

# IAEA – NDS data retrieval tools

Marco Verpelli  
IAEA Nuclear Data Section

Trieste  
ICTP workshop on Nuclear Structure and Decay Data  
October 2018

# www-nds.iaea.org



International Atomic Energy Agency

## Nuclear Data Services

提供核数据组，原子能机构

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Download data, codes, packages

Quick Links

- ADS-Lib
- Atomic Mass Data Centre
- CINDA
- Charged particle reference cross section
- DROSG-2000
- DXS
- Decay Data Library for Actinides
- EMPIRE-3.2
- ENDF Archive
- ENDF Retrieval
- ENDF-6 Codes
- ENDF-6 Format
- ENDVER
- ENSDF
- ENSDF ASCII Files
- ENSDF programs
- EPICS Electron & photon interaction data
- EXFOR
- FENDL
- Fission Yields

**NEW**

**TENDL-2017** TALYS-based Evaluated Nuclear Data Library, 2017: [page] [list] [retrieve]

**JENDL/AD-2017** JENDL Activation Cross Section File for Nuclear Decommissioning 2017: [page] [list] [retrieve]

**ENDF/B-VIII.0** U.S. Evaluated Nuclear Data Library, issued in 2018: [page] [list] [retrieve]

Main All Reaction Data Structure & Decay by Applications Doc & Codes Index Events Links News



**EXFOR**  
Experimental nuclear reaction data



**LiveChart of Nuclides**  
Interactive Chart of Nuclides



**CINDA**  
Nuclear reaction bibliography



**ENDF**  
Evaluated nuclear reaction libraries



**ENSDF**  
evaluated nuclear structure and decay data (+XUNDL)\*\*



**NSR**  
Nuclear Science References\*

**NuDat-2**  
selected evaluated nuclear structure data\*\*

**RIPL**  
reference parameters for nuclear model calculations

**IBANDL**  
Ion Beam Analysis Nuclear Data Library

**Charged particle reference cross section**  
Beam monitor reactions

**PGAA**  
Prompt gamma rays from neutron capture

**FENDL**  
Fusion Evaluated Nuclear Data Library

**Photonuclear**  
- IAEA Photonuclear Data Library, 1999  
- EPICS Electron & Photon Interaction Data, 2017

**IRDF**  
International Reactor Dosimetry and Fusion File

**NAA**  
Neutron Activation Analysis Portal

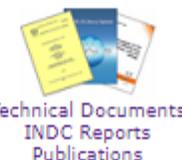
**Safeguards Data**  
recommendations, August 2008

**Medical Portal**  
Data for Medical Applications

**Standards**  
- Neutron cross-sections, 2006  
- Decay data, 2005

\*Database at the IAEA, Vienna \*\*Database at the US NNDC

### IAEA Nuclear Data Section



# Links – quick reference

- **Atomic Mass Data Centre + Nubase** <https://www-nds.iaea.org/amdc/>
- **ENSDF codes** [https://www-nds.iaea.org/public/ensdf\\_pgm/](https://www-nds.iaea.org/public/ensdf_pgm/)
- **Nuclear Moments** <https://www-nds.iaea.org/nuclearmoments/>
- **Decay data portal** [https://www-nds.iaea.org/relnsd/vcharthtml/VChartHTML\\_libs.html](https://www-nds.iaea.org/relnsd/vcharthtml/VChartHTML_libs.html)
- **Pocket Nuclear Database** <https://www-nds.iaea.org/relnsd/pndb/pndb.html>
- **Isotope Browser** for mobile devices [Google Play](#) **or** [App Store](#)
- **Livechart** <https://www-nds.iaea.org/relnsd/vcharthtml/VChartHTML.html>

**Query tool & Plot3D** links are inside Livechart

The screenshot shows the 'Isotope Browser' app interface. At the top, it displays the title 'Isotope Browser' and 'IAEA Nuclear Data Section'. Below this is a navigation bar with 'CHART', 'ELEMENT', and '90 - C - 6'. A secondary bar contains 'GO', 'CLEAR', and 'EXPERT'. The main search area includes fields for 'N', 'A', and 'Jπ', with a 'Stable' checkbox and a 'Y' dropdown. Below this is a section titled 'Decay and Main Radiations' with two rows of controls: 'Decay mode' (set to 0) and 'Decay Rad.' (set to 0), each with a '< % <' and '< keV <' field (both set to 100). A 'Guide' section follows, containing instructions on how to use the app, such as 'Change language going to Preferences', 'Pick an Element', and 'Tap an item'. It also states 'The Database includes ground states and isomers having half-life > 0.1 s'. A 'Chart' section explains that the app shows selected nuclides on the Nuclides Chart and that color represents the main decay mode. It also mentions that zooming gets nuclide names and summary data, and tapping goes to the detail page. The 'Decay chain' section notes that a long press shows the decay chain, including ground state decay modes and parents. Finally, it states that spontaneous fission and branching ratios marked as '?' are not drawn, and a long press on the same nuclide resets the chart. Dashed lines represent secondary decay modes.

**Isotope Browser**  
IAEA Nuclear Data Section

CHART ELEMENT 90 - C - 6

GO CLEAR EXPERT

N A Jπ  Stable

s <T<sub>1/2</sub>< Y

**Decay and Main Radiations**

Decay mode 0 < % < 100

Decay Rad. 0 < keV < 100

[Guide](#)

[Change language](#) going to **Preferences**

**Pick an Element** (or enter a **Symbol**, e.g. xe, or an **Atomic Number**, e.g. 54, or a **Nuclide**, e.g. 135xe), the search starts automatically

**Tap an item** in the result list to get detailed information

**The Database includes ground states and isomers having half-life > 0.1 s**

**Chart**

Shows the selected nuclides on the Nuclides Chart. All nuclides are shown when no query is active

**The color** represents the main decay mode

**Zoom** to get nuclide names, more to get summary data

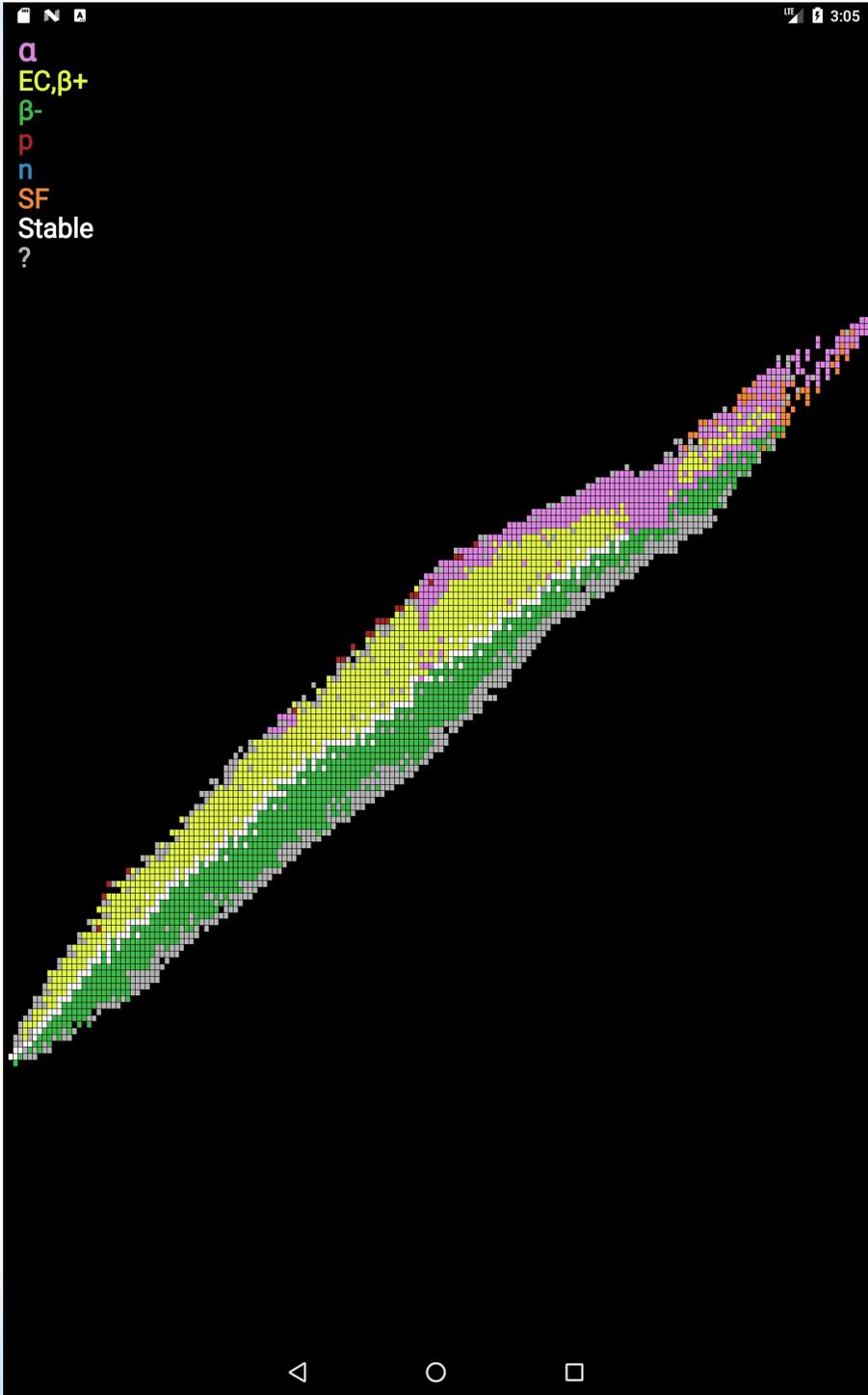
**Tap** to go to the detail page

**The Decay chain** is shown by a **long press** on a nuclide. It includes all ground state decay modes having a branching ratio value, and all the possible parents. Use the Preferences to change this

Spontaneous fission and branching ratios marked as ? are not drawn

Long press on the same nuclide to reset the chart

Dashed lines represent secondary decay modes



α  
EC,β+  
β-  
p  
n  
SF  
 Stable  
 ?

																Sg	Sg						
														255	256	257	258						
														Db	Db	Db	Db						
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												Rf	Rf	Rf	Rf	Rf							
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					Cm																		
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				Am																			
			228	229	230	231	232	233	234	235	236	237	238	239	240	241	242	243	244	245	246	247	
			Pu																				
		225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240	241	242	243	244		
		Np																					
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	Pa																						
	222	223	224	225	226	227	228	229	230	231	232	233	234	235	236	237	238						
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	Ac																						
	220	221	222	223	224	225	226	227	228	229	230	231	232	233	234								
	Ra																						
	219	220	221	222	223	224	225	226	227	228	229	230	231	232	233								
	Fr																						
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	Rn																						
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	At																						
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	Po																						
	215	216	217	218	219	220	221	222	223	224													
	Bi																						
	214	215	216	217	218	219	220																
	Pb																						
	213	214	215	216	217																		
	Tl	Tl	Tl	Tl	Tl																		

- More about this nuclide on [NDS web](#)
- Uncertainty example: 12.3 (11) means  $12.3 \pm 1.1$
- Refer to the Guide for the meaning of the data

**Z 93 N 143 Jπ (6-)**  
**Half-life** 153 10<sup>3</sup> (5) Y

**Parents**

 **240-Am** α 1.9 10<sup>-4</sup> %<sup>7</sup>

**Decays** see the [decay chain](#)

 ec 86.3(8)% → **236-U**

 β- 13.5(8)% → **236-Pu**

 α 0.16(4)% → **232-Pa**

**Qα** 5010 (50) keV

**Qβ** 480 (50) keV

**Qec** 930 (50) keV

**Sn** 5740 (50) keV

**Sp** 4830 (50) keV

**Binding energy/A**

7579.21 (21) keV

**Mass**

236.04657 (50) AMU

**Thermal neutron capture**

142 barns

**Decay radiations ordering**

 From β- decay

**Y**

En [keV]	Int [%]
158.35 (2)	4.2 (3)
102.82 (2)	0.91 (7)
44.6 (1)	0.0182 (14)

**X**

En [keV]	Transition	Int [%]
117.800 - 121.556	Kβ	0.186 (14)
104.279	Kα1	0.38 (3)
99.979	Kα2	0.237 (17)
12.169 - 22.841	L	13.4 (8)

 From ec decay

**Y**

En [keV]	Int [%]
160.33 (2)	31.3 (17)
104.23 (2)	7.2 (4)

The screenshot shows the 'Isotope Browser' app interface. At the top, it displays the app name and 'IAEA Nuclear Data Section'. Below this is a navigation bar with 'CHART', 'ELEMENT', and '90 - C - 6'. A secondary bar contains 'GO', 'CLEAR', and 'EXPERT' buttons. The main interface has input fields for 'N', 'A', and 'Jπ', with a 'Stable' checkbox. Below these are dropdown menus for 's' (under <math>\langle T\_{1/2} \rangle</math>) and 'Y' (under <math>\langle Y \rangle</math>). A section titled 'Decay and Main Radiations' contains two rows of data: 'Decay mode' with a dropdown set to '0' and '<math>\langle \% \rangle</math>' set to '100', and 'α' with a dropdown set to '0' and '<math>\langle \text{keV} \rangle</math>' set to '100'. A 'Guide' section follows, providing instructions on how to use the app, including how to pick an element, tap items, and understand the chart's color coding and zooming.

**Decay and Main Radiations**

Decay mode	0	<math>\langle \% \rangle</math>	100
α	0	<math>\langle \text{keV} \rangle</math>	100

**Guide**

[Change language](#) going to **Preferences**

**Pick an Element** (or enter a **Symbol**, e.g. xe, or an **Atomic Number**, e.g. 54, or a **Nuclide**, e.g. 135xe), the search starts automatically

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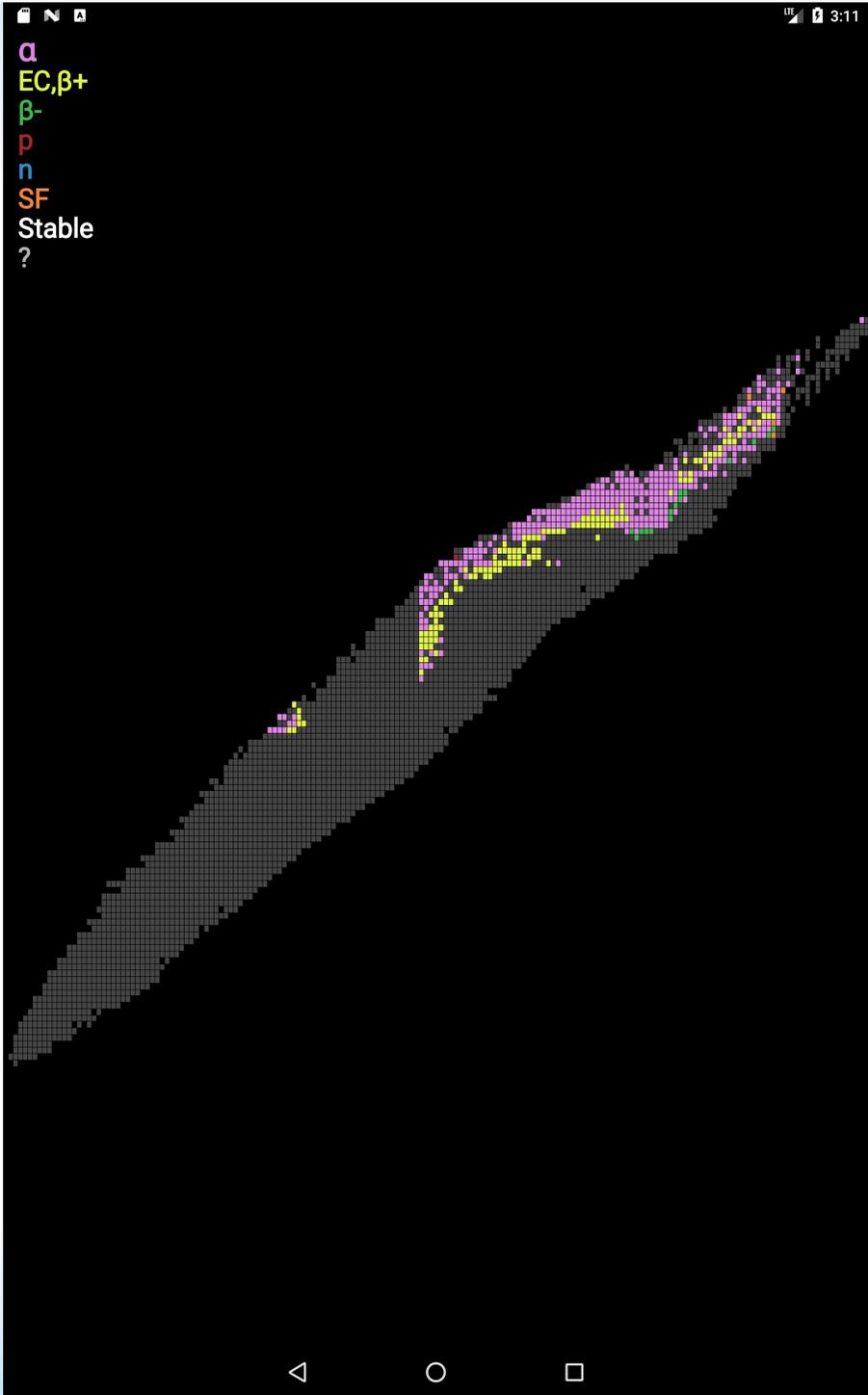
Spontaneous fission and branching ratios marked as ? are not drawn

Long press on the same nuclide to reset the chart

Dashed lines represent secondary decay modes

	CHART	T ½	%
105Te 52	0.62 (7) us	α 100%	4703 keV
106Te 52	70 (17) us	α 100%	4128 keV
110Xe 54	93 (3) ms	α 100%	3745 keV
144Nd 60	2.29 10 <sup>15</sup> (16) Y	α 100%	1905.2 keV
146Sm 62	6.8 10 <sup>7</sup> (7) Y	α 100%	2460 keV
147Sm 62	1.060 10 <sup>11</sup> (11) Y	α 100%	2248 keV
148Gd 64	71.1 (12) Y	α 100%	3182.69 keV
148Sm 62	7 10 <sup>15</sup> (3) Y	α 100%	1932.3 keV
150Gd 64	1.79 10 <sup>6</sup> (8) Y	α 100%	2726 keV
152Gd 64	1.08 10 <sup>14</sup> (8) Y	α 100%	2146.9 keV
154Dy 66	3.0 10 <sup>6</sup> (15) Y	α 100%	2870 keV
156Hf 72	23 (1) ms	α 100%	5873 keV
156mHf 72	0.52 (1) ms	α 100%	7782 keV
156mLu 71	198 (2) ms	α 100%	5565 keV
157mTa 73	4.3 (1) ms	α 100%	6214 keV
157mTa 73	1.7 (1) ms	α 100%	7744 keV
158W 74	1.25 (21) ms	α 100%	6445 keV
162Os 76	2.1 (1) ms	α 100%	6602 keV

CHART				$T_{1/2}$	%
<sup>214m</sup> Rn 86	6.5 (30) ns	8+	IT ≈90%		
<sup>219</sup> Pa 91	53 (10) ns	9/2-	α 100%		
<sup>217</sup> Ac 89	69 (4) ns	9/2-	α ≈100%		
<sup>216m</sup> Fr 87	71 (5) ns	(3-)	Uncertain		
<sup>215</sup> Fr 87	86 (5) ns	9/2-	α 100%		
<sup>218</sup> Th 90	117 (9) ns	0+	α 100%		
<sup>213</sup> At 85	125 (6) ns	9/2-	α 100%		
<sup>212</sup> Po 84	0.299 (2) us	0+	α 100%		
<sup>214</sup> At 85	558 (10) ns	1-	α 100%		
<sup>105</sup> Te 52	0.62 (7) us	(5/2+)	α ≈100%		
<sup>216</sup> Fr 87	0.70 (2) us	(1-)	α 100%		
<sup>217m</sup> Ac 89	740 (40) ns	(29/2)+	IT 95.7%		
<sup>214m</sup> At 85	760 (15) ns	9-	α ≤100%		
<sup>219</sup> Th 90	1.05 (3) us	(9/2+)	α 100%		
<sup>218</sup> Ac 89	1.08 (9) us	(1-)	α 100%		
<sup>217</sup> Ra 88	1.6 (2) us	(9/2+)	α ≈100%		
<sup>215</sup> Rn 86	2.30 (10) us	9/2+	α 100%		
<sup>213</sup> Po 84	3.72 (2) us	9/2+	α 100%		



### Nuclides list ordering

- Z and N
- N and Z
- Half-life

### Decay Radiation ordering

- Intensity
- Energy

### Decay chain display

- Show all parents

### Languages

- English
- العربية
- Español
- Français
- Italiano
- 日本語
- Русский
- Slovenščina
- 简体中文
- 繁体中文

App Version Code 88 Version Name 4.2.42



Provided by the  
IAEA Nuclear Data Section

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		At																				
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		Bi																				
		214	215	216	217	218	219	220														
		Pb	Pb	Pb	Pb	Pb																
		213	214	215	216	217																
		Tl	Tl	Tl	Tl																	

- α
- EC,β+
- β-
- p
- n
- SF
- Stable
- ?

## Querytool exercises

- **$\beta$  decay**

1. List nuclides having an evaluated  $\beta$ - decay branching ratio and display on nuclear chart
2. List nuclides that can theoretically  $\beta$  decay. Compare with results of 1.
3. Plot  $Q_{\beta}$  against  $Q_{\beta-n}$  for those nuclides with evaluated  $\beta$ - and  $\beta$ - n decay
4. Find  $\beta$ - decaying nuclides which have  $\beta$  transitions with  $9 \leq \log ft \leq 10$ . Check  $\Delta J$  and  $\Delta \pi$  values.

# Querytool exercises

- **$\alpha$  decay**

5. List nuclides with evaluated  $\alpha$  decay and display on nuclear chart
6. List nuclides that can theoretically  $\alpha$  decay and compare with 5.
7. Plot  $Q_\alpha$  vs  $A$ . Plot the same for even-even, even-odd (odd-even), and odd-odd nuclei
8. Find  $\alpha$  decaying nuclides with Hindrance Factor  $HF=1$ . Plot  $Q_\alpha$  vs  $A$ . Compare with plots from 7.

# Querytool exercises

9. Plot  $B(E_2)$  strengths of transitions from first excited  $2^+$  states to the ground state vs  $A$ , then  $Z$  (for e-e, e-o/o-e, o-o nuclides).
10. Plot dipole magnetic moments of e-e, e-o, o-o nuclei vs  $A$  and for  $Z = 19$  isotopic chain vs  $A$ .
11. Find nuclides which emit  $\gamma$  rays of energy 197 keV through internal transitions and induced reactions.

In this section we consider the excited states as members of quasirotational bands. Figure 3 illustrates how the multiple-phonon levels may be decomposed into various intrinsic excitations

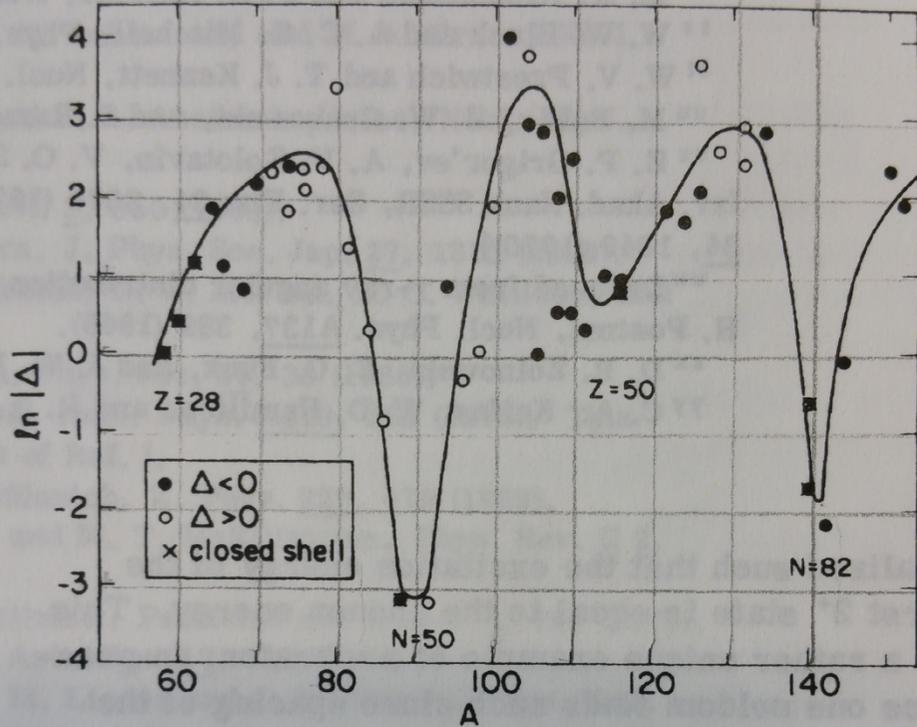


FIG. 2.  $E2/M1$  mixing ratios of  $2' \rightarrow 2$  transitions in even-even nuclei  $60 \leq A \leq 150$ . The solid curve indicates the trend of the measured values and shows pronounced minima in the vicinity of closed shells.

vs  $A$ , then  $S_n$  vs  $T_{1/2}$

00 levels decaying via an evaluated  $n$  emission

K.S. Krane, Phys.Rev. C 10 (1974) 1197  
( $\Delta$  is a function of  $\delta$ )

15. Plot  $A$  vs  $\delta$  for  $E_2/M_1$  transitions from  $J^\pi 2^+$  to  $2^+$  for e-e nuclides having  $60 \leq A \leq 150$ .

# Querytool exercises

- 16 Plot  $Z$  vs Atomic Mass for  $A = 212$
- 17 Plot  $Q_{\beta}$  versus  $Q_{EC}$  for the entire set

# Pocket Nuclear Database

File Edit View Help

New Database Open Database Write Changes Revert Changes

Database Structure Browse Data Edit Pragmas Execute SQL

Create Table Create Index Modify Table Delete Table

Name	Type	Schema
▼ Tables (10)		
> cum_fy		CREATE TABLE cum_fy ( PARENT_NUCID varchar(5) NOT NULL, DAUGHTER_NUCID varchar(5) NOT null, L_SEQNO int(11) NOT N
> decay_codes		CREATE TABLE decay_codes (ensdf_code varchar(10) DEFAULT NULL ,decay_code int(10) NOT NULL ,dataset_code varchar(10) DE
> decay_radiations		CREATE TABLE decay_radiations (parent_nucid varchar(10) NOT NULL ,parent_l_seqno int(10) NOT NULL ,z int(10) NOT NULL ,n ir
> descriptions		CREATE TABLE descriptions (item varchar(10) NOT NULL ,short_desc varchar(50) DEFAULT NULL ,long_desc varchar(200) DEFAUL
> ensdf		CREATE TABLE ensdf (file varchar(10) NOT NULL ,identification varchar(60) DEFAULT NULL ,date_ensdf varchar(20) DEFAULT NUL
> gammas		CREATE TABLE gammas (z int(10) NOT NULL ,n int(10) NOT NULL ,nucid varchar(10) NOT NULL ,g_seqno int(10) NOT NULL ,l_sec
> ind_fy		CREATE TABLE ind_fy ( PARENT_NUCID varchar(5) NOT NULL , DAUGHTER_NUCID varchar(5) NOT NULL , L_SEQNO int(11) NOT I
> l_decays		CREATE TABLE l_decays (z int(10) NOT NULL ,n int(10) NOT NULL ,nucid varchar(10) NOT NULL ,l_seqno int(10) NOT NULL ,decay
▼ levels		CREATE TABLE levels (z int(10) NOT NULL ,n int(10) NOT NULL ,nucid varchar(10) NOT NULL ,l_seqno int(10) NOT NULL ,energy v
z	int ( 10 )	`z` int ( 10 ) NOT NULL
n	int ( 10 )	`n` int ( 10 ) NOT NULL
nucid	varchar ( 10 )	`nucid` varchar ( 10 ) NOT NULL
l_seqno	int ( 10 )	`l_seqno` int ( 10 ) NOT NULL
energy	varchar ( 10 )	`energy` varchar ( 10 ) DEFAULT NULL
energy_unc	varchar ( 10 )	`energy_unc` varchar ( 10 ) DEFAULT NULL
energy_limit	varchar ( 10 )	`energy_limit` varchar ( 10 ) DEFAULT NULL
energy_num	double	`energy_num` double DEFAULT NULL
energy_unc_num	double	`energy_unc_num` double DEFAULT NULL
energy_series	varchar ( 10 )	`energy_series` varchar ( 10 ) DEFAULT NULL
half_life	varchar ( 10 )	`half_life` varchar ( 10 ) DEFAULT NULL
half_life_unc	varchar ( 10 )	`half_life_unc` varchar ( 10 ) DEFAULT NULL
half_life_units	varchar ( 10 )	`half_life_units` varchar ( 10 ) DEFAULT NULL
half_life_limit	varchar ( 10 )	`half_life_limit` varchar ( 10 ) DEFAULT NULL
half_life_num	double	`half_life_num` double DEFAULT NULL
half_life_unc_num	double	`half_life_unc_num` double DEFAULT NULL
half_life_sec	double	`half_life_sec` double DEFAULT NULL
half_life_sec_unc	double	`half_life_sec_unc` double DEFAULT NULL
jp	varchar ( 30 )	`jp` varchar ( 30 ) DEFAULT NULL
parity	int ( 10 )	`parity` int ( 10 ) DEFAULT NULL
jp_order	int ( 10 )	`jp_order` int ( 10 ) DEFAULT NULL
jp_weak	int ( 10 )	`jp_weak` int ( 10 ) DEFAULT NULL
quadrupole_m	varchar ( 10 )	`quadrupole_m` varchar ( 10 ) DEFAULT NULL

# Pocket Nuclear Database

Database Structure Browse Data Edit Pragmas Execute SQL



```
select (CAST(ROUND(energy_num + 0.5) AS INT) /100)*100 as energy, count(*)
from
levels
where
energy_num is not null/* remove null values*/
and energy_series = ''/* remove values with unknown baseline*/
--and nuclid = '238U'/* remove to get all nuclides */
group by 1 order by 1;
```

	energy	count(*)
1	0	5404
2	100	2360
3	200	2586
4	300	2584
5	400	2523
6	500	2716
7	600	2760
8	700	2879

Export data as CSV

Column names in first line

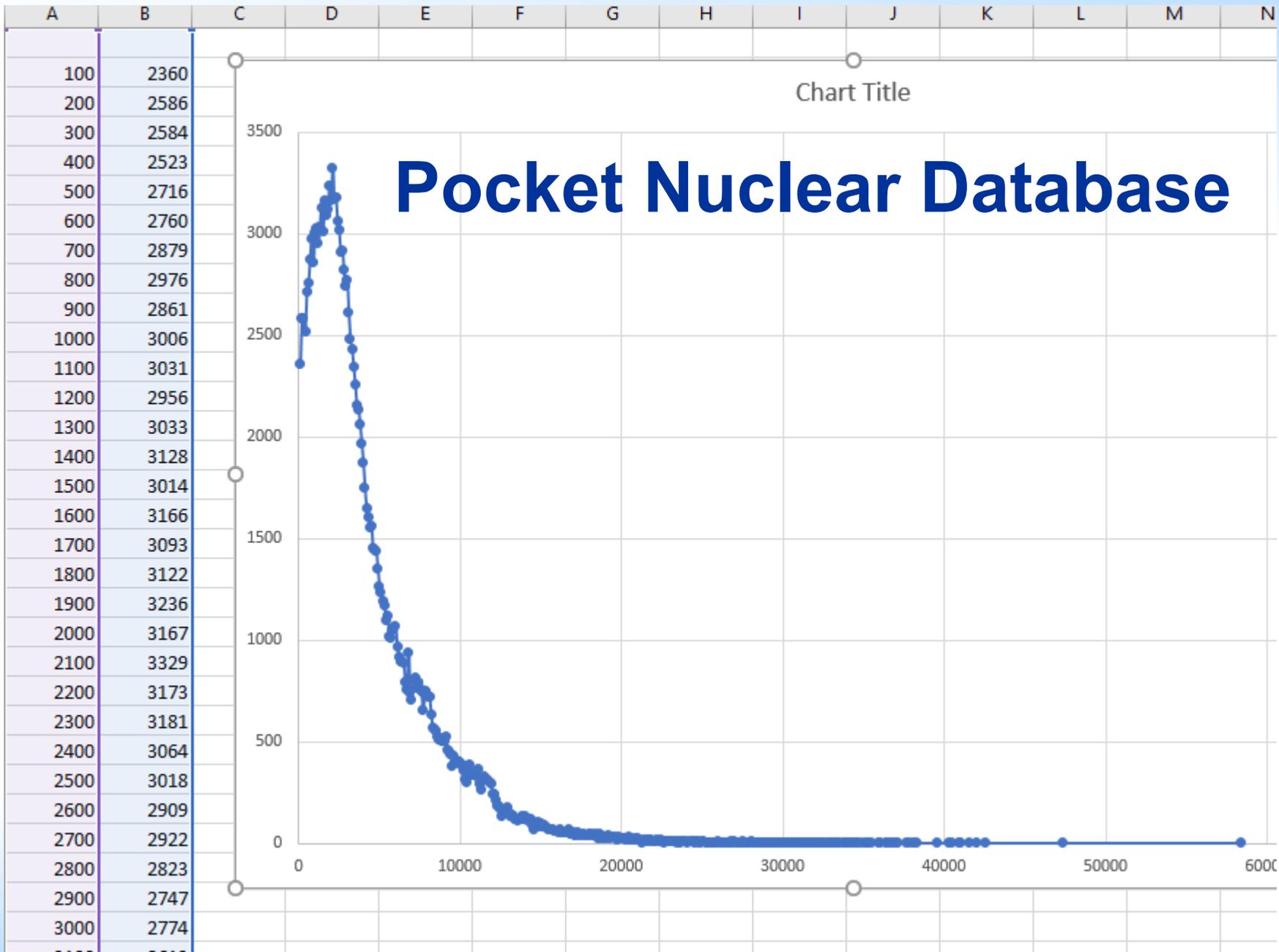
Field separator

Quote character

New line characters

OK Cancel

367 rows returned in 677ms from: select (CAST(ROUND(energy\_num + 0.5) AS INT) /100)\*100 as energy, count(\*)  
from  
levels  
where  
energy\_num is not null





SQL 1

```
1 select distinct l.parent_nucid,l.daughter_nucid as daughter, l.daughter_l_seqno
2 as daughter_level, l.start_l_en_num as daughter_level_energy
3 from decay_radiations l where daughter_l_seqno != -1
4 and l.daughter_nucid = '210AT' /* remove this to get all nuclides*/
5 and not exists (
6   select * from levels ll where l.daughter_nucid = ll.nucid
7   and l.start_l_en_num = ll.energy_num )
8 order by 1, 2, 3;
```

	parent_nucid	daughter	daughter_level	daughter_level_energy
1	214FR	210AT	1	72.77
2	214FR	210AT	1	70.0
3	214FR	210AT	2	498.0
4	214FR	210AT	3	507.38
5	214FR	210AT	3	597.0
6	214FR	210AT	5	1039.0
7	214FR	210AT	10	1228.0

## 210-At adopted dataset

Nuclide	$E_x$ [keV]	$J^{\pi}_{order}$	B
$^{210}_{85}\text{At}_{125}$	0.0	(5)+	
$^{210}_{85}\text{At}_{125}$	72.65 5	(4)+	
$^{210}_{85}\text{At}_{125}$	496.17 5	(4)+ 2	
$^{210}_{85}\text{At}_{125}$	507.4 1	(6)+	
$^{210}_{85}\text{At}_{125}$	530.88 6	(3)+	
$^{210}_{85}\text{At}_{125}$	576.4 1	(7)+	
$^{210}_{85}\text{At}_{125}$	594 ? 7		
$^{210}_{85}\text{At}_{125}$	603 5 5		

## 214-Fr $\alpha$ 210-At decay dataset

total of 7 rows used in Excel to determine step

**Alpha** 

$E_{\alpha}$ [keV]	$I_{\alpha}(\text{abs})$ [%]	Daughter level [keV]
7406 8	0.3	1039 10
7605 8	1.0	837 10
7840	< 0.1	597
7937 8	1.0	498 10
8358 4	4.8 2	70 7
8427 4	<b>93.0 5</b>	0.0

*Thank you!*

