



Isotopes Project

LAWRENCE BERKELEY NATIONAL LABORATORY

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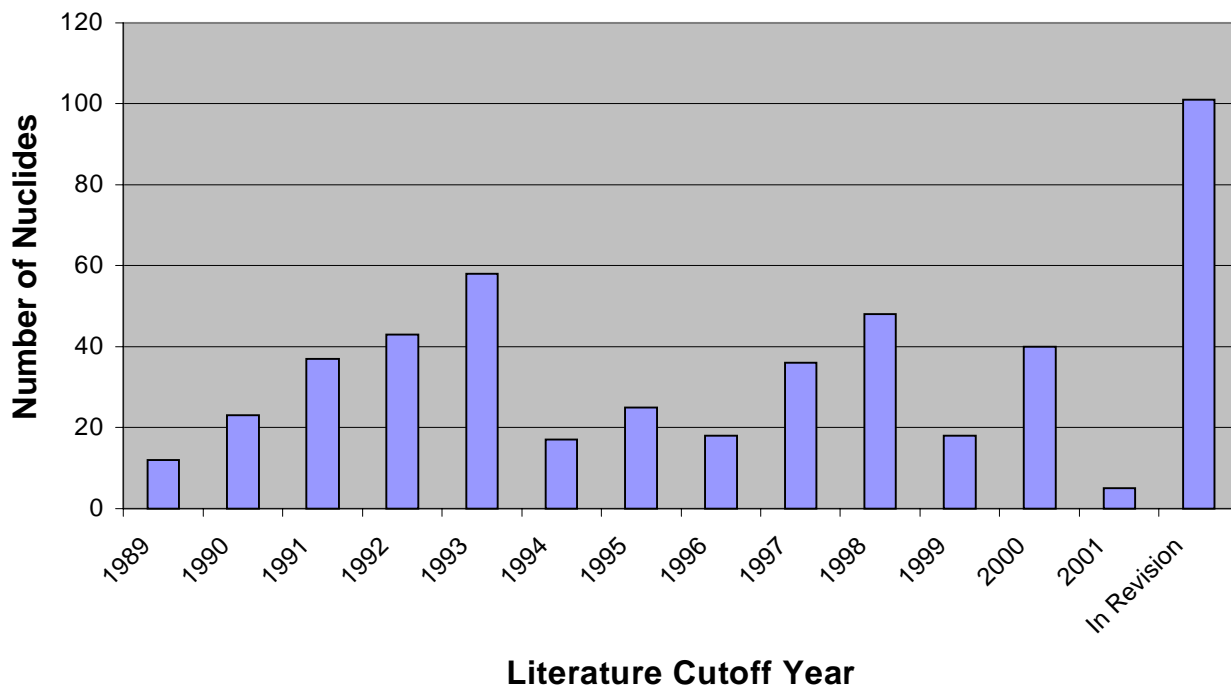
NUCLEAR DATA EVALUATION ACTIVITIES April 2000 - April 2001

MASS CHAIN RESPONSIBILITY, STATUS (~500 nuclides)

Permanent: A = 59, 81, 83, 90-93, 166-187, 189, 191-193, 206, 210-212, 215, 219, 223, 227
Temporary: A = 235, 239

The literature cutoff dates for the ~500 permanently-assigned nuclides are shown below.

Age of Nuclides Assigned to LBNL



PERSONNEL (EVALUATION)

Isotopes Project personnel involved in data evaluation/compilation are as follows:

C. Baglin	1.0 FTE	E. Browne	1.0 FTE
R. Firestone	0.5 FTE		

In addition, one guest spent leave with the Isotopes Project: Professor Shiu Chin (Alice) Wu (Taiwan) (July - August '00). Dr. Wu evaluated A=83.

Ongoing international collaborations exist with Gabor Molnar (Hungary) and Zhou Chunmei (China) (preparation of evaluated (n, γ) data), and with French, German, British, US, Spanish, Brazilian and Russian scientists participating in the radioactive Decay Data Evaluation Project (DDEP).

The group is indebted to Jean Zipkin (also a guest of LBNL) for data entry of many (n, γ) and A=21-39 datasets.

EVALUATION ACCOMPLISHMENTS (since April 2000 Meeting)

- **Mass Chain Evaluations:**

Submitted: 83, 169, 227, 231
Published: 46, 92, 167, 267-293

- **Complete Nuclide Evaluations:**

The nuclide evaluations (listed below) were undertaken because of their 'priority' status (those marked with *), the existence of significant, newly-published information which could be expeditiously included in ENSDF (thus improving the timeliness of the file), the need to revise α -decay parent or daughter information (for internal consistency of the file), or the absence of a published evaluation for the nuclide.

- Published:
 $^{183}\text{Hg}^*$.
- Unpublished (reviewed and added to ENSDF):
 ^{91}Kr , ^{91}Sr , ^{91}Zr , $^{93}\text{Kr}(\text{Br})$, $^{93}\text{Rh}(\text{Pd})$, ^{179}Tl , ^{187}Pb , ^{191}Bi , ^{191}Po .

- **DDEP Evaluation:** ^{152}Eu .

- **Continuation of IAEA CRP to develop an (n, γ) Database:**

This 3-year IAEA-sponsored Coordinated Research Project is to be completed in 2002. It aims to produce a database for use in neutron-induced prompt gamma-ray activation (PGAA) analysis. Thermal and cold neutron capture isotopic data are being evaluated in China and the US to obtain best values for gamma-ray yields per 100 neutron captures. CRP participants in Hungary and the US will then combine those data (in ENSDF format) with measured elemental data (from Hungary and elsewhere) to produce recommended values for prompt-gamma energies and intensities and other useful information. The database will be tested at several neutron facilities.

Evaluated (thermal n, γ) data sets not already in ENSDF will ultimately be submitted to NNDC for inclusion in ENSDF.

- **Reviews of Evaluations:**

Mass Chains: A=141, 144

- **ENSDF Coding of non-US Evaluations:**

- **1998 Update for A=21-44 by P. Endt**

The remaining 13 chains (A=27-39) have been completed and included in ENSDF. For each chain:

- The updated information from Endt (1998) was added to the Adopted Levels, Gammas datasets previously existing in ENSDF.
- The existing decay datasets in ENSDF were updated from the literature and new datasets were created when necessary.
- Reaction datasets were created from material given in Endt's evaluation (this information had not been in ENSDF).
- Evaluated (n, γ) datasets (from the IAEA CRP activity) were added.

- **DDEP Material:**

Evaluations for ^{68}Ge , ^{68}Ga , ^{125}I , ^{141}Ce were coded, and the resulting Decay and Adopted data sets have been included in ENSDF.

NUCLEAR DATA DISSEMINATION ACTIVITIES

April 2000 - April 2001

DISSEMINATION RESPONSIBILITY, STATUS

The Isotopes Project collaborates with Lund University (Sweden) and EVITech (Finland) to develop Isotope Explorer 2 (C++, Windows), Isotope Explorer 3 (Java, HTML), and the WWW Table of Radioactive Isotopes. The group also supports WWW dissemination home pages for Nuclear Astrophysics, Neutron Capture, Spontaneous Fission, Radioactive Decay, Nuclear Structure, Atomic Masses, Education, and other topics. The demand for these services has increased substantially each year and the usage, derived from the server log, is summarized in Table 1.

Table 1. Usage Summary from the LBNL Isotopes Project Server

	1996	1997	1998	1999	2000
Total Requests	240,035	509,920	902,024	1,934,757	2,799,762
Users per Month [#]	1,542	3,190	4,470	5,855	8,945
Isotope Explorer 2	68,264	162,468	246,525	395,727	515,914
Isotope Explorer 3	0	0	1,266	44,127	96,750
XUNDL Isotopes	0	0	0	3,738	7,114
WWW TORI Search	0	0	50,217	189,979	NA
NSR Searches	0	12,253	32,212	44,586	28,302*
Education	0	0	6,701	21,727	54,361
Astrophysics	3,956	8,322	7,254	9,782	9,452
Atomic Masses	3,124	5,935	8,070	12,334	19,575
Radioactive Decay	3,152	5,563	7,319	8,794	11,039
Nuclear Structure	1,729	2,920	4,394	5,547	6,498
Neutron Capture	0	0	3,013	7,540	9,269
Fission	0	0	2,476	5,589	6,547
Isotopes Project	3,665	6,166	11,323	22,892	31,851

[#] Individual users logging in.

* LBNL only. Lund statistics are not available.

PERSONNEL (DISSEMINATION)

Isotopes Project personnel involved in data dissemination are as follows:

R. Firestone 0.5 FTE

In addition, two students from the Espoo-Vantaa Institute of Technology (EVITech), Samuli Ruuskanen and Jyri Ranki, spent extended training periods with the Isotopes Project.

DISSEMINATION ACTIVITIES

- **ISOTOPE EXPLORER 2 (C++, Windows)**

Isotope Explorer 2 and its predecessor VuENSDF were first developed in 1996 by the LBNL/Lund collaboration. The Windows C++ program is a helper application for displaying *Nuclear Data Sheets* style tables, level scheme and rotational band drawings, plots, and nuclear charts. There are currently about 3200 registered users of the program. Isotope Explorer 2 can interactively retrieve and display ENSDF data from the WWW, *Table of Isotopes* CD-ROM, or from local files. Data can be restricted to a range of property values, tables can be sorted by column, and level scheme drawings can be restricted by coincidence relationships. The nuclear charts can be colored by property and used to search and display data from the ENSDF file or from a ground state/isomer property database. Reference keyword abstracts can be displayed for each dataset, and the references can be searched by author name. The databases used have been updated whenever a new release became available.

- **ISOTOPE EXPLORER 3 (Java, HTML)**

Isotope Explorer 3 was developed by the LBNL/Lund collaboration. The program provides Internet access to ENSDF, XUNDL, SDBAND, and TORI databases. The data can be selected by dataset, decay or reaction type, or by isotope. Information is displayed both as *Nuclear Data Sheet* style tables, and as level scheme or rotational band drawings. The data can be selected by level and gamma properties. References are linked to the NSR file. However, Java language is still limited for displaying Greek characters, slanted text, and other desired capabilities. Files cannot be saved and the output is often too slow. These limitations have reduced the acceptance of Isotope Explorer 3; it is used by less than 10% of all Isotope Explorer users. The databases used have been updated whenever a new release became available.

- **ISOTOPE EXPLORER REFERENCE SERVER**

The Isotope Explorer reference server was developed by the LBNL/Lund collaboration. It supports rapid searches of the NSR file by author(s), nuclide, publication year, keynumber, keyword, reaction, and other criteria. References to recent AIP journal articles are linked directly to the papers. Recently a second mirror server has been added to provide better service for users. The database used is updated whenever a new release becomes available.

- **WWW TABLE OF RADIOACTIVE ISOTOPES**

The WWW Table of Radioactive Isotopes was developed by the LBNL/Lund collaboration. Alpha-, beta- and gamma-ray decay data from ENSDF has been installed into a database that is searchable on the Internet. We have added calculated x-ray and Auger-electron energies and intensities for vacancies in the K, L1, L2, and L3 atomic shells. Beta spectra have been calculated and are displayed with a Java plotting applet. These data can be searched by energy, intensity, and by parent mass, atomic number, neutron number, and/or half-life. The data are also linked to decay scheme drawings generated with Isotope Explorer 3. Work is in progress to calculate bremsstrahlung and conversion electron spectra and to generate genetic feedings.

- **WWW HOME PAGES**

The Isotopes Project maintains WWW home pages for a variety of topics of nuclear interest. The Nuclear Astrophysics home page provides astrophysical rates and other related information necessary for nucleosynthesis calculations. The Nuclear Structure home page offers access to the Table of Superdeformed Nuclear Bands and Fission Isomers and other information for the high-spin

community. The Neutron Capture home page gives access to capture gamma-ray data from Lone and ENSDF, and thermal neutron cross sections. The Fission home page was developed for users of the Gammasphere spontaneous fission data. The Educational home page provides a periodic table linked to information about the isotopes of any element, and animated Gifs displaying various nuclear and astrophysics phenomena. Experimental and theoretical atomic masses are on the Atomic Mass home page. A new page for nuclear structure and decay systematics was added in FY2001 at the behest of the recent Nuclear Reactions Town Meeting in Berkeley.

- **PGAA DATABASE SEARCH**

The Isotopes Project is developing dissemination software as part of its commitment to the IAEA Coordinated Research Project for the *Development of a Database for Prompt γ -ray Neutron Activation Analysis*. Beta test software, developed in collaboration with EVITech, has been prepared in Javascript, for Internet dissemination, and in JAVA for standalone distribution. Both programs are similar to the LBNL/Lund *Table of Radioactive Isotopes* supporting both data retrievals and searches by element and/or γ -ray energy.

- **DATABASE POLICY**

One Isotopes Project member is participating in a global discussion concerning the need to preserve irreplaceable data that constitute an often-neglected legacy in various scientific fields, including nuclear science. A project to address such a need is the subject of a FY2001 DOE SBIR proposal submitted in conjunction with Virtual Physics Associates.

INTERNET ADDRESSES

LBNL/Lund Nuclear Data Dissemination home page - <http://ie.lbl.gov/toi.html>
Isotope Explorer 2 - <http://ie.lbl.gov/isoexpl/isoexpl.htm>
Isotope Explorer 3 - <http://ie.lbl.gov/ensdf/>
WWW Table of Radioactive Isotopes - <http://nucleardata.nuclear.lu.se/nucleardata/toi/>
Nuclear Science References(LBNL) - <http://128.3.5.61:6023/welcome.htm>
Nuclear Science References (Lund) - <http://130.235.93.31:6023/welcome.htm>
Educational Website - <http://ie.lbl.gov/education/isotopes.htm>
Nuclear Astrophysics home page - <http://ie.lbl.gov/astro.html>
Nuclear Structure home page - <http://ie.lbl.gov/hspin.html>
Neutron Capture home page - <http://ie.lbl.gov/ng.html>
Fission home page - <http://ie.lbl.gov/fission.html>
Atomic Mass data home page - <http://ie.lbl.gov/toimass.html>
Nuclear Structure Systematics home page <http://ie.lbl.gov/systematics.html>
Isotopes Project home page - <http://ie.lbl.gov/ip.html>
Lund Nuclear Data WWW Service home page –
http://nucleardata.nuclear.lu.se/nucleardata/index.asp?page=Links_database
Evitech home page - <http://www.evitech.fi/en/index.html>

PUBLICATIONS (since April '00 Meeting)

- **Nuclear Data Evaluation**

Nuclear Data Sheets for A=267-293, R.B. Firestone and J. Gilat, Nuclear Data Sheets **90**, 391 (2000)

Nuclear Data Sheets for A=167, Coral M. Baglin, Nuclear Data Sheets **90**, 431 (2000).

Nuclear Data Sheets for A=46, S.-C. Wu, Nuclear Data Sheets **91**, 1 (2000).

Nuclear Data Sheets for ^{183}Hg , Coral M. Baglin, Nuclear Data Sheets **91**, 117 (2000).

Nuclear Data Sheets for A=92, Coral M. Baglin, Nuclear Data Sheets **91**, 423 (2000).

- **Nuclear Structure and Nuclear Astrophysics Research:**

Measurement of Excitation Functions in the Reaction $^{197}\text{Au}(^{11}\text{C},xn)^{208-x}\text{At}$ Using a Radioactive ^{11}C Beam, R. Joosten, J. Powell, F.Q. Guo, P.E. Haustein, R.-M. Larimer, M.A. McMahon, E.B. Norman, et al., Phys. Rev. Lett. **84**, 5066 (2000).

New Determination of the Ba-Mo Yield Matrix for ^{252}Cf , S.-C. Wu, R. Donangelo, J.O. Rasmussen, A.V. Daniel, J.K. Hwang, A.V. Ramayya, J.H. Hamilton, Phys. Rev. C **62**, 041601 (2000).

Determination of the Half-life of ^{37}Ar by Mass Spectrometry, P.R. Renne and E.B. Norman, Phys. Rev. C **63**, 047302 (2001).

Search for the Decay of the 3.5 eV $^{229}\text{Th}^m$, E. Browne, E.B. Norman, R.D. Canaan, D.C. Glasgow, J.M. Keller, J.P. Young, submitted to Phys. Rev. Letters (2001).

- **Data Evaluation Talks:**

"Update on the U.S. Nuclear Structure and Decay Data Evaluation Program", Coral M. Baglin, Bull. Am. Phys. Soc. **45**, No. 2, 30, B14.7 (Long Beach, 2000).

- **Other Talks/Publications Related to Nuclear Data**

IAEA Coordinated Research Project on the Development of a Database for Prompt Gamma-Ray Neutron Activation Analysis: Progress Report, Richard B. Firestone in **INDC(NDS)-411**, 45 (2000).

The New Prompt Gamma-ray Catalog for PGAA, G.L. Molnar, Zs. Revay, T. Belgya and R. B. Firestone, Proc. 4th Topical Meeting on Industrial Radiation and Radioisotope Measurement Applications (IRMMA'99), 3-7 October 1999, Raleigh NC; Appl. Radiat. Isot. **53**, 527 (2000)

Nuclear Structure and Decay Data in the Electronic Age, R.B. Firestone, J. Radioanal. Nucl. Chem. **243**, 77 (2000).

Application of Prompt Gamma Activation Analysis (PGAA) to Inorganic Photochromic Host Materials, D.L. Perry, R. Gatti, R.B. Firestone, G.L. Molnar, Z. Rezavy and Z. Kasztovszky, Am. Chem. Soc. National Meeting, 26-30 March 2000, San Francisco CA, Paper INOR590.

Application of Prompt Gamma Activation Analysis (PGAA) to Ocean Floor Geothermal Vent-Produced Metal Sulphides, D.L. Perry, R. Gatti, R.B. Firestone, P. Wilde, G.L. Molnar, Z. Rezavy and Z. Kasztovszky, Am. Chem. Soc. National Meeting, 26-30 March 2000, San Francisco CA, Paper GEOC83.

The Nuclear Science Database: 60 Years of Community Experience, R.B. Firestone, keynote address to the HUGO Mutation Database Initiative Meeting, 9 April 2000, Vancouver, Canada.

Precise Determination of Ga-66 Decay Gamma-Ray Intensities, T. Belgya, G.L. Molnar, F. Szelecsenyi, C.M. Baglin, E. Browne, E.B. Norman, Bull. Am. Phys. Soc. **45**, No. 2, 29 (2000), Paper B14.4.

Databases: Science's Neglected Legacy, S.M. Maurer, R.B. Firestone and C.R. Sriver, Nature **405**, 116 (2000).

A new gamma-ray spectrum catalog for PGAA, Zs. Révay, G.L. Molnár, T. Belgya, Zs. Kasztovszky, and R.B. Firestone, Journal of Radioanalytical and Nuclear Chemistry 244, 379-382 (2000).

Terrestrial Evidence of a Nuclear Catastrophe in Paleoindian Times, R.B. Firestone and W. Topping, The Mammoth Trumpet 16, 9 (2001).

Did a Supernova in Paleo-Indian Times Reset the Radiocarbon Clock?, R.B. Firestone, invited seminar for the UC Berkeley seminar series "YnK Conservation: Time, the Overlooked Dimension", March 2, 2001.

Neutron-Induced Prompt Gamma Activation Analysis (PGAA) of Metals and Non-metals in Ocean Floor Geothermal Vent-Generated Samples, D.L. Perry, G. Molnar, Zs. Revay, Zs. Kasztovszky, R.C. Gatti, R.B. Firestone, and P. Wilde, submitted to Journal of Analytical Atomic Spectrometry (2001).

⁶⁶Ga and ²²⁹Th: Two puzzles in nuclear data, Eric B. Norman, Am. Chem. Soc. National Meeting, 1-5 April 2001, San Diego CA, Paper NUCL 90.