTERS

1990/91

a. National Nuclear Data Center
Brookhaven National Laboratory
Upton, NY 11973, U.S.A.
Contact: S. Pearlstein

b. Nuclear Data Project
Oak Ridge National Laboratory
Oak Ridge, TN 37831, U.S.A.
Contact: M. J. Martin

c. Isotopes Project
Lawrence Berkeley Laboratory
Berkeley, CA 94720, U.S.A.
Contact: E. Browne/R. B. Firestone

d. Idaho National Engineering Laboratory
E.G. and G. Idaho, Inc.
P.O. Box 1625
Idaho Falls, ID 83415, U.S.A.
Contact: C. W. Reich

e. Triangle University Nuclear Lab.
Duke University
Durham, NC 27706, U.S.A.
Contact: H. R. Weller/D. R. Tilley

f. Center for Nuclear Structure and Reaction Data of the U.S.S.R.
State Committee on the Utilization of Atomic Energy U.S.S.R.
46 Ulitsa Kurchatova
Moscow, D-182, U.S.S.R.
Contact: F. E. Chukreev

g. Data Centre
Leningrad Nuclear Physics Inst.
Gatchina, Leningrad Region
188350, U.S.S.R.
Contact: I. A. Kondurov

h. Fysisch Laboratorium
Princetonplein 5, Postbus 80.000
3508 TA Utrecht, The Netherlands
Contact: C. van der Leun

i. Institute of Atomic Energy
P.O. Box 275 (41), Beijing
People's Republic of China
Contact: Cai, Dunjiu

j. Centre d'Etudes Nucleaires
DRF-SPH
Cedex No. 85
F-38041 Grenoble Cedex, France
Contact: J. Blachot

k. Nuclear Data Center
Tokai Research Establishment
JAERI
Tokai-Mura, Naka-Gun
Ibaraki-Ken 319-11, Japan
Contact: Y. Kikuchi

l. Institute of Physics
University of Lund
Solvegatan 14
S-223 62 Lund, Sweden
Contact: P. Ekström

m. Nuclear Data Project
Kuwait Institute for Scientific Research
P.O. Box 24885
Kuwait, Kuwait
Contact: A. Farhan

n. Laboratorium voor Kernfysica
Proeftuinstraat 86
B-9000 Gent, Belgium
Contact: D. De Frenne

o Tandem Accelerator Laboratory
McMaster University
Hamilton, Ontario L8S 4K1
Canada
Contact: J. A. Kuehner

EVALUATION RESPONSIBILITY

Center	Mass Chains
a. US/NNDC	45-50,57,58,65-73,94-97,99,136-148, 150,152,163,165
b. US/NDP	81-85,199-237,237-243 (odd), 244-266
c. US/LBL	89-93,167-194
d. US/INEL	87,153-162
e. US/TUNL	3-20
f. USSR/MOS	1,2,164,166,238-244 (even)
g. USSR/LEN	86,88,130-135
h. Holland	21-44
i. PRC	51-56,195-198
j. France	101,104,107-109,111,113-117
k. Japan	118-129
l. Sweden	59-63
m. Kuwait	74-80
n. Belgium	102,103,105,106,110,112
o. Canada	64,98,100,149,151

NSDD DISTRIBUTION CENTERS

National Nuclear Data Center
Brookhaven National Laboratory
Upton, NY 11973, U.S.A.
Contact: J.K. Tuli

NEA Data Bank
B.P. N° 9, (Bât. 45)
F-91190 Gif-sur-Yvette, France
Contact: N. Tubbs

Center for Nuclear Structure
and Reaction Data of the U.S.S.R.
State Committee on the Utilization
of Atomic Energy U.S.S.R.
46 Ulitsa Kurchatova
Moscow, D-182, U.S.S.R.
Contact: F.E. Chukreev

IAEA Nuclear Data Section
P.O. Box 100
A-1400 Vienna, Austria
Contact: J.J. Schmidt

Fachinformationszentrum Energie,
Physik, Mathematik GmbH
Kernforschungszentrum
D-7514 Eggenstein-Leopoldshafen 2
F.R.G.
Contact: H. Behrens

X-RAYS EVALUATION CENTRE

Bureau Central de Mesures Nucléaires
C.E.C.
Steenweg naar Retie
B-2440 Geel, Belgium
Contact: W. Bambynek

IAEA Consultants' Meeting
of the participants in the international network of
NUCLEAR STRUCTURE AND DECAY DATA EVALUATORS

Kuwait, 10-14 March 1990

hosted and supported by the
Kuwait Institute for Scientific Research

AGENDA

Technical part of the agenda

A. Introductory Items

1. Opening Statements
2. Election of Chairman
3. Adoption of the Agenda
4. Announcements
5. Review of Actions from last meeting, see report INDC(NDS)-206, p. 27

B. NSDD Network

1. Status of members, Mass Chain evaluation assignments
2. Short reports from network members
3. Report from the US NSDD Network
4. Call for additional network evaluators for the review of A-chains
5. Re-assignment of A = 81-100 to other centers (previously Karlsruhe)

C. Evaluation of Nuclear Structure and Decay Data

1. Current mass-chain evaluation status
2. Proposed ENSDF formats for A<45
3. Guidelines for evaluators and evaluation physics rules
   - "Should an evaluator check the author's interpretation of experimental data?"
4. How to improve productivity and currency of mass-chain evaluation with the inclusion of important physics developments

D. Publication of Nuclear Structure and Decay Data

1. NSDD Publication in Nuclear Physics (A<45)
2. Nuclear Data Sheets publications (A>44)
   - new formats: a. Interleaving of tables and plots
     b. Properties-oriented tables for adopted levels and gammas
3. Table of Radioactive Isotopes
4. Wall Charts
5. Horizontal Compilations and Evaluations

E. The Nuclear Structure Reference (NSR) File

Status, contents, format, publication

F. The Evaluated Nuclear Structure Data File (ENSDF) System

1. Status, contents, format, changes?
2. ENSDF physics computer codes
3. ENSDF output computer codes

G. NSDD Publicity and Distribution

1. Distribution of the ENSDF Data Tapes
2. Data centre services
   On-line access to nuclear data at the NNDC, status and enhancements
3. ENSDF for specific user groups
   On-line access to the Radioactivity Data Base at Lund, Sweden
4. Publicity of ENSDF

H. Next Meeting

I. Summary of Conclusions and Recommendations

Scientific Lectures

See Annex 16.

IAEA Consultants' Meeting
of the participants in the international network of
NUCLEAR STRUCTURE AND DECAY DATA EVALUATORS

Kuwait, 10-14 March 1990

hosted and supported by the
Kuwait Institute for Scientific Research

LIST OF PARTICIPANTS

Belgium	D. de Frenne Laboratorium voor Kernfysika Proeftuinstraat 86 B-9000 Gent
China	Zhou Chunmei Chinese Nuclear Data Centre Institute of Atomic Energy P.O. Box 275 (41) Beijing
France	J. Blachot DRF/Service de Physique MDIH Centre d'Etudes Nucléaires de Grenoble B.P. No. 85 F-38041 Grenoble Cédex
Japan	A. Hashizume RIKEN Institute of Physical and Chemical Research 2-1 Hirosawa, Wako-shi Saitama 351-01
Kuwait	A.R. Farhan (Local Organizer) Nuclear Data Project Kuwait Institute for Scientific Research P.O. Box 24885 13109 Safat
	Adnan Shihab-Eldin (same address as above)
	Shaheen Rab (same address as above)
Netherlands	P.M. Endt Fysisch Laboratorium Rijksuniversiteit Princetonplein 5 P.O. Box 80 000 NL-3508 TA Utrecht

C. van der Leun
Fysisch Laboratorium
Rijksuniversiteit
Princetonplein 5
P.O. Box 80 000
NL-3508 TA Utrecht

Sweden

P. Ekstroem
Department of Physics
Lund University
Solvegatan 14
S-223 62 Lund

U.S.S.R.

F.E. Chukreev
Institut Atomnoi Energii
I.V. Kurchatova
Ploschad Kurchatova
Moscow D-182, 123182

V.A. Vukolov
(same address as F.E. Chukreev)

I.A. Kondurov
Data Centre
Leningrad Nuclear Physics
Institute
Gatchina, Leningrad 188350

U.S.A.

M.R. Bhat
Bldg. 197D
National Nuclear Data Center
Brookhaven National Laboratory
Upton, New York 11973

J.K. Tuli
(same address as M.R. Bhat)

M.J. Martin
Nuclear Data Project
Bldg. 6000, MS-371
Oak Ridge National Laboratory
P.O. Box X
Oak Ridge, TN 37831

V. Shirley
Bldg. 50A
Nuclear Science Division
Lawrence Berkeley Laboratory
Berkeley, CA 94720

presently at:
Freie Universität Berlin
c/o Prof. Kaindl Group
Fachbereich Physik
WE 1, Arnimallee 14
1000 Berlin 33

C.E.C.	W. Bambynek Central Bureau of Nuclear Measurements Steenweg naar Retie B-2440 Geel Belgium
I.A.E.A.	H.D. Lemmel (Scientific Secretary) IAEA Nuclear Data Section Wagramerstr. 5, P.O. Box 100 A-1400 Vienna Austria

Mass-chain Assignments

(April 1990)

A-range	No. of mass-chains	Evaluation Group
1-2	2	CAJaD/USSR
3-4	2	TUNL/USA
5-20	16	Univ. of Pennsylvania/USA
21-44	24	Univ. of Utrecht/Netherlands
45-50	6	NNDC/USA
51-56	6	CNDC/PRC
57,58	2	NNDC/USA
59-63	5	Lund Univ./Sweden
64	1	McMaster/Canada
65-73	9	NNDC/USA
74-80	7	KISR/Kuwait
81-85	5	NDP/USA
86,88	2	CAJaD/USSR
87	1	INEL/USA
89-93	5	LBL/USA
94-97, 99	5	NNDC/USA
98, 100	2	McMaster/Canada
101-110	10	Grenoble/France
111-117	7	Univ. of Gent/Belgium
118-129	12	JAERI/Japan
130-135	6	LIYaF/USSR
136-148	13	NNDC/USA
149,151	2	McMaster/Canada
150,152	2	NNDC/USA
153-162	10	INEL/USA
163,165	2	NNDC/USA
164,166	2	CAJaD/USSR
167-194	28	LBL/USA
195-198	4	CNDC/PRC
199-237	39	NDP/USA
238-244 (even)	4	CAJaD/USSR
239-243 (odd)	3	NDP/USA
245-266	22	NDP/USA

IAEA Consultants' Meeting of the
Participants in the

NETWORK OF NUCLEAR STRUCTURE AND DECAY DATA EVALUATORS

Kuwait, 10 - 14 March 1990

hosted and supported by the
Kuwait Institute for Nuclear Research

LIST OF ACTIONS
agreed at the Meeting

Actions

A) Standing actions

1.	Network	Inform the US/NNDC of errors in ENSDF, NSR, NDS publications, and distributed codes. The US/NNDC is requested to acknowledge these communications and inform the network on the disposition of the suggested corrections.
2.	Network	Inform the center responsible of any evaluation errors.
3.	Network	Send to US/NNDC comments and suggestions on all ENSDF-related manuals as well as symbols, abbreviations and conventions used in the NDS publications.
4.	Network	Send to M. Martin comments and suggestions on the "Guidelines for Evaluators".
5.	Network	Inform US/NNDC of any new computer codes written, so that they can distribute them to interested members of the network.
6.	Network	NSDD evaluators are encouraged to seek comments from their colleagues and/or experts in the pertinent mass region during the evaluation and publication process.
7.	Network	Identify to US/NNDC prospective referees within and outside their groups.
8.	Network	The center/project heads should keep US/NNDC informed of changes of personnel in their respective groups.
9.	Network	The center/project heads are responsible for the dissemination of memos and communications regarding the evaluation within their respective groups. (Network communications will in the future be distributed only to the contact person of a center/project.)

B) Actions arising from this meeting

1. NNDC — Try to persuade Phys. Rev. C to restore the use of keywords in that journal.

2. IAEA/NDS — In collaboration with US/NNDC, prepare a pamphlet advertising the NSDD network. Also publicize NSDD network in the Nuclear Data Section Newsletter.

3. Martin — Collect all existing and revised rules for spin/parity assignments in time for discussion at the next meeting and circulate it to the network.

4. NNDC — Find out if US/LBL will enter the data for A=21-44 from the next evaluation by NED/Utrecht into ENSDF. If they cannot take full reponsibility for the task, the previously agreed upon responsibilities remain.

5. NNDC — Investigate the possibility of making and distributing interactive versions of analysis programs such as LOGFT and HCICC for PC.

6. NNDC — Distribute the present versions of all ENSDF physics and output codes.

7. IAEA/NDS — Advertise ENSDF/NSR and how to access these files to the NDS service area; in particular to include ENSDF/NSR presentation in their training courses.

8. Blachot — Look into the orderly transfer of evaluation responsibilities for the A-chains assigned to France to other French physicists starting in 1992, and report progress to the IAEA.

9. NNDC — Possibly add to the NSR system laboratory codes which would improve retrieval possibilities and which would be useful for EXFOR data compilation.

   Note added after the meeting: Adding laboratory codes to NSR would require changes in the database structure and in the codes which could not be implemented under the given staff restrictions.

Status Reports by participants

V.A. Vukolov presented the status report by CAJaD	Annex 6.1
I. Kondurov: Status report LIJaF	Annex 6.2
C. v.d. Leun: Status report Utrecht	Annex 6.3
J. Blachot: Status report France	Annex 6.4
H.D. Lemmel: IAEA Nuclear Data Section	Annex 6.5
W. Bambynek: Statement on CBNM	Annex 6.6
A. Hashizume presented the Japanese status report	Annex 6.7
P. Ekström: Status report Sweden	Annex 6.8
A. Farhan: Status report Kuwait	Annex 6.9
D. de Frenne: Status report Ghent	Annex 6.10
H.D. Lemmel presented the Canadian status report received by mail from B. Singh	Annex 6.11
Zhou Chunmei: Status report CNDC	Annex 6.12
M.R. Bhat presented the status report on US activities	Annex 6.13
H.D. Lemmel presented a letter from FIZ	Annex 6.14

STATUS REPORT OF THE CAJAD RELATED TO THE EVALUATION OF NUCLEAR STRUCTURE AND DECAY DATA

(The USSR State Committee for Utilization of Atomic Energy)

V.A.Vukolov, F.E.Chukreev, E.N.Shurshikov

Over a period of 1988-1989 the CAJAD in the sphere of its responsibility had finished the evaluation for following mass chains: A=4 (April-88), A=242 (June-88), A=1 (March-89), A=164 (June-89) and A=166 (December-89).

As previously announced in Ghent, the CAJAD continued its investigations to provide better coverage of all available experimental information for the evaluation of nuclear structure characteristics. For this purpose the method of the evaluation and checking of experimental data based on use of mathematical methods "operations research" was developed. Application of this method opens possibilities:

- to find out consistency of experimental results;
- to draw up recomendations to planning new experiments and its accuracies which are the most critical to ambiguons interpretation of the evaluated data.

More detail, our experience of this method application for structure analysis a number of nuclei will be reported by F.Chukreev at this meeting.

In conclusion, we would like to contirm our readiness to the evaluation of mass chains with A=86,88 instead of A=3,4. The information about our decision had been sent to NNDS.

Status Report on the LIJAF Data Centre Activity in the Field of Nuclear Structure and Decay Data

I. Kondurov, Ju. Sergeenkov

Our last report to the NSDD network was done more than 10 years ago. All this time the Centre have continued evaluation of mass-chains in the A range 130-135 and preparation of keyword references of reports published in Sovijet secondary sources.

The mass-chains 134,133,130 have been published. A=132 is in correction, A=131 - in progress.

About 2500 keyword references have been sent to BNL and included in the "Nuclear References" of the Nuclear Data Sheets.

Computer base of the Centre was changed. VAX-11 compatible computers and IBM-PC/AT are the main computers now. The system was checked with physical evaluation codes supplied by BNL. Results are perfect. Now we are preparing to use NSR and ENSDF file with the new system.

Neutron activation analysis data file is prepared from ENSDF including also neutron cross-section data from BNL-325.

ENSDF file was also widely used for searching nonstatistical effects in the distribution of distances between nuclear levels.

The work on A-chain and keyword references are continuing.

90/3

STATUS REPORT - UTRECHT

Mass-chain evaluation

The A = 21-44 region has last been covered in 1978 (edition VI). A new version (edition VII) will appear in 1990, also in the journal Nuclear Physics. At the moment the
A = 21-26 part has been typeset,
A = 27,28 is being typeset,
A = 29-44 is ready in pencil.

A computer program has been developed (and implemented) for the production of the 126 level schemes.

Pieter M. Endt

Gamma-ray calibration energies

The list of γ-ray lines recommended for energy calibration purposes (published in ANDT in 1979) is being revised and updated. A 6-7 ppm adjustment of the "gold standard" will be the most important change. The new list will be presented at the next IUPAP conference on Atomic Masses and Fundamental Constants (AMCO) to be held in September 1990 (collaboration with R.G. Helmer and P.H.M. Van Assche).

Cornelis van der Leun

STATUS OF MASS CHAIN EVALUATION IN FRANCE

Jean Blachot
(with the collaboration of G. Marguier, F. Hass)

A) Mass Chain Evaluation:

Since the last NSDD meeting, the status of the evaluation is summarized as:

Sent to publisher:	A = 116 (900206)	
	A = 113 (900314)	
Under review :	A = 111	sent (890323)
	A = 114	sent (890417)
	A = 108	sent (891023)
	A = 107	sent (891204)
On-going :	A = 104	
Next evaluation :	A = 109 and after A = 101	

B) Publicity for the on-line system:

During the last 2 years, we have given many lectures on ENSDF and NSR in the major Nuclear Physics Labs in France.

Some statistics on the use of the system at the NEA DATA BANK in Saclay will be given during the meeting.

c) Use of ENSDF for applied users files:

ENSDF has been extensively used to produce some internal reports dealing with the most important radioactive parameters.

To produce the second version of JEF (Joint European File), the ENSDF has been the major source.

IAEA Nuclear Data Section

Status Report 1990/3/10

H.D. Lemmel

In addition to its coordinative function, IAEA/NDS is a distributive center of ENDSF and related data primarily to scientists in East Europe and developing countries.

After the retirement of Alex Lorenz and other staff changes the continuity in the detailed knowledge of the ENSDF system has been interrupted. At present the purchase of a VAX computer is considered. If this is approved it will be possible to take over from NNDC the ENSDF system for on-line service to customers.

Provisions of data files and codes on PC diskettes is considered at the IAEA as a project of particular importance to developing countries. Therefore, the data center services provided by IAEA/NDS will be heavily based on data sub-files derived from ENSDF to be used on a PC.

The IAEA support for NSDD network meetings is expected to continue. However, the financial ceiling will remain limited due the continuing "zero-growth" budget which, due to increasing cost, means even some shrinking.

IAEA/NDS has two NSDD related activities.

- A co-ordinated research program (CRP) on x-ray and gamma-ray standards for detector efficiency calibration has held its final meeting in 1989. The product will be a handbook on selected x-rays and gamma-rays for a suitable set of materials for which the CRP participants determined precise values of half-lives and emission probabilities by experiment and evaluation. It is planned that the handbook will be accompanied by a data file on diskette.

- The IAEA handbook on actinide decay data which had been published in 1986 as IAEA Technical Report No. 261 is planned to be updated and supplemented.

Statement on CBNM's Activity in Evaluation and Compilation of Deacay Data during 1988 and 1990

W. Bambynek

Evaluations of X- and Gamma-Ray Emission Probabilities

In the frame of an IAEA Coordinated Research Project on X- and Gamma-Ray Standards for Detector Efficiency Calibration the X-ray emission probabilities of the radionuclides selected by the CRP members (^{51}Cr, ^{54}Mn, ^{55}Fe, ^{57}Co, ^{58}Co, ^{65}Zn, ^{75}Se, ^{85}Sr, ^{88}Y, $^{93}Nb^{m}$, ^{109}Cd, ^{111}In, ^{113}Sn, ^{125}I, ^{137}Cs, ^{133}Ba, ^{139}Ce, ^{152}Eu, ^{154}Eu, ^{198}Au, ^{203}Hg, ^{207}Bi, ^{241}Am) (Christmas, P., A.L. Nichols and H.D. Lemmel (1989), INDC(NDS)-221/GE) have been re-evaluated.

Measurements of Alpha-Emission Probabilities of Actinides

Measurements of the alpha-emission probabilities of ^{137}Np have been performed. A paper with the results was sent to NIN A for publication (G. Bortels et al.).

In addition, measurements of the alpha-emission probabilities of ^{236}Pu, ^{239}Pu and ^{243}Am were finished. The evaluation of the results is in progress.

Status Report on Japanese Activities in Nuclear Structure and Decay Data

Annex 6.7

1. Managerial change of NSDD activities in Japan

Due to the retirement of Dr. S. Igarashi, Dr. Y. Kikuchi, General Manager of JAERI/Nuclear Data Center, is representing Japanese group of the international network for nuclear structure data evaluation since October 1989.

2. Mass-chain evaluation

The Japanese group will maintain the permanently assigned mass range of 118-129, and also 177 as a temporary projection. Now, evaluations of A=119 and 121 have reached to final stages. We will be able to submitt all of them by the end of next April. Evaluation of A=177 will be submitted by the end of ~~next~~ May 1990. Then we will start the evaluation of A=123 and 126.

3. Evaluators

On all part-time basis:

K.Kitao (NIRS, Chiba), M.Kanbe (Musashi Inst. Tech., Tokyo), and K.Ogawa (Kantou Gakuin Univ., Yokohama) for A=119,

T.Tamura (Inst. Radiat. Mesur., Tokai), H.Iimura (JAERI), M.Miyano and S.Ohya (Niigata Univ.) for A=121, and

A.Hashizume (RIKEN), Y.Tendow (RIKEN), and M.Oshima (JAERI) for A=177.

4. Computer

Most of evaluation work is carried out with FACOM-M780 computers, IBM compatible machine, of JAERI Tokai and RIKEN. Now the analysis program FMTCHK, PANDORA, GTOL, FETCH, HSICC, LOGFT, and RADLIST are operational on these computers. Other programs may be running successfully on the M780 computer.

5. Other related activities on nuclear structure and decay data

a. Bibliographic data compilation

Computerized compilation of Japanese references (secondary sources) is being carried out by JAERI and RIKEN nuclear data group continuously.

b. Revision of the Chart of Nuclides (4th edition 1988)

The 5th edition is in preparation and will be published in 1992. The chart is characterized by inclusion of e -imated values for unmeasured beta-decay partial half-lives of the nuclides far from the beta-stable line based on the gross theory of beta-decay.

c. Horizontal compilation

A table of gamma-rays not placed in decay scheme is now in preparation for workers engaged in estimating radiation energy from radioactive nuclides, spectroscopic analysis of metal irradiated with high energy charged particles. The table will be publised as a JAERI Memo in 1990.

A-Chain Evaluation Results and Status

A	Cutoff Date	Publication	Evaluator
118	850531	NDS 51, 355-394 (1987)	Tamura,Miyano,Ohya
119	under evaluation		Kitao,Kanbe,Ogawa
120	860328	NDS 52, 641-714 (1987)	Hashizume,Tendow,Ohshima
121	781015	NDS 26, 385-471 (1979)	Tamura,Matsumoto, Hashizume,Tendow,Miyano, Ohya,Kitao,Kanbe
121*	under evaluation		Tamura,Miyano,Iimura
122	841231	NDS 49, 315-381 (1986)	Kitao,Kanbe,Matsumoto,Seo
123	790630	NDS 29, 453-531 (1980)	Tamura,Matsumoto,Miyano, Ohya
124	820531	NDS 41, 413-510 (1984)	Tamura,Miyano,Ohya
125	801130	NDS 32, 497-591 (1981)	Tamura,Matsumoto,Ohshima
126	800630	NDS 36, 227-288 (1982)	Tamura,Miyano,Ohya
127	791001	NDS 35, 181-277 (1982)	Hashizume,Tendow,Kitao, Kanbe,Tamura
128	830228	NDS 38, 191-275 (1983)	Kitao,Kanbe,Matsumoto
129	820331	NDS 39, 551-640 (1983)	Hashizume,Tendow,Ohshima
177	under evaluation		Hashizume,Tendow, Ohshima

IAEA meeting on the Coordination of the International Network of Nuclear Structure and Decay Data Evaluators, Kuwait, 10-14 March 1990

Status report: Sweden Annex 6.8

Nuclear Structure and Decay Data Evaluation in Sweden

Peter Ekström and Jacquette Lyttkens

Financial support and personnel

The project is funded (one full-time post) jointly by the Swedish Nuclear Power Inspectorate (SKI), the National Institute for Radiation Protection (SSI), the National Defence Research Establishment (FOA), the National Committee for Used Nuclear Fuel (NAK), Studsvik Energiteknik and Vattenfall. The post has, during the last two years, been mostly vacant. Attempts to obtain more long-term funding are being made, but at present no definite results have been obtained.

Mass-chain evaluation

Work on A=90 has been dormant since the last meeting. It has, however, recently been started again, and we hope to be able to finish the evaluation soon.

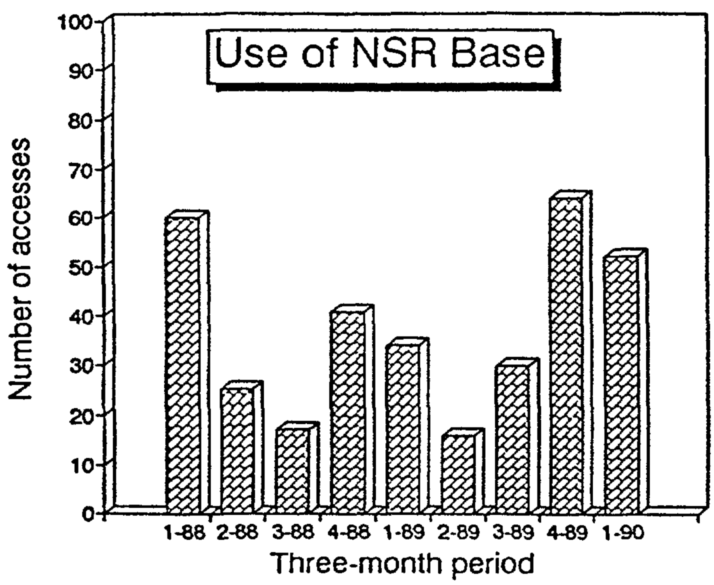
Data base for radioactivity gammas

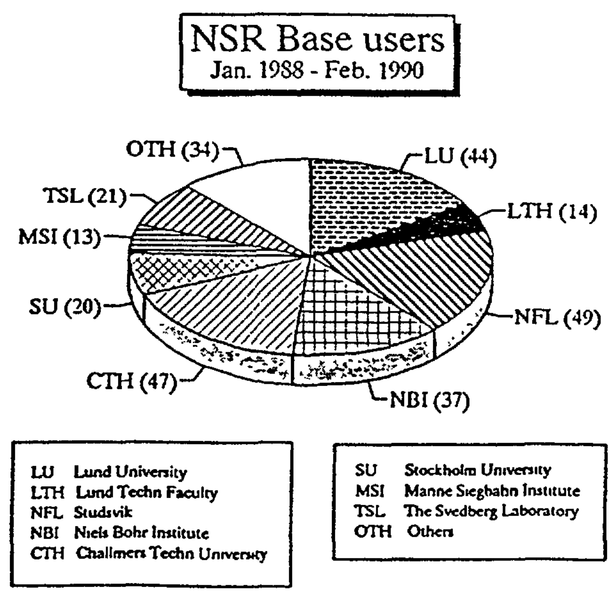
A data base system for radioactivity gamma rays has been developed. A base with approximately 15000 gamma rays from 2777 decays is available for installation on the hard disk of a PC, and a complete system with approximately 73000 gamma rays is available for on-line access via the NORDic University computer NETwork (NORDUNET) and the Swedish University computer NETwork (SUNET).

The Nuclear Structure Reference on-line data base

A program to retrieve nuclear structure references from the NSR file (part of which is resident on disc on a VAX8200 computer (GARBO)) has been written. References can be selected with a large number of criteria on, e.g., title, authors, keywords and nucleus/reaction selectors. The retrieve facility can be reached from any computer connected to the SUNET/NORDUNDET data communication network.

The use of the data base system is now quite extensive, and the response from the users has been very positive. The usage of the base is illustrated in the figures below.





Dr. Ameenah Farhan of Kuwait University is the Project Leader and spends 25% of her time. Dr. Shaheen Rab of KISR is supported full time by the project. The group has applied to KFAS for an extension of the project fund for coming three years.

Other Activities

The group has been involved in other theoretical and experimental research activities in Kuwait as well as in collaboration with other outside universities and institutions.

Computer Programs

All codes necessary for mass chain evaluation have been installed at KISR IBM computer main frame. ENSDF and NSR files are updated regularly.

Data Dissemination

The Nuclear Data Group in Kuwait supply tables of nuclear structure and radioactive decay data to interested users in the Middle Eastern, African and Asian subcontinent. The required programs use ENSDF and NSR files to produce tables for adopted levels, gammas and half-lives for a particular mass or a limited number of mass chains. So far, the group received about thirty requests from different neighbouring countries.

STATUS REPORT GHENT GROUP

D. De Frenne, E. Jacobs

Laboratorium voor Kernfysica
Proeftuinstraat, 86
9000 Gent
Belgium

Research activities

1. Photofission studies:

Over the last two years we were dealing with the photofission of ^{232}Th at excitation energies around the fission barrier. Provisional mass distributions were obtained with Si surface barrier detectors and post neutron mass distributions were measured off-line with the γ-spectrometry catcherfoil technique. The first goal of the latter experiments was the study of proton odd-even effects in the mass and charge distribution of ^{232}Th. Preliminary results for the charge distribution of ^{232}Th indicate a value of around 30% with bremsstrahlung endpoint energies of 6 MeV

2. Nuclear Spectroscopy:

The search for intruder states in odd-mass Rh and Ag isotopes was also continued in collaboration with research groups of especially Mainz and Groningen. Evidence for intruder states was found in ^{113,115}Ag and ^{101,103,105,107,109}Rh.

Nuclear Data Project

Since the last meeting in Ghent we have finished the evaluation of mass chain A=112 and the evaluation of A=102 is almost finished. For next year we plan the evaluation of mass chain A=110

Status of mass-chain evaluation at McMaster University, Canada
(March 1990)

B. SINGH

The mass chain A=151 was published in the October 1988 issue of NDS. The mass chain A=100 (a temporary assignment to McMaster) was submitted for publication in November 1988. It has recently been through the review stage and its publication is expected during the next couple of months.

The mass chain A=64 (also a temporary assignment to McMaster) is in the final stages of completion. It will be submitted for publication within the next two months.

The present funding allows support for only about 0.5 FTE person. Our attempts to seek higher funding for the project have not been successful.

We would like to request that the McMaster group be assigned permanent responsibility for five mass chains. A=151, 149, 100, 98 and 64. We have already worked on four of these and the work on the fifth mass chain (A=98) could start soon. This commitment would of course depend on the continued support from our funding agency.

STATUS ON EVALUATION OF NUCLEAR STRUCTURE AND DECAY DATA IN CHINA

Zhou Chunmei

Chinese Nuclear Data Center
Institute of Atomic Energy
P.O.Box 275 (41), Beijing 102413
People's Republic of China

China is permanently responsible for the mass chains 51-56 and 195-198, and temporarily for 170 and 172.

Financial Support and Person

The project is funded by Department of Science and Technology, China Nuclear Energy Industry Corporation. But finacial support is very limited.

The basical members are three part-time (≈1 full-time) physicists from Institute of Atomic Energy, Beijing; Physics Department of Jilin University, Changchun; and Institute of Nuclear Research, Shanghai.

Mass Chain Evaluation

The status of evaluation at present is as follows ;

Published :

A = 55	NDS,	Vol. 44, 463(1985)
A = 51	NDS,	Vol. 48, 111(1986)
A = 54	NDS,	Vol. 50, 255(1987)
A = 170	NDS,	Vol. 50, 351(1987)
A = 56	NDS,	Vol. 51, 1(1987)
A = 172	NDS,	Vol. 51, 577(1987)
A = 195	NDS,	Vol. 57, 1(1989)
A = 52	NDS,	Vol. 58, 677(1989)

Submitted for publication :

A = 198, 197, 53

Evaluating :

A = 196, 51, 55

We will be through the first evaluation cycle by May of 1990. We began the second cycle at beginning of this year.

We wish also to maintain the same region in A = 51 - 56 and 195 - 198 in the future.

U.S.Contribution to the Evaluation of Nuclear Structure Data and Related Activities

M. R. Bhat

March 1, 1990

Introduction

This report reviews the evaluation of nuclear structure, decay data and related activities of the U.S.Nuclear Data Network (USNDN) for the period May 1988 – Feb. 1990. Members of the USNDN are: BNL–National Nuclear Data Center (NNDC), INEL–Nuclear Physics Branch, LBL–Isotopes Project, ORNL– Nuclear Data Project, University of Pennsylvania–Light Nuclei Energy Levels Evaluation Project, Triangle Universities Nuclear Laboratory (TUNL), and the NIST– Photon and Charged Particle Data Center.

1 BNL–National Nuclear Data Center (NNDC)

1.1 Recruitment and Training of New Evaluators

The evaluation responsibility for A=5–20 will be transferred to D. R. Tilley (North Carolina State University) and H. R. Weller (Duke University) beginning in 1990. This evaluation group located at the Triangle Universities Nuclear Laboratory (TUNL) has already published a new evaluation of A=3 with emphasis on medium and high energy data and are nearing completion on a similar evaluation of A=4. M. M. King of the National Tsing Hua University, Taiwan continues her participation in the network; A=72 was published in 1989, A=62 has been submitted for publication and A=63 is being evaluated. Agda Artna- Cohen, one of the former evaluators from the Nuclear Data Project (NDP) at ORNL is evaluating A=211 and also reviewing mass-chains on a part-time basis. Coral M. Baglin, a former Nuclear Information Research Associate (NIRA), will work part-time and evaluate mass-chains in association with the Isotopes Project at Berkeley. Prof. K. A. Gridnev (Leningrad State Univ.) expressed an interest in starting an evaluation group in Leningrad. During his visit to the NNDC, we had discussions with him on the details of mass-chain evaluations, support services and other network activities. We hope to hear from him in the future. Dr. Irina Turkiewicz (Inst. Problemow Jadrowycl) and Dr. Brunon Sikora (Inst. Fizyki) both of Warsaw, Poland were contacted as possible evaluators. They are interested in doing mass-chain evaluations and may join the network at a future date. In March 1989, the Fachinformationszentrum (FIZ), Karlsruhe decided that they would like to terminate their evaluation work. However, they indicate that they might rejoin the network in perhaps two years. The FIZ had a permanent assignment of A=81-100. In 1989 they submitted for publication A=85, 87 and 91. Their participation in the network lasted 13 years and resulted in 23 evaluations including the three in the production pipe-line. A. N. Mantri and P. C. Sood (Banaras Hindu Univ., India) spent a few weeks in the summer of 1988 at the NNDC working on A=175. Since then, they decided that they will not be able to complete it; A=175 is now being evaluated by the Isotopes Project (LBL).

M. R. Bhat visited the Institute of Atomic Energy, Beijing; Jilin Univ., Changchun and the Institute of Nuclear Research, Shanghai in 1988 as a continuation of the exchange program between the Chinese Nuclear Data Centers and the NNDC. J. K. Tuli visited the Institute of Atomic Energy, Beijing, the Institute of Nuclear Research, Shanghai and the Japan Atomic Research Institute, Tokyo in 1989. Talks on the evaluation of nuclear structure and decay data, the processing of mass-chain evaluations for the production of the *Nuclear Data Sheets* and the NNDC on-line data system were given at these data centers.

1.2 Nuclear Structure References (NSR)

1.2.1' The NSR File Status

As of December 15,1989, the NSR file contained 115413 entries. The number of primary entries is steady at about 2500/year. Primary reference coverage continues to be complete. In spite of manpower problems, secondary entries have stabilized at approximately 1000/year. The publication of the four-monthly issues of Recent References in the *Nuclear Data Sheets* continues on schedule.

1.2.2 Improvements and Corrections to the NSR File

In order to serve the interests of the NSR user community more comprehensively, as of 1988, all secondary source entries are being included complete with Reference, Title and Authors. The author indexing in the NSR data base has been revised so that references with variants in spelling of an author's name will be retrieved when the standard spelling of the name is entered in a retrieval. At the same time approximately 10% of the entries were corrected for misspelled author names, often misspelled in the publications themselves.

All corrections brought to the attention of the NSR file manager by evaluators and others are checked and the file is promptly updated with the corrections and the user who suggested the corrections is notified by letter in all cases including those where the corrections were deemed not necessary or feasible.

1.2.3 The NSR Coding Manual and the Coding of Russian, Japanese, and Chinese Journals

The NSR coding manual is being updated as required for the compilation effort at the NNDC. Data centers already involved in preparing NSR entries are on the distribution list. Two tapes containing Russian conference proceedings and JINR reports were received from the compilers at Gatchina (USSR); they were checked and merged with the NSR file. A tape containing entries from Laboratory Reports was received from the Riken data center in Japan. These entries have been checked and will be merged with the NSR file soon. J.Blachot (Grenoble) has decided not to start coding Laboratory Reports from France for the NSR due to other demands on his time. Reports from major French and other European Laboratories continue to be coded at the NNDC. There has been no participation from China in the NSR coding effort. Chinese journals continue to be coded at the NNDC.

The NNDC continues to receive author keyword abstracts at a reduced rate of of about 25-30% of the NSR entries for *Physical Review C*. These are prepared for entry after major modifications by the NSR compiler.

1.2.4 NSR Services

Monthly and triannual distributions of the NSR file entries are being sent to the various data centers and evaluators according to schedule. A-chain related updates as well as the handling of evaluator key-numbers and references has proceeded smoothly. In the period May '88 to Feb. '90, 52 retrieval requests for the NSR file on varied topics were received and processed by the NNDC.

1.2.5 NSR On-line Services

We have also developed a menu driven version of the NSR on-line program for use with ANSI–standard video terminals. This new feature improves the interaction with the user.

For the period April '88 through January '90, users made about 6400 retrievals from the NSR on-line data base. This represents about 40% of the total number of on-line requests. The on-line access statistics for 1986-1989 for the NSR are shown in Table 1.

Table 1

On-line Access Statistics 1986-1989

Year	Runs	Retrievals	NSR	ENSDF	NUDAT	CINDA	CSISRS	ENDF
1986	648	1621	814	142	536	129	--	--
1987	1275	4263	2521	863	815	60	--	4
1988	2264	8748	5022	1303	1492	285	459	187
1989	3374	8406	3253	850	1841	522	1649	150

Table 2

Nuclear Data Sheets Processing Statistics for 1985-89

Elapsed Time (months)

Year	No. of A-chains Published	NNDC	Evaluator	Review	Editor-in-Chief	Publisher	Total Elapsed Time
1985	22	4.4	2.7	2.2	0.4	2.2	11.8
1986	22	5.2	3.6	2.8	1.0	2.2	14.7
1987	27	4.6	3.3	3.4	0.5	2.1	13.9
1988	19	3.8	3.7	3.6	0.8	2.5	14.4
1989	21	4.5	3.7	4.4	0.6	2.2	15.5
Nominal		4.0	3.0	2.5	1.0	2.0	12.5

1.3 The Evaluated Nuclear Structure Data File (ENSDF)

1.3.1 The ENSDF Status

The ENSDF is being continuously updated on the basis of new evaluations and correction of errors noted either in using the data file with physics processing codes or brought to the attention of the NNDC by users. New entries to the ENSDF are run through a new code RADCHK which checks for energy balance, normalization and parent records and a few other quantities. The current status of mass-chains for A>44 in the ENSDF is shown in Fig. 1. This figure also shows those A-chains that are being evaluated and/or have been submitted for publication.

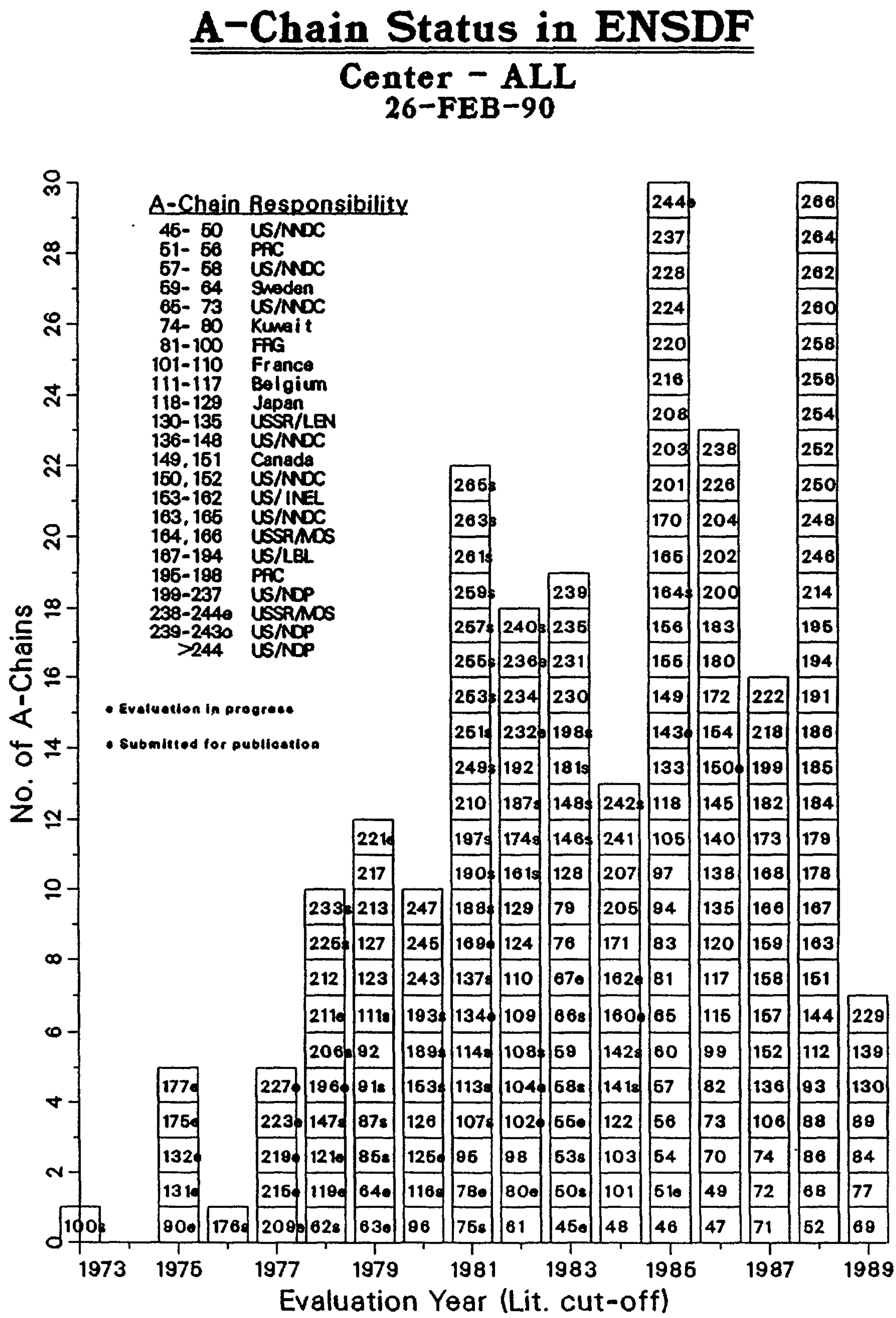
The ENSDF is distributed twice a year; in February and in August. Usually, only those A-chains that have been modified since the last distribution are sent out; however, those data centers that have requested the complete file continue to receive the full ENSDF.

Since the evaluations of mass-chains A<45 are not automatically entered into the ENSDF, a procedure was established at the NSDD meeting in 1980 for the conversion of the evaluated data for these A-chains into the ENSDF format. The division of responsibility for this conversion as agreed at Grenoble June '86 is as follows:

Center	A-Range	Status
US/NNDC	A=5-12	A=5-10 coded and sent for author approval; A=11,12 to be done
US/NDP	A=13-26	A=25-26 done; A=13-24 to be done
FR/Grenoble	A=27-32	up to date
US/LBL	A=33-44	up to date

1.3.2 ENSDF Formats for A<45

When the TUNL group assumes evaluation responsibility for A=5-20 in 1990, it is expected that they will make available all the evaluated data in the ENSDF format. The problem of expanding the current ENSDF format to accommodate any new physical quantities needed for these light nuclei was investigated by the NNDC and the results presented in a memo distributed to the network. These formats were discussed briefly by the Formats and Procedures Subcommittee and it was felt that until the evaluators begin to use these formats it would be difficult to assess their completeness and convenience. The NNDC will work closely with the TUNL group on this problem and consider any necessary future modifications in the proposed formats.



A-Chain Status in ENSDF
Center - ALL
26-FEB-90
A-Chain Responsibility
46- 50 US/NNDC
51- 56 PRC
57- 58 US/NNDC
59- 64 Sweden
65- 73 US/NNDC
74- 80 Kuwait
81-100 FRG
101-110 France
111-117 Belgium
118-129 Japan
130-135 USSR/LEN
136-148 US/NNDC
149,151 Canada
150,152 US/NNDC
153-162 US/INEL
163,165 US/NNDC
164,166 USSR/MOS
167-194 US/LBL
195-198 PRC
199-237 US/NDP
238-244e USSR/MOS
239-243o US/NDP
>244 US/NDP
• Evaluation in progress
• Submitted for publication
No. of A-Chains
Evaluation Year (Lit. cut-off)

(Fig. 1)

1.3.3 Use of ENSDF in Nuclear Medicine

At the request of the Society of Nuclear Medicine's Medical Internal Radiation Dose (MIRD) Committee, the NNDC has started work to provide processed nuclear data from ENSDF in a form suited to their applications. The NNDC will extract decay data from 242 selected nuclides of biomedical importance from the ENSDF and make it available for on-line access. The NNDC will also monitor the data on these nuclides and when there are significant changes in their properties, alert the MIRD committee to the availability of new data and maintain communication and discussion on methods for providing better access to nuclear data for the nuclear medicine and radiology community.

1.3.4 ENSDF On-line Services

We have added two programs which produce tables and graphics output files in either POSTSCRIPT or TEKTRONIX format. The MIRD program produces tables in the format of the Medical Internal Radiation Dose publication. The second program is CPLOT which produces level and decay schemes from the ENSDF format files. The graphic output can be viewed on the screen or the files transmitted over the networks to the user's computer for output on a laser printer. A video version of the ENSDF retrieval program with interactive features similar to the NSR retrieval program described previously has been made operational. In the near future we will generalize the ENSDF retrieval program and add the menu driven features to NUDAT. For the period April '88 through January '90, users made about 5200 retrievals from the ENSDF and NUDAT data bases. The on-line access statistics for 1986–1989 for the ENSDF and the NUDAT are shown in Table 1.

1.4 The *Nuclear Data Sheets* (NDS) Publication

1.4.1 Status of the NDS Production Pipeline

At present there are 41 A-chains in the production pipeline. Information on the status of the NDS production pipeline has been sent to the members of the NSDD network every month beginning in Oct. '86 with a list of the A-chains being processed. The different stages of processing of an A-chain are shown along with dates when it was received at the NNDC or sent from here. If the evaluators find that the NNDC has not received material mailed by them or vice versa they are requested to contact us immediately to trace it and/or send duplicates to avoid delays in processing. Efforts are also made to smooth out the processing load in spite of the evaluations arriving at the NNDC in groups with dormant periods in between. The processing codes are made more efficient continually by including many automatic features and updated to include new format changes. Changes in the NDS production policies and procedures were adopted (NS/1A-128 of July 26, '88) to let the evaluator and reviewer know on the review copy those portions of an evaluation that would be eliminated in the NDS presentation. The production codes were changed so that footnotes on truncated tables are preserved as comments automatically. Work is in progress to be able to interleave plots and tables in the NDS and later on to show them intermixed. This juxtaposition of the tables and the relevant drawings will improve the readability of the NDS and will be of great convenience to the users. The codes will also be changed to show the adopted level properties split into: (1) general comments, (2) listing of adopted properties with no spin-parity or half-life comments, (3) spin-parity arguments, and (4) half-life data used to recommend adopted values.

1.4.2 NDS Processing Statistics for 1985-1989

The processing statistics for A-chains published in the NDS for 1985-1989 are shown in Table 2. In addition to the average elapsed time spent in the various steps of processing, nominal times are shown. These are the time intervals we would like to achieve for an efficient and smoothly operating system with the present number of personnel. The NNDC continually reviews A-chain processing to make it as efficient as possible and deliver reviewed evaluations of good quality quickly. Excessive time taken by some evaluators in returning their A-chains to the NNDC and the time spent in review continue to be problems. These can be reduced only with the active cooperation of the persons involved. Evaluators can help by submitting clean evaluations conforming to the evaluator guidelines, corrected for format and physics errors and by responding promptly and completely to the questions or comments by the reviewer or editors.

1.4.3 Network Evaluators as Reviewers for NDS

The average time spent in review has increased from 2.2 months in 1985 to double the amount or 4.4 months in 1989 (see Table 2). In 1989, 7 A-chains out of a total of 21 were in review for 6.0 to 6.8 months which is too long to be acceptable. In addition, for the past few months a large number of mass-chains were found to be overdue from review. All these facts pointed out that the review was a problem area in the NDS production pipe-line and steps had to be taken to ensure a smooth flow of A-chains past this stage of processing. The delays appeared to be due to the fact that the Editors of the NDS had difficulty in finding reviewers and they had done most of the reviews by themselves. Hence, it was proposed (see the memo NS/1A-138 of June 26, 1989) that the network evaluators review at least one A-chain/year to eliminate the current delays. The Editors have also assembled guidelines for reviewers to ensure some uniformity of scrutiny. This proposal has decreased delays in the NDS processing.

1.4.4 Size of the A-chains in the NDS

In June '86 at the Grenoble NSDD meeting a new set of guidelines were adopted for the publication format for the NDS. It eliminated redundant presentation of data without sacrificing any essential information. The page length statistics for the past three years are as follows:

Year	No. of A-chains	No. of pages/A-chain
1987	27	76p.
1988	19	92p.
1989	21	101p.

The average length of an A-chain has increased gradually showing an increase of about 33% in 1989 compared to 1987. Since not many A-chains were ready for publication in 1988, 1989 the guidelines were not applied strictly. In 1989 the NNDC received 27 new evaluations. We project a publication of 30 A-chains in 1990 with an average length of 70-75 pages in order to stay current with network productivity and avoid any surges in subscription costs determined from a current ceiling of 2500 pages/year.

1.5 Mass-chain Evaluations and Related Activities

The NNDC submitted for publication A=69, 137, 146, 147 and 148 in 1988 and A=50, 58, 66, 141 and 142 in 1989. In these two years A=68, 69, 71, 138, 139, 144, 152 and 163 were published in the NDS. Work is in progress on A=45, 67, 143, and 150. Apart from the evaluation of mass-chains, the NNDC physicists' effort has been directed towards improving the NDS production and processing codes, ENSDF code development and in reviewing several mass-chains. Some NNDC evaluators have also collaborated with their colleagues in the Chemistry department at Brookhaven, Lawrence Berkeley Laboratory, and Vanderbilt University in carrying out research on nuclear structure and decay data.

1.6 Nuclear Structure Related Publications

Nuclear Wallet Cards published and distributed in Jan. '85 continue to be in great demand. The initial printing 10,000 copies has been exhausted and there are plans to bring out a new edition in 1990. In addition to the new data published since the last edition, the new Wallet Cards will contain data on hypernuclei, information on how to access the NNDC on-line data bases and updated Appendices.

1.7 ENSDF Related Codes

The code PANDORA has been enhanced to include new formats, better energy matches, complete field identifications and more help to the evaluator using it. The code RADLST is being upgraded to: (i) provide additional details required by the MIRD Committee, (ii) implement the latest ENSDF formats and (iii) conform to the latest recommendations of the F & P Subcommittee pertaining to the calculation of radiation intensities and their uncertainties. Since RADLST is a versatile code for processing ENSDF data for various applications, a short description of the code has appeared in *Health Physics* **57**, August 1989 to publicize its availability. The other ENSDF codes continue to be maintained by the NNDC; their current status is given in Table 3.

1.8 NNDC On-line System

1.8.1 On-line System Enhancements

In the last two years a number of improvements and additions have been made to the NNDC on-line system. These changes have made the system more user- friendly. It is now possible to access the newsletter, mail facility, NNDC address list, and a get-acquainted HELP file without formal authorization. The new features added to the NSR and ENSDF retrievals have been described earlier. The retrieval strategy for NUDAT has been improved and retrievals may be made either by elemental symbols or A-number. Setting of the retrieval parameters has been made more easy and there are now choices in output format and display of retrieved data. Brief information about the on-line data system such as a list of data bases available and how to access such data has appeared in the NDS starting with the October '88 issue (NDS, **55**, no. 2, 1988)

1.8.2 Physics Code Package

A new package of analysis codes has been added to the on-line system. The program package is called PHYSCO (short for physics codes). The codes HSICC and LOGFT are currently available in this package. The program RULER to calculate reduced gamma-ray transition probabilities and some other useful codes will be added in the future. PHYSCO is interactive and prompts the user for proper input. The user may provide input through a terminal (independent of the ENSDF format) or in the form of a computer file in ENSDF format. Ample HELP files are available while running the code.

Table 3

Status of ENSDF Physics Processing Codes
(March 1990)

Code	Function	Version No.	IBM-PC	Documentation
FMTCHK	Format check of a file in ENSDF format	7.120	yes	no
TREND	Displays ENSDF data in tabular form	6.01	yes	no
PREND	Constructs level diagrams from the ENSDF data sets	2.2	no	no
DELTA	Analyzes angular correlation data	1	yes	yes
GTOL	Least-squares fit to γ energies to determine level energies and feedings	5.8	yes	yes
HSICC	Interpolates internal conversion coefficients	11.1	yes	yes
LOGFT	Calculates logft	7.2	yes	yes
RADLST	Calculates atomic and nuclear radiations and checks energy balance	5.4g	#	yes
PANDORA	Physics check of the ENSDF data sets. Helps with adopted gammas and XREF	4.3	yes	yes
RULER	Calculates reduced transition probabilities	1.9	yes	yes
INSDF	Interactive program to create and check ENSDF sets	10/84		no
GABS	Calculates uncertainties of absolute γ- intensities	V		yes
ADDGAM	Adds γ's in adopted set	1.2	yes	no
SPINOZA	Physics check of the ENSDF data sets	1.2		no
GAMUT	Assembles adopted levels, gammas from reaction and decay data sets			

#- with limitations due to memory capacity
V - program as received from author

1.8.3 *Nuclear Data Digest*

For the users who do not wish the in-depth information of the NDS and/or who would be satisfied with the radioactive decay data and the adopted properties and their sources, it is proposed that a *Nuclear Data Digest* be prepared for every mass-chain in the ENSDF. The Data Digest information would be available through the on-line system and may be viewed by the user at his/her terminal or printed out on a laser printer. The Digest will present data in the form of drawings and tables in concise, non-redundant format and will be automatically updated when a new A-chain is published or more frequently if needed.

1.9 User Services

The NNDC provides the following services to the NSDD network evaluators and others on routine basis: (i)monthly NSR updates to all evaluation centers for A-chains assigned to them, (ii)complete NSR retrieval at the start of an A-chain evaluation, (iii)copies of references to evaluators (with help from the NDP for older references), (iv)ENSDF updates are sent twice a year, (v)NSR updates are sent once in four months, (vi)special retrievals from the NSR and ENSDF, (vii)ENSDF physics codes are maintained and corrections and updates are sent when done, (viii)a plot of the new NSR references vs. mass number and table giving the number of new references added since the last evaluation are sent every six months, and (ix)network evaluator list is maintained and sent out every year.

The NNDC personnel attend professional meetings like the American Physical Society's Nuclear Physics Division meeting and special topical conferences devoted to nuclear structure and decay data and their applications in order to publicize the NSDD network activities and the availability of the above data bases and services. Demonstrations of on-line data access were found to attract a number of attendees who later on requested to be put on the roster of regular users. " An Overview of the National Nuclear Data Center " describing the data resources at the NNDC appeared in *Health Physics*, 57, 680 (1989). T. W. Burrows of the NNDC delivered a paper on " The Evaluated Nuclear Data File: Philosophy, Content and Uses " at the International Committee for Radionuclide Metrology Symposium on Nuclear Data, Braunschweig, FRG, June 5–9, 1989.

2 Mass-chain Evaluations and Related Activities at INEL

2.1 Mass-chain Evaluations

Within the International Nuclear Structure and Decay Data Evaluation Network, INEL has permanent evaluation responsibility for the ten mass-chains in the region A=153–162. Two individuals, funded at a total level of approximately 0.8 full-time equivalent, are involved in the mass-chain evaluation effort. The current status of the mass-chain evaluations within our area of responsibility is summarized as follows:

A-chain	Status(according to currency)
162	NDS **44**, 659 (1985)
	Being evaluated
160	NDS **46**, 187 (1985)
	Being evaluated
153	In review
161	NDS **59**, 1 (1990)
158	NDS **56**, 199 (1989)
157	NDS **55**, 71 (1988)
159	NDS **53**, 507 (1988)
154	NDS **52**, 1 (1987)
155	NDS **50**, 563 (1987)
156	NDS **49**, 383 (1986)

As is evident from this listing, our mass-chain evaluation effort satisfies one of the objectives of the international network, namely currency of the mass-chain evaluations to be less than or equal to 5 years.

We have also, at the request of the ORNL Nuclear Data Project, taken on as a temporary assignment the evaluation of the nuclear data for the A=206 mass-chain. The previous publication of this mass-chain was in the *Nuclear Data Sheets* **26**, 145 (1979). This evaluation has now been completed and is now in the pre-publication review process.

2.2 Related Activities

2.2.1 The Evaluated Nuclear Data File/B (ENDF/B)

The Nuclear Physics Group at INEL has the primary responsibility for the preparation of evaluated nuclear decay data for inclusion in the Evaluated Nuclear Data File/B (ENDF/B), the accepted base of nuclear data for the U. S. program in reactor research and technology. For the past several years, a major effort has been in progress at INEL to prepare such information for the next version, Version VI of ENDF/B, which is scheduled for release during the summer of 1990. The INEL evaluation work in this area has now been completed. The nuclides to be included in Version VI of ENDF/B are grouped into three general categories. These, together with the number of such nuclides for which INEL generated evaluations have been prepared, are: the Activation File (149 nuclides); the Actinide File (108 nuclides); and the Fission-Product File (510 nuclides).

In order to avoid the proliferation of files of " evaluated " data, drawn from the same base of experimental information, whose contents differ trivially from each other, ENSDF has been used as the starting point for this evaluation. However, ENDF/B contains important data categories not included in ENSDF, and where deemed appropriate data other than those in ENSDF have been used.

2.2.2 Other Evaluations

We continue to be involved in other evaluation activities, namely:

γ–ray energies for detector calibration, under the auspices of the Commission on Atomic Masses and Fundamental Constants of the International Union of Pure and Applied Physics; and

γ–ray emission probabilities for radionuclides used for detector calibration, as part of an IAEA Coordinated Research Program.

The results of these efforts should be available in late 1990 or 1991 for use by the A-chain evaluators.

3 LBL-Isotopes Project

3.1 Mass-chain Evaluations

The LBL Isotopes Project is responsible for evaluating 28 mass-chains from A=167–194 and for converting A=33–44 to ENSDF format. Responsibility for mass-chain A=177 has been temporarily assigned to Japan. A summary of the current status of LBL mass-chains is given in the table below:

Status of LBL Mass-chain Assignments		
Mass-chain	**Publication Year**	**Status**
33–44	1978	Sent to BNL 1987 (LBL)
167	1989	Published (LBL)
168	1988	Published (LBL)
169	1982	Published (LBL)
		Being evaluated (LBL)
170	1987	Published (China)
171	1984	Published (LBL)
172	1987	Published (China)
173	1988	Published (LBL)
174	1984	Submitted 12/89 (LBL)
175	1976	Being evaluated (LBL)
176	1976	Submitted 5/89 (LBL)
177	1975	Being evaluated (Japan)
178	1988	Published (LBL)
179	1988	Published (LBL)
180	1987	Published (LBL)
181	1984	Submitted 12/89 (LBL)
182	1988	Published (LBL)
183	1987	Published (LBL)
184	1989	Published (LBL)
185	1989	Published (LBL)
186	1988	Published (LBL)
187	1982	Submitted 9/89 (LBL)
188	1981	In press (LBL)
189	1981	In press (LBL)
190	1982	Submitted 12/89 (LBL)
191	1989	Published (LBL)
192	1983	Published (LBL)
		Being evaluated (LBL)
193	1981	Submitted 9/89 (LBL)
194	1989	Published (LBL)

The Isotopes Project dedicated approximately 2.5 full-time employees (FTE) to mass-chain evaluation in 1989. This figure includes Balraj Singh, who has been dividing his time between the LBL and the McMaster evaluation groups. The group has reached a stable production rate of more than 2 mass-chain evaluations per FTE/year. A total of 7 mass-chains were completed in 1989 and submitted for publication. One of our evaluators, Virginia Shirley will be spending a year at the Free University of Berlin, starting in October, 1989. She will continue evaluating mass-chains for the Isotopes Project while in Berlin on professional leave. A new evaluator, Augusto O. Macchiavelli, has been hired as of September, 1989. His experience in the study of high-spin states in nuclei, and involvement with the early stages of the Gammasphere proposal, will bring a new area of expertise to the Isotopes Project. After proper training we expect Augusto to produce mass-chain evaluations at the established rate of two per FTE/year.

3.2 Major Horizontal Evaluations

Table of Radioactive Isotopes, John Wiley & Sons, Inc., 1986. This book, tailored to the needs of applied users in industry, biology, medicine, and other fields, but also serving as an indispensable reference for nuclear physicists and chemists, contains 1056 pages and sells for $59.95. Sales through August, 1989 were 2104 volumes, and sales for the past year were 235 volumes.

Table of Isotopes, 7th edition, John Wiley & Sons, Inc., 1978. This 1630-page book, which contains nuclear structure data not presented in the *Table of Radioactive Isotopes*, is an excellent complement to the latter. The *Table of Isotopes* was reprinted in 1986 and currently sells for $48.50. 10,190 volumes were sold through August 1989, and sales for the past year were 272 volumes.

3.3 *8th* Edition of the *Table of Isotopes*

The Isotopes Project has begun to design a new edition of the *Table of Isotopes* with the goal of completing the book in three years. The new edition will emphasize nuclear structure data and will be based on the ENSDF file. It is anticipated that the book will be a single volume and maintain the high production standards of previous editions.

3.4 Evaluation Methodology

The Isotopes Project has a continuing interest in developing methods for evaluating nuclear data in order to improve efficiency and the quality of the evaluations. The group's contributions to the mass-chain evaluation effort are described below:

3.4.1 Methods and Procedures for Analyzing Nuclear Data

A recent research product of the Isotopes Project, *Analysis of α-, β-, and γ-Ray Emission Probabilities*, R. B. Firestone, Report LBL-27109, April 1989, presents a self-consistent analysis of radiation intensities, which includes physical constraints, for normalizing decay schemes. This paper was given at the *International Committee for Radionuclide Metrology (ICRM) Meetings and International Symposium*, Braunschweig, June 5–9, 1989. The Proceedings of the conference will be published in Nucl. Instr. and Meth. in Physics Research A.

3.4.2 Computer Codes

The Isotopes Project develops computer codes for implementing new or revised methods and procedures, and maintains a library of codes for evaluating nuclear data for ENSDF. These codes are available in the *Berkeley ENSDF Evaluation Program Library* (BEEP).

3.5 Measurements

An important task for evaluators is to produce a set of *best* and *consistent* values of nuclear properties. Unfortunately, this is not always possible because often the data are inconsistent, and usually additional experimental information is needed to solve the problem. This point has been well illustrated by C. W. Reich in his paper on *Evaluation of β Intensity Data in Nuclear Decay Schemes: Comments on Some Pitfalls*, presented at the IAEA Meeting on the Coordination of the International Nuclear Structure and Decay Data Evaluation Network, Grenoble, France, June 2–5, 1986. The paper describes a serious inconsistency in the normalization of the ^{233}Pa β^- decay scheme which was unveiled by their precise measurement of the 312-kev γ-ray emission probability [1]. A reliable value for this emission probability is also needed to determine (by activation analysis) the neutron cross section of ^{232}Th. This quantity is relevant to the ^{232}Th/^{233}U reactor fuel cycle. Solving the problem required a *precise* measurement of conversion coefficients, which was performed by E. Browne, from the Isotopes Project, in collaboration with other scientists from LBL [2].

3.6 Remote Access to Databases and Computer Code Packages

Computer guest accounts are available for use of the LBL VAX/8650 computer cluster, which provides access to the LBL/ENSDF and BNL data bases and to the LBL Physics Program Library (PPL). This is a subset of interactive programs from BEEP. There is no charge for this service, and those interested in using it may contact:

E. Browne or R. B. Firestone
Lawrence Berkeley Laboratory
Isotopes Project
Bldg. 50A, Room 6102
Berkeley, California 94720
Telephone: (415) 486-6152

[1] Emission Probability of the 312-kev Gamma-Ray from the Decay of Protactinium-233, R. J. Gehrke, R. G. Helmer, and C. W. Reich, *Nucl. Sci. Eng.* 70, 298 (1979)

[2] Nuclear Penetration Effects in ^{233}U, E. Browne, B. Sur, E. B. Norman, H. L. Hall, R. A. Henderson, K. T. Lesko, R. M. Larimer, and D. C. Hoffman, Report LBL-26801, Feb. 1989; to be published in *Nucl. Phys. A*

28 guest accounts have been issued to remote users so far, and about 400 "logins" on these accounts were recorded during the period 9/88 to 9/89. Especially tailored computer files containing radiation data were prepared and electronically transferred to: Dr. Kevin Hurley, Space Sciences Laboratory, U. C. Berkeley, for developing, in collaboration with Prof. Bernard Saudolet, an x-ray detector and to Dr. Peter Moller, LANL, for a systematic study of nuclear properties of β^--emitters in rare-earth region.

3.7 Reviewing Mass-chain Evaluations

Members of the Isotopes Project reviewed two mass-chains during 1989.

3.8 Isotopes Project Reference Library

The Isotopes Project continues to maintain the extensive reference library it developed for the production of the *Table of Isotopes*. The library consists of reference binders, ordered by mass number (A) and atomic number (Z), containing reference citations and keywords for primary nuclear structure and decay papers. Scanning was begun in 1958 and covered 42 journals issue by issue. After a thorough check of overlap with the Nuclear Data Project at Oak Ridge, the Berkeley scanning effort was discontinued for journals dated after January 1, 1970. Successive issues of *Recent References* have been incorporated into the binders so that all references for a given nucleus can be seen in one place. A second set of binders contains reprints of articles from journals which are not in the Isotopes Project's library of core journals. These reprints cover all nuclei for 1966 through about 1978. After that, they cover just the A-chain range for which the Isotopes Project has responsibility. This library is available to all LBL researchers and visitors, and limited requests for information are processed by the Isotopes Project staff.

4 ORNL–Nuclear Data Project

4.1 Mass-chain Evaluations

The mass-chains 214, 229, 233, 246–266 (even A), 249–263 (odd A) have been published.

The mass-chain 225 has been submitted for publication.

The mass-chains 209, 221, 232, and 236 are being worked on.

4.2 Mass-chain Editing

The NDP staff provided reviews of the mass-chains 52, 58, 72, 75, 77, 89, 100, 112, 116, 130, 139, 144, 146, 148, 152, 153, 176, 179, 184, 185, 186, 189, 191, 194, 195, 240, and 242.

4.3 Other Activities

The following network publication was coauthored by the NDP:

Guidelines for Reviewers by M. J. Martin and J. K. Tuli

THe NDP prepared the initial draft of the new introductory material **GENERAL POLICIES–Presentation of Data** that first appeared in the December 1989 issue of the *Nuclear Data Sheets.* The final draft was prepared after extensive review by members of the Formats and Procedures Subcommittee of the USNDN.

5 University of Pennsylvania-Light Nuclei Energy Levels Evaluation Project

Since the last report the review of A=5–10 has been published in Nuclear Physics **A490**, 1 (1988), and that for A=11–12 has been published in Nuclear Physics **A506**, 1 (1990). Preprints of A=13 and 14 have been sent out in 1989 and the preprint of A=15 will be mailed in February 1990. We will send A=13–15 to Nuclear Physics in about July 1990. Our work is being transferred to the TUNL group (Drs. Tilley and Weller) in 1990.

6 Triangle Universities Nuclear Laboratory

The evaluation of A=3 was published in Nuclear Physics **A474**, 1 (1987); A=4 is nearing completion. The preprints of this evaluation by the TUNL group and G. M. Hale (LANL) will be mailed to colleagues working in this mass region in the near future for comments. In view of the transfer of responsibility for A=5–20 from Prof. F. Ajzenberg-Selove to the TUNL group in 1990, evaluation of A=16 and 17 has been started.

FACHINFORMATIONSZENTRUM
KARLSRUHE
Gesellschaft für wissenschaftlich-technische Information mbH

Datum
5.3.90

Dear Dr. Schmidt,

On the occasion of the next nuclear structure and decay data network meeting in Kuwait we would like to take the opportunity to give you some kind of summary report about our activities in the last 14 years. The reason is that after so many years of joining the cooperation in 1989 we were forced to terminate our corresponding contribution and participation (as we already announced in our letter of March 3, 1989) for the moment. We regret this very much but we had no other choice.
FIZ joined the NSDD Network in 1976 and was charged with the evaluation of the 2o mass chains A = 81-100. During the past 14 years, 23 mass chains have been evaluated (see the enclosed list). We finished the first run through our mass range in 1988 and evaluated 5 mass chains in a second cycle (2 mass chains, A = 90 and A = 100, had been temporarily assigned to other groups).
Further, FIZ developed and installed an online retrieval system for ENSDF and MEDLIST data which could be accessed via usual telecommunication lines (this latter has also been cancelled in 1989). In addition, several requests have been answered for ENSDF or MEDLIST data by providing the data on magnetic tape since many users prefer receiving nuclear structure and decay data on magnetic tape.
Furthermore, the ENSDF file has been presented on several scientific conferences or meetings, and applications have been demonstrated (see enclosed reference list).

In addition some non-ENSDF data compilations on nuclear data have been initiated and published in our series PHYSICS DATA. For the database GAMCAT - a catalog of gamma rays and alpha particles from radioactive decay - a PC version has been developed which can be obtained from FIZ Karlsruhe.

We regret that we presently do not have the manpower to do further evaluation work. Nevertheless we continue to answer nuclear data request. Therefore we would like to obtain the ENSDF update tape also in the future.

From now on we would, however, like to see us as a "silent member" of the NSDD network. We would like to thank all our colleagues for the excellent cooperation during so many years. Special thanks are also due to J.K. Tuli, M.R. Bhat, and M.J. Martin for their efforts in the preparation of the mass chains.

With best regards,

Yours sincerely,
FACHINFORMATIONSZENTRUM KARLSRUHE
Gesellschaft für wissenschaftlich-technische Information mbH
- Fachabteilung III Physik und Astronomie -

Müller

i.V. (Dr. H. Behrens) i.A. (Dr. H.-W. Müller)

Enclosures

Mass Chain Evaluations at FIZ Karlsruhe

Nuclear Data Sheets for A=81
J. Müller
Nuclear Data Sheets 46, 487 (1985)

Nuclear Data Sheets for A=82
H.-W. Müller
Nuclear Data Sheets 50, 1 (1987)

Nuclear Data Sheets for A=83
J. Müller
Nuclear Data Sheets 49, 579 (1986)

Nuclear Data Sheets for A=84
H.-W. Müller, J.W. Tepel
Nuclear Data Sheets 27, 339 (1979)

Nuclear Data Sheets for A=84
H.-W. Müller
Nuclear Data Sheets 56, 551 (1989)

Nuclear Data Sheets for A=85
J.W. Tepel
Nuclear Data Sheets 30, 501 (1980)

Nuclear Data Sheets for A=85
H. Sievers
Nuclear Data Sheets (in review)

Nuclear Data Sheets for A=86
J.W. Tepel
Nuclear Data Sheets 25, 553 (1978)

Nuclear Data Sheets for A=86
H.-W. Müller, J.W. Tepel
Nuclear Data Sheets 54, 527 (1988)

Nuclear Data Sheets for A=87
P. Luksch, J.W. Tepel
Nuclear Data Sheets 27, 389 (1979)

Nuclear Data Sheets for A=87
H. Sievers
Nuclear Data Sheets (in review)

Nuclear Data Sheets for A=88
H.-W. Müller
Nuclear Data Sheets 54, 1 (1988)

Nuclear Data Sheets for A=89
H. Sievers
Nuclear Data Sheets 56, 551 (1989)

Nuclear Data Sheets for A=91
H.-W. Müller
Nuclear Data Sheets 31, 181 (1980)

Nuclear Data Sheets for A=91
H.-W. Müller
Nuclear Data Sheets (post review)

Nuclear Data Sheets for A=92
P. Luksch
Nuclear Data Sheets 30, 573 (1980)

Nuclear Data Sheets for A=93
H. Sievers
Nuclear Data Sheets 54, 99 (1988)

Nuclear Data Sheets for A=94
H.-W. Müller
Nuclear Data Sheets 44, 277 (1985)

Nuclear Data Sheets for A=95
P. Luksch
Nuclear Data Sheets 38, 1 (1983)

Nuclear Data Sheets for A=96
H.-W. Müller
Nuclear Data Sheets 35, 281 (1982)

Nuclear Data Sheets for A=97
B. Haesner, P. Luksch
Nuclear Data Sheets 46, 607 (1985)

Nuclear Data Sheets for A=98
H.-W. Müller
Nuclear Data Sheets 39, 467 (1983)

Nuclear Data Sheets for A=99
H.-W. Müller, D. Chmielewska
Nuclear Data Sheets 48, 663 (1986)

Presentations of the ENSDF File

Dynamical Properties of the Deformed Nuclei Deduced from the Evaluated Nuclear Structure Data File
J.W. Tepel, H.-W. Müller
International Conference on Dynamical Properties of Heavy-Ion Reactions
Johannesburg, South Africa, August 1978

A simplified method for selecting physical information from the Evaluated Nuclear Structure Data File (ENSDF)
J.W. Tepel
Spring Meeting of the American Physical Society
Knoxville, Tennessee, 1979
Bull. Am. Phys. Soc. 24, 837, EC 14 (1979)

Systematik der logft-Werte beim Beta-Zerfall
(Systematics of logft Values in Beta Decay)
H. Behrens, P. Luksch, H.-W. Müller, J.W. Tepel
Spring Meeting of the Nuclear Physics Section of the German Physical Society (DPG), Munich, March 17 - 21, 1980
Verhandl. DPG, (VI) 15, G4.2 (1980)

The Evaluated Nuclear Structure Data File (ENSDF)
H. Behrens, P. Luksch, H.-W. Müller, J.W. Tepel
Spring Meeting of the Nuclear Physics Section of the German Physical Society (DPG), Munich, March 17 - 21, 1980
Verhandl. DPG, (VI) 15, G4.1 (1980)

Systematics of logft Values in Beta Decay
H. Behrens, P. Luksch, H.-W. Müller, J.W. Tepel
International Conference on Nuclear Physics (ICNP 1980)
Berkeley, California, USA, August 24 - 30, 1980
Vol. 1. Proceedings P. 817 (1980)

Contents, Structure, and Applications of a Numerical File on Nuclear Structure and Decay Data (ENSDF) at Karlsruhe
J.W. Tepel
Lecture at "Instituto Nacional de Investigaciones Nucleares (ININ)"
Mexico City, September 1980

Kernphysik aus dem Computer ?
(Nuclear Physics through the Computer ?)
J.W. Tepel
Spring Meeting of the Nuclear Physics Section of the German Physical Society (DPG), Karlsruhe, March 22 - 26, 1982
Verhandl. DPG, (VI) 17, PS 4.18 (1982)

Information und Dokumentation der Kerndaten
(Information and Documentation of Nuclear Data)
H. Behrens
Jahrestagung Kerntechnik 1981, Deutsches Atomforum e.V.

Numerical Databases Online at INKA with Special Reference to ENSDF
H.-W. Müller
Quintas Journadas Argentinas de Cibernetica
Rosario, Argentina, September 22 - 24, 1983

The PC as a Tool for Information Retrieval in Nuclear Physics
J.W. Tepel, H. Behrens, W. Detemple, C.D. Siems
Spring Meeting of the Nuclear Physics Section of the German Physical Society (DPG)
Groningen (Netherlands), March 23 - 27, 1987
Verhandl. DPG (VI) 22, H8.1 (1987)

ENSDF - A Computerized Data File Produced by the International Network of Nuclear Structure and Decay Evaluators
H.-W. Müller
16th Consultative Meeting of INIS Liaison Officers, IAEA
Istanbul, Turkey, May 24 - 27, 1988

ON-LINE ACCESS

National Nuclear Data Center
Brookhaven National Laboratory
Upton, N.Y. 11973

February 9, 1990

On-line access to computerized numeric and bibliographic nuclear physics information is available from the National Nuclear Data Center (NNDC) at Brookhaven National Laboratory to users in the United States and Canada. Similar services may also be available from other members of the International Nuclear Structure and Decay Data Network.

1 ACCESS

Use ESNET, INTERNET, MFENET, or SPAN networks or remote modem to access the NNDC on-line service. The service is available on two NNDC VAX machines, an 11/780 and an 8820.

1.1 TELEPHONE

Only the NNDC VAX 11/780 can be accessed via telephone using the commercial telephone number (516) 282-5390 or FTS 666-5390. Use the following communications parameters:

Protocol: ASCII only. Full duplex.

Speed: 300, 1200 or 2400 bps.

Word: space parity, 1 stop bit or
8-bit, parity off, 1 stop bit or
7-bit, parity off, 2 stop bits.

After getting the on-line signal, type a carriage return, wait and then type a second carriage return. The VAX login prompt should then appear on your terminal.

1.2 ESNET

ESNET is a merger of the HEPNET/PHYSNET and MFENET networks. The network operates with both DECNET and TCP/IP protocols.

1.3 INTERNET

INTERNET is a merger of the MILNET and ARPANET networks. The network operates with TCP/IP protocol only.

1.4 MFENET

Some computers in the MFENET network have not yet been integrated into the ESNET network. In such cases, you can use MFENET's remote login capability to access the computer node "BNL". The login prompt will then appear.

1.5 SPAN

SPAN is a network sponsored by NASA. The network operates with DECNET protocol only.

1.6 TCP/IP PROTOCOL

Use TCP/IP's `TELNET` command to access the computer node

VAX 8820	address BNLND2.DNE.BNL.GOV (130.199.128.132) or
VAX 11/780	address BNLNDC.DNE.BNL.GOV (130.199.128.131).

The login prompt will then appear.

1.7 DECNET PROTOCOL

Use DECNET's `SET HOST` command to access the computer node

VAX 8820	address BNLND2 (44436 or 43.404) or
VAX 11/780	address BNLNDC (44437 or 43.405).

The VAX login prompt will appear as soon as the connection is made.

1.8 LOGIN

You will need to enter the account name, NNDC, in response to the VAX login prompt, Username and your authorization (see *authorization*) code when asked.

USERNAME: NNDC
AUTHORIZATION CODE: Your code (allotted by NNDC)

1.9 LOGOUT

When terminating a retrieval session, enter LOGOUT.

1.10 AUTHORIZATION

No special authorization is required to access the NNDC address list, on-line newsletter, mail facility, and help files to become acquainted with the system.

Contact NNDC for authorization to access other data bases.

ON-LINE ACCESS
National Nuclear Data Center
Brookhaven National Laboratory
Upton, NY 11973
Tel: (516) 282-2901 or FTS: 666-2901. FAX: (516) 282-2806

Please give your name, postal address, telephone number and a code of six or fewer characters which will be your personal authorization code. This code must be given during the login sequence for full access to the on-line services.

2 AVAILABLE INFORMATION

NSR – Nuclear Structure Reference file – bibliographic information for low and intermediate energy nuclear physics, from 1910 to the present. The data is updated weekly.

ENSDF – Evaluated Nuclear Structure Data File – evaluated experimental data on nuclear level properties, radiations, radioactive decay and reaction data for all known nuclides.

NUDAT – NUclear DATa – evaluated numeric data extracted or derived from the ENSDF and the Nuclear Wallet Cards.

PHYSCO – PHYSics COdes – calculation of physics quantities, e.g., internal conversion coefficients, logft values, etc.

CINDA – Computer Index of Neutron Data – bibliographic references to neutron reaction data.

CSISRS – Cross Section Information Storage and Retrieval System – experimental data on neutron, photon, and charged particle reactions.

ENDF – Evaluated Nuclear Data File – evaluated neutron-induced reaction and decay data.

NNDC address list – addresses of many nuclear physics researchers; includes telephone numbers and electronic mail addresses.

Newsletter – List of upcoming conferences/meetings in Nuclear Physics and other nuclear data-related information.

3 RETRIEVAL SYSTEM

A user-friendly system provides ample help to the user who specifies the retrieval criteria in response to step-by-step prompts by the system. The output can be displayed on the user's terminal or output as a file to the online disk area for later transfer to the user's computer. Some modules prepare files containing graphic displays in Tektronix or PostScript formats for output at a user's local facility.

3.1 COMMANDS

The following commands are available to the user after login. A User need to enter only the letters of the command which are capitalized.

$ ADDress	(query NNDC address file)
$ CINDA	(access to neutron physics bibliography)
$ CSISRS	(access to experimental reaction data)
$ DELete	(delete a file from the online disk area)
$ DIRectory	(list files on the online disk area)
$ ENDF	(access to the ENDF/B-V evaluated data library)
$ ENSDF	(access to the ENSDF data base)
$ EXPert	(set expert switch)
$ HELp	(enter user assistance facility)
$ LOGout	(terminate access to NNDC VAX)
$ MAIl	(send a message to someone)
$ MESsage	(displays any messages from the system manager)
$ MIRD	(medical internal radiation dose)
$ NEWs	(get news from NNDC)
$ NSR	(access to Nuclear Structure References)
$ NUDAT	(access to nuclear structure data)
$ PHYSCO	(physics codes)
$ PLOT	(plot decay/level scheme)
$ PRInt	(print a file from the online disk area)
$ SAMple	(execute a sample data base retrieval)
$ SENd	(send a file to the user or someone else)
$ TERminal	(revise user terminal characteristics)
$ TYPe	(display a file from the online disk area)

One may obtain further information about any command by entering HELP followed by the command, *i.e.* HELP NSR.

4 HELP

Assistance for the on-line user is provided via the VAX/VMS HELP facility. This facility uses a hierarchical structure to provide information in increasing detail.

- To get information about a topic, enter the keyword for the topic. One need only enter the capitalizes letters of the keyword.
- To get a list of keywords on topics for which information is available at each level, enter a question mark (?).
- To return to the next higher level, enter a carriage return.
- A carriage return at the top (entry) level will exit the user from the HELP facility.
- To do an immediate exit from the HELP facility, enter a control-Z.
- When executing a retrieval program, one may answer a prompt for input with a question mark (?). In response, HELP information for that prompt will be provided.

5 OUTPUT

Output device is the user's terminal unless alternate file specifications are given. The user can transfer a disk output file from the ONLINE facility to his/her computer through BITNET/EARN mail or the file transfer functions of DECNET, TCP/IP, or KERMIT.

6 New Features and Enhancements

New features have been added to the online system recently. One feature makes the system more user friendly through screen managed displays for users with VT100 compatible video terminals. Apart from displaying the menu as a form with defaults built into it, it enables the user to save and print the screen display. *See the example enclosed.*

The PHYSCO package of codes will be expanded to include other codes.

A package of calculation aides and a list of fundamental constants are being considered for addition to our online facility.

In short, the NNDC Online System is evolving. New features and programs will be added when found useful and feasible. Comments and/or suggestions are welcome.

```
+----------------------- Nuclear Structure References -----------------------+
| BROWSE                                                                      |
+-----------------------------------------------------------------------------+
|   Publication Years : All    Type : All        Entry Cutoff Date : None     |
|     -----------------------------------------------------------------      |
| Initialize    Look    Extract    Combine    Scroll List    Done    ?       |
+-----------------------------------------------------------------------------+
+------------------------- Keynumber Lists Saved ---------------------------+
|  Number    Contents                          References   Retrieved        |
|     1      N 189PB                                10         None          |
|     2      R (D,T)                               670         None          |
|     3      C 1.OR.2                              680         None          |
|     4      A DUNFORD,C.                            2         None          |
|                                                                             |
+-----------------------------------------------------------------------------+
```

The ENSDF Radioactivity Data Base for IBM-PC and Computer Network Access

Peter Ekström and Leif Spanier

Department of Physics, Sölvegatan 14, S-223 62 Lund, Sweden

August 1989

A data base system for radioactivity gamma rays is described. A base with approximately 15000 gamma rays from 2777 decays is available for installation on the hard disk of a PC, and a complete system with approximately 73000 gamma rays is available for on-line access via the NORDic University computer NETwork (NORDUNET) and the Swedish University computer NETwork (SUNET).

Introduction

In basic and applied nuclear physics one often obtains Ge(Li) gamma-ray spectra with many gamma rays, which are not immediately identifiable. One then needs some means to find out which gamma rays are known, and to which decay they belong. There are several gamma-ray catalogues, but very few where gamma rays can be easily identified from their energy, since in most catalogues the gamma rays are ordered by parent nucleus and not by energy.

Our gamma-ray catalogues [1,2] have, judging from the demand for copies and user comments, been very useful in identifying gamma rays. Since hard disks for PC:s have become cheaper and more commonplace, it was thought that an update of the catalogues should take the form of computer data bases rather than printed reports. The development of computer networks (e.g. the Swedish University computer NETwork, SUNET), also makes it feasible to access data bases on remote computers. Our ambition was to make a system which is as easy to use as a book, but considerably faster an more versatile.

This report describes the two data base systems for PC:s and (as part of an existing data base system for Nuclear Structure References [3]) for the department's VAX8200 computer GARBO. The data bases are intended as a complement to publications of decay data (e.g. the very useful Table of Radioactive Isotopes [4]) in that they allow the experimentalist to search for possible nuclide assignments of any gamma ray with a reasonably well determined energy.

The data files required for the base were created on a VAX8200. Programs for the data base system have been written in FORTRAN 77, and compiled with VAX/VMS FORTRAN and Microsoft FORTRAN 77, version 4, for VAX and PC, respectively. Since the programs perform virtually no real number arithmetic, the PC version is compiled to make no use of a Math processor (FPU).

The PC data base contains approximately 15000 gamma rays from 2777 decay data sets. Only the *ten most intense gamma rays from each decay* are included. The complete data base on GARBO contains approximately 73000 gamma rays.

The following uses of the data base are anticipated:

(i) To look for and identify a gamma ray with a certain energy.

(ii) To obtain information such as half-life, decay mode and branching ratio of a given nuclide.

(iii) To list (with the possibility of obtaining a hard-copy) gamma rays from a certain decay.

(iv) To use the ASCII files with gamma rays and data set information in other applications, e.g. as radioactivity data for an automatic peak-search program.

Origin and treatment of data

The data have been retrieved automatically from ENSDF [5] (March 8, 1989). Please observe, however, that some data in ENSDF may be considerably older than this, since ENSDF is not continuously updated. Instead, one mass number at a time is updated with a frequency of 5-10 years. The last line in the data set header produced by the Set command of GDISP (see below) gives information on how current the data are.

First all decay data sets in ENSDF were extracted. Then gamma-ray normalization, parent half-life and branching ratio were extracted, and gamma-ray and decay properties were stored in sequential ASCII files. A number was assigned to each data set, and this number was stored with each gamma ray. Then the file with gamma rays was sorted by energy with the VMS SORT command.

The files with data set information and gamma-ray data were used as input to the program GCONV, see below.

System requirements and installation

The data base system requires the following:

IBM-XT, AT, 386 or compatible

640 kB RAM

1.7 MB hard disk space (and additional 1.6 MB temporarily for installation). Note that it is advantageous if the disk is not too fragmented. Use a commercial disk optimizer program to obtain large unused areas on the disk!

FILES=6 (or greater) in CONFIG.SYS

PC- or MS-DOS 3.2 or later

To install programs and data base, insert disk 1 in a floppy disk drive and make this drive current by typing e.g. A: <cr>. If you are installing on hard disk drive C: in sub directory \GAMMAS from floppy drive A: type

INSTALL C GAMMAS A <cr>

After installation the following files should be present on the hard disk:

gammas.bat	Batch file to facilitate running of data base program. This file should be moved to a directory present in the SET PATH command in the AUTOEXEC.BAT file
gdisp.exe	The program GDISP
gammas.dat	Direct access file with gamma ray data ordered by energy
gammas.inx	Unformatted file with gamma ray energies to serve as an index for gamma ray energy
dsets.dat	Direct access file with information on all decay data sets ordered as in ENSDF
dsets.inx	Unformatted file containing the data set number (as defined in DSETS.DAT) of each gamma ray
readme.doc	This document

Contents of distribution disks

The six distribution disks contain the following files:

Disk 1:

disk1.lab	File to identify disk 1
readme.doc	This document
install.bat	Installation initialization file
inst.bat	Installation file
gconv.exe	Program to make direct access files and index files from sequential ASCII files
gdisp.exe	Program to look for gamma rays and list decays
gammas.bat	Sample batch file to facilitate running of the program GDISP

Disk 2:

disk2.lab	File to identify disk 2
gammas1.lis	Gamma-ray data file, part 1

Disk 3:

disk3.lab	File to identify disk 3
gammas2.lis	Gamma-ray data file, part 2

Disk 4:

disk4.lab	File to identify disk 4
gammas3.lis	Gamma-ray data file, part 3

Disk 5:

disk5.lab	File to identify disk 5
gammas4.lis	Gamma-ray data file, part 4

Disk 6:

disk6.lab	File to identify disk 6
dsets.lis	Data set data file

Since the data files on disks 2-6 can quite easily be used for other applications, the contents of the files will be briefly descibed.

The gamma-ray data files contain information on all gamma rays in the data base. The file consists of fixed format records (maximum 79 bytes long), one record for each gamma ray. The records are ordered by increasing energy. Each record contains gamma-ray energy, intensity, which decay the transition belongs to, the data set number of this decay, half-life and a maximum of two energies of associated gamma rays (the strongest transitions in the decay).

The data set data file contains information on all data sets (a data set describes one decay mode of a parent nuclear state). Each fixed format record contains information on one data set. The maximum record length is 109 bytes. In addition to the complete data set identification (parent nucleus, decay mode) each record contains reference information, excitation energy of the parent state, half-life and branching ratio.

The program GCONV

This program converts the sequential ASCII files with gamma-ray data and data set information into direct-access files. In addition, unformatted index files for gamma-ray energies and data set numbers are created. These index files are used to facilitate quick access to gamma-ray data and data set information. The program is only used for installation, so it is deleted from the hard disk after installation.

The program GDISP

This program is used to display and list gamma-ray data. The introductory page and the help page are shown in the appendix. Commands are given by entering the first letter+<cr>. Gamma-ray energies should be entered in keV as normal decimal numbers (decimal point may be omitted).

Most commands are *self* evident, see the sample session and description in the appendix, so only two will be discussed:

D(ecay)

This command is used to search for information on a certain decay. Input a string that defines the decay (e.g. 60CO B-, note that CAPITAL letters have to be used), and the program will output a line for each data set that is consistent with the string. The set (data set) number should be remembered for the Set command, see below. The Decay command may take some time on slow computers, since the whole file containing the data set information has to be scanned.

S(et)

This command gives detailed information on a selected (by the set number) decay. All gamma rays in the decay present in the data base are listed in order of increasing energy. The listing may be written to a file.

The program GDISP starts by reading in the gamma-ray index file and the data set index file into arrays in core. Both index files have one entry per gamma ray present in the data base.

The gamma-ray index file contains all gamma-ray energies (real numbers) in the data base in the same order as the gamma-ray data are stored in the gamma-ray data file. When a certain energy is requested, the nearest is very quickly localized in the array, and the corresponding array element index gives the location of the gamma-ray data in the direct access file.

The data set index file contains the data set number (integer) for each gamma ray. This index is used (for the Set command) to extract all gamma rays from a certain decay (data set).

Computer network access to the complete base on GARBO

The radioactivity gamma-ray data base has been added as an extra option to the Nuclear Structure Reference system NSR_BASE resident on the VAX8200 of the Department of Physics. The reference system and how to access it is described in ref. [3].

Access is possible from any VAX connected to the NORDic University computer NETwork (NORDUNET, of which the Swedish University computer NETwork SUNET is a part) by entering:

$SET HOST GARBO
Username: NSR_BASE
Password: NSRBASE

and answering a few questions. The radioactivity data base is accessed with the command GAMMAS. The data base resident of GARBO contains all gamma rays from decay data sets in ENSDF, approximately 73000 gamma rays. Access to the data base is via a VAX/VMS version of the program GDISP. It is possible to extract gamma-ray listings if a list is made in GDISP. These lists may subsequently be transferred with the VAX/VMS MAIL system.

Ordering information
You can obtain the installation files for the Radioactivity Gammas Database free of charge by sending *six 5 1/4 inch formatted 360 kB floppy disks* to Peter Ekström under the above address.

Programs and data files may be freely copied for non-commercial use only. If you find the data base useful, we would be very grateful if you would write and tell us what you use it for. This would help us to obtain funding for nuclear data activities in the future.

Acknowledgements
The present work was supported by a grant from the Swedish Nuclear Power Inspectorate (SKI), the National Defence Research Establishment (FOA), the National Committee for Used Nuclear Fuel (NAK), the National Institute for Radiation Protection (SSI), Studsvik Energiteknik and Vattenfall.

References
1) Catalogue of gamma rays from radionuclides, L P Ekström and P Andersson, Nuclear Physics Report LUNFD6/(NFFR-3050)/ 1-198/ (1983)

2) Catalogue of gamma rays from radionuclides ordered by nuclide, L P Ekström and P Andersson, Nuclear Physics Report LUNFD6/(NFFR-3052)/ 1-250/ (1984)

3) NSR_BASE - program package for the on-line retrieval of references from the Nuclear Structure Reference file, User's guide, L P Ekström and M Bergström, Nuclear Physics Report LUNFD6/(NFFR-3058)/ 1-27/ (1988)

4) Table of Radioactive Isotopes, E Browne and R B Firestone, John Wiley & sons, 1986

5) ENSDF, the Evaluated Nuclear Structure Data File, produced by in international collaboration under IAEA, and edited and maintained by the National Nuclear Data Center, Brookhaven National Laboratory

Appendix

Sample session with GDISP

This session has been run with the VAX/VMS version of the program, but the PC version gives almost identical output (except that there are fewer gamma rays). The session illustrates the Help facility, looking for a gamma with the energy 661.6 keV, and listing the gamma rays in the decay of 60Co. Data entered by the user are marked with an exclamation mark (!). The output reproduced on the following pages will be discussed below in order to help the user to interpret it.

First the file name of the (optional) output file for decay listings is entered. An introductory text on the program and data base is then displayed. The help option is chosen by entering H <cr>. In addition to the commands, the help text gives the correct interpretation of symbols, which may occur in the data.

When the number 661.6 is entered, the program displays the nearest gamma-ray energy in the middle of the page surrounded by the nine next lower and higher entries. The user can browse through the table with P <cr> and <cr>.

In addition to the energy, the intensity of most gamma rays is given. Note that for internally converted transitions only the fraction of the intensity which decays by gamma quanta rays is listed. A minus (-) sign signifies that no intensity was given in ENSDF, either because it was not known or because the transition is completely converted (e.g. 0-->0 transitions). If a % sign is present to the right of the intensity field, the intensity is given in normalized units: *gamma ray intensity per 100 decays of parent.*

The decay column gives the parent nucleus and the decay mode. EC is electron capture, B+/- is beta +/- decay and IT is isomeric transition.

The set column gives the number of the data set. This number is used to extract the complete decay with the Set command.

The half-life is given in the following units:

AS	attoseconds (10**-18 s)	S	seconds
FS	femtoseconds (10**-15 s)	M	minutes
PS	picoseconds (10**-12 s)	H	hours
NS	nanoseconds (10**-9 s)	D	days (24 H)
US	microseconds (10**-6 s)	Y	years (365.256 D)
MS	milliseconds (10**-3 s)		

The columns with associated gamma rays list the two strongest gamma rays in the decay. These columns are useful, together with the nuclide assignment and the half-life, for identifying an unknown gamma ray.

After the gamma-ray listing the Decay command is demonstrated. This command can be used to search for any decay(s) in the data base. If, for instance, you are interested in mass number A=123, entering 123 on the prompt will yield a list of all decays for which the parent nucleus has mass number 123. In addition to the data set identification, the data set number is given (for use with the Set command).

The Set command prompts the input of a data set number, and produces (in addition to all gamma rays in the decay present in the base) some information on the decay:

Excitation energy refers to the parent state (in most cases the ground state, but for isomeric states this number is >0).

The half-life is given in the units listed above. Branching is <1 for the cases where the parent state has more than one decay mode,. in which case there ought to be at least one additional data set with the alternative decay mode.

The reference field contains key numbers of references used for the data. These key numbers can be decoded with the Nuclear Data Sheet issue indicated in the 'Published in' field. The last entry is the date of entry of the data set into ENSDF.

```
NSR data base, enter command: GAMMAS !

Do you want the data set gamma ray listings on a file? Then type
the file name, e.g. DECAY.OUT (else <cr>): DECAY.OUT !


                    **********************************
                    * GDISP, vers 1.1, August 1989 *
                    **********************************

        * A program to assist identifying and to list
        * radioactivity gamma rays

        Leif Spanier and Peter Ekstrom,
        Department of Nuclear Physics,
        Solvegatan 14, S-223 62 Lund, Sweden

        Data are taken from ENSDF (the Evaluated Nuclear
        Structure Data File) from 8 March 1989.
        ENSDF is edited and maintained by the National Nuclear
        Data Center, Brookhaven National Laboratory, on behalf
        of the International Network for Nuclear Structure Data
        Evaluation.
             Number of gamma rays in data base:  73318
             Number of decay data sets:           2777
             List file:                         DECAY.OUT


Egamma (dec.number) Previous Next - + First Last Set Decay Help Introd Exit
h !


   ***************** HELP TEXT ***************************
   Egamma          : Type a number and the program will display the known
                     gamma rays that are closest to this energy.
  Only the first character is necessary for the following commands:
   Previous        : Displays previous page.
   Next            : Displays next page.
   <cr>            : Carriage Return (<cr>) displays next page.
   -               : Displays the gamma rays 5 pages above.
   +               : Displays the gamma rays 5 pages below.
   First           : Displays the first page.
   Last            : Displays the last page.
   Set             : Displays information about a decay.
   Decay           : Search for mass number or nucleus.
   Help            : Displays this text.
   Introd          : Displays the introductory text.
   Exit            : Exit from the program.
  If errors are given in output they are in the format
  12.345 67  which means  12.345+-0.067
    % - Absolute intensity per 100 decays of parent
    ? - Questionable gamma or placement.  S - Expected, not observed
    GT,GE,LT,LE,AP,SY,CA - >,>=,<,<=, approximately, systematics, calculated
Egamma (dec.number) Previous Next - + First Last Set Decay Help Introd Exit
661.6 !
```

```
661.6
 Energy (keV)      Intensity     Decay     Set  Half-life      Associated gammas
   661.5     7  ?   0.91 22    % 201BI EC  2248 108 M       3    629.1     936.2
   661.5     3    25.0 10     % 50MN B+     199 1.75 M      3    1098.0    783.3
   661.5     2    69 7        % 148HO EC  1436 9 S         1    1688.3    504.3
   661.5     5     5.304      % 117I B+    958 2.3 M       1    325.9     274.4
   661.5     3     1.8 5      % 154HO EC  1555 3.25 M      10   334.6     412.4
   661.55    15    0.022 9    % 151PM B-  1485 28.40 H     4    340.08    167.75
   661.58    7     0.88 13    % 99SR B-    665 270 MS      10   125.12    536.12
   661.58    12    2.54 25    % 204BI EC  2295 11.22 H     10   899.15    374.76
   661.6     1     -          % 88NB B+    525 14.5 M      1    1082.6    1057.1
   661.6     1     1.90 10    % 88NB B+    526 7.8 M       1    1057.1    1082.6
   661.62    22    0.056 12   % 155DY EC  1572 10.0 H      3    226.918   184.564
   661.64    11    0.19 4     % 93RB B-    577 5.7 S       1    432.61    213.43
   661.660   3     -          % 137BA IT  1238 2.5513 M    7
   661.660   3    85.21 7     % 137CS B-  1237 30.0    Y   2
   661.7     3     4.33 15    % 143CS B-  1332 1.77 S      2    195.554   232.421
   661.8     4     3.0 7      % 181RE EC  1930 19.9 H      7    365.5     360.7
   661.9     7     0.32 13    % 186IR EC  2009 16.64 H     3    296.89    137.157
   661.9     5    30 8          142XE B-  1316 1.22 S      2    571.83    657.05
   661.9     1     0.30 6     % 157HO EC  1603 12.6 M      2    279.97    341.16
--------------------------------------------------------------------------------
Egamma (dec.number) Previous Next - + First Last Set Decay Help Introd Exit
d !
Look for a specific nucleus or decay by exact match.
Format: MassnumberElementsymbolBlankDecaymode
Items may be excluded from left or from right,
for example: 60CO B- or 60CO or CO or 60
See the decay column for other examples.
Type decay (<cr> to skip) : 60CO !
Scanning data set information file, wait.....
Data set no:    257     Decay: 60CO IT DECAY
Data set no:    258     Decay: 60CO B- DECAY (5.2704 Y)
Data set no:    259     Decay: 60CO B- DECAY (10.47 M)
Egamma (dec.number) Previous Next - + First Last Set Decay Help Introd Exit
s !
Type data set number : 258 !

Decay               : 60CO B- DECAY (5.2704 Y)       Data set number  :   258
Excitation energy: 0.0          keV
Half-life           : 5.2704 Y  13         Branching        : 1.0
References          : 76CA18,68HA03
Published in        : 86NDS                In ENSDF on      : 860805

 Energy (keV)      Intensity
   346.93    7      0.0076 5  %
   826.28    9      0.0076 8  %
  1173.237   4     99.900 20  %
  1332.501   5     99.9820 10 %
  2158.77    9      0.00111 18%
  2505              2.0E-6 4  %
------------------------------
Do you want this set on the list file type <cr> (N for no):
Egamma (dec.number) Previous Next - + First Last Set Decay Help Introd Exit
e !
        END OF GDISP
```

Should an evaluator check the author's interpretation of experimental data?

F.E.Chukreev.

The rules for ENSDF data sets preparation [1] contain the item 3: "Read all papers carefully - do not assume everything in the paper must be correct ".

Accumulated experience for data set preparation permits to do some generalizations as the participants of our network to follow to this rule.

But , before to analyse existed situation , I would like to say some words on the subject why I believe that the following this item is important and interesting.

Our expierence of the relation with experimental physicists have testified that ones use ENSDF data and Nuclear Data Sheets as reference data and feel the trust to these data. But physics history knows some cases, when the confidence in experimenal data interpretation lead to delay of the rise or the recognition new ideas. Suitable example have been given in the book [2] regarding to motion of Mercury's peryhelion.

Do our community satisfy Nuclear Data Sheets reader's trust constantly? I must recognize that is not constantly. I would like to quote some examples and I would like to begin ~~with~~ from CAJAD's evaluation.

1-st example: Energy levels and the transition in 166-Er. The evaluator [3] have informed about gamma-rays characteristics for 166-Tm decay. (see page 427). He ascribed to 1447 kev transition (E2+E0) multipolarity. This conclusion have been based on the data from the paper [6]. This investigators had measured internal conversion coefficient (ICC) for K-shell and had found that ICC is 0.0057(15). They had conclused that this transition is (E2+E0) type and spin-parity of 1528.2 kev level is 2+. But the datum for ICC may be interpreted as pure M2 transition too and 1528.2 kev level spin-parity must be changed, consequently.

Therefore, the independent evaluation 166-Ho(g.s.) decay scheme had been executed. All conversion data from another decays have been used. This investigation have based on operation methods [5] and gives 16 variants for spin-parity assignment.

In our opinion, experimental data do not contradict for any variants.

2-nd example regards to decay scheme of 133-Ba [6].

The authors of this evaluation proceeded from the assumption that 356 kev transition is pure E2. That is why they have been obliged to introduce penetration factors for some transitions. But, if to exclude the propose that 356 kev transition is pure E2, then, using operation methods again [5], another set of spin-parities for energy level of 133-Cs is possible. This new set is not contradicts experimental data too [7].

3-rd example regards to 180-Hf isomer decay [8]. "Adopted Levels" say that isomer level (5.5 hours) have 8- spin-parity, as E1 transition to 8+ and M2+E3 one to 6+ are observed. But, if we assume these multipolarities ,then we are obliged to introduce large corrections on penetration factors for ICC. I can suppose, that these ICC data could be interprete as M1+E2 and M3+E4, if suitable penetration factors will introduce.

In our opinion, existed experimental data is not sufficiently to confirm that isomeric state of 180-Hf is 8-.

4-th example we have found when we had attempt to use the data for neutron radiative capture in 181-Ta [9]. We have observed, that among 275 quanta, which were placed between 182-Ta levels, the agree for 24 quanta is bad. When I say "is bad", I have in view, that the difference of level energies differ from quantum energy more two uncertainties. At the same time not a little unplaced quanta could be assignmented for known levels.

I believe that the number of similar examples could be increased.

Is our activity correct? May be we create erromous impression about the plenitude our information for low-lying nuclear states?

Demonstrated examples show their sources. This is borrowing author's interpretation of experimental data by the evaluator without any checking of simple interpretation. I believe that some checking is needed.

When a physicist analyses its experimental data, he have the tendency to put its brick for existing building known theoretical scheme. It is clearly! But, should the evaluator supports this situation?

I believe this question must have the answer: "No". An evaluator must find the ambiguities, that will help to eliminate them.

I foresee the objection: "What say this man? We have not man-power enought, but he propose to increase existing large volume of the evaluations, to investigate the ambiguities".

Obviously that this increasing mountain of the evaluations can not be executed without large help from the computers.

The algorithms for this computers are existing - its have been developed by modern mathematics and named " operation researchs". CAJAD have applied these methods to solve the problem of optimal disposition of gamma-transition between known levels [10] and to analyse the ambuguities of the interpretation ICC and angular correlation experiments. Above-mentioned preprint [5] contains main ideas to solve this problem.

I hope to show the action of the codes for checking of ICC data ambuguities some later.

The path to construct the system of linear restrictions by using the experimental data from ENSDF sets is clear now. We will have possibility to execute needed check on non-unique ascribing the multipolarities for the transitions.

I would like to believe that the labour to create needed algorithms will be remunarated by founded results.

The development of needed methods will be gradual, step by step, as far as we will accumulate the expierence and codes.

Undoubtedly, the including in NDS text the information about possible non-unique interpretation of experimental data a few increase the volume of this edition, but commercial success of NDS will be increased too, as the physicists will have possibility to find new problems for their experimental investigation side by side the results of another investigations.

1. T.W.Barrows, "Getting Started on Mass-chain Evaluation" in "Procedure Manual for Evaluated Nuclear Structure Data File". October 1987, Brookhaven national Laboratory.

2. N.T.Roseveare, "Mercury's Prihelion. From Le Verrier to Einstein". Clarendon Press, Oxford 1982.

3.A.E. Ignatochkin et al., NDS, 52,365 (1987)

4.J.Adam et al., Czech.J.Phys.,B29,997 (1979)

5.F.E.Chukreev, "The operation research as an instument for analysis and planning of nuclear spectroscopic experiment". Preprint IAE-4801/2, Moscow,1989.

6.Yu.V.Sergeenkov,V.M.Sigalov, NDS,49,639 (1986).

7.F.E.Chukreev, V.A.Vukolov, "The intensity of gamma radiation in the decay of barium-133", The document GS/51 for Braunshweig Meeting, 31.05-02.06.1989.

8.E.Browne, NDS,52,127 (1987)

9.R.B.Firestone, NDS,54,307 (1988)

10. F.E.Chukreev, Yadernie Konstanty, 1, 68 (1989)

Reproduced unchanged from the Minutes of the 1988 NSDD Meeting in Ghent, INDC(NDS)-206, Appendix 22.

PRESENTATION OF ENSDF DATA IN THE NUCLEAR DATA SHEETS AND HOW EVALUATORS CAN INFLUENCE IT

R. R. Kinsey
(May 12, 1988)

There are a number of things that the evaluator can do to improve the presentation of the data in the Nuclear Data Sheets. Some of the information presented here merely informs the evaluator how the data will be handled by the processing codes and translators so that the evaluator can take advantage of that information. The following is a list in no particular order of importance of this information.

1) Footnotes are generated as they are encountered in the data set. This includes footnotes created by the data such as normalization factors from the N card and comments on multiple placement and intensities from flags on the G cards. The comments on multiple placement will always come last in the footnotes at the end of a table since they will always be encountered last. However, the evaluator is free to rearrange the other footnotes in the dataset, including the placement of the N card, to improve the presentation. For example, the footnotes can be arranged to reflect the order in which they are encountered by the reader.

2) A given footnote should not be used more than once in a table. If the footnote applies to more than one data field then multiple SYM's should be used on the footnote comment card. SYM as used here and in the formats manual refers to the alphabetic codes used to name the formatted data fields in the manual.

3) Footnotes can only be used with a SYM corresponding to one of the allowed data fields on one of the six formatted data cards used to make a data table. Any other use, such as trying to footnote quantities on data continuation records, only results in the comment being lost.

4) The evaluator has total control of the order of the data sets in the cross reference table and column in the adopted levels table. That order is the order in which the cross-reference records are placed in the adopted dataset. It has nothing to do with the character, DSSYM, which is used on that record and as a parameter in the XREF expression. Since only the first fourteen datasets are given a unique symbol, it is important in some cases for the evaluator to determine which datasets will be lumped together under the 'O' symbol. It is also very important that the DSID field on the cross-reference record exactly match the DSID used for that dataset.

5) Any adopted dataset which includes BAND footnotes will cause a drawing showing the bands (and gammas if present) to be created. The title of the band will be the comment appearing on the first card of the band footnote but not including the rest of the comment about the band which may appear on comment continuation records. Thus, the band footnote may be quite extensive but the title may be very short. The order of the bands in the drawing will be the order of the bands in the dataset. If the evaluator wishes to order the footnotes in one way and present the bands in a different order then the evaluator must communicate this to the production staff at either the pre-review or post review stage of production.

6) A special form of the footnote comment allows relabeling of the standard label heading of a formatted field. This form, SYM followed by LABEL= in the comment field, is presently limited to the S field of the L card. The evaluator must make sure when using this form to limit the size of the new heading or the table will look ridiculous. In general, the number of printed characters in the new label should be no more than the maximum width of the data in the column. Enter any other information such as angles and units in another footnote on the S field.

7) A DSID continuation record is now allowed. The evaluator should be aware of several pitfalls currently involved with using this form. The first and most important is that the DSID field on the DSID card (this does not include the continuation field) must be unique for each dataset since the database will only keep one unique DSID. The second is that a very long title in the tables generated from a long DSID may not fit on the page and no decision has been made on how to handle this. The third is that there is no specification on where or how to split the DSID from one card to the next. Finally, these extra long DSID's could create a problem in displaying data retrieved on-line.

8) Evaluators should be aware that data continuation cards with an 'S', for Suppress, in column 6 will be suppressed in the final publication. The information on these cards is presented in the pre-review and review copies but not in the final galley and publication. The evaluator should make sure that any codes that are used to insert calculated quantities into datasets on data continuation cards use 'S' and not '2'. Older datasets may still use '2' and these must be changed.

The ENSDF publication is unique in that the copy submitted by the evaluator is translated by a computer code before it is published. Historically, this was based on only having upper case characters on punched cards and the publication was to be in standard upper and lower case characters and include a number of Greek characters as well. This means that the evaluator must be aware of what the translator program is going to do with the text. In addition, we'll include a few notes on punctuation. Some of this material has been circulated before but we'll cover it again since the problems continue to occur.

1) Any 'word' containing a lower case character will not be translated. This is especially useful for proper names. The other side of this is that any 'word' in all upper case characters which is not found in the translation dictionary will be converted to all lower case. This is also why we need to know if you have included any nonstandard all upper case mnemonics in your evaluation. See Appendix D in the ENSDF format manual for the translation dictionary.

2) Any comment field on any comment card which uses the lower case 'c' or 't' in column 7 rather than the upper case 'C' or 'T' will have no translations done on that comment field. The evaluator is then responsible for any special characters codes, seeing that the fourth character of a keynumber is lower case, and all capitalization. This can be useful in the essentially straight text of the address fields and funding acknowlegement in the COMMENTS dataset.

3) The difference between 'C' and 'T' comment cards is that the 'T' cards comment will be output using fixed character spacing as in a table or typewriter (thus 'T') whereas the 'C' comment uses publication quality variable character spacing. Using 'T' comments for text looks bad and should be avoided.

4) In a comment field TI will always translate as I(gamma+ce) even if the evaluator is referring to the TI field on an E card. There is one and only one translation for each code word. In cases of conflict, the most common has been chosen. In this example, the evaluator must use 'I(B+EC)' and not TI in a comment field even though the SYM is still TI.

5) Because of the need to translate E2 as E2, E4 as E4, etc., it is necessary that numbers in comment fields and on data continuation cards use the '+' sign in the exponent of numbers given using the engineering notation such as 1.547E+3.

6) The translation of material after 'CONF=' for shell model configurations is very difficult and while numerous examples are given in the manual there always seems to be some way of presenting the information which is not covered by them. However, one common problem which the evaluators can take care of is to include the proper number and nesting of parenthesis. Only the information within the first encountered set of parenthesis will be put through this special translation. Therefore, CONF=((P,1/2(512))(N,3/2(523))) will translate correctly while CONF=(P,1/2(512))+(N,5/2(624)) will not.

7) The code for the degree sign is DEG and not DEGREE as is commonly done.

8) Within parenthesis, keynumbers are seperated by commas and no spaces. Otherwise, keynumbers in a list are treated like any other list, that is, in a list of more than two items a comma and a space seperate the items and the word 'and' precedes the last item.

9) The code for g.s. is 'GS' and not 'G.S.'. The only place to use 'G.S.' is at the end of a sentence since 'GS.' translates as 'g.s..'.

10) In referring to other references which the evaluator wishes to bring to the readers notice, 'Other:' is used with a single reference and 'Others:' with a list of two or more. These words should be capitalized, so if other information precedes them, that information should end with a period and not any other form of punctuation.

Format Proposal-JKT-89-1

Properties-oriented tables

Purpose: To simplify presentation of information in Adopted Levels table.

Proposal (same as at 1988 meeting):

At the last meeting I was asked to prepare samples for the presentation of half-life data, JPI arguments and Level properties in separate tables under the Adopted Levels. Such an example was prepared and sent to the subcommittee members and other attendees of the last meeting. Dick Helmer, Eddie Browne, and NNDC attendees have expressed their approval of the examples sent. No comments were received from others.

Final disposition of the proposal is requested at this meeting.

Format Proposal-JKT-89-2

Table of reduced transition probabilities

Purpose:

To simplify presentation of information in Adopted Gammas table

Proposal:

It is proposed that a table of reduced transition probabilities be presented under adopted gammas for each nucleus. This will have the effect of simplifying the adopted gammas table considerably, making it less cluttered, and easier to read. The reduced transition probabilities should be given only for those transtions for which multipolarity is known. Table will consist of E(gamma), E(level), Multipolarity, Mixing ratio and BELW, BMLW from the continuation G records.

Impact: Evaluators - none

Production - NDSLST enhancement will be needed

Format Proposal-JKT-89-3

Table of ground-state and isomeric-level properties

Purpose:

Many applied users need only the g.s./isomeric level properties and complain of considerable complexity of presentation of data in NDS. These are users who need information slightly more than what is normally given in the Wallet Cards.

Proposal:

It is proposed that a table of g.s. and isomeric level properties be given. The table should contain the following properties:

E(level)
JPI
T1/2
Q-
Decay modes
Static moments

This table could follow the skeleton scheme.

Impact: Evaluators - none

Production - NDSLST enhancement will be needed

Format Proposal-JKT-89-4

Interleaving of drawings and tables in NDS

Purpose:

Improve readability of NDS by keeping drawings and corresponding tables together in NDS

Proposal:

It is proposed that the data presentation in NDS be restructured so that the drawings and tables for a given nucleus appear together. Initially, the drawings and tables, for a given Z, can appear on separate pages but near the corresponding tabular data. In future, hopefully we should be able to intermix tables and drawings on the same page.

The following would then be the sequence of presentation of data in NDS:

a. Abstract

b. Index for the A-chain

c. Skeleton scheme for the A chain

d. Ground-state and Isomeric level properties table (if JKT-89-3 approved)

e. Drawings AND tables for each Z (in order of increasing Z)

f. References for the entire evaluation

In this presentation A chain will be clearly divided by nuclides. It is necessary that all data for a nucleus, including radiations from various parents be given under the daughter. This should hopefully eliminate long standing separation between the levels and radiation tables by several pages. For the convenience of those who expect the radiation tables to be associated with the parent a comment saying that the reader should see the daughter nucleus for radiation information should be given under the parent nucleus.

Impact: Evaluators - none

Production - NDSLST enhancement will be needed

Format Proposal-JKT-89-5

New quantity PUB

(Reçonsideration of proposal presented in 1988)

Purpose: To eliminate non-numeric characters from numeric fields in ENSDF but retain them in publication.
To suppress selected quantities in the publication.

Format: 1. A quantity PUB be defined and given on a "publication comment" record whose effect will be to modify the specified field in the publication of NDS.

Ex. NUCID PK PUB=SYM$

K= L,G,A,E, or B
SYM= Any valid field for record type K

2. SYM will indicate how the quantity on the last formatted record (see also note 6, below) should be displayed in NDS. For example, to put parentheses around the energy value and "?" on the half-life value given on L record, one would include the follwing record following the L record:

Ex. 144SMP L PUB=(E)$PUB=T?$

3. For the present, the use of this format will be confined to the modifications defined in (4) of energy, intensity, and half-life fields only, or for suppression of these and any other fields.

4. For the present, modifications will be restricted to introduction of a set of parentheses, a set of square brackets, and a question mark. Suppression of value(s) in a given field is also possible (see 5).

5. If a quantity is incuded within single quotes (apostrophe) then the corresponding value will be suppressed in publication

Ex. 144SM PG PUB='CC'$PUB='DE'

In NDS this will result in suppression of CC value and the uncertainty on E. Of course, one can not show the uncertainty without the value to which it pertains. For example, once CC is suppressed, so will be DCC.

6. If the "publication-comment" record precedes all formatted data records then it will affect all records of the given type in that data set.

Ex.

```
144CE    ADOPTED LEVELS, GAMMAS
144CE PG PUB='CC'$
144CE  L 0.0          0+                  284.893 D 8
144CE  L    397.441 92+
144CE  L      938.65 64+
144CE  G 541.20       6   100.0  E2                          0.00843
144CE  L    1242.21153(-)
144CE  G 844.8        4     100 4(E1+M2)    -0.126  5        0.0013
```

In NDS output all CC will be suppressed.

Impact: Evaluators - yes

Production - NDSLST enhancement will be needed

Analysis codes - modifications needed

BROOKHAVEN NATIONAL LABORATORY
ASSOCIATED UNIVERSITIES, INC.

Upton, Long Island, New York 11973

National Nuclear Data Center
Bldg. 197D

(516) 282 / FTS 666 2901, 2902

MEMORANDUM

DATE: September 26, 1989

TO: USNDN Members
Panel on Basic Nuclear Data Compilations

FROM: Sol Pearlstein SP

SUBJECT: Nuclear Data Digest - An On-line Enhancement

Purpose:

For the users who do not need the in-depth information of Nuclear Data Sheets, we plan that a Data Digest be prepared for every mass chain in ENSDF.

Availability:

ENSDF information is available through the on-line system and may be viewed by the user at his/her terminal and/or reproduced in hard copy. The Nuclear Data Digest is an on-line enhancement that can be output to the user's laser printer having a Postscript or Tektronix interface.

Presentation:

The Digest will present data in the form of drawings and/or tables in concise form and will be automatically updated when a new A-chain is published or ENSDF is significantly revised.

Scope:

It is proposed that the Digest include only the following information:

1. For an A Chain

   A skeleton scheme showing the g.s. and isomeric level properties of all known nuclides and isomers for a given mass chain. Level properties include the following:

   a. Excitation energy
   b. Decay energies, g.s. Q values
   c. Decay modes and respective branchings
   d. Half-life
   e. J^{π} value

TELEX: 6852516 BNL DOE   FACSIMILE· (516)282-3000, FTS 666-3000   CABLE BROOKLAB UPTONNY

2. For each nucleus in an A chain

   A. All adopted levels with the following properties:

      a. Excitation energy
      b. Half-life
      c. J^{π} value
      d. Symbols showing population in various experiments

   B. All adopted gammas with the following properties:

      a. Transition energy
      b. Level placement
      c. Branching ratio
      d. Multipolarity
      e. Conversion coefficient

   C. Radioactivity

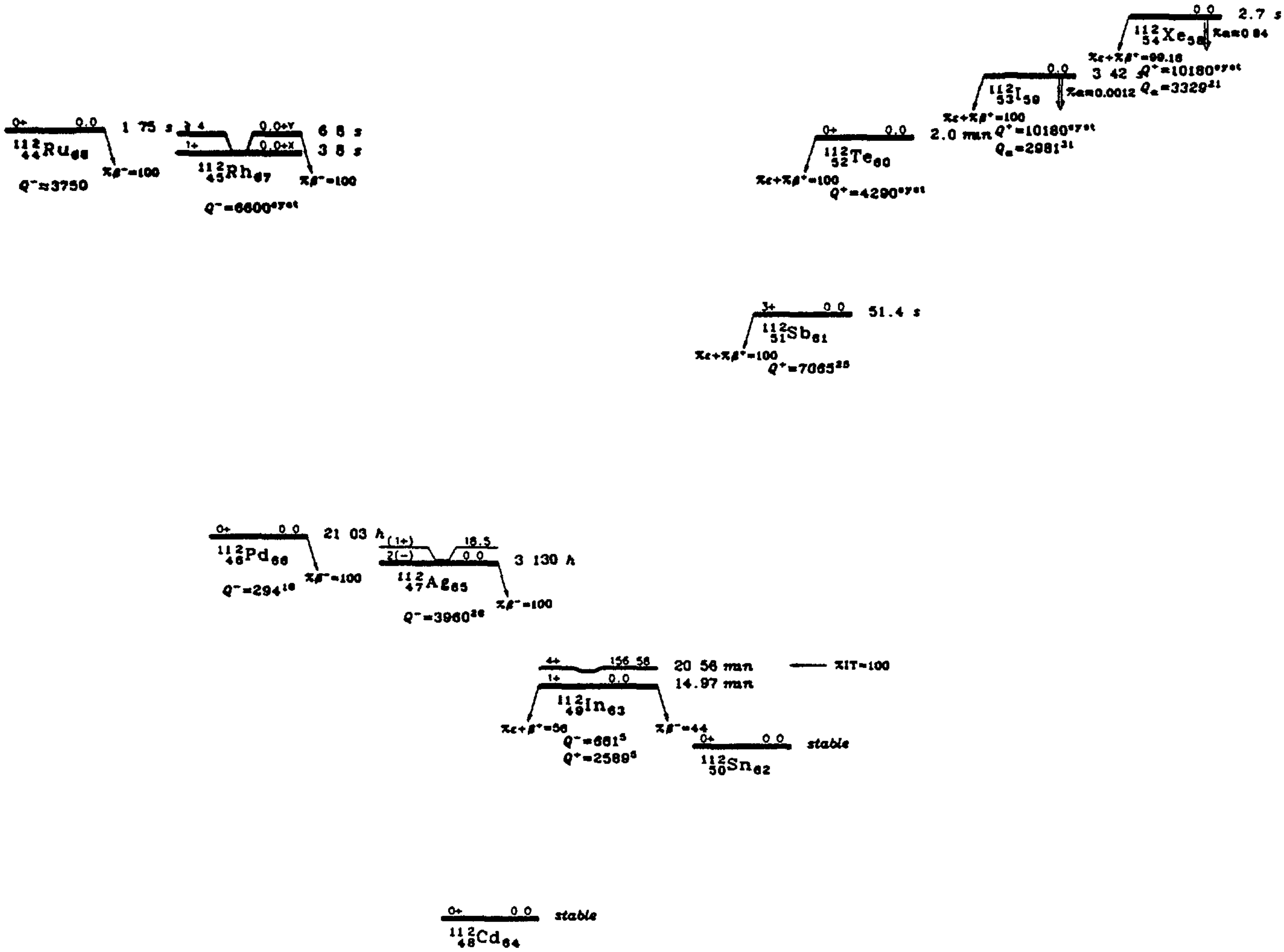
      All radioactive decays will be given in the form of drawings or tables. The level feedings by various radiations will be given. Only adopted levels and gamma-ray information will be given.

Examples:

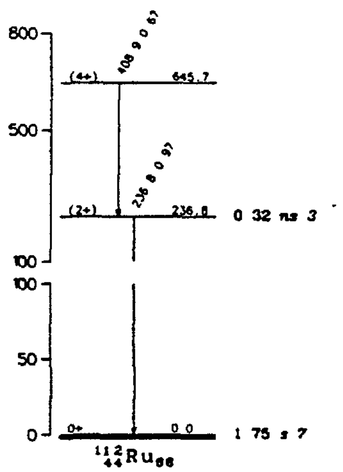
An example has been put together to illustrate the scope and possible presentation.

/vec

NDS 57, 443 (1989) - D. de Frenne, E. Jacobs, M. Verboven



$^{112}_{44}Ru_{68}$

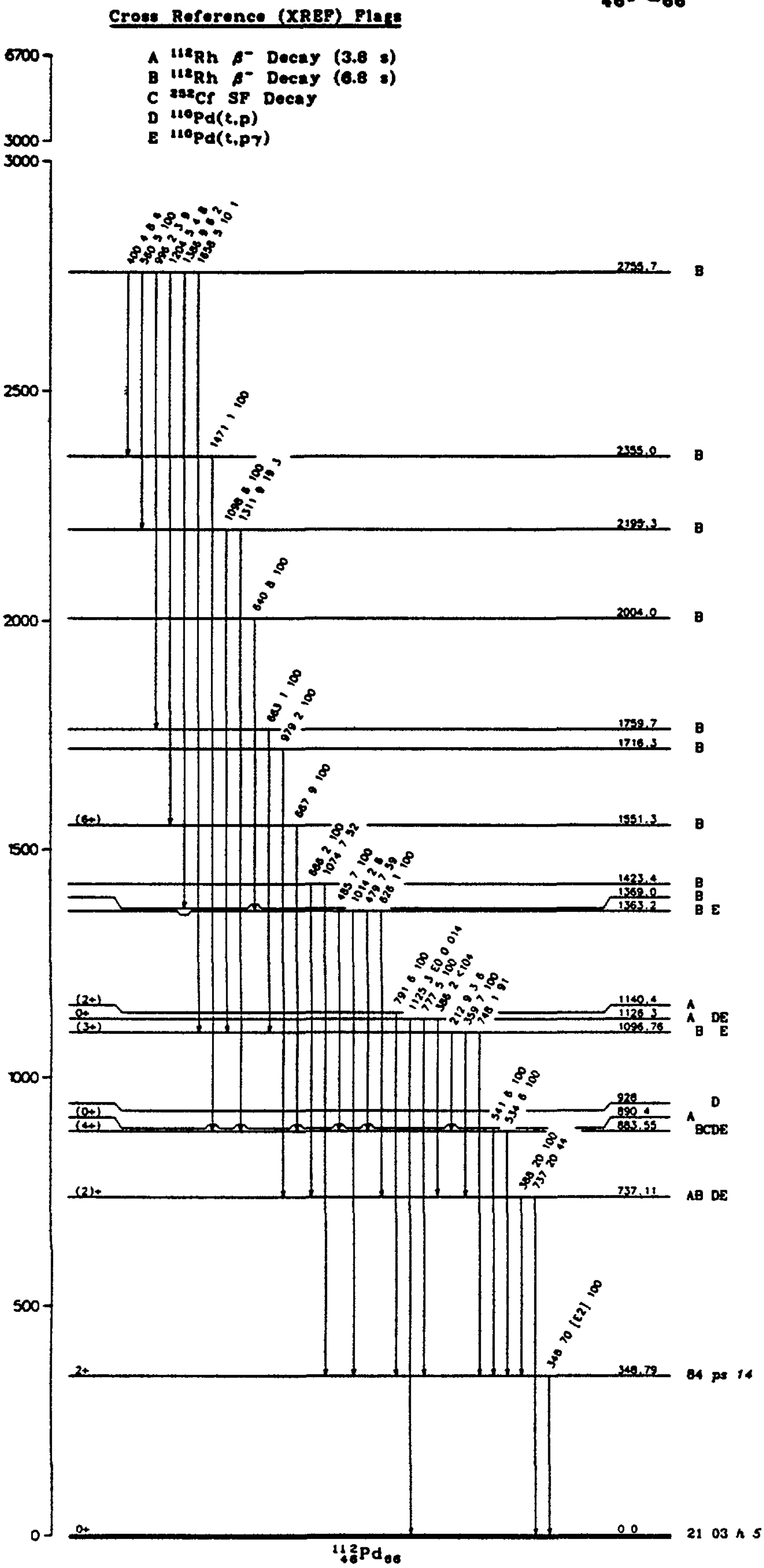


$^{112}_{45}Rh_{67}$

^{112}Rh Adopted Levels

E(level)	Jπ	$T_{1/2}$
0.0+x	1+	3.8 s *6*
0.0+y	≥4	6.8 s *2*

$^{112}_{46}Pd_{66}$



^{112}Rh β^- Decay (3.8 s)

Eβ⁻	E(level)	Iβ⁻	Log ft
(5460+x)	1140.3	1.6 15	6.8
(5474+x)	1126.2	3.6 33	6.4
(5710+x)	890.3	1.3 12	7.0
(5863+x)	737.12	<13	6.0
(6251+x)	348.78	22 18	5.9
(6600+x)	0.0	65 32	5.5

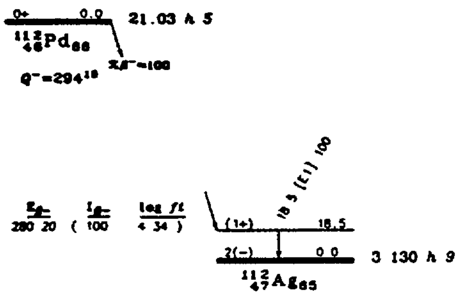
^{112}Rh β^- Decay (6.8 s)

Eβ⁻	E(level)	Iβ⁻	Log ft
(3844+y)	2755.7	62.5 6	4.780 14
(4596+y)	2004.0	0.8 3	7.01 17
(4840+y)	1759.7	2.4 7	6 63 13
(4884+y)	1716.3	4.0 5	6.43 6
(5049+y)	1551.3	3.7 8	6.53 10
(5177+y)	1423.4	5.3 8	6.42 7
(5237+y)	1363.2	5.2 8	6.45 7
(5503+y)	1096.8	8 5	6.4 3
(5717+y)	883.5	8 3	6 43 17

^{112}Pd Adopted γ radiations

Eγ	E(level)
212.9 3	1096.76
348.70 21	348.79
359.7 3	1096.76
386.2	1126.3
388.20 21	737.11
400.4 3	2755.7
479.7 3	1363.2
485.7 3	1369.0
534.6 3	883.55
541.6 3	890.4
560.5 3	2755.7
626.1 3	1363.2
640.8 3	2004.0
663.1 3	1759 7
667.9 3	1551 3
686.2 3	1423.4
737.20 21	737.11
748.1 3	1096.76
777.5 3	1126.3
791 6 3	1140.4
979.2 3	1716.3
996.2 3	2755 7
1014.2 4	1363.2
1074.7 3	1423 4
1098.6 3	2195.3
1125.3	1126.3
1204 5 3	2755.7
1311.9 3	2195.3
1386 9 3	2755.7
1471.1 3	2355.0
1658.5 3	2755.7

$^{112}_{47}Ag_{65}$



$^{112}_{48}Cd_{64}$

Cross Reference (XREF) Flags

A ^{112}Ag β^- Decay	F ^{111}Cd(d,p)	K ^{112}Cd(p,p')
B ^{112}In ε Decay	G ^{111}Cd(d,pγ)	L ^{111}Cd(α,α')
C ^{110}Pd(^{3}He,n)	H ^{112}Cd(γ,γ')	M Coulomb Excitation
D ^{110}Pd(α,2nγ)	I ^{112}Cd(e,e')	N ^{114}Cd(t,p)
E ^{110}Cd(t,p)	J ^{112}Cd(n,n'γ)	O ^{112}Cd(d,d')

E(level)	Jπ	XREF	$T_{1/2}$
0.0	0+	ABCDEFGHIJKLMNO	stable
617.57 9	2+	AB DEFGHIJKLMNO	6.51 ps 6
1224.06 13	0+	ABC EFGH JK MNO	4.2 ps 11
1312.32 10	2+	AB DE GH JKLMNO	2.0 ps 3
1415.38 15	4+	AB DE JKLM O	0.90 ps 8
1433.16 15	0+	A EFGH JK	1.9 ns 1
1468.73 10	2+	AB DEF H JKLMNO	2.7 ps 5
1870.94 13	0+	AB DEF H JK	
2005.18 12	3−	A DEF H JKLM O	
2064.22 18	2+,3	A D J	
2081	4+	D F H K O	
2121.6 4	1+,2+,3+	B EF H J	
2156.23 16	2+	AB EF H J	
2167	(6+)	D	
2231.09 15	(2+)	AB EF H JK	
2301.1 4	0+	B EF H J	
2335 20		K	
2372.7 3	5−	DEF JK	
2416.02 14	(1−,2+)	A JKL O	
2418 1	3−	K	
2424 8		F	
2457 4	4+	E K	
2506.61 13	(1)+	A EF H J O	
2571	(6)	D	
2572 2	(1,2)	DEF K	
2584 4	1−	K	
2607		D	
2637 8	1+,2+,3+	F	
2640	0+	C	
2644 3	3−	K	
2657		F	
2668.96 17	(2−,3,4+)	A E J	
2674.02 23	1+,2+,3+	A EF J	
2718 4	(0+)	E	
2723.65 15	(1,2)+	A EF H JK	
2765.5 5	1+,2+,3+	A EF JK O	
2794	(7)	D	
2819		D L	
2829.38 14	1,2	A F J O	
2832 3	0+	EF H L O	
2833		D	
2850 3	(2+)	H K	
2866.75 17	3−	A E K	
2875		F	
2880	(8+)	D	
2901		F O	
2936 8	1+,2+,3+	F	
2936	(6,7)	D	
2962.0 7	(2)+	A F	
2962 4	3−	K	
2970	2+	K	
2974 4	4+	E	
2988 8		F	
3067.8 9		A EF K	
3108 4	2+	EF H	
3130.94 20	(2+)	A E	
3169.2 3	(1,2)	A	
3175		D	
3176 3	3−	DE K	
3184 8	1+,2+,3+	F	
3193		H	
3214		D	
3242 4		EF H	
3303.3 5		A EF H	
3320	(9−)	D	
3326 2	3−	K	
3335 4	4+	EF	
3344 1	3−	K	
3370.4 4		A E	
3393.1 12		A E	
3415 4	4+	E K	
3573	(8,9)	D	
3683	(9,10)	D	
3686 20		K	
3920	0+	C	

^{112}Ag β^- Decay (3.13 h)

Eβ^-	E(level)	Iβ^-	Log ft
(570 30)	3393.1	0.0043 13	8.96 16
(590 30)	3370.4	0 94 13	6.67 10
(660 30)	3303.3	0.27 4	7 38 10
(790 30)	3169.3	0 191 27	7 82 9
(830 30)	3131.02	0.27 4	7 74 9
(890 30)	3068.0	0.030 9	8.81 14
(1000 30)	2962 0	0 026 6	9.05 11
(1090 30)	2866.82	0.46 6	7 95 7
(1130 30)	2829 32	0.85 12	7 74 8
(1190 30)	2765.7	0.098 14	8 77 8
(1240 30)	2723.69	2 7 4	7 39 8
(1290 30)	2674.10	0.58 8	8 12 7
(1290 30)	2668.97	0.62 8	8.10 7
(1450 30)	2506.65	1.51 19	7 91 7
(1540 30)	2416.10	1.47 19	8 02 7
(1730 30)	2231.18	3.1 5	7.89 8
(1800 30)	2156.42	0.63 8	8 66 7
(1900 30)	2064.2	0 072 18	9.69 12
(1950 30)	2005.24	5.7 9	7 84 8
(2090 30)	1871.00	4.3 5	9 18¹ᵘ 7
(2490 30)	1468.79	1.32 22	8 91 8
(2530 30)	1433 19	0 157 27	11.11¹ᵘ 8
(2540 30)	1415.55	0.27 6	10 89¹ᵘ 10
(2650 30)	1312 41	1 91 23	8 86 6
(2740 30)	1224.22	2 8 5	10.06¹ᵘ 9
(3340 30)	617 57	20 5 24	8.25 6
3940 40	0 0	54 5	9 76¹ᵘ 5

^{112}Cd Adopted γ radiations

E(level)	Eγ	Mult.	I(γ+ce)
617.57	617.27 *19*	[E2]	
1224.06	606.49 *12*	[E2]	
	1223.9	E0	0.12 *2*
1312.32	694.66 *14*	E2+M1	
	1312.29 *15*	[E2]	
1415.38	797.80 *14*	[E2]	
1433.18	121.00 *20*	E2	
	208.9	E0	4.4 *6*
	815.77 *17*	E2	
	1432.8	E0	1.4 *5*
1468.73	244.80 *21*		
	851.10 *13*	M1+E2	
	1468.81 *16*		
1870.94	402.00 *29*		
	558.52 *21*		
	1253.43 *12*	(E2)	
2005.18	536.4 *3*		
	692.70 *20*		
	1387.67 *17*	[E1+M2]	
2064.22	649.5 *6*		
	751.80 *17*	D+Q	
	1446.6 *6*	D+Q	
2081	666		
2121.6	1504.0 *3*		
2156.23	688.9 *4*		
	842.8 *15*		
	1538.48 *15*		
	2156.0 *5*		
2167	752	Q	
2231.09	226.0 *3*		
	762.3 *3*		
	918.7 *3*		
	1007.0 *3*		
	1613.54 *18*	D(+Q)	
2301.1	1683.5 *3*		
2372.7	957.30 *20*		
2416.02	410.70 *20*		
	947.3 *3*		
	983.8 *3*		
	1103.35 *25*		
	1798.3 *3*		
2506.61	1037.9 *3*		
	1194.1 *5*		
	1282.9 *5*		
	1888.76 *19*		
	2506.80 *19*		
2571	197	(Q)	
	1156	(Q)	
2572	702		
2607	440		
2668.96	663.5 *3*		
	1356.70 *20*		
	2051.5 *3*		
2674.02	2056.42 *21*		
2723.65	718.40 *20*		
	1411.8 *8*		
	1498.0 *10*		
	2106.16 *19*	D+Q	
	2723.6 *3*		
2765.5	2147.9 *5*		
2794	420	(Q)	
	627		
2818	444		
2829.38	2211.60 *20*		
	2829.37 *19*		
2832	2215 *3*		
2833	769		
2850	850 *2*		

E(level)	Eγ	Mult.
2850	1538 *2*	
	2851 *3*	
2866.75	450.9 *3*	
	802.3 *4*	
	861.60 *20*	
	1397.4 *6*	
	1451.4 *3*	
2880	713	Q
2936	562	
	769	
2962.0	957.1 *10*	
	2961.7 *10*	
3067.8	1652.4 *8*	
3130.94	714.8 *3*	
	1125.90 *20*	
	1714.7 *6*	
3169.2	1944.7 *4*	
	2551.9 *3*	
3175	604	
3176	604	
3214	607	
3303.3	629 2 *4*	
	2686.0 *10*	
3320	440	
	526	(Q)
3370.4	2752.8 *3*	
3393.1	3393.0 *12*	
3573	779	
3683	803	
3989	814	
7632	4323 *6*	
	4385 *6*	D+(Q)
	4439 *6*	(D+Q)
	4522 *6*	D(+Q)
	4782 *3*	D+Q
	4800 *3*	E1+(M2)
	4909 *2*	
	5126 *2*	
	5337 *4*	
	5403 *2*	
	5477 *2*	
	5512 *2*	
	5551 *4*	
	5763 *2*	[E1+(M2)]
	6164 *2*	[E1+(M2)]
	6203 *3*	[E1+(M2)]
	6409 *2*	[E1+(M2)]
	7015 *2*	[E1+M2]
	7632 *1*	E1

^{112}In ε Decay (14.9 min)

Eε	E(level)	Iβ⁺	Iε	Log *ft*
(288 *5*)	2300.6		0 025 *1*	5 781 *25*
(434 *5*)	2155.3		0.018 *8*	6.30 *20*
(465 *5*)	2124 4		0.065 *4*	5.82 *3*
(719 *5*)	1870.21		0.32 *2*	5.51 *3*
(1121 *5*)	1468 04		0 33 *3*	5.90 *4*
(1277 *5*)	1312.1		0.023 *12*	7 17 *23*
(1365 *5*)	1223.52		1 64	5.376 *9*
(1972 *5*)	617 11	0.554 *12*	4 02 *5*	5 309 *7*
2580 *20*	0 0	20.6 *13*	28.4 *18*	4 70 *3*

$^{112}_{49}In_{63}$

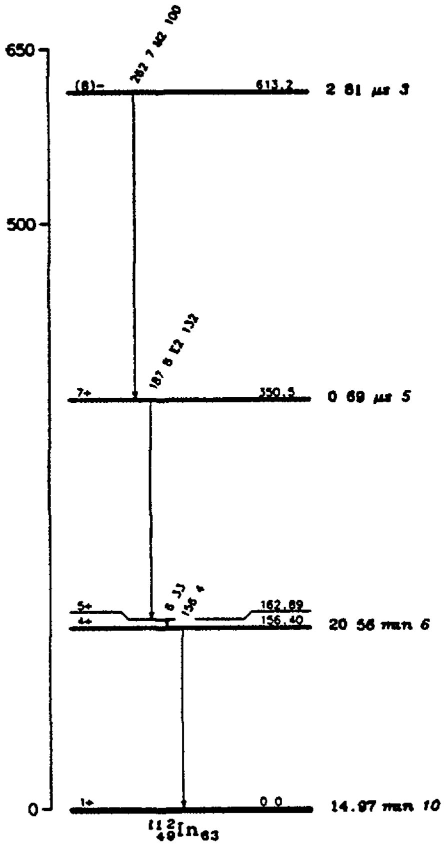
Cross Reference (XREF) Flags

A ^{109}Ag(α,nγ)
B ^{112}In IT Decay (20.5 min)
C ^{112}In IT Decay (2.81 μs)
D ^{110}Pd(^{6}Li,4nγ)
E ^{110}Pd(α,npγ)
F ^{110}Cd(α,d)
G ^{111}Cd(^{3}He,d)
H ^{112}Cd(p,nγ)
I ^{112}Cd(d,nγ)
J ^{113}In(p,d)
K ^{113}In(d,t)

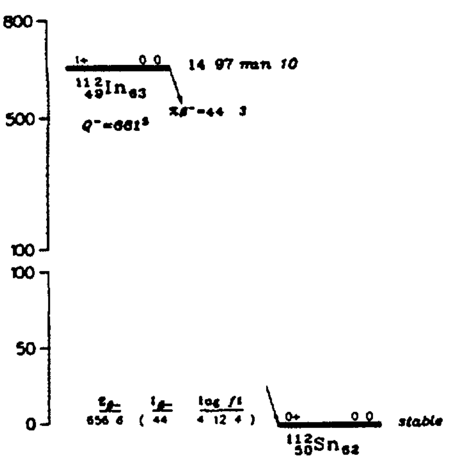
E(level)	Jπ	XREF	$T_{1/2}$
0.0	1+	ABCDEFGHIJK	14.97 min 10
156.58 5	4+	ABCDEFGHIJK	20.56 min 6
162.91 10	5+	A CDE GHIJK	
206.695 24	2+	A E HIJ	
350.82 14	7+	A CD F HIJK	0.69 μs 5
420		F	
456.44 3	3+	A F HIJK	
562.78 10	(3,4,5,6)+	A F J	
592.11 5	4+	A HIJK	
594.914 25	2+	A H JK	
613.73 17	8−	A CDEF HI	2.81 μs 3
622 4	+	J	
624.42 17	(7−)	A EF I	
648		K	
670.15 17		A F J	
676.32 20	(6−)	A F I	
728.95 3	(1,2)+	A FGH K	
729.85 4	3+	A FGH K	
790.20 17		A F	
795.27 7	(5)+	F H J	
800.63 20	(9−)	A D F	
822.32 23	(5−)	A IJ	
833.01 17	(6,8)+	A J	
866		K	
883.70 4	3+	A H	
886	+	J	
918.83 3	1−	A FGH	
924.66 4	(2,3,4)+	A F H J	
928.64 4	(≤3)+	F H	
955	(1,2,3)+	G K	
1007.42 25	+	A F IJK	
1037.66 5	≤3	H K	
1056	3+,4+,5+	G	
1062.92 3	1−,2+	F H	
1117		K	
1150.06 6	(4,5)+	H J	
1212.33 4	(1,2)−	GH JK	
1213 6	+	JK	
1250.87 5	+	H J	
1260.51 4	(≤3)+	F H	
1261.35 5	+	F H	
1279.67 4	≤3	F H	
1286.33 5		F H	
1286.8 3		A F HI	
1338	(0,1)+	FG K	
1388 9 11	(10−)	D	
1398	(1,2,3)+	FG	
1435	(1,2,3)+	G	
1473	(1,2,3)+	G	
1488		G	
1529	(1,2,3)+	G	
1608	(0,1)+	G	
1631		G	
1678	(1,2,3)+	G	
1708	(1,2,3)+	G	
1741	(1,2,3)+	G	
1777	(1,2,3)+	G	
1872	(1,2,3)+	G	
1955	(1,2,3)+	G	
2067	(1,2,3)+	G	
2172	(1,2,3)+	G	
2234		G	

^{112}In Adopted γ radiations

Eγ	E(level)	Iγ	Mult.
(6.33 10)	162.91	100	
51.90 10	676.32	100	D
135.67 4	592.11	100	D(+Q)
138.38 5	594.914	1.2 12	
146.00 10	822.32	100	
149.43 5	1212.33	16 5	
156.56 10	156.58	100	M3
185.10 10	1007.42	100	
186.90 10	800.63	100	
187.92 10	350.82	100	E2
189.89 5	918.83	21.3 21	
195.72 4	924.66	48 4	
199.61 5	928.64	4.2 21	
203.16 4	795.27	100	(D+Q)
206.72 4	206.695	100	(M1)
223.50 5	1286.33	89 9	
249.72 4	456.44	100	(M1)
262.93 10	613.73	100	E1+M2
273.44 5	729 85	11.2 19	
273.60 10	624.42	100	D(+Q)
279.40 10	1286.8	100	
283 62 5	1212.33	26 5	
287.69 5	1212.33	91 19	
288.78 4	883 70	100.0 21	D+Q
319.33 10	670.15	100	
323.89 4	918.83	100.0 10	
326 19 5	1250.87	100 8	
333.11 5	1062.92	6.1 12	
367.40 5	1286.33	100 9	
388.19 4	594.914	28 4	M1(+E2)
399.87 10	562.78		
406.20 10	562.78		
421.11 5	1150.06	100	
427.27 5	883.70	13.6 23	
439.38 10	790.20	100	
468.23 5	924 66	1.5 15	
482 19 10	833 01	100	
483.43 5	1212.33	100 16	
521.94 5	1250.87	96 8	
522.10 10	728.95	9.5 10	
523.16 7	729.85	83 8	
531.53 5	1260.51	49 7	
573.26 4	729 85	100 6	D+Q
588.3	1388 9		
594 87 4	594 914	100 4	M1+E2
666.28 5	1261.35	15 8	
717.92 6	924.66	100 4	
728.97 6	728 95	100.0 9	D+Q
823.23 5	1279 67	100 16	
856.24 5	1062 92	15 9 12	
918.77 5	918.83	91 4	
928.63 5	928 64	100.0 21	
1037.65 5	1037 66	100	
1054.80 5	1261 35	100 8	
1062.98 5	1062 92	100.0 24	
1072.99 5	1279 67	74 11	
1260.53 5	1260.51	100 7	
1279 65 5	1279 67	89 13	



$^{112}_{50}Sn_{62}$



^{112}Sn Adopted Levels

Cross Reference (XREF) Flags

A ^{112}In β^- Decay
B ^{112}Sb ϵ Decay
C ^{100}Mo(^{16}O,4nγ)
D ^{110}Cd(^{3}He,n)
E ^{110}Cd(α,2nγ)
F Coulomb Excitation
G ^{112}Cd(^{3}He,3nγ)
H ^{112}Sn(p,p'),(p,p'γ)
I ^{112}Sn(α,α')
J ^{112}Sn(d,d')
K ^{113}In(p,2nγ)
L ^{114}Sn(p,t)

E(level)	Jπ	XREF	$T_{1/2}$
0.0	0+	ABCDEFGHIJKL	stable
1256.85 7	2+	C EF HIJKL	0.37 ps 2
2151.09 11	2+	B D F H	1.4 ps 5
2190.9 5	0+	D F H L	
2247.62 12	4+	BC EF H JKL	3.3 ps 6
2354.53 14	3-	B EF HIJ L	
2476.20 12	(2+)	B F H	
2521.05 10	4+	B EF H J L	
2549.30 14	6+	C E H KL	13.7 ns 1
2558.8 3	≤2	B	
2618 2	0+	H L	
2721.56 12	2+	B H L	
2756.19 11	2+,3,4+	B H	
2783.92 15	4+	B E H J L	
2860 5		H	
2913.4 3	4+	B H	
2917.71 19		B	
2926.78 16	6+	C E H L	
2945.96 12	4+	B E H	
2967.00 15	2+	B H J L	
2989 5	0+	H L	
3078.87 16	2+,3,4+	B	
3093.07 17	2+	B H	
3116 7		H	
3137 5	5-	H L	
3149.41 20	4+	B H J	
3248.81 19	2+	B H L	
3278 5	4+	H L	
3286.39 19	2+	B H	
3354.43 16	7-	C E H KL	
3384.54 19		B H	
3402 5		H	
3414.19 13	6+	E	
3417.77 22	4+	B H L	
3430.70 17	8-	C E J	0.62 ns 4
3440 7		H	
3456.48 21		B	
3477 5		H L	
3502 7		H	
3524.79 19	2+,3,4+	B H L	
3530.44 16	2+,3,4+	B H	
3553.98 22	2+,3+,4+	B H	
3570	0+	D	
3580 5	4+	H	
3611 7		H	
3624 7	(2+)	H L	
3654 7	2+	H L	
3693.73 19	9-	C E H	47 ps 6
3715		L	
3737 7		H	
3756 7		H	
3773 7		H L	
3814.08 14	2+,3+,4+	B H L	
3832 7		H	
3857 7		H	
3877 7		H L	
3914 7		H	
3930		L	
3988 7		H	
4031 7		H	
4048		L	
4077.85 15	8+	E H	
4105 7		H L	
4138 7		H	

Continued on next page

^{112}Sn Adopted Levels (continued)

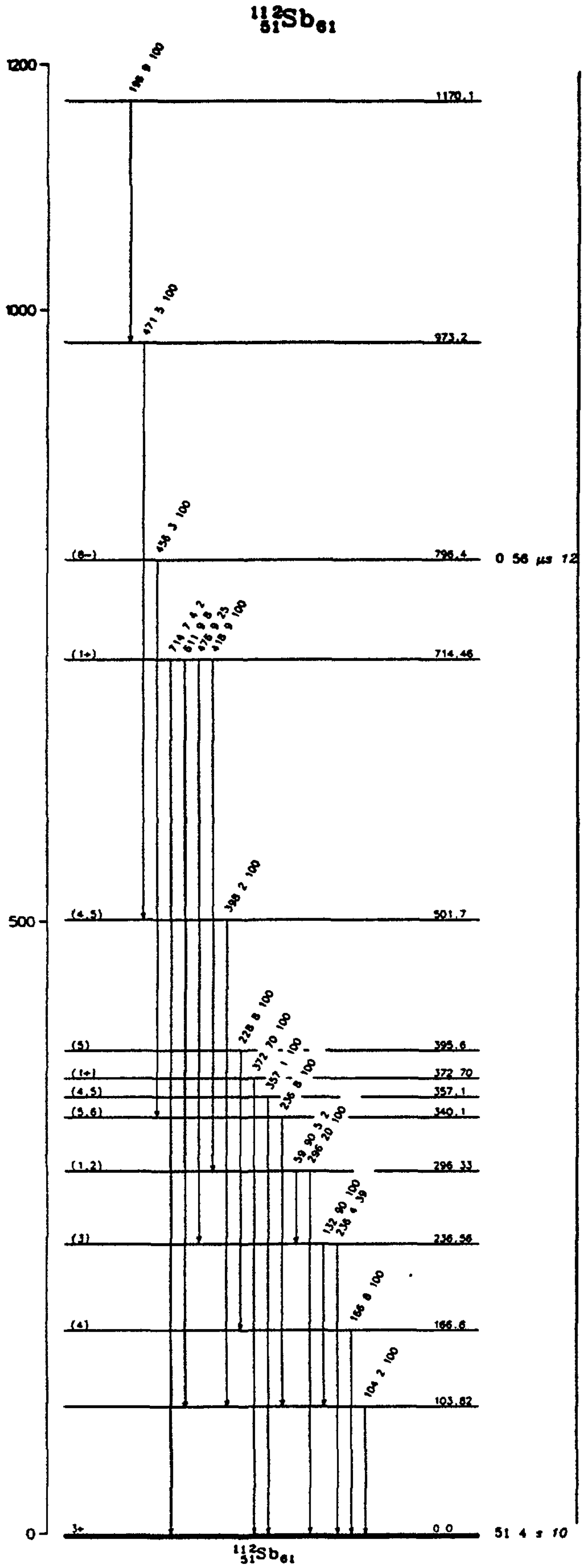
E(level)	Jπ	XREF	$T_{1/2}$
4151 7		H	
4171 7		H L	
4193 7		H	
4222 7		H	
4239 7		H L	
4279 7		H L	
4325 7		H L	
4364 7		H L	
4402 7		H	
4437 7		H	
4461 7		H L	
4502 7		H L	
4544 7		H	
4571 7		H	
4582.64 20	10−	E	<21 ps
4610 7		H L	
4629		L	
4685 7		H	
4738 7		H L	
4757 7		H L	
4794 7		H	
4819.7 3	10+	E H	
4825 7		H	
4850 7		H	
4887 7		H	
4928 7		H	
4929.0 4	11−	C E H	<21 ps
5059 7		H	
5089 7		H	
5116 7		H	
5144 7		H	
5181 7		H	
5270 7		H	
5355 7		H	
5564.7 4	(12+)	E	
5684.9 3	12+	E	

β^+,ε Data from ^{112}Sb ε Decay

Eε	E(level)	$I\beta^+$	Iε	Log ft
(3250 30)	3814.4	1.96	1.14	5.12
(3510 30)	3554.2	0.79	0 32	5.73
(3530 30)	3530.6	0 236	0.094	6.27
(3540 30)	3524.9	0.33	0.131	6.13
(3610 30)	3456.7	0.26	0.096	6.28
(3650 30)	3417.9	0.76	0.26	5.85
(3680 30)	3384.6	0.67	0.223	5.93
(3780 30)	3286.5	1.00	0.30	5.83
(3820 30)	3248.5	1.20	0.34	5.78
(3920 30)	3149.7	0 72	0.187	6.07
(3970 30)	3093.3	0.96	0.24	5 98
(3990 30)	3079.2	1 19	0.29	5.90
(4100 30)	2967 1	2.00	0.43	5.75
(4120 30)	2946.0	0.215	0.045	6.73
(4150 30)	2918.0	3 4	0.69	5.55
(4150 30)	2913.6	0.37	0.076	6.51
(4280 30)	2784.6	0.051	0.0092	7.46
(4310 30)	2756.5	1.50	0.26	6.00
(4340 30)	2721.7	0.44	0.074	6.56
(4510 30)	2556.6	0.192	0.028	7.01
(4540 30)	2521.4	0.67	0.096	6.49
(4590 30)	2476.2	0.55	0.075	6.60
(4710 30)	2355.0	0.76	0.094	6 53
(4820 30)	2247 9	7.5	0.85	5.59
(4910 30)	2151.3	1.29	0.137	6.40
5770 50	1257.05	61	3.5	5.14

^{112}Sn Adopted γ radiations

Eγ	E(level)	Iγ	Mult.
78.3 2	3430.70	100	M1(+E2)
234.8 3	2756.19	5.9 6	
263.03 7	3693.73	100	M1
279.50 20	2756.19	4.0 3	
283.80 20	3814.08	2.59 24	
301.68 7	2549.30	100	E2
377.50 8	2926.78	100	M1
392.3 4	2913.4	12.3 14	
401.3 5	2756.19	2.6 6	
427.67 10	3354.43	5.83 28	E1
431.9 6	3524.79	9.2 14	
467.2 3	3384.54	16.1 15	
468.03 13	3414.19	32.0 20	E2
605.10 20	2756.19	21.2 13	
612.70 20	2967.00	28.4 21	
630.36 12	3414.19	56.0 20	E2
663.66 8	4077.85	100	E2
670.0 4	2917 71	100 15	
700.3 6	3456.48	22 5	
741.80 20	4819.7	100	E2
745.00 20	5564.7	100	(E2)
766.80 20	2917.71	11.8 8	
772.80 20	3248.81	25.9 19	
805.11 7	3354.43	100 6	E1
831.1 4	3078.87	8.8 19	
865.21 9	5684.9	100	E2
893.20 20	3414.19	38 12	E2
894.1 5	3248.81	27 19	
894.60 20	2151.09	100 8	
900.8 5	3149.41	24 7	
	3814 08	17 3	
927.60 20	3078.87	97.3 27	
934.3 5	2190.9		
990.70 14	2247.62	100	E2
1009.4 4	3530.44	84 19	
1029.6 7	3814.08	43 3	
1097.7 3	2354.53	100	E1
1151.94 11	4582.64	100	E2
1166.9 3	3414.19	100 10	E2
1219.30 20	2476.20	27.6 26	
1235.3 3	4929.0	100	E2
1257.05 8	1256 85	100	E2
1264.18 8	2521.05	100	E2
1277.7 5	3524.79	22 8	
1282.4 4	3530.44	65 13	
1293.6 7	3814.08	6 3	
1379.60 20	3530.44	100 5	
1459.50 10	3914.08	27 1 12	
1464.70 10	2721.56	100 4	
1499.50 10	2756.19	100.0 28	
1527.30 21	2783.92	100	E2
1566.40 20	3814.08	100.0 24	
1656 7 6	2913.4	100 5	
1688.95 11	2945.96	100	
1710.20 20	2967 00	100 4	
1822.20 20	3078.87	100 4	
1836.50 20	3093.07	100.0 29	
1892.70 20	3149.41	100.0 30	
2029.70 20	3286.39	84 5	
2127.50 20	3384.54	100 6	
2151.00 20	2151.09	16.7 11	E2
2160.90 20	3417.77	100	
2190.9 5	2190.9		E0
2199.60 20	3456.48	100 6	
2267.80 20	3524.79	100 8	
2297.10 20	3553.98	100	
2475.90 20	2476.20	100 7	
2556.6 3	2556.6	100	
2721.3 7	2721 56	15.9 13	
2966.3 3	2967 00	53 4	
3092.4 3	3093 07	26 2 19	
3248.1 4	3248 81	100 6	
3285.6 4	3286.39	100 7	[E2]



^{112}Sb Adopted γ radiations

Eγ	E(level)
59.90 *20*	296.33
104.2 *3*	103.82
132.90 *20*	236.56
166.8 *2*	166.8
196.9 *3*	1170.1
228.8 *2*	395.6
236.4 *4*	236.56
236.6 *2*	340.1
296.20 *20*	296.33
357.1 *2*	357.1
372.70 *20*	372.70
398.2 *2*	501.7
418.9 *2*	714.46
456.3 *2*	796.4
471.5 *3*	973.2
476.9 *2*	714.46
611.9 *5*	714.46
714.7 *5*	714.46

PROPOSAL FOR AN 8th EDITION OF THE *TABLE OF ISOTOPES*

R.B. Firestone, E. Browne, and the Isotopes Project Staff
Lawrence Berkeley Laboratory, Berkeley, CA 94720
February 28, 1990

1. BACKGROUND

One of the first compilations of radioactivity data, *A Table of Induced Radioactivities*[1] by J.J. Livingood and G.T. Seaborg, was published in Reviews of Modern Physics, in 1940. Four subsequent editions[2-5] of the *Table of Isotopes* appeared at 4-5 year intervals. By 1958 it became evident that the next edition would be too large for journal publication. The 6th Edition of the *Table of Isotopes*[6] was produced in book form by C.M. Lederer, J.M. Hollander, and I. Perlman and published by John Wiley & Sons, New York, in 1967. The 7th Edition of the *Table of Isotopes*[7] (1978) was edited by C.M. Lederer and V.S. Shirley, and for the first time it also included extensive data on nuclear reactions. Sales of this book through August 31, 1989 were 10190 volumes. A second printing was made in 1986, and in the past year (11 years after publication) 272 volumes were sold.

After publication of the 7th Edition, the Isotopes Project became a member of the U.S. Nuclear Data Network (USNDN) with principal responsibility for evaluating the mass region $167 \leq A \leq 194$. Work on a new book, the *Table of Radioactive Isotopes*[8], started in 1982. This book, published by John Wiley & Sons in 1986, is based on the Evaluated Nuclear Structure Data File (ENSDF)[9] and contains data primarily for applied research. Sales of this book through August 31, 1989 were 2104 volumes including 235 volumes during the previous year.

The IAEA International Network of Nuclear Structure and Decay Data (NSDD) expressed interest in a new book on nuclear structure and requested a feasibility and cost benefit study at the Ghent Meeting in 1988[10]. Subsequently, the National Academy of Sciences Panel on Basic Nuclear Data Compilations requested proposals for a new version of the *Table of Isotopes* at the Brookhaven Meeting in 1988. Members of the Isotopes Project group have discussed with others in the nuclear physics community the possibility of producing a new version of the *Table of Isotopes*. Strong encouragement for this project also was voiced at the Low-Energy Nuclear Physics Town Meeting at Argonne in April, 1989. An initial proposal emphasizing an electronic version of the *Table of Isotopes* was presented by the Isotopes Project to the NAS Panel at its Berkeley Meeting in 1989[11]. Subsequent discussions indicated that funding would not be available for the electronic version and development should therefore be limited to publication of the new book version.

After the Berkeley Meeting, Dr. Craig Stone of the National Institute of Standards and Technology (NIST) discussed with Isotopes Project members the feasibility of an electronic *Table of*

Isotopes on a Macintosh II computer using data from the *Table of Radioactive Isotopes.* Dr. Stone had developed a spreadsheet based on the BNL Wallet Cards[12] several years ago. He supports many of the ideas that are in our 1989 proposal. A formal collaboration has been formed with Dr. Stone to begin development of a personal computer nuclear data system using initially data from the *Table of Radioactive Isotopes.* The Office of Standard Reference Data at NIST distributes electronic databases and has shown interest in both distributing and updating the electronic *Table of Isotopes.* Substantial progress has already been made on the electronic version, and a preliminary sample can be provided upon request. This proposal describes the design and development of a book version for the next edition of the *Table of Isotopes.*

2. PROJECT CONSIDERATIONS

2.1. RESOURCES

In the current funding environment it is not realistic to expect additional funds to become available for this project. A publication advance, which could be sought from the publisher, might defray a small portion of the costs, but would have a minor impact on the project. Also, with reductions in the worldwide evaluation effort, it is even more important for the Isotopes Project to maintain its high evaluation rate. Despite these restrictions, there are several reasons to believe that the 8th Edition of the *Table of Isotopes* can be completed by 1992 with the present group strength. Development of the graphics and table generation programs can proceed as part of our continuing research effort and should have no adverse impact on the evaluation schedule. We have already achieved substantial progress producing level and mass-chain summary schemes. Increased efficiency in mass-chain evaluation has been attained as the Isotopes Project started its second round of evaluations. This efficiency will provide additional time for the new project. Also, our recent experience producing large books, like the *Table of Radioactive Isotopes,* will be invaluable in managing the production of the next *Table of Isotopes.*

2.2 PROJECT DESIGN

The *Table of Isotopes* has established a tradition of scientific quality and unsurpassed presentation style, both of which should endure with the next edition. Also, it is desirable that the book remain a single volume for maximum portability and ease of use. The 7th Edition of the *Table of Isotopes* was 1523 pages, exclusive of appendices. This represents an average of less than 6 pages for each mass chain including no more than one page for the summary scheme. With the increase of data during the past twelve years it would be impossible to use the previous data presentation format. Thus some compromises will be necessary. Emphasis will be placed on nuclear structure information, and decay schemes will be limited to one page. This would complement the recent *Table of Radioactive Isotopes* (1986) where data from radioactive decay were given in greater detail. We anticipate not more than one page for decay-scheme and rotational-band drawings. Data not shown on the drawings would be presented in tables. The actual design of the new book is still evolving and some of these considerations are discussed below.

2.3 PRODUCTION SCHEDULE

The production schedule for an 8th edition of the *Table of Isotopes* is shown in Table 1. This schedule is designed to complete the book in 1992. By that time many mass-chain evaluations in ENSDF, which are currently out-of-date, will have been be updated. The Isotopes Project mass-chain evaluation schedule has been integrated into the production schedule. Refinement of the tabular and graphical presentation for the book will continue through the end of 1991 while normal mass-chain evaluation efforts continue. It is expected that through the evaluation efficiency gains, outlined below, the group will move substantially ahead of a five-year cycle allowing an intense production effort in 1992. This schedule is predicated on the assumption that the current manpower in the group can be maintained. Details of the production process are described below.

3. PRODUCTION PROCESS

3.1. SOURCES OF NUCLEAR DATA

The ENSDF file would be the primary source of information for the next edition of the *Table of Isotopes*. We will use data for $A \leq 44$ from evaluations published in Nuclear Physics A[13,14]. We would also like to take responsibility for entering this information into ENSDF as part of our regular mass-chain assignment. This would include adding decay data sets that are not normally complete in those evaluations. We updated most of the decay data in that region for the *Table of Radioactive Isotopes*. Of the remaining 222 mass chains, Mulki Bhat has estimated[15] that only 84 mass chains do not conform to current standards. That is the approximate number of mass-chain evaluations that are expected to be completed by 1992. Assuming the US data centers update all remaining nonstandard mass chains (45) and the foreign centers continue to evaluate at a normal rate, we expect that only the 7 mass chains assigned to Germany will be out-of-date at that time. Minimal editing of mass-chain evaluations, to insure both uniformity and the inclusion of all known isotopes, will be done. All sources of non-ENSDF data would be clearly indicated in the book. Additional references will include Wapstra *et al.*'s mass evaluation[16] and Raghavan's nuclear moment evaluation[17].

3.2 DATA MANAGEMENT

The computer codes for the production of the *Table of Isotopes* will be designed to work directly from the ENSDF file with additional control parameters added to the file. Thus, these programs also could be used by evaluators for photoready production in the future.

3.3 TABULAR DATA PRESENTATION

In order to maximize the efficient utilization of page space, tabular data will be presented in the paragraph style of the 7th edition of the *Table of Isotopes*. Although this presentation is not preferable to that with standard, linear tables, it is a necessary choice for producing a compact book. Unlike the 7th edition, this edition will present data from radioactive decay only from ENSDF. Level data, not presented in the figures due to space considerations, will be tabulated. A sample table generated from ENSDF with the computer code TOITABLE is shown in figure 1. The reference boxes from the *Table of Isotopes* will be updated from ENSDF and included with the level schemes as shown in figure 2. These references, which are inserted in available white space on the drawings, add negligible size to the book. Note that the conventional references, not cryptic keywords, will be used for ease in reading, and also to avoid a lengthy reference list. Tables will be generated with UNIX TROFF[18] which was used for the production of the *Table of Radioactive Isotopes*.

3.4 GRAPHICAL DATA PRESENTATION

A trademark of the Isotopes Project publications has been high-quality graphical presentation. POSTSCRIPT[19], a device independent page description language, offers high-quality integrated text and graphics and has been chosen to prepare the decay scheme figures. The computer code ACHILLES is being developed to generate mass chain summary decay schemes. An example, in the style of the 7th edition of the *Table of Isotopes*, is shown in figure 3. The next *Table of Isotopes* will be more nuclear structure oriented. Therefore design of the summary scheme has been modified. Neutron and proton separation energies have been added in this example.

A versatile level scheme drawing program, LS, is also being developed. This program can draw conventional decay schemes and 'stackplot' schemes similar to those in the 7th edition of the *Table of Isotopes*. Rotational band drawings have been added. Adopted level and γ-ray data will be shown for all nuclei allowing no more than 1-2 pages for each isotope. Excess information will be given with the tabular data. Rotational bands will be shown on the scheme as will be all low-lying or yrast levels. Decay and reaction feedings also will be indicated on the level scheme. Considerable effort is necessary to optimize compact decay scheme presentation. A preliminary example of a drawing showing rotational bands is given in figure 4 and a compact decay-scheme drawing in figure 5.

3.5 APPENDICES

The appendices of the previous editions of the *Table of Isotopes* are still widely used. Some appendices such as the "Interaction of Radiation with Matter" and "Standard Radioactive Sources" can be taken (with minor changes) from previous editions. Since the new addition will emphasize nuclear structure, it would be desirable to have appendices stressing various subjects in nuclear theory such as rotational and shell models. These appendices could be written by experts on these subjects. It is also an important consideration that the appendices be of limited length to keep the book a reasonable size.

4. MASS CHAIN EVALUATION SCHEDULE 1990-1992

The Isotopes Project must evaluate 14 mass chains from now through 1992 to maintain a five year cycle. By then all mass chains with A=167-194 will have been published and/or submitted no earlier than 1988. With the current manpower (~3 FTE), it is reasonable to assume that these mass chains can be completed by 1991. In 1990, a half-time evaluator (Coral Baglins) will be funded to evaluate mass chains under the auspices of the Isotopes Project. Additional mass chains in the Actinide region have been added on a temporary basis (Table 1), and the group is proposing to enter the upcoming Endt and Van der Leun evaluation of A=21-44 into ENSDF format. The evaluation schedule in Table 1 has been adjusted to allow a concentrated group effort in 1992 to produce the *Table of Isotopes*. After completion of this new edition of the *Table of Isotopes*, the Isotopes Project has set a goal of evaluating 3 mass chains per FTE. Recent productivity has neared 2.5 per FTE. This new evaluation rate would permit the group to accept an additional committment for over 20 mass chains in 1993.

With the development of electronic data retrieval, it has become evident that even a 5-year evaluation cycle is too long. A pilot project will begin at LBL to cut the cycle time to less than one year. This would be accomplished by continually updating recently submitted mass chains while evaluating the older ones. If the Isotopes Project can 'catch up' on its committment, there is no inherent reason why that improved situation cannot be maintained. A progress report on this experiment will be presented at the 1990 NAS Panel Meeting.

5. ELECTRONIC VERSION OF THE *TABLE OF ISOTOPES*

The production of an electronic version of the *Table of Isotopes* was proposed to the NAS Panel by the Isotopes Project at the 1989 Berkeley Meeting. This version would be available on personal computers and offer many exciting features which cannot be given in a book. Unfortunately, the additional manpower needed for this development could not be accommodated in current funding scenarios. After the Berkeley Meeting, Dr. Craig Stone of the National Institute for Standards and Technology (NIST) expressed interest in developing the electronic version, and a collaboration was formed between the Isotopes Project and NIST for this purpose. Most of the PC computer development will be done by Dr. Stone, while the Isotopes Project will provide data files and the graphics presentation programs described before. Significant progress has already been achieved, and a preliminary Macintosh version should be available for use in 1991. A pre-release sample version will be made available to the Panel with this proposal.

REFERENCES

1. J.J. Livingood and G.T. Seaborg, *Reviews of Modern Physics* **12**, 30 (1940).

2. G.T. Seaborg, *Reviews of Modern Physics* **16**, 1 (1944).

3. G.T. Seaborg and I. Perlman, *Reviews of Modern Physics* **20**, 585 (1948).

4. J.M. Hollander, I. Perlman, and G.T. Seaborg, *Reviews of Modern Physics* **25**, 469 (1953).

5. D. Strominger, J.M. Hollander, and G.T. Seaborg, *Reviews of Modern Physics* **39**, 585 (1958).

6. C.M. Lederer, J.M. Hollander, and I. Perlman, *Table of Isotopes*, John Wiley and Sons, Inc., New York (1967).

7. *Table of Isotopes, 7th* edition: C.M. Lederer and V.S. Shirley, editors; E. Browne, J.M. Dairiki, and R.E. Doebler, principal authors; A.A. Shihab-Eldin, L.J. Jardine, J.K. Tuli, and A.B. Buryn, authors, John Wiley and Sons, Inc., New York (1978).

8. E. Browne and R.B. Firestone, *Table of Radioactive Isotopes*, edited by V.S. Shirley; John Wiley and Sons, Inc., New York (1986).

9. *Evaluated Nuclear Structure Data File* - a computer file of evaluated experimental nuclear structure data maintained by the National Nuclear Data Center, Brookhaven National Laboratory.

10. *Co-ordination of the International Network of Nuclear Structure and Decay Data Evaluators*, Summary Report of a Consultants' Meeting organized by the International Atomic Energy Agency and held at Ghent, Belgium, 16-20 May 1988.

11. R.B. Firestone, E. Browne, and the Isotopes Project Staff, *Proposal for an 8th edition of the Table of Isotopes*, presented at the Joint Meeting of the U.S. Nuclear Data Network and the National Academy of Sciences Panel on Basic Nuclear Data Compilations, Berkeley, 15-17 October, 1989.

12. J.K. Tuli, *Nuclear Wallet Cards*, National Nuclear Data Center Publication, 1985.

13. F. Ajzenberg-Selove, evaluations of A=5-20, published in *Nuclear Physics* A.

14. P.M. Endt and C. van der Leun, evaluations of A=21-44, published in *Nuclear Physics* A.

15. M.K. Bhat, private communication, 1990.

16. A.H. Wapstra, and G. Audi, *Nuclear Physics* **A432**, 1 (1985).

17. *Table of Nuclear Moments*, P. Raghavan, *Atomic Data and Nuclear Data Tables* **42**, 189 (1989).

18. *TROFF*, a text-formatting program for driving the Graphics Systems phototypesetter on the UNIX (Trademark of Bell Laboratories) operating system.

19. *POSTSCRIPT*, a device independent page description language developed by Adobe Systems Incorporated, Palo Alto, California.

Table 1. ***TABLE OF ISOTOPES*** **PRODUCTION SCHEDULE**

Calendar Year	1990	1991	1992
Graphics and Table Programming	--------------	------------>	
Appendix Generation		--------------	------------>
Production			------------>
Mass Chain Evaluations	169,171,175, 192,215[a],219[a], 223[a],227[a]	21-44[b],170, 172,173,178, 179,180,183	168,182,186
TOI Effort (FTE)	0.5	0.5	2.0
Mass Chain Effort (FTE)	3.0	3.0	1.5
Additional Effort[c] (FTE)	0.0	0.0	0.0

[a]On temporary assignment from ORNL

[b]Publication expected in 1990; one-time entry into ENSDF format.

[c]No additional personnel will be required for this proposal.

FIGURE CAPTIONS

1. A sample table in the paragraph style of the *Table of Isotopes* generated with the computer code TOITABLE. Level and transition properties that are not shown on the level drawings will be presented in these tables.

2. A Sample reference box containing the most significant references associated with the various reactions and decays populating ^{182}Re.

3. A Sample summary mass chain decay scheme in the style of the *Table of Isotopes* generated with the computer code ACHILLES. Here, neutron and proton separation energies, and the stable isotope mass excess have been added. This figure is plotted on an $E^{1/2}$ scale which linearizes the mass parabola. The level and separation energies are shown to scale except where additional room for labels is needed.

4. Rotational band drawing generated from the ENSDF "Adopted Levels, Gammas" with the computer code LS. Transition energies and adopted branching intensities (when not obviously 100%) are shown in a modified 'stackplot'. Multipolarity information is tabulated separately. Note that the equivalent information in the *Nuclear Data Sheets* required two full pages.

5. Decay scheme drawing generated from an ENSDF decay data set using the computer code LS. The γ-ray branching intensities from "Adopted Gammas" have been substituted for the decay intensities and normalizations which are included in the tabular data. Note that the equivalent information in the *Nuclear Data Sheets* required a full page.

$^{182}_{75}$Re

Δ: -45450 *100* keV
μ: 0.0 7+ 2.79 *6*, Q=+4.1 *5*; 0.0+x 2+ 3.11 *33*, Q>+1.7; 235.736+x 2− 2.12 *8*.
γ(^{182}Re): *K=2 band;* 55.506 *8* $B(M1)_{W.U.}$>0.91 $B(E2)_{W.U.}$>22 δ=0.045 *3*, 76.3 *1* M1, 119.5 *1* M1, 136.4 *1*, 161.3 *2* M1, 175.1 *1* (M1), 197.2 *1*, 210.6 *1*, 230.1 *3*.

*K=4 band;*79.8 *1* M1, 107.1 *1* M1, 131.4 *1* M1, 160.4 *2*, 179.3 *1*, 217.0 *1* M1, 220.8 *1* (M1), 276.0 *1*, 461.3 *1* ($B(M2)_{W.U.}$=0.048 *6*).

K=7 band; 154.15 *8* M1+E2 δ=0.32 *3*, 185.30 *7* M1+E2 δ=0.39 *5*, 212.56 *7* M1+E2 δ=0.40 *6*, 237.52 *7* M1+E2 δ=0.49 *7*, 260.88 *7* M1+E2 δ=0.53 *11*, 282.35 *9* M1+E2 δ=0.50 *11*, 303.40 *9* (M1+E2) δ=0.47 *6*, 321.11 *9* (M1+E2) δ=0.32, 339.45 *8* E2, 341.64 *8* (M1+E2) δ=0.32, 397.86 *8* E2, 450.08 *8* E2, 498.40 *8* E2, 543.23 *8* E2, 585.76 *8* (E2), 624.52 *8* (E2), 662.76 *8* (E2).

K=9 band; 181.84 *8* M1+E2 δ=0.23 *3*, 209.32 *7* M1+E2 δ=0.32 *3*, 234.89 *7* M1+E2 δ=0.35 *5*, 258.90 *7* M1+E2 δ=0.30 *7*, 281.01 *9* M1+E2 δ=0.42 *11*, 289.0 *1* $B(E1)_{W.U.}=1.4\times10^{-6}$, 302.82 *8* (M1+E2) δ=0.36 *4*, 391.16 *8* E2, 444.22 *8* E2, 493.79 *8* (E2), 539.91 *8* (E2), 583.84 *8* (E2).

K=15 band; 344.54 *8* $B(E1)_{W.U.}=2.4\times10^{-8}$, 647.36 *8* $B(M2)_{W.U.}$=0.057.

γ(^{182}W): ε+β$^+$ (64.0 *5* h) <norm: γ_{229}=25.7 *14*%>, 18.05 *5* ($\dagger_\gamma$4.8 *12*) M1+E2 δ=0.016 *5*, 19.85 *5* ($\dagger_\gamma$1.4 *5*) M1+E2 δ=0.07 *2*, 31.7 *1* ($\dagger_\gamma$10 *2*) E1, 39.1 *1* ($\dagger_\gamma$10 *2*) M1+E2 δ=0.061 *7*, 42.0, 42.7 *1* ($\dagger_\gamma$18 *4*) E1, 60.65 *5* ($\dagger_\gamma$4 *1*), 65.8 *1* ($\dagger_\gamma$112 *22*) M1+E2 δ=0.093 *6*, 67.85 *5* ($\dagger_\gamma$862 *86*) E1+M2 δ<0.02, 84.68 *5* ($\dagger_\gamma$107 *6*) M1+E2 δ=+0.345 *11*, 100.10 *5* ($\dagger_\gamma$638 *17*) E2, 107.13 *5* ($\dagger_\gamma$55 *4*) M1+E2 δ=−0.8 *2*, 108.58 *5* ($\dagger_\gamma$31 *2*) M1+E2 δ=−0.6 *2*, 110.38 *5* ($\dagger_\gamma$4 *4*), 111.07 *5* ($\dagger_\gamma$8.1 *6*), 113.68 *5* ($\dagger_\gamma$189 *12*) M1+E2 δ=+0.358 *28*, 116.23 *5* ($\dagger_\gamma$20 *2*) E1, 130.81 *5* ($\dagger_\gamma$290 *20*) M1+E2 $\delta=-0.51^{+6}_{-8}$, 133.80 *5* ($\dagger_\gamma$93 *6*) M1+E2 $\delta=+0.39^{+4}_{-3}$, 145.43 *5* ($\dagger_\gamma$26 *2*) (E1), 147.69 *5* ($\dagger_\gamma$35 *3*) M1+E2 δ=+0.8 *2*, 148.86 *5* ($\dagger_\gamma$68 *5*) M1+E2 $\delta=+0.28^{+8}_{-6}$, 149.45 *5* ($\dagger_\gamma$35 *3*) M1+E2 $\delta=-0.15^{+15}_{-18}$, 150.25 *5* ($\dagger_\gamma$20 *2*) (E1), 151.15 *5* ($\dagger_\gamma$17 *2*) M1+E2 δ=0.8 *3*, 152.43 *5* ($\dagger_\gamma$330 *20*) E1+M2 δ=+0.069 *17*, 154.10 *5* ($\dagger_\gamma$9 *3*) M1+E2 δ=0.6 *3*, 156.39 *5* ($\dagger_\gamma$280 *20*) E1, 160.2 *1* ($\dagger_\gamma$9.3 *6*), 169.15 *5* ($\dagger_\gamma$440 *30*) M1+E2 δ=+0.094 *6*, 172.87 *5* ($\dagger_\gamma$139 *9*) M1+E2 δ=+0.26 *1*, 178.47 *5* ($\dagger_\gamma$88 *5*) (E1), 179.40 *5* ($\dagger_\gamma$117 *7*) M1+E2 δ=+0.92 *8*, 187.34 *5* ($\dagger_\gamma$12.5 *12*) E1+M2 $\delta=+0.25^{+27}_{-20}$, 188.54 *5* ($\dagger_\gamma$5.1 *5*), 189.65 *5* ($\dagger_\gamma$15 *7*) M1+E2 $\delta=+0.31^{+15}_{-12}$, 191.39 *5* ($\dagger_\gamma$260 *20*) M1+E2 $\delta=-0.23^{+6}_{-8}$, 198.34 *5* ($\dagger_\gamma$157 *13*) E2+M3 δ=+0.067 *10*, 203.55 *5* ($\dagger_\gamma$19 *2*) E1+M2 $\delta=-17^{+10}_{-24}$, 206.00 *5* ($\dagger_\gamma$20 *2*) E1, 208.26 *5* ($\dagger_\gamma$24 *2*) M1+E2 δ=−1.0 *5*, 209.40 *5* ($\dagger_\gamma$19 *2*) M1+E2 $\delta=-0.28^{+23}_{-15}$, 214.32 *5* ($\dagger_\gamma$43 *3*) M1+E2 $\delta=+0.25^{+8}_{-7}$, 215.73 *5* ($\dagger_\gamma$30 *2*) (E2), 217.55 *5* ($\dagger_\gamma$127 *8*) (E1), 221.61 *5* ($\dagger_\gamma$250 *20*) E1, 222.07 *5* ($\dagger_\gamma$330 *30*) E1, 226.19 *5* ($\dagger_\gamma$119 *8*) M1+E2 δ=+0.15 *2*, 229.32 *5* ($\dagger_\gamma$1000) E2, 247.46 *5* ($\dagger_\gamma$196 *13*) E2, 256.45 *5* ($\dagger_\gamma$370 *30*) M1+E2 $\delta=+0.037^{+6}_{-7}$, 264.07 *5* ($\dagger_\gamma$139 *9*) E2, 276.31 *5* ($\dagger_\gamma$340 *20*) E2, 281.45 *5* ($\dagger_\gamma$221 *15*) E2, 286.56 *5* ($\dagger_\gamma$274 *18*) E2, 295.67 *10* ($\dagger_\gamma$8 *3*) E2, 299.90 *10* ($\dagger_\gamma$49 *10*) E2, 300.36 *5* ($\dagger_\gamma$66 *15*) M1+E2 δ=+0.048 *26*, 313.98 *1* ($\dagger_\gamma$31 *2*) E2, 323.40 *10* ($\dagger_\gamma$68 *5*) E2, 339.06 *10* ($\dagger_\gamma$216 *14*) E2, 342.03 *10* ($\dagger_\gamma$41 *3*) E2, 345.46 *10* ($\dagger_\gamma$19 *2*) E2, 351.07 *10* ($\dagger_\gamma$400 *30*) E2, 357.04 *10* ($\dagger_\gamma$21 *2*) E2, 891.9 *1* ($\dagger_\gamma$1.3 *2*) E2, 928.0 *1* ($\dagger_\gamma$14.4 *15*) E2, 943.2 *3* ($\dagger_\gamma$8.8 *14*) E2, 959.7 *1* ($\dagger_\gamma$7.8 *15*) M2+E3 $\delta=-5.5^{+19}_{-10}$, 1001.7 *1* ($\dagger_\gamma$95.7 *34*) M1+E2 $\delta=-8.9^{+21}_{-18}$, 1044.4 *1* ($\dagger_\gamma$11.1 *4*) E1+M2 δ=0.46 *9*, 1076.2 *2* ($\dagger_\gamma$410 *12*) E2(+M1) $\delta=+2.56^{+9}_{-8}$, 1088.5 *3* ($\dagger_\gamma$7.7 *8*) E1+M2 δ=0.4 *2*, 1113.3 *1* ($\dagger_\gamma$183 *4*) M1+E2 $\delta=+5.6^{+13}_{-10}$, 1121.3 *1* ($\dagger_\gamma$855 *25*) M1+E2 $\delta=+30^{+6}_{-4}$, 1157.3 *1* ($\dagger_\gamma$14.4 *15*) M1+E2 $\delta=-9^{+3}_{-6}$, 1158.1 *1* ($\dagger_\gamma$34.3 *17*) E1, 1180.8 *3* ($\dagger_\gamma$21.5 *10*) E2(+M1) δ=−2.8 *10*, 1189.0 *1* ($\dagger_\gamma$351 *10*) E1+M2+E3, 1221.4 *1* ($\dagger_\gamma$677 *14*) E2, 1223.9 *1* ($\dagger_\gamma$10.2 *13*) E1+M2 δ=0.32 *7*, 1231.0 *1* ($\dagger_\gamma$579 *11*) M1+E2 $\delta=-33^{+6}_{-9}$, 1257.5 *1* ($\dagger_\gamma$41.4 *12*) E2, 1273.8 *1* ($\dagger_\gamma$36.7 *17*) E1+M2+E3, 1279.8 *3* ($\dagger_\gamma$2.4 *3*), 1289.2 *2* ($\dagger_\gamma$29.4 *6*) M2, 1291.8 *4* ($\dagger_\gamma$9.1 *9*) E1+M2 δ=0.4 *2*, 1294.0 *3* ($\dagger_\gamma$62.7 *12*) E2(+M1) δ>30, 1330.9 *2* ($\dagger_\gamma$14.6 *13*) E1+M2 δ=0.5 *2*, 1342.7 *1* ($\dagger_\gamma$100 *25*) E2+M3 $\delta=-0.11^{+4}_{-20}$, 1373.8 *1* ($\dagger_\gamma$11.5 *4*) E3, 1387.4 *1* ($\dagger_\gamma$10.3 *10*) M2+E3 δ=2.6 *4*, 1410.1 *1* ($\dagger_\gamma$10.8 *7*) E2, 1427.3 *2* ($\dagger_\gamma$381 *7*) E2, 1439.3 *3* ($\dagger_\gamma$6.2 *4*) E1+M2, 1453.1 *1* ($\dagger_\gamma$1.5 *3*) M2+E3, 1521.3 *4* ($\dagger_\gamma$3.7 *4*) (E3), 1560.4 *4* ($\dagger_\gamma$2.8 *3*) (E3), 1631.4 *5* ($\dagger_\gamma$0.49 *9*) M2+E3 δ−2.5.

γ(^{182}W): ε+β$^+$ (12.7 *2* h) <norm: γ_{1121}=31.8 *16*%>, 31.74 *5* ($\dagger_\gamma$1.42 *3*) E1, 42.71 *5* ($\dagger_\gamma$0.88 *9*) E1, 65.72 *5* ($\dagger_\gamma$0.8 *1*) M1+E2 δ=0.093 *6*, 67.75 *5* ($\dagger_\gamma$120 *4*) E1+M2 δ<0.02, 84.68 *5* ($\dagger_\gamma$8.4 *7*) M1+E2 δ=+0.345 *11*, 100.12 *5* ($\dagger_\gamma$45 *3*) E2, 110.4 *1* ($\dagger_\gamma$0.05 *1*), 113.70 *5* ($\dagger_\gamma$1.3 *2*) M1+E2 δ=+0.358 *28*, 116.40 *5* ($\dagger_\gamma$1.1 *3*) E1, 121.5 *2* ($\dagger_\gamma$0.008 *2*), 152.43 *5* ($\dagger_\gamma$22.0 *19*) E1+M2 δ=+0.069 *17*, 156.38 *5* ($\dagger_\gamma$1.7 *3*) E1, 179.38 *5* ($\dagger_\gamma$0.92 *17*) M1+E2 δ=+0.92 *8*, 198.36 *5* ($\dagger_\gamma$0.55 *8*) E2+M3 δ=+0.067 *10*, 222.08 *5* ($\dagger_\gamma$2.17 *17*) E1, 229.32 *5* ($\dagger_\gamma$8 *1*) E2, 264.08 *5* ($\dagger_\gamma$0.90 *12*) E2, 470.26 *5* ($\dagger_\gamma$6.3 *3*) (E1+M2) δ=0.6 *1*, 536.04 *5* ($\dagger_\gamma$0.65 *10*) (E1+M2) δ=0.7 *2*, 555 *1* ($\dagger_\gamma$0.35 *10*) (E2), 598.56 *5* ($\dagger_\gamma$1.23 *13*) (M1), 649.73 *5* ($\dagger_\gamma$1.06 *15*) (E1+M2) δ=0.8 *2*, 734.53 *5* ($\dagger_\gamma$1.18 *14*) (E1+M2) δ=1.0 *3*, 787.11 *5* ($\dagger_\gamma$0.95 *18*) (M1), 800 *1* ($\dagger_\gamma$0.46 *12*), 810.24 *5* ($\dagger_\gamma$1.20 *14*) (M1), 835.98 *5* ($\dagger_\gamma$1.45 *15*) (E1+M2) δ−0.8, 892 *1* ($\dagger_\gamma$0.162 *12*) E2, 894.85 *5* ($\dagger_\gamma$6.6 *5*) (M1), 900.80 *5* ($\dagger_\gamma$1.11 *19*) (M1+E2) δ−0.5, 927.99 *5* ($\dagger_\gamma$1.62 *17*) E2, 959.81 *5* ($\dagger_\gamma$1.7 *4*) M2+E3 $\delta=-5.5^{+19}_{-10}$, 1001.8 *1* ($\dagger_\gamma$0.7) M1+E2 $\delta=-8.9^{+18}_{-21}$, 1035.71 *8* ($\dagger_\gamma$0.023 *6*) E2, 1044.5 *1* ($\dagger_\gamma$0.55 *7*) E1+M2 δ=0.46 *9*, 1113.4 *1* ($\dagger_\gamma$1.1 *2*) M1+E2 $\delta=+5.6^{+13}_{-10}$, 1121.4 *1* ($\dagger_\gamma$100) M1+E2 $\delta=+30^{+6}_{-4}$, 1135.81 *8* E0, 1157.3 *1* ($\dagger_\gamma$1.8 *2*) M1+E2 $\delta=-9^{+3}_{-6}$, 1158.1 *1* ($\dagger_\gamma$0.3 *1*) E1, 1189.2 *1* ($\dagger_\gamma$47.3 *19*) E1+M2+E3, 1221.5 *1* ($\dagger_\gamma$78 *3*) E2, 1223.9 *1* ($\dagger_\gamma$0.07 *1*) E1+M2 δ=0.32 *7*, 1231.1 *1* ($\dagger_\gamma$4.11 *20*) M1+E2 $\delta=-33^{+6}_{-9}$, 1257.3 *1* ($\dagger_\gamma$4.39 *19*) E2, 1273.8 *1* ($\dagger_\gamma$1.66 *14*) E1+M2+E3, 1289.3 *1* ($\dagger_\gamma$3.85 *17*) M2, 1342.6 *1* ($\dagger_\gamma$0.06 *1*) E2+M3 $\delta=-0.11^{+4}_{-20}$, 1373.9 *1* ($\dagger_\gamma$0.56 *6*) E3, 1387.4 *1* ($\dagger_\gamma$0.05 *1*) M2+E3 δ=2.6 *4*, 1410.4 *3* ($\dagger_\gamma$0.12 *2*), 1453.1 *1* ($\dagger_\gamma$0.008 *1*) M2+E3, 1523 *2* ($\dagger_\gamma$0.05), 1537 *2* ($\dagger_\gamma$0.05), 1543 *2* ($\dagger_\gamma$0.05), 1558 *2* ($\dagger_\gamma$0.24 *3*), 1756.0 *2* ($\dagger_\gamma$0.19 *4*), 1771.0 *2* ($\dagger_\gamma$1.01 *10*) E1, 1818.8 *2* ($\dagger_\gamma$0.33 *3*) (M2), 1857.3 *2* ($\dagger_\gamma$0.099 *7*) (E2), 1871.2 *2* ($\dagger_\gamma$0.91 *7*) E1, 1877.6 *2* ($\dagger_\gamma$0.19 *6*) (E1+M2) $\delta=0.8^{+4}_{-3}$, 1879.6 *2* ($\dagger_\gamma$0.17 *5*) E1, 1911.8 *2* ($\dagger_\gamma$0.139 *24*) (M1), 1957.4 *2* ($\dagger_\gamma$1.43 *10*) (E1+M2) $\delta=1.0^{+6}_{-4}$, 2010.1 *3* ($\dagger_\gamma$0.30 *4*) (E1+M2) $\delta=0.9^{+7}_{-4}$, 2016.3 *3* ($\dagger_\gamma$2.5 *3*), 2033.3 *3* ($\dagger_\gamma$0.07), 2047.3 *3* ($\dagger_\gamma$0.36 *3*) (E1+M2) $\delta=1.0^{+10}_{-5}$, 2057.4 *3* ($\dagger_\gamma$2.90 *23*) (M2), 2073.2 *3* ($\dagger_\gamma$0.13 *2*), 2084.0 *3* ($\dagger_\gamma$0.204 *21*), 2099 *3* ($\dagger_\gamma$0.08), 2106.8 *3* ($\dagger_\gamma$<0.9), 2108.6 *3* ($\dagger_\gamma$<0.9), 2109.5 *3* ($\dagger_\gamma$<0.9), 2140.3 *2* ($\dagger_\gamma$0.121 *21*) (M1), 2148 *3* ($\dagger_\gamma$0.088 *19*), 2175.2 *3* ($\dagger_\gamma$0.147 *21*) E1, 2189 *3* ($\dagger_\gamma$0.055 *15*), 2207.7 *3* ($\dagger_\gamma$0.33 *3*) (E3), 2216 *3* ($\dagger_\gamma$0.07), 2230 *3* ($\dagger_\gamma$0.034 *10*), 2316 *3* ($\dagger_\gamma$0.025 *5*).

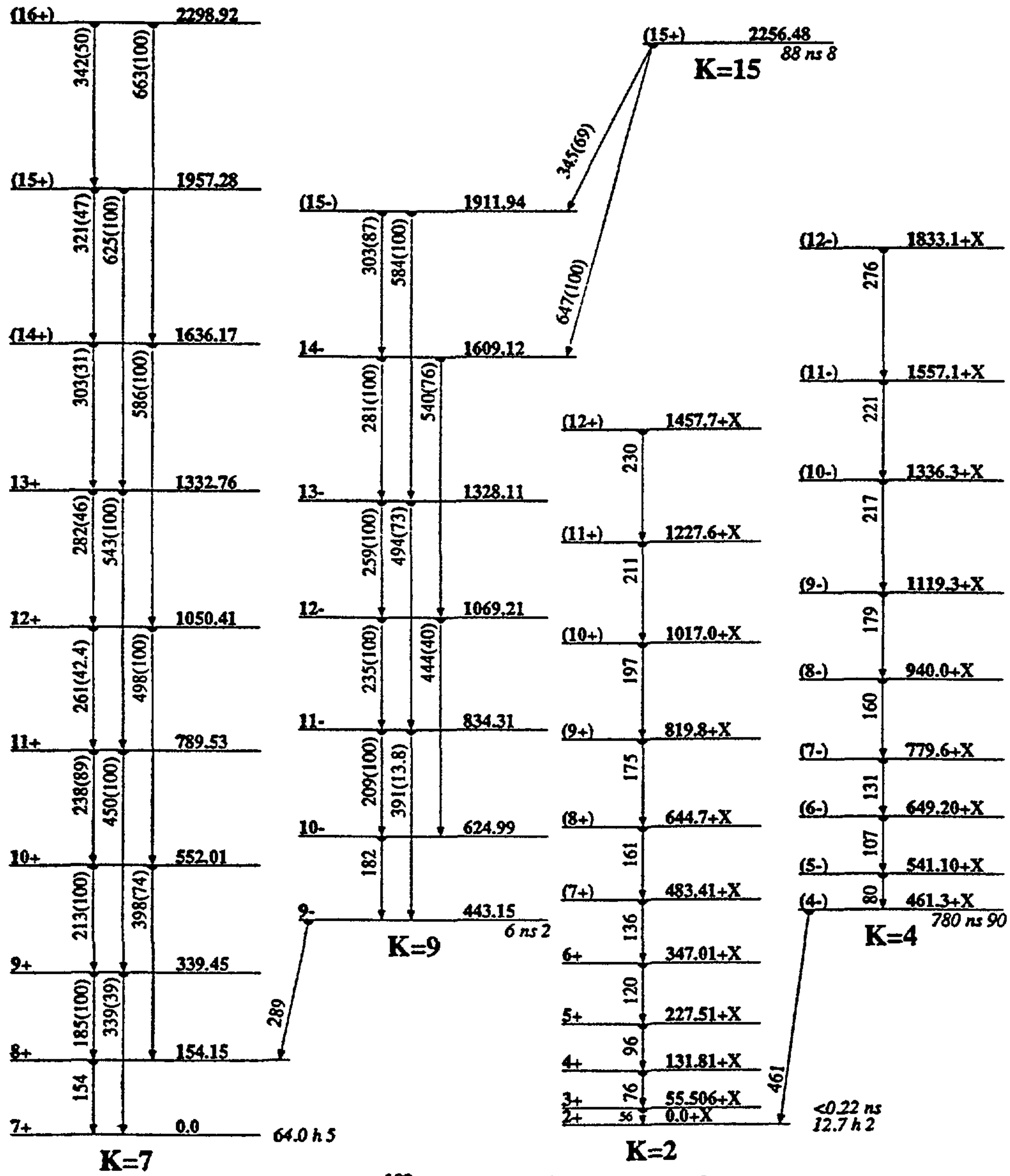
Figure 1.

$^{182}_{75}$Re levels - References	
Decay:	PScr 7 257(73), NP A204 337(73)
^{181}Ta(α,3nγ),W(p,xnγ):	PR C29 114(84), ArkF 38 537(69)

Figure 2.

A=187
3/2- 23.9 h
187 74 W β−
$Q_{β-}$ 1312.4 17
Sn 8580 60
Sp 5466.4 10
5/2+ 4.6×10^10 y
187 75 Re β−
$Q_{β-}$ 2.64 4
Sn 7363.0 18
Sp 5996.5 18
1/2-
187 76 Os
Δ -41227 3
Sp 6583.3 18
Sn 6291.2 15
3/2(+) 10.5 h
EC 187 77 Ir
Q_{EC} 1500(syst)
Sn 8620
Sp 4010
3/2(-) 2.35 h
EC 187 78 Pt
Q_{EC} 2900(syst)
Sn 7050
Sp 4940
1/2+ 8.0 m
EC 187 79 Au
α ?
Q_{EC} 3720(syst)
$Q_α$ 4790 50
Sn 9600
Sp 2540
13/2+ 1.7 m
3/2- 2.4 m
EC 187 80 Hg
100%
α >2.5×10^-4%
α >1.2×10^-4%
Q_{EC} 4940(syst)
$Q_α$ 5150 50
Sn 7700
Sp 3890
(9/2-) 329 ~15.6 s
(1/2+) 0 51 s
EC 187 81 Tl
IT
α
Q_{EC} 6040(syst)
$Q_α$ 5570(syst)
Sn 10190
Sp 880
15.2 s
(13/2+) 18.3 s
EC 187 82 Pb
98%
α 2%
Q_{EC} 7070(syst)
$Q_α$ 6404 10
Sn 8510
Sp 2330
(1/2+) 60 8 ms
(9/2-) 0 35 ms
187 83 Bi
α >50%
$Q_α$ 7750 10
1.3 m
191 82 Pb
α 0 013%
$Q_α$ 5400 50
~20 s
13 s
191 83 Bi
α ~40%
$Q_α$ 6773 7

Figure 3.



^{182}Re Rotational Bands

Figure 4.

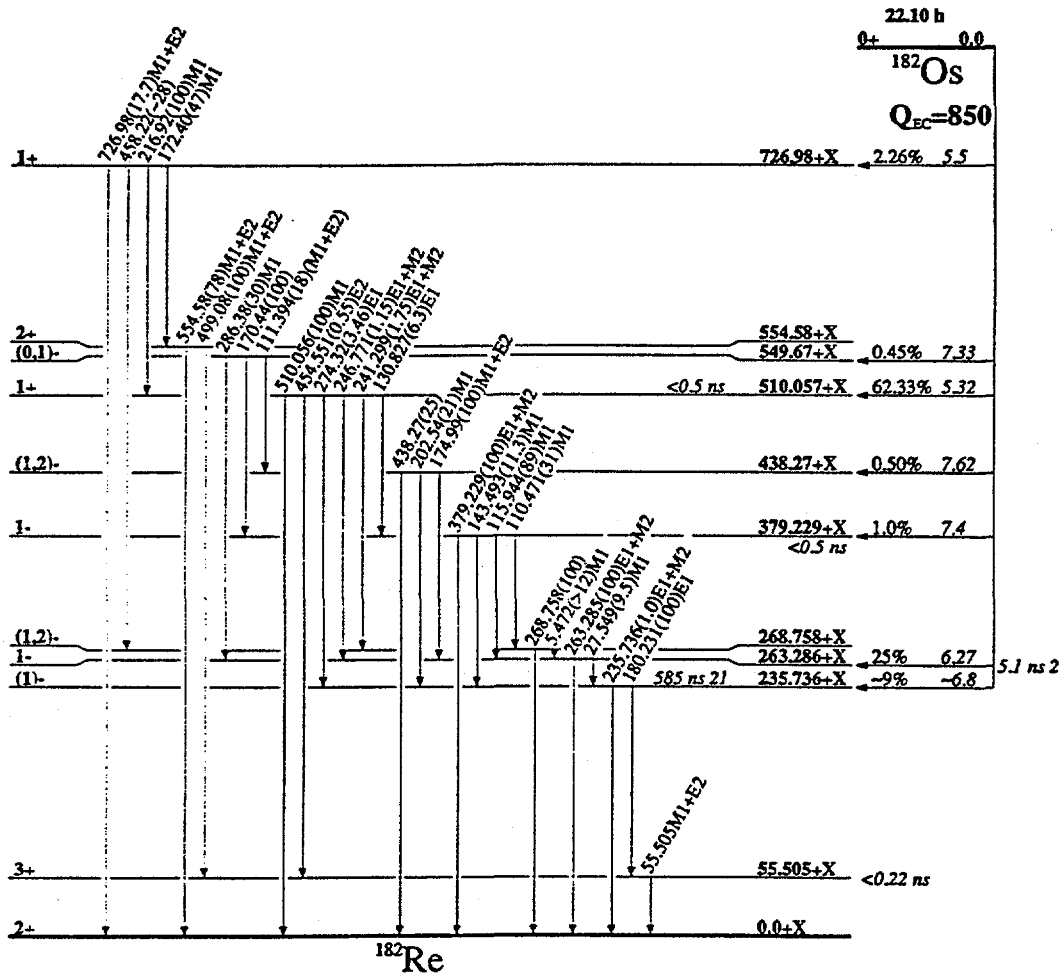

22.10 h
0+ 0.0
^{182}Os
Q_{EC}=850
726.98+X 2.26% 5.5
554.58+X
549.67+X 0.45% 7.33
510.057+X 62.33% 5.32
438.27+X 0.50% 7.62
379.229+X 1.0% 7.4
268.758+X
263.286+X 25% 6.27
235.736+X ~9% ~6.8
5.1 ns 2
55.505+X
0.0+X
^{182}Re

Figure 5.

مجموعة الكويت للمعلومات النووية

KUWAIT NUCLEAR DATA GROUP

معلومات عن : النشاط الاشعاعي و التركيب النووي

RADIOACTIVITY and NUCLEAR STRUCTURE DATA

معهد الكويت للأبحاث العلمية
قسم الفيزياء - جامعة الكويت

Kuwait Institute for Scientific Research
Physics Department—Kuwait University

NUCLEUS: 76SE. ADOPTED LEVELS

ENERGY		SPIN	HALF-LIFE	
0.0		0+	STABLE	
559.101	5	2+	12.3 PS	2
1122.281	7	0+	11 PS	5
1216.146	7	2+	3.4 PS	2
1330.858	8	4+	1.52 PS	5
1688.959	7	(3+)	1.5 PS	6
1787.646	8	2+	6 PS	+6-2
2025.990	9	4+	1.6 PS	7
2127.213	8	(2+)		
2170.55	2	(0+)		
2262.3	3	6+	0.5 PS	1
2362.95	2	(2+,3+,4+)		
2429.09	2	3-	9 PS	+4-2
2488.6	3	(5+)	1.4 PS	5
2514.66	2	(2+)		
2570	10			

NUCLEUS: 76BR. GAMMA-RAYS FROM 76KR EC DECAY (14.8 H)

GAMMA ENERGY		PHOTON INTENSITY		MULTI-POLARITY	MIXING RATIO		CONVERSION COEFFICIENT		INITIAL LEVEL	FINAL LEVEL
35.6	2	0.22	5	IF M1			2.2		487.72	451.98
38.0	3	0.35	9	IF M1			1.8		936.47	898.38
40.0	5	0.14	3	IF M1			1.6		355.28	315.68
45.5	2	50	5	M1			1.066		45.48	0.0
57.2	2	0.14	3				9.71		102.64	45.48
63.6	2	0.17	4	M1(+E2)			0.41		315.68	252.06
91.1	2	0.53	11	M1(+E2)			0.15		446.15	355.28
96.6	2	0.28	6	M1(+E2)			0.127		451.98	355.28
103.3	2	8.5	9	M1(+E2)			0.106		355.28	252.06
104.9	2	0.42	9	IF DIPOLE			0.1		150.51	45.48
134.9	2	6.5	7	(M1)			0.051		451.98	317.05
136.4	2	2.7	3	(M1)			0.050		451.98	315.68
150.5	2	0.5	LT						252.06	101.56**
150.5	2	0.50	LT	IF DIPOLE			0.04		150.51	0.0
166.7	2	0.42	9	IF M1			0.03		317.05	150.51
171.0	3	0.35	9	IF M1,E2	IF 1		0.08	4	487.72	317.05
199.8	2	3.0	3	M1+E2	0.6	2	0.031	5	451.98	252.06
214.5	3	0.78	8	IF M1,E2	IF 1		0.04	2	317.05	102.64
232.7	3	0.14	3	IF M1,E2	IF 1		0.026	13	1047.78	815.10
252.0	2	16	2	E1			0.0057		252.06	0.0

NUCLEAR STRUCTURE DATA

The Nuclear Data Group in Kuwait can supply tables of nuclear structure and radioactive decay data. The data are obtained from the Evaluated Nuclear Structure Data File (ENSDF) and the Nuclear Structure Reference File (NSRF), which are up-dated and distributed to Nuclear Data groups about three times a year by Brookhaven National Laboratory in the USA. These computer files are used to generate the journal *Nuclear Data Sheets.*

The data consist of level and decay properties of all known nuclei. The evaluated data in ENSDF are provided by an international network of evaluators under the auspices of the International Atomic Energy Agency. The data are grouped as Isobaric "Mass Chains" containing information from individual experiments and recommended values for each nucleus adopted by the evaluators.

The following table can be provided for ENSDF and NSRF for one mass chain or for a limited range of mass chains, giving adopted values or values from particular experiments. Full details of references are given.

LEVEL TABLE

Level energies, spins, parities, half-lives and ℓ- transfers are listed.

Information on all levels in a nucleus or a specified number of low-lying levels can be provided.

GAMMA RAY TABLES

Ordered by gamma ray energy or by energy of the de-exciting level. Gamma ray energies, relative intensities, branching ratios (when table ordered by energy of de-exciting level), gamma multi-polarities and mixing ratios and the energies, spins and parities of initial and final levels are listed.

HALF-LIFE TABLE

Adopted values for all known nuclear ground state half-lives are listed in order of isotope or in ascending order of half-life.

Requests for data or further information may be sent to:

Nuclear Data Project
c/o Office of the Director General
Kuwait Institute for Scientific Research
P. O. Box 24885 Safat
KUWAIT

السياسة
AL-SEYASSAH

٢٨ صفحة
الاربعاء ١٧ من شعبان ١٤١٠ هـ الموافق ١٤ مارس ١٩٩٠ م (السنة ٢٤) - العدد ٧٧٦٧
AL SEYASSAH, Wednesday, March 14, 1990 — 24th year, No. 7767
١٠٠ فلس

الكويت عضو منذ عام ٧٨ وتستضيفها لاول مرة

الشبكة الدولية للبيانات النووية تختتم اجتماعاتها اليوم بمعهد الابحاث

تختتم صباح اليوم بمعهد الكويت للابحاث العلمية جلسات الاجتماع الدوري التاسع للشبكة الدولية للبيانات النووية التابعة للوكالة الدولية للطاقة الذرية.

وقد نسقت لهذا الاجتماع وشاركت فيه د. امينة الفرحان عضو هيئة التدريس بقسم الفيزياء في جامعة الكويت بصفتها ممثل الكويت في الشبكة.

والتقى مدير معهد الكويت للابحاث العلمية احمدالجسار رجال الصحافة امس لتعريفهم على فريق العمل الخاص بالكويت والاعمال التي يقوم بها بحضور د. امينة الفرحان ود. بيتر اندت والسيد هانز ليميل.

وقال د. الجسار ان الكويت عضو فعال في الشبكة الدولية للبيانات النووية وتاتي مشاركتها في هذه الشبكة ايمانا منها باهمية البحث العلمي الذي تعطيه كثير من اهتماماتها اسوة بمشاركتها في وكالات الامم المتحدة الاخرى.

وتضم الشبكة الدولية للبيانات النووية في عضويتها عدة مراكز علمية في كل من الولايات المتحدة الاميركية والاتحاد السوفياتي وكندا وهولندا وفرنسا والسويد وبلجيكا واليابان والصين والكويت.

وقد انضمت دولة الكويت لهذه الشبكة عام ١٩٧٨ بدعوة من اعضائها لمعهد الكويت للابحاث العلمية وتعتبر دولة الكويت العضوة الوحيدة المشاركة في هذه الشبكة من الدول النامية.

وقد انشات هذه الشبكة نتيجة لتضافر الجهود بين مختبر (Oak Ridge) الوطني ومختبر الـ Brookhaven الوطني في الولايات المتحدة ومجموعة من العلماء من مختبر Utrecht في هولندا.

□ د. امينة الفرحان □

وتتلخص مهام الشبكة في تحليل وتقييم النتائج المخبرية لجميع الاوزان النووية وتنشر هذه النتائج في مجلة علمية يطلق عليها اسم مجلة «البيانات النووية».

يتم تنظيم اجتماع دوري استشاري مرة كل سنتين بدعوة من احد الدول الاعضاء في الوكالة الدولية للطاقة الذرية وتهدف هذه الاجتماعات الى تعزيز التعاون بين الدول الاعضاء والتنسيق فيما بينها في مجال البيانات النووية ومناقشة القوانين والاجراءات المتبعة في تحليل وتقييم هذه البيانات ومتابعة التطورات الحديثة في نظم الحاسب الآلي المستخدمة في معالجة البيانات النووية.

وتساهم مؤسسة الكويت للتقدم العلمي مع معهد الكويت للابحاث العلمية في تمويل حصة دولة الكويت من الدراسات والنشاطات البحثية في مجال البيانات النووية.

واوضحت د. امينة ان الشبكة لا تقبل الا الاعضاء الذين يهتمون بالبحث العلمي ويمولونه الا ان المعلومات يمكن ان يستفيد منها الاعضاء وغيرهم.

واشارت الى ان من اهم اعمال الوكالة التنسيق بين المراكز البحثية التي تقوم بالدراسات النووية. كما ان مجموعات الوكالة تقوم بادوار مختلفة ومحددة.

وذكرت ان الاجتماع المقبل للشبكة سيستضيفه الاتحاد السوفياتي على ان يكون مختبر اوبرج الوطني في الولايات المتحدة بديلا في حال اعتذار الاتحاد السوفياتي.

واعربت عن شكرها لمصدر الابحاث العلمية لاستضافة هذا الاجتماع الذي يعقد لاول مرة بالكويت.

Annex 15

انجازات المركز

وحول انجازات المركز قال د. هانز الذي يعمل منذعام ٦٤ في الوكالة الدولية للطاقة الذرية انها تتلخص في تبادل البيانات النووية على نطاق عالمي - وضع صيغ مقبولة دوليا فيما يتعلق بقواعد البيانات النووية التي تعمل بمساندة الحاسب الآلي وتقييم البيانات المرجعية القياسية المعمول بها دوليا في مجال العلوم النووية والتنسيق الوطني والاقليمي بين مراكز البيانات على نطاق عالمي بهدف تيسير وتوفير كافة البيانات النووية للعلماء في كافة أقطار العالم.

وقال: قسم البيانات النووية هو جزء من دائرة العلوم الطبيعية والكيميائية والذي هو بدوره جزء من ادارة البحث والنظائر المشعة ويرأسه جاي جاي اشمدت (المانيا الاتحادية) ومديره في كونشين (الاتحاد السوفياتي) ونائبه المدير د. ام زيفريرو (ايطاليا).

واضاف ان البيانات النووية تقدم وصفا لتفاعلات مختلف انواع الاشعاع مع النوى

الذرية للمادة والمطلوب هو بنوك معلومات ضخمة تتسع لحوالي ٢٠٠٠ نواة ذرية.

وتعتبر البيانات النووية ضرورية لتطبيقات العلوم النووية في المجالات التالية:

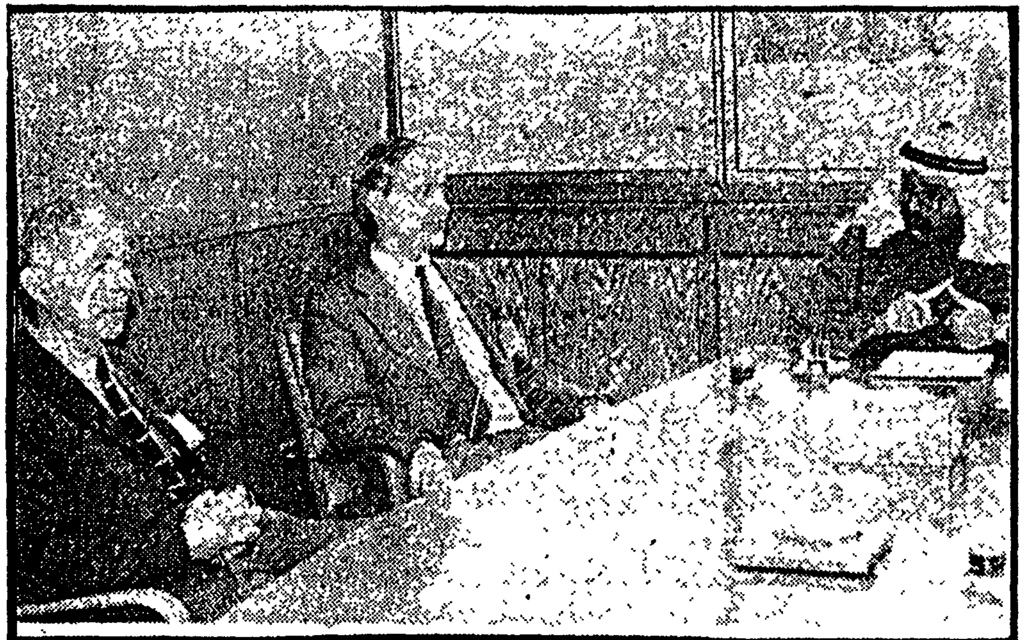
تصميم وتشغيل المفاعلات النووية والالتحام النووي وادارة النفايات النووية والطب النووي والابحاث التي تعني بتحديد خواص المواد واستخدام الاساليب النووية في الزراعة واستخدام الاساليب النووية في الجيولوحيا وغيرها.

واوضح ان اهداف برنامج البيانات النووية التابع للوكالة الدولية للطاقة الذرية تشمل تبادل البيانات النووية على نطاق دولي وتيسير توفير البيانات النووية لكافة العلماء في مختلف بلدان العالم وانشاء مراكز اقليمية ودولية للبيانات النووية والارتقاء بالخبرات في مجال معالجة البيانات النووية بالحاسب الالي والارتقاء باستخدام الاساليب النووية في مجال العوم والتكنولوجيا.

واشار الى ان الادوات والنواتج تتمثل في توفير ملفات البيانات النووية في الحاسب الالي على نطاق دولي وعقد اجتماعات للتنسيق بين مراكز البيانات واصدار كتيبات للبيانات النووية المرجعية القياسية وتنظيم دورات تدريبية في مجال تطبيقات البيانات النووية وتقديم العون الفني للدول النامية وعقد اجتماعات علمية لتحديد ما تحتاجه الاساليب والتطبيقات النووية المختلفة من بيانات.

وقال د. بيتر اندت: ان الوكالة الدولية للطاقة الذرية هي احدى الوكالات التابعة لمنظمة الامم المتحدة ومقرها الرئيسي فينا (النمسا) وتتلخص مهمة الوكالة في تعزيز التعاون الدولي في مجال استخدامات الطاقة النووية للاغراض السلمية وبهذه الروح تم تشكيل لجنة دولية من العلماء لتقوم بدراسة خواص المواد المشعة مثل (النظائر المشعة) وقد شاركت مجموعة البيانات النووية الكويتية في هذا الجهد الذي شارك فيه علماء من امريكا الشمالية ومن العديد من اقطار غرب اوروبا والاتحاد السوفياتي والهند والصين واليابان وقد طور المشاركون في هذا الجهد قواعد عالمية للبيانات تعمل بمساندة الحاسب الآلي تحتوي على كم هائل من جداول البيانات التي تقدم وصفا لخواص كافة المواد المشعة المعروفة وللاشعاعات المنبعثة منها. وقد القيت على مجموعة البيانات النووية بالمعهد مسؤولية الاحتفاظ بقسم محدد من هذه البيانات بينما تغطي المجموعات المشابهة في البلدان الاخرى غير ذلك من الاقسام. وقاعدة البيانات متوفرة بالكامل لدى المعهد حيث تقوم مجموعة البيانات النووية بتزويد العلماء في الكويت والبلدان المجاورة بالبيانات النووية التي يحتاجونها في ابحاثهم.

واضاف: تنتهز الوكالة الدولية للطاقة الذرية الفرصة لتعرب عن عظيم شكرها للمجموعة الكويتية للبيانات النووية ورئيسها الدكتورة امينة الفرحان وللمعهد ومديره العام الدكتور احمد علي الجسار ولمؤسسة الكويت للتقدم العلمي ولجامعة الكويت واخيرا وليس اخرا لوزارة التعليم العالي وذلك لاستضافتهم الاجتماع الدوري التاسع للجنة البيانات النووية ولكرم ضيافتهم الذي شملوا به المشاركين في الاجتماع وللامكانات الممتازة التي يتسم بها المعهد مما كان سببا في نجاح الاجتماع. ونامل ان تتلقى المجموعة الكويتية للبيانات النووية دعما مستمرا لقاء خدماتها المتميزة.



□ د الجسار و. بيتر ود هانز □

the 9th meeting of the network of nuclear structure and decay data evaluators

الإجتماع الدورى التاسع للشبكة الدولية للبيانات النووية

INTERNATIONAL ATOMIC ENERGY AGENCY

Kuwait, March 10-14, 1990

Kuwait Institute for Scientific Research
Kuwait Foundation for the Advancement of Sciences
Kuwait University

- 2 -

The scientific lectures presented during the meeting

P. Endt:	Spectroscopy of ^{26}Al (completeness and precision)
F. Chukreev:	New applications of operation research methods for ENSDF data control. (With demonstrations on a PC/AT).
J. Blachot:	1. NSR.DOS, a program written in dBase to manage, on the PC, data and references retrieved from NSR. (With demonstrations on PC.) 2. ENSDF and JEF2 (Joint European File 2).
M.J. Martin:	(to be announced)
P. Ekström:	The ENSDF Radioactivity Data Base for IBM-PC and Computer Network Access. (See Annex 8).
C. van der Leun:	Statistical nuclear-spin assignments.

Related references are:

For the method:

[1] C. VAN DER LEUN, Proc. Leuven Conference on Capture gamma-ray spectroscopy 1987, Inst. Phys. Conf. Series No. 88, p. S109.

[2] S.W. KIKSTRA and C. VAN DER LEUN, to be submitted to Nucl. Phys. A (1990).

For the data:

[3] H.P.L. De ESCH and C. VAN DER LEUN, Nucl. Phys. A454 (1986) 1.

[4] P.M. ENDT et al., Nucl. Phys. A476 (1988) 333 and A487 (1988) 221.

[5] E.L. BAKKUM and C. VAN DER LEUN, Nucl. Phys. A500 (1989) 1.

A. Hashizume	Signature dependence of M1 and E2 transition probabilities for the $i_{13/2}$ and $f_{7/2}$ rotational band in ^{161}Dy, ^{163}Dy, ^{167}Er and ^{173}Yb studied by heavy-ion coulomb excitation - See Annex 9.
I. Kondurov:	1. Archive type of the holographic memory disk system with automatic document search. 2. Index system for gamma-ray data. 3. Non statistical effects in the distribution of nuclear levels.

Signature Dependence of M1 and E2 Transition Probabilities for the $i_{13/2}$ and $f_{7/2}$ Rotational Band in ^{161}Dy, ^{163}Dy, ^{167}Er and ^{173}Yb Studied by Heavy-Ion Coulomb Excitation

A. Hashizume
The Institute of Physical and Chemical Research(RIKEN)

In the deformed region of rare earth nuclei, it is known that high-j orbitals such as $i_{13/2}$ give rise to large perturbation to rotational levels by the coupling effect of Coliolis's force between rotational motion and particle motion. However experimental works of this effect on transition moments have been discussed mostly through γ-ray branching and mixing ratios.[1,2] Our series of work have been motivated to measure M1 and E2 transition probatilities between the members of the rotation band built on a high- and low j orbital. Recently electromagnetic transition probabilities have been studied for the rotational bands based on high-j orbitals such as $h_{11/2}$ or $i_{13/2}$.[3-6]

Coulomb excitation using heavy-ion beams has enabled us to extract absolute transition probabilities up to moderate high-spin states in a model-independent way. We studied ^{167}Er, one of the typical deformed odd-mass nuclei with ground-state rotational bands built on the $i_{13/2}$-neutron orbital. Another nucleus, ^{161}Dy, which is also based on the $i_{13/2}$ neutron single-particle state were also studied.

In contrast, few data on transition probabilities are available for rotation bands built on lower-spin orbitals being the rotational perturbation effect on such orbits believed to be rather weak. We studied ^{163}Dy whose ground-state rotational band is based on an $f_{7/2}$ single-particle orbital. Tis nucleus have the characteristic coherence between the orbital and spin contributions in the spin-down ($\Omega=\Lambda-1/2$) dominant one-quasiparticle states.[7]

In the counterpart, the nucleus ^{173}Yb which have spin-up ($\Omega = \Lambda +1/2$) dominant configurations has been studied. The ground-state in ^{173}Yb rotational band is based on the natural-parity Nilsson state 5/2[512].

2. Experimental procedure

The targets are consisted of self-supporting metalic foils which are isotopically enriched. The heavy ions used for Coulomb excitation were obtained from a tandem accelerator at Japan Atomic Energy Research Institute. Kinds of heavy ions and their energies used for experiments were shown in table 1. We intentionally chosed the beam energies at about the Coulomb barrier to excite higher spin states.

Table 1 Heavy-ions used for Coulomb excitation

Reaction	Energy
^{161}Dy(^{58}Ni,^{58}Ni')	250 MeV
^{163}Dy(^{58}Ni,^{58}Ni')	250
^{167}Er(^{35}Cl,^{35}Cl')	160
^{173}Yb(^{58}Ni,^{58}Ni')	250

We used three sets of Compton-suppressed Germanium detectors: single γ-ray spectra, γ-γ coincidence measurements, angular distributions,

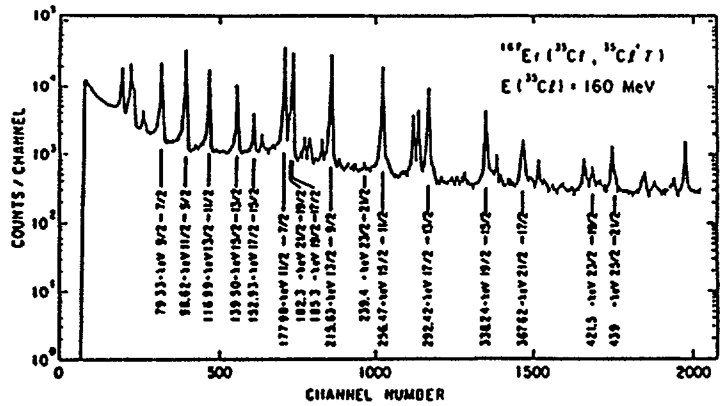


Fig. 1. A Compton-suppressed γ-ray spectrum measured at 0 degree to the beam. (Ref. b)

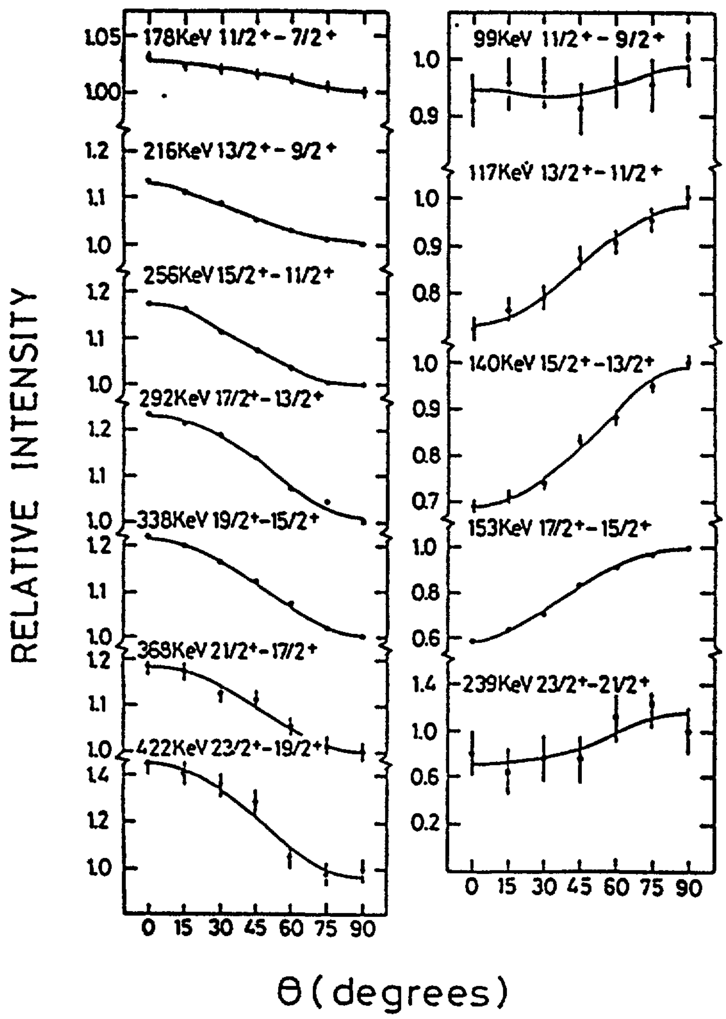


Fig. 2. Gamma-ray angular distributions following Coulomb excitation of ^{167}Er. (Ref. b)

directional correlation from oriented nuclei(DCO). Lifetime measurements were made using Doppler-shift attenuation method and/or recoil distance method.

3. Experimental results

A single gamma-ray spectrum of ^{167}Er is shown in Fig.1.

Mixing ratios: Measurements of angular distributions of γ-rays in ^{167}Er are shown in Fig.2. E2/M1 mixing ratios have been extracted as follows. Since all cross-over transitions between the band memebers are of pure E2, ratios of the experimental A_2 values and calculated ones for complete alignment give attenuation factors of nuclear alignment for these states. The experimental attenuation factors were compared with those calculated using the Winther-de-Boer code.[8] The measured attenuation factors for states with spins up to 19/2 were systematically smaller than those calculated. For higher spin states statistics of the data were not so good enough to extract attenuation factors. We used the calculated values multiplied by a factor of 0.83 for the 21/2 and 23/2 states(denoted by asterisk in table 2) instead of experimental values because the experimental attenuation factors of 17/2 and 19/2 states were smaller than the calculated ones by about 17 %. The attenuation factors obtained were used in the analysis of angular distributions for M1+E2 stop-over tansitions. The extracted mixing ratios are listed in table 2. The phase convention for δ is that of Yamazaki in nuclear data which leads to the same sign as $Q_0/(g_k-g_R)$. The mixing ratios for ^{161}Dy, ^{163}Dy, and ^{173}Yb are also obtained by the same procedure.

Lifetime measurements: In the Coulomb excitation, there is no difficulty of unknown feeding time from the compound nucleus to yrast cascade as in the case of (HI,xn) reactions. In the beginning of our work, only Doppler broadened lineshap analysis was available. The electronic stopping powers for Er ions in Er material used were estimated from the Northcliffe and Schilling table. The method of analysis is reported by Inamura.[8] The results of lineshape analysis on ^{167}Er are shown in Fig. 3.

Table 2 E2/M1 mixing ratios for stop-over transitions in ^{167}Er.

I	E (I I-1) (keV)	δ
11/2+	98.62	-0.45(15)
13/2+	116.99	-0.23(11)
15/2+	139.50	-0.25(9)
17/2+	152.93	-0.31(8)
19/2+	185.3	-0.35(15)
21/2+	182.3	-0.15(45)*
23/2+	239.4	-0.20(10)*

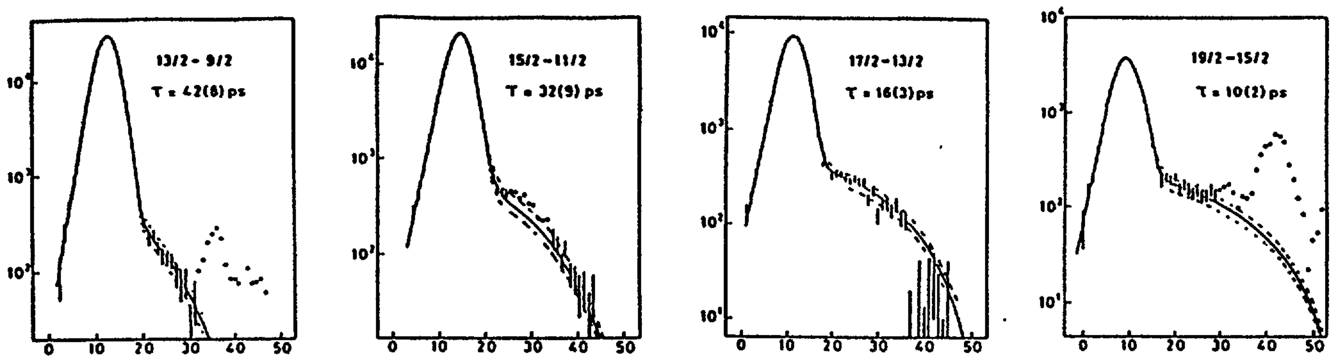
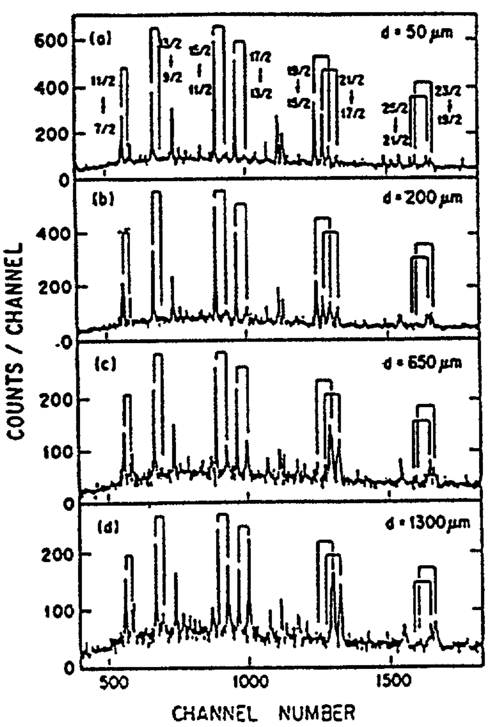


Fig. 3 Results of lineshape analysis on ^{167}Er gamma-ray. Solid curves represent the best fits and dashed ones show the range of uncertainties. The open circles are neglected in the fit because there are considerable effects from intruder gamma-rays. (Ref. b)



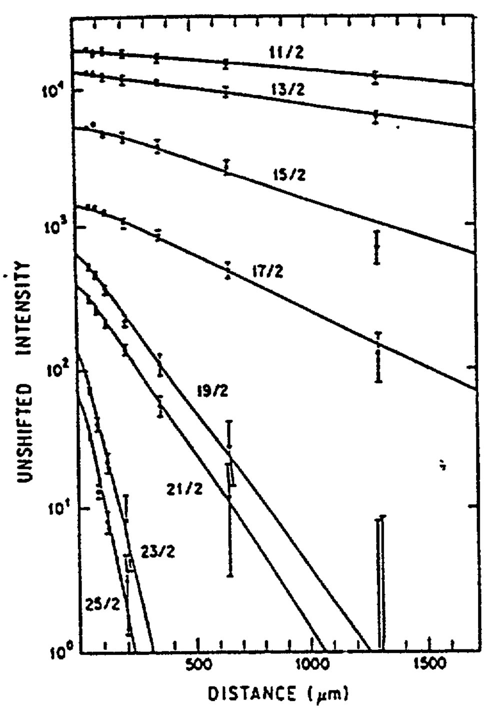


Fig. 4 Illustrative particle-gated γ-ray spectra of ^{161}Dy covering the 200-700 keV region for four of the ten distances measured (left side),(Ref. d)

Fig. 5 Decay curves for the ground-band members of ^{161}Dy. (right side),(Ref.d)

A recoil distance method (RDM) is more direct way to measure lifetimes, because this method needs not the knowledge of stopping powers. During the course of experiments we made a setup for the measurement by RDM. The results of spectra and analysis are shown in Fig 4 and 5 for the ground-band members of ^{161}Dy.

Level scheme: The level schemes excited by Coulomb excitation in our course of experiments are shown in Fig. 6-9.

For ^{161}Dy, the high-spin states up to 33/2 are already known from ^{160}Gd(α,3n) reaction. The lifetimes from 11/2+ state up to 25/2+ state were obtained in this experiment (Fig. 6). For the ground-state band of ^{163}Dy, the states from 19/2- to (27/2-) were assigned and lifetimes from 11/2- to 23/2- states were measured for the first time (Fig. 7).

For ^{167}Er, the states and their lifetimes in ground state band from 13/2+ to 25/2+ were identified by our heavy-ion Coulomb excitation experiments (Fig. 8).

For the nucleus ^{173}Yb, the ground band has been known up to I=13/2, and lifetimes of the ground-band members were known up to the second excited state(9/2-) by light ion Coulomb excitation. Our experiments extended the band members up to (27/2-) state and lifetimes up to 25/2- state (Fig.9).

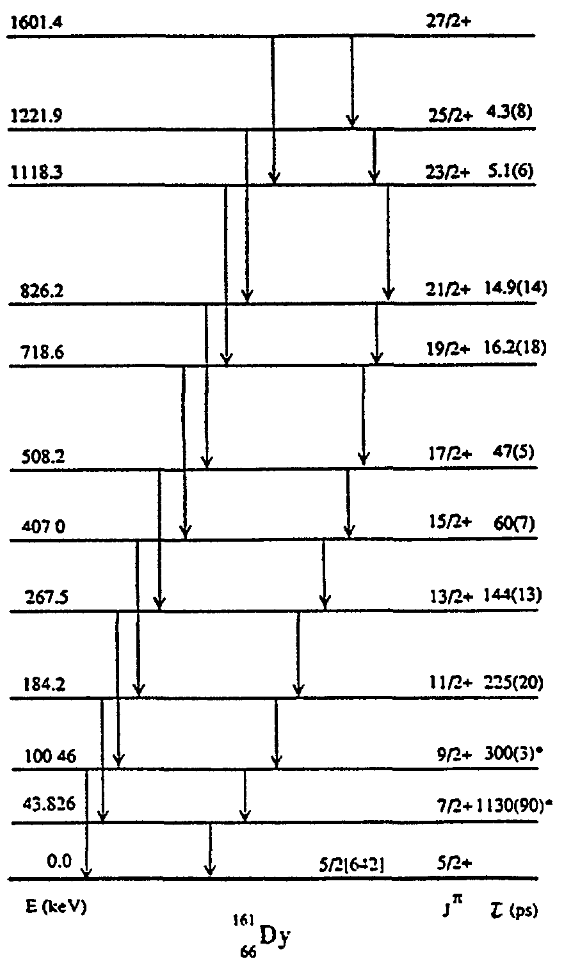


Fig. 6 A level scheme of the ground-state rotational band of ^{161}Dy. Energies are from Ref. 1.

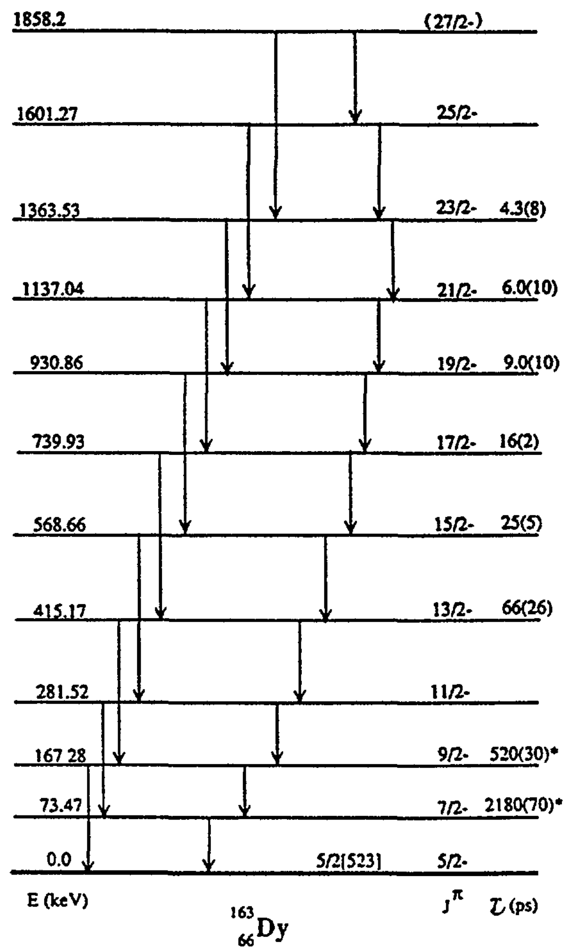


Fig. 7 A level scheme of the ground-state rotational band of ^{163}Dy. Asterisk is given to previously reported lifetime values.[9]

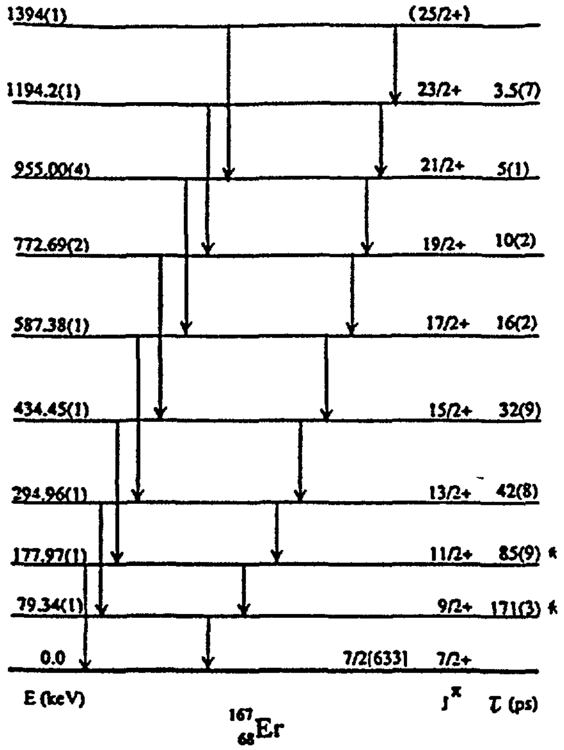


Fig. 8 A level scheme of the ground-state rotational band of ^{167}Er. Asterisk is given to previously reported lifetime values.[10)]

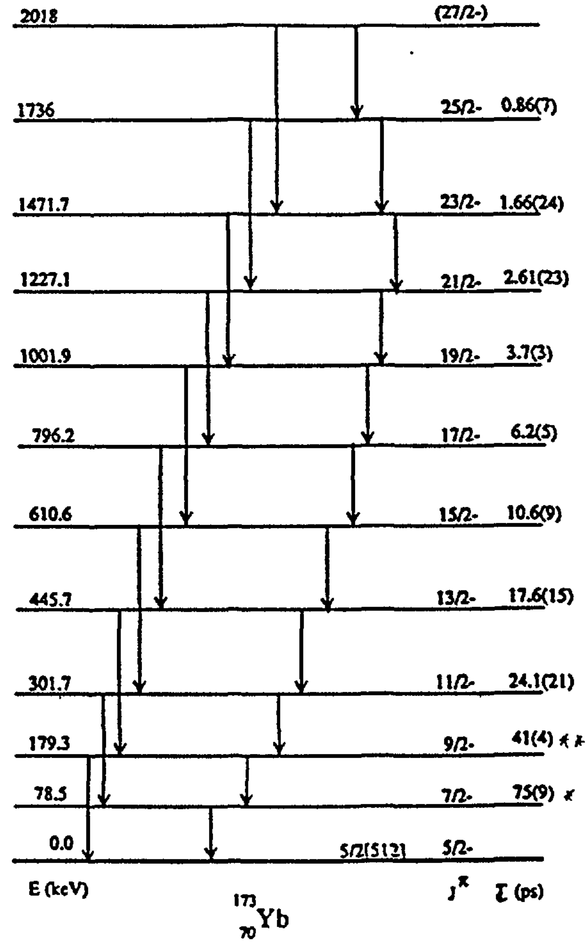


Fig. 9 A level scheme of the ground-state rotational band of ^{173}Yb. Asterisk is given to previously reported lifetime values.[11)] Double asterisk is given to another previously reported values.[12)]

4. Reduced transition probabilities

From nuclear lifetimes, branching ratios and E2/M1 mixing ratios, reduced transition probabilities were obtained. To study the signature dependence, plots were made on these cross-over and stop-over transtions of B(E2) and B(M1) valeus as a function of angular momentum of the ground-state band. Examples are shown in Fig. 10-15.

To examine the Coriolis effect on rotational levels, we first calculated the Coriolis interaction in unified-model for ^{167}Er. Wave functions were obtained to fit experimental energies of the ground-state rotatinal band members (Ref.b). These wave functions were used to calculate the electromagnetic transition probabilities in the ground state rotational band. Both B(E2;I → I-2) and B(E2;I→ I-1) values thus obtained (Fig. 10,11) change monotonically with spin, however B(M1) values show remarkable oscillation at high spins (Fig.12), suggesting the existence of signature dependence on B(M1). In the figure, the results of calculations with other models were shown, where Hamamoto used a cranking model, Iwasaki calculated by the cranked-Hartree-Fock-Bogoljubov method and Marshalek

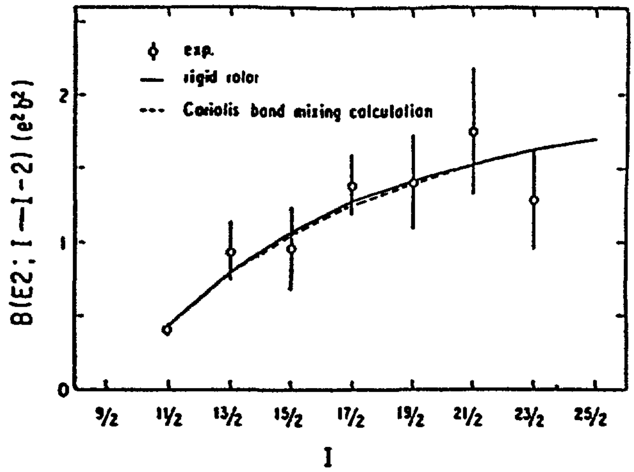


Fig.10 Reduced E2 transition probabilities for cross-over (E2) transitions in ^{167}Er. Experimental values are denoted by the open circles connected by the solid line. The rigid-rotor values are obtained by adopting an intrinsic quadrupole moment Q_0 =7.7 b.(Ref.b)

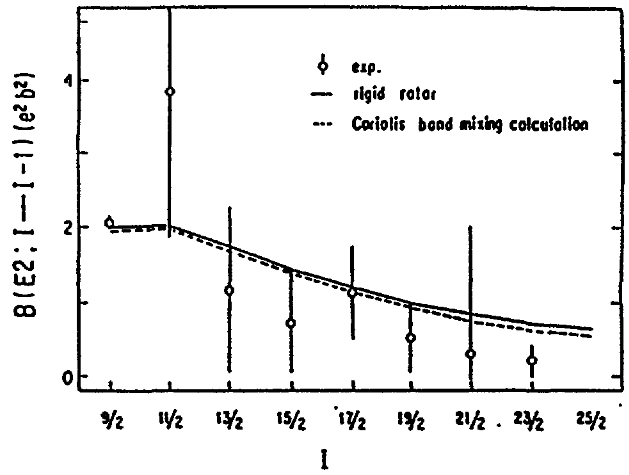


Fig.11 Reduced E2 transition probabilities for stop-over transitions in ^{167}Er. The rigid-rotor values are obtained by adopting an intrinsic quadrupole moment Q_0 = 7.7 b. (Ref. b)

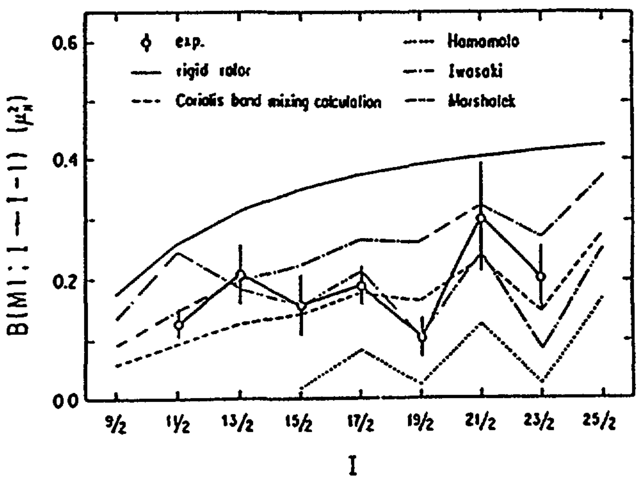


Fig.12 Reduced M1 transition probabilities for stop-over (M1+E2) transitions in ^{167}Er. The rigid-rotor values are obtained by adopting g_K-g_R= -0.57.
Experimental values denoted by the open circls and connected by the solid line are compared with theoretical calculations. (Ref. b)

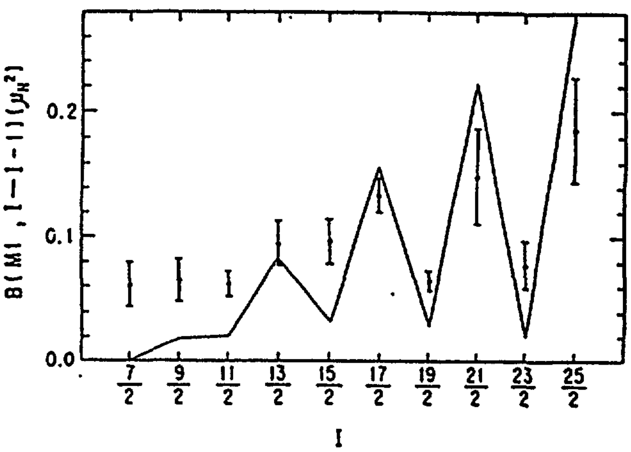


Fig.13 The B(M1) values for the ground-state rotaional band of ^{161}Dy. The experimental values for I=7/2 and I=9/2 are from Ref.13 and others the present data. The solid line denotes the present AMP calculation. (Ref. d)

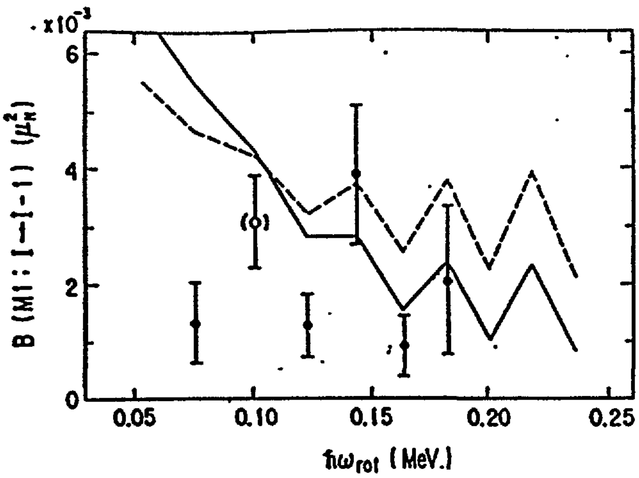


Fig.14 B(M1;I→I-1) values for the ground-state rotational band of ^{163}Dy. The solid (broken) line shows the calculation with (without) the γ vibrations. The experimental values for I=11/2 was obtained by assuming Q_t=7.2 b. The calculated values of g_{RPA} are about 0.34 which is almost independent of $\hbar\omega_{rot}$ because we used the diabatic representation. (Ref. c)

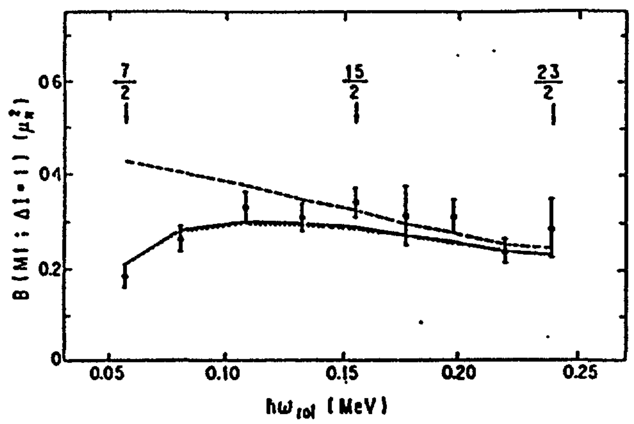


Fig.15 B(M1;I→I-1) values for the ground-state rotational band of ^{173}Yb. The experimental values for I=7/2 and 9/2 are from Ref.14. The solid (broken) line shows the calculation with (without) the geometrical factor. The dotted line includes the γ vibration besides the geometrical factor. (Ref. e)

used particle-rotor model by means of the Holstein-Primakoff boson expansion (Ref b and references therin).

As shown in Fig.13, experimental B(M1) values of ^{161}Dy oscillate very clearly at high spin showing considerable signature dependence. The experimental results were compared with microscopic calculation using angular momentum projection (AMP) method (Ref. d).

The ground state of ^{163}Dy is assigned as $5/2^-$[523]. However experimental B(M1) values also seem oscillate as a function of spin or rotational energy (Fig. 14). Matsuzaki performed a microscopic calculation based on the rotating shell model where γ-vibration modes are constructed by the random-phase approximation (Ref. e). The results of calculation are shown also in Fig. 14. This "inverted" signature dependence was shown in terms of the rotating shell model to originate from the characteristic coherence between the orbital and spin contributions in the spin-down dominant one-quasiparticle states.

To confirm such a mechanism, we performed a same kind of experiment with ^{173}Yb whose ground-state rotational band is based on the natural-parity Nilsson state 5/2[512]. As shown in Fig.15, no signature dependence were observed in B(M1) (Ref. f).

5. Conclusion

By our experiments, 18 new levels were identified and 36 lifetimes of the states belonging to the ground state rotational band were measured for the first time by a Doppler shift attenuation method and/or a recoil distance method. Eighty six reduced transition probabilities of B(M1) or B(E2) were obtained between the states in ^{161}Dy, ^{163}Dy, ^{167}Er and ^{173}Yb.

From the energies of states and reduced transition probabilities, the following conclusion can be deduced.

(1) The significant signature dependence of B(M1) as well as of level energies was observed for the ground-state rotational band in ^{167}Er. The band is built on the $i_{13/2}$-neutron orbital.

(2) For the ground-state rotaional band of ^{161}Dy which is based on the $i_{13/2}$, a significant signature dependence was observed for the B(M1;I→I-1) values. Both experimental B(E2;I→I-2) and B(M1;I→I-1) values were reproduced well by the calculation of angular momentum projection method (AMP).

(3) The ground-state rotational band of ^{163}Dy is based on the 5/2[523] Nilsson orbital. A signature dependence was observed in the B(M1;I→I-1) values but not in the excitation energies nor in the B(E2) values. The signature splitting of quasiparticle energy and the absolute values of the B(M1) indicate predominant $h_{9/2}$ character for the ground-state rotational band. The phase of the zigzag in the B(M1) values is opposite to the one which is expected for the dominant j=9/2 configuration, while the quasiparticle energy splitting and the absolute value of the B(M1) are in agreement with the dominant j=9/2 character for this band. This inverted signature dependence was shown in terms of the rotating shell model to originate from the characteristic coherence between the orbital and spin contributions in the spin-down($\Omega=\Lambda-1/2$) dominant one-quasiparticle states.

(d) To confirm such a mechanism, ^{173}Yb which have spin-up ($\Omega=\Lambda+1/2$) dominat configurations was studied. The ground-state roational of ^{173}Yb is based on the natural-parity Nilsson state 5/2[512]. All of the observed quantities show almost no signature dependence as generally expected for the spin-up one-quasiparticle bands with natural parity. A rotating-shell-model calculations[7)] reproduce both the absolute values and the signature dependence of these quantities well.

This report is a summary of the following reports.

a) M.Ohshima, E.Minehara, M.Ishii, T.Inamura and A.Hashizume: 'Multiple Coulomb Excitation of ^{167}Er' J. Phys. Soc. Japan 52,2959(1983).

b) M.Ohshima, E.Minehara, M.Ishii, T.Inamura and A.Hashizume: 'Multiple Coulomb Excitation of ^{167}Er', Nucl. Phys. A436,518(1985).

c) E.Minehara, M.Oshima, S.Kikuchi, T.Inamura, A.Hashizume, H. Kumahora:

'Signature dependence observed for M1 transitions between Rotational Levels Based on an $f_{7/2}$ single-particle state in ^{163}Dy',

Phys. Rev.C35,858(1987), (rapid communication).

d) M.Oshima, E.Minehara, S.Ichikawa, H.Iimura, T.Inamura, A.Hashizume, H.Kusakari and S.Iwasaki*

'Signature dependence of M1 and E2 transition probabilities for the $i_{13/2}$ rotational band in ^{161}Dy',

Phys. Rev.C37,2578(1988)

e) M.Oshima, E.Minehara, S.Kikuchi, T.Inamura, A.Hashizume H.Kusakari and M.Matsuzaki:

'Rotational perturbation to the natural-parity rotational band of ^{163}Dy',

Phys. Rev. C39,645(1989).

f) M.Oshima, M.Matsuzaki, S.Ichikawa, H.Kusakari, T.Inamura A.Hashizume,M.Sugawara:

'Electromagnetic transition probabilities in the natural-parity rotational band of ^{173}Yb',

Phys. Rev. C40,2084(1989).

References

1) S.A.Hjorth, A.Johnson and G.Ehrling, Nucl. Phys. A184,113(1972).
2) E.Selin, S.A.Hjorth and H.Ryde, Physica Scripta 2,181(1970).
3) G.B.Hagemann, J.D.Garrett, B.Herskind, J.Kownacki, B.M.Nyako, P.L.Nolan, J.F. Sharpey-Schafer, and P.O.Tjom, Nucl. Phys.A424,365(1984); D.C.Radford, H.R.Andrews, G.C.Ball, D.Horn, D.Ward,F.Banville, S.Flibotte, P.Taras, J. Johansson, D.Tucker, and J.C.Waddington, in contribution to the workshop on Nuclear Structure, The Niels Bohr Institute, May, 1988.
4) J.Gascon, P.Taras, D.C.Radford, D.Ward, H.R.Andrews and F.Banville, Nucl. Phys. A467,539(1987).
5) C.-H.Yu, M.A.Riley, J.D.Garrett, G.B.Hagemann, J.Simpson, P.D.Forsyth, A.R. Mokhtar, J.D.Morrison, B.M.Nyako, J.F.Sharpey-Schafer and R.Wyss, Nucl. Phys. A489,477(1988).
6) P.Frandsen, R.Chapman, J.D.Garrett, G.B.Hagemann, B.Herskind, C.-H.Yu, K. Schiffer, D.Klarke, F.Khazaie, J.C.Lisle, J.N.Mo, L.Carlen, P.Ekstrom and H.Ryde, Nucl. Phys. A489,508(1988).
7) M.Matsuzaki, Phys. Rev.C39,691(1989).
8) T.Inamura, F.Kearns and J.C.Lisle, Nucl.Inst.Meth. 123,529(1975).
9) J.M.Dairiki, E.Browne and V.S.Shirley, Nucl.Data Sheets 29,653(1980).
10) B.Harmatz, Nucl.Data Sheets 17,143(1976).
11) Y.Dar, J.Berger, A.Macher and J.P.Vivien, Nucl. Phys. A171,575(1971).
12) B.Elbek, Thesis, University of Copenhagen (1963).

13) R.G.Helmer, Nucl. Data Sheets 43,1(1984).
14) B.Harmatz and D.J.Horen, Nucl.Data Sheets 14,297(1975).

List of NSDD meetings

	place	date	report
1.	Vienna, Austria	29.4.-3.5.1974	INDC(NDS)-60
2.	Vienna, Austria	3.-7.5.1976	INDC(NDS)-79
3.	Oak Ridge, USA	14.-18.11.1977	INDC(NDS)-92
4.	Vienna, Austria	21.-25.4.1980	INDC(NDS)-115
5.	Zeist, Netherlands	11.-14.5.1982	INDC(NDS)-133
6.	Karlsruhe, Germany	3.-6.4.1984	INDC(NDS)-157
7.	Grenoble, France	2.-5.6.1986	INDC(NDS)-182
8.	Ghent, Belgium	16.-20.5.1988	INDC(NDS)-206
9.	Kuwait, Kuwait	10.-14.3.1990	INDC(NDS)-250