

# Nuclear Reaction Databases of the NNDC



## Evaluated Nuclear (reaction) Data File (ENDF)

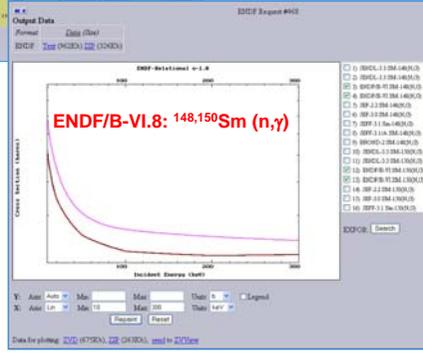
www.nndc.bnl.gov/endlf

### Retrieval for $^{148,150}\text{Sm} (n,\gamma)$

**Nucleosynthesis beyond Iron:**  
The s-process reaction flow in the neodymium/promethium/samarium region is characterized by branchings at A=147-149, which reflecting the strength of stellar neutron flux.

### ENDF: Core Nuclear Reaction Database

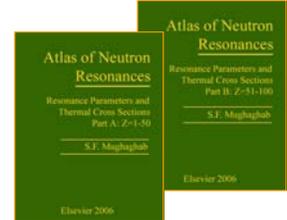
- ✓ Evaluated (recommended) cross sections, spectra, angular distributions, fission product yields, decay data, photo-atomic and thermal scattering law data, with emphasis on neutron-induced reactions
- ✓ Covering all nuclides of practical relevance
- ✓ Principal input for neutronics calculations
- ✓ Includes all international libraries



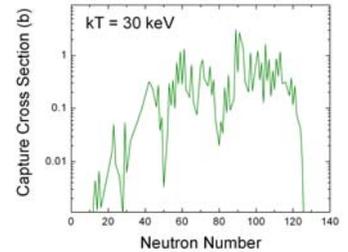
## Atlas of Neutron Resonances

S.F. Mughabghab  
To be published by Elsevier early 2006

- ✓ Individual resonance parameters and thermal cross sections for Z=1-100
- ✓ 473 isotopes, 353 resonance regions



- ✓ 186 (n,gamma) cross sections at 30 keV
- ✓ 173 (96.1%) s-process nuclei are covered

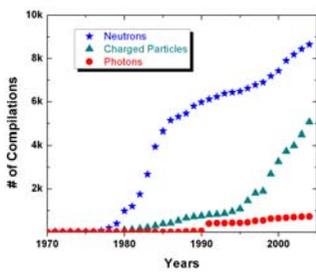


## Experimental Nuclear Reaction Data (EXFOR/CSISRS)

www.nndc.bnl.gov/exfor

- ✓ Incident neutrons, charged particles, photons
- ✓ More than 15,500 experiments (105,000 datasets)
- ✓ Nearly all of neutron-induced reactions

### Compilations



In last 10 years neutron data from 435 journal papers were compiled, with 60 % compilations from papers published in 5 out of 263 refereed journals:

- ✓ Phys. Rev. C 28 %
- ✓ Nuclear Science & Engineering 11 %
- ✓ Nuclear Physics A 8 %
- ✓ Yadernaya Fizika 7 %
- ✓ Yadernye Konstanty 6 %

### Retrieval for $^{14}\text{N}(p,\gamma)^{15}\text{O}$

**CNO cycle:** The CNO reactions in the Sun form a polycycle of reactions, among which the main CNO-I cycle accounts for 99% of CNO energy production. The reaction  $^{14}\text{N}(p,\gamma)^{15}\text{O}$  determines, at solar temperatures, the rate of the main CNO cycle.

- ✓ Interactive database query form
- ✓ Clone experimental data request to ENDF and CINDA databases
- ✓ User feedback options
- ✓ Direct links to journals
- ✓ Data in EXFOR and tabulated (T4) data format (original reference and tabulated dataset only)

# Web Services of the National Nuclear Data Center



B. Pritychenko\*, R. Arcilla, M. Herman, D. Rochman, P. Oblozinsky, A. Sonzogni, J. Tuli, D. Winchell

National Nuclear Data Center, Brookhaven National Laboratory, Upton, NY 11973-5000

\* Email: pritychenko@bnl.gov

## Nuclear Data Portal

www.nndc.bnl.gov

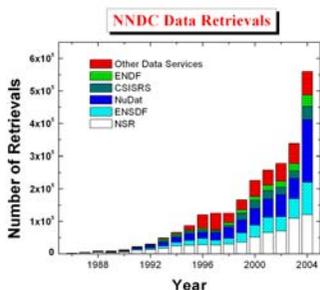
### NNDC Web Services

Web services (Nuclear Data Portal) integrate internal applications such as database access with external applications in NNDC Web site. Nuclear Data Portal features:

- ✓ New generation of DELL servers running Linux
- ✓ Relational Database Software (Sybase)
- ✓ Java solutions for Web applications
- ✓ Nuclear structure, decay and reaction data, as well as bibliographical information
- ✓ Web Interfaces for CINDA, ENDF, CSISRS, ENSDF, NSR, NuDat, XUNDL Databases
- ✓ Search using optimized query forms; results are presented in tables and interactive plots
- ✓ Number of nuclear science tools, codes, applications, and links are provided

### User Response

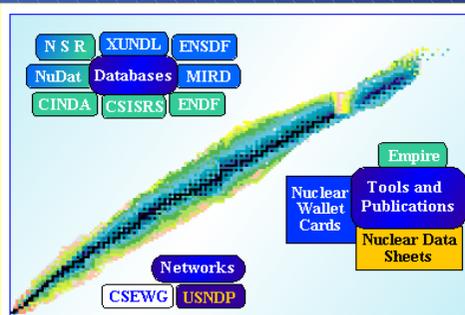
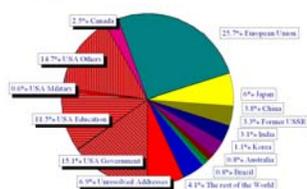
New Web service, launched in April 2004, raised number of database retrievals to 560K in 2004, compare with 338K in 2003. Web statistics analysis for 1986-2004 is shown below.



Results indicate that database retrievals increased approximately two-folds compared with an old product over equivalent time interval. This allows to make a projection that total number of retrievals in 2005 will be at 720 K.

Analysis of NNDC users indicate that 45% of retrievals come from U.S. and Canada, followed by EU and Japan at 25.7% and 6%, respectively.

### Geographical Distribution of NNDC Users



- Nuclear Structure and Decay Databases
- Nuclear Structure and Decay Tools
- Nuclear Reaction Databases
- Nuclear Reaction Tools
- Bibliography Databases
- Networks and Links
- About the Center
- Publications
- Meetings

Nuclear Wallet Cards 2005 **New** Q-value Calculator

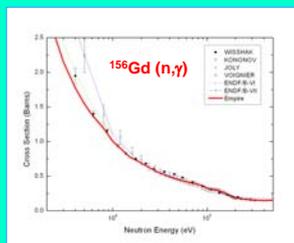
Site Index - Search the NNDC:  go

<b>AMDC</b> Atomic Mass Data Center, <b>Q-value Calculator</b> [New]	<b>CapGam</b> Thermal Neutron Capture Gamma-rays	<b>CINDA</b> Computer Index of Nuclear (reaction) Data	<b>CSEWG</b> Cross Section Evaluation Working Group
<b>CSISRS</b> alias EXFOR Nuclear reaction experimental data	<b>Empire</b> Nuclear reaction model code	<b>ENDF</b> Evaluated Nuclear (reaction) Data File	<b>ENSDF</b> Evaluated Nuclear Structure Data File
<b>For NMMSS &amp; DoE NMIRD</b> safeguards & inventory decay data standards	<b>IRDF</b> International Reactor Dosimetry File [IRDF-2002]	<b>MIRD</b> Medical Internal Radiation Dose	<b>NSR</b> Nuclear Science References
<b>Nuclear Data Sheets</b> Nuclear structure and decay data journal	<b>Nuclear Wallet Cards</b> Ground and isomeric states properties	<b>Nuclear Wallet Cards for Homeland Security</b>	<b>NuDat</b> Nuclear structure and decay data
<b>RIPL</b> Reference Input Parameter Library	<b>USNDP</b> U.S. Nuclear Data Program	<b>XUNDL</b> Experimental Unevaluated Nuclear Data List	<b>Coming Early 2006: Atlas of Neutron Resonances</b>

## Empire-2.19

www.nndc.bnl.gov/empire

Modular system of nuclear reaction codes for comprehensive modeling of nuclear reactions using various theoretical models. It consists of a number of linked FORTRAN codes, input parameter libraries, and experimental data library.



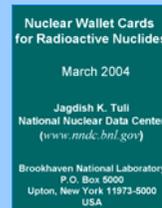
### Features of Empire-2.19:

- ✓ Suitable for neutron capture
- ✓ Full featured Hauser-Feshbach
- ✓ Extensive optical model parameterization
- ✓ Fission with under-barrier effects in terms of optical model for fission
- ✓ Multi-modal fission
- ✓ Reactions on excited targets
- ✓ Width fluctuation correction
- ✓ Suite of gamma-ray strength functions
- ✓ Discrete levels, decay schemes

## Nuclear Wallet Cards

www.nndc.bnl.gov/wallet

- ✓ Up-to-date properties of 3841 ground and isomeric states of all-known nuclei
- ✓ Distributed as a booklet and in PDA format for Palm Pilot
- ✓ Available as seventh (2005), sixth (2000) and radioactive nuclides (2004) editions
- ✓ The sixth edition is used as a decay data standard by DOE Nuclear Materials and Safeguards System



The radioactive nuclides or Homeland Security edition consists of two tables: Nuclide Properties  $T_{1/2} > 1$  h and  $\gamma$ -rays, energy (keV) ordered ( $I_\gamma > 5\%$ ). First table provides half-life, major radiations and major  $\gamma$ -rays information for 737 nuclides. Second table contains information on 944  $\gamma$ -rays and parent nuclides sorted by energy from 101 to 2951 keV.



# Nuclear Structure Databases of the NNDC

## Evaluated Nuclear Structure Data File (ENSDF)

[www.nndc.bnl.gov/ensdf](http://www.nndc.bnl.gov/ensdf)

- Evaluated nuclear structure and decay data for over 2,929 nuclides; 15,451 individual datasets
- Considers all known experimental data for each nuclide
- Principal source of nuclear structure data for research, nuclear spectroscopy applications, databases MIRD and NuDat, and publications such as Nuclear Data Sheets and Table of Isotopes
- Combined data searches between ENSDF and XUNDL
- Web retrievals for Reaction Search are based on indexed reaction quantities
- Web retrievals for Decay Search are based on indexed decay quantities

## Retrieval for <sup>180m</sup>Ta isomer

The nucleosynthesis of <sup>180m</sup>Ta is a challenging problem. The production mechanism is not clear but possible paths have been predicted for s-process, v-process and p-process.

## ENSDF Applications

The ground state of the heaviest odd neutron and proton numbers isotope of <sup>180</sup>Ta has  $T_{1/2} = 8.1$  h. <sup>180</sup>Ta owes its existence to a low-lying <sup>9</sup> isomer with  $T_{1/2} > 1.2 \times 10^{15}$  y.

$E_{level}$	$J^{\pi}$	$T_{1/2}$	Comments
0.0	1+	8.17 d	$T_{1/2}$ weighted average of 13.3 d (2002Wd10) and 8.15 h (2009Wd4)
77.1 d	9-	$> 1.2 \times 10^{15}$ y	$T_{1/2}$ from adopted levels
1087.10	1.5	ps	$T_{1/2}$ identified as the 1076 keV $\gamma$ -ray level in 2001Wd45
1297.20	1.7	ps	$T_{1/2}$ partial resolved as the 1276 keV $\gamma$ -ray level in 2001Wd45
1507.20			$T_{1/2}$ partial resolved as the 1499 keV $\gamma$ -ray level in 2001Wd45
1630.00			
1930.00			
2237.00			
2480.00			
2720.00			
2880.00			

## Nuclear structure & decay Data (NuDat)

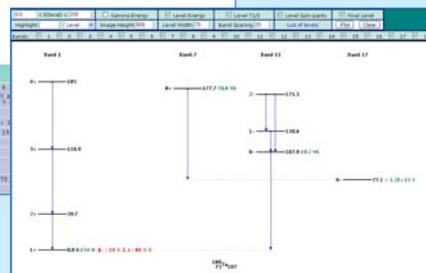
[www.nndc.bnl.gov/nudat2](http://www.nndc.bnl.gov/nudat2)

- Derived database, information extracted from Evaluated Nuclear Structure Data File (ENSDF) and Nuclear Wallet Cards
- Search for levels energy, half-life,  $J^{\pi}$  and decay modes;  $\gamma$ -rays energy, intensity, multipolarity and coincidences; radiation energy and intensity following nuclear decay
- Interactive level and decay schemes
- $\gamma$ - $\gamma$  coincidence search

## NuDat 2.1 retrieval for <sup>180m</sup>Ta isomer

The color of the cell indicates the ground state half-life or predominant decay mode.

NuDat 2.1 main page includes an interactive chart of nuclei. Known nuclei are represented by a cell in a chart with the number of neutrons on the horizontal axis and the number of protons on the vertical axis.



## Nuclear Science References (NSR)

[www.nndc.bnl.gov/nsr](http://www.nndc.bnl.gov/nsr)

- Indexed bibliography of 180,000 nuclear science articles
- About 80 journals are regularly scanned
- Recent references are added on a weekly basis
- Approximately 4500 entries are added to the database annually
- Search on indexed quantities such as nuclide, author, and subject

## Search for A. Aprahamian and rp-process

Where available, digital object identifier (doi) links to publishers pages are provided.

Combined search for A. Aprahamian and rp-process (Combined retrieval allows a boolean "and" search over text and indexed fields) produces 6 matches.