

2484-21

**ICTP-IAEA Joint Workshop on Nuclear Data for Science and Technology:
Medical Applications**

30 September - 4 October, 2013

Nuclear Data Retrieval and Dissemination

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Nuclear Data Retrieval and Dissemination

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3 October 2013

*Workshop on Nuclear Data for Science and Technology: Medical Applications
ICTP, Trieste, Italy, 30 September – 4 October 2013*

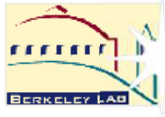
Where to get the data



National Nuclear Data Center

BROOKHAVEN
NATIONAL LABORATORY

www.nndc.bnl.gov



NUCLEAR SCIENCE DIVISION

LBNL

ie.lbl.gov



**TUNL Nuclear Data
Evaluation Project**

www.tunl.duke.edu/nucldata

data for $A < 20$



Nuclear Data Services

www-nds.iaea.org

IAEA Nuclear Data Section: Medical Portal

www-nds.iaea.org

www-nds.iaea.org/medportal/

ENSDF

ENSDF:

www.nndc.bnl.gov/ensdf/

NUDAT:

www.nndc.bnl.gov/nudat2/

NSR:

www-nds.iaea.org/nsr/index.jsp

MIRD:

www.nndc.bnl.gov/mird/

Decay Data Evaluation Project (DDEP)

DDEP:

www.nucleide.org/DDEP_WG/DDEPdata.htm

Introductory text:

www.nucleide.org/DDEP_WG/Introduction_2011.pdf

JANIS, NEA-OECD, Nuclear Data Bank, Paris

JANIS:

www.oecd-nea.org/janis/

INL: X-ray and γ -ray spectra

www.inl.gov/gammaray/catalogs/catalogs.shtml

Specific catalogues:

- **NaI(Tl) scintillator**

www.inl.gov/gammaray/catalogs/pdf/naicat.pdf

- **Ge and Si(Li) detectors**

www.inl.gov/gammaray/catalogs/pdf/gecat.pdf

IAEA LiveChart

Marco Verpelli

Nuclear Data Section

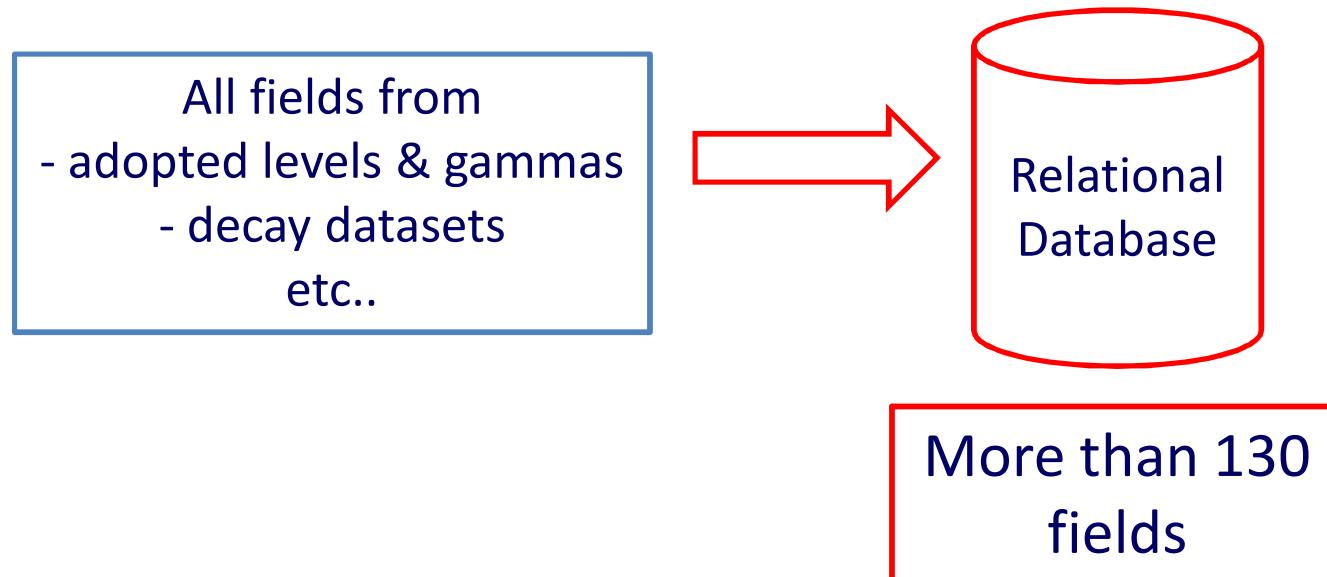
Department of Nuclear Sciences and Applications

LiveChart

LiveChart:

www-nds.iaea.org/relnsd/vcharthtml/VChartHTML.html

LiveChart: a Relational Database for Structure and Decay Data



A relational database enables
very powerful retrieval and presentation of data

LiveChart

Half life color code, value in seconds:

0 8.2E-4 1.4E-2 4.6E-2 1.E-1 2.3E-1 0.5 0.9 1.8 3.5 6.2 12 23.5 43 83.4 1.6E2 2.9E2 6E2 1.3E3 3E3 8.6E3 3.4E4 1.4E5 1.1E6 3E7 1E8



Show Filter

Visible Nuclides: 2934

Lock info panel

Nuclide

☐

single selection

zoom and
move

nuclide data on
mouse-move

151
66 Dy Double click for more

JP 7/2(-)

Delta (MeV) -68.7586

Half Life 17.9 3 min

Decay 94.4 4 EC+ β^+
5.6 4 α

Parent 151Ho 155Er
Daughter 147Gd 151Tb

Radiations

Type	keV	%
α	4069.4	5.6
	4069.4	5.6
β^+	1363	0.58
γ	386.100	19.4
	49.460	18.0

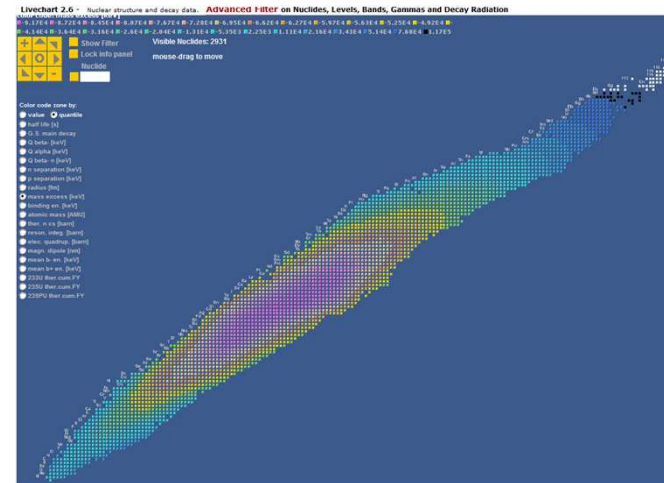
parent-daughter
chains (white - red)

LiveChart colour code - examples

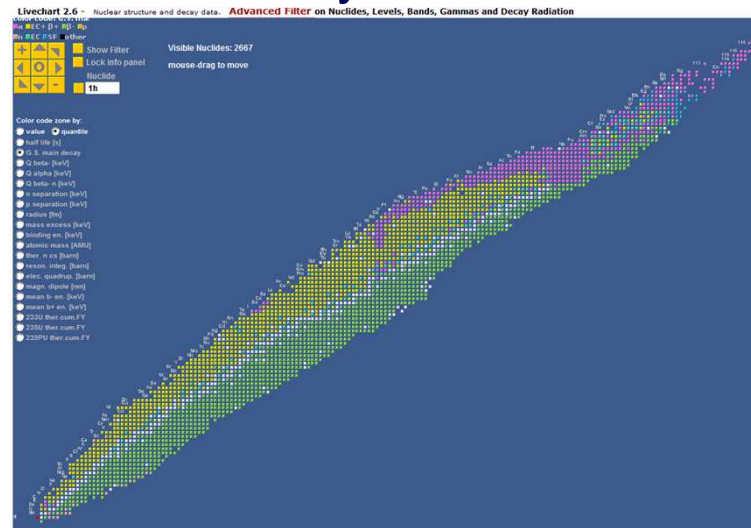
Fission yields



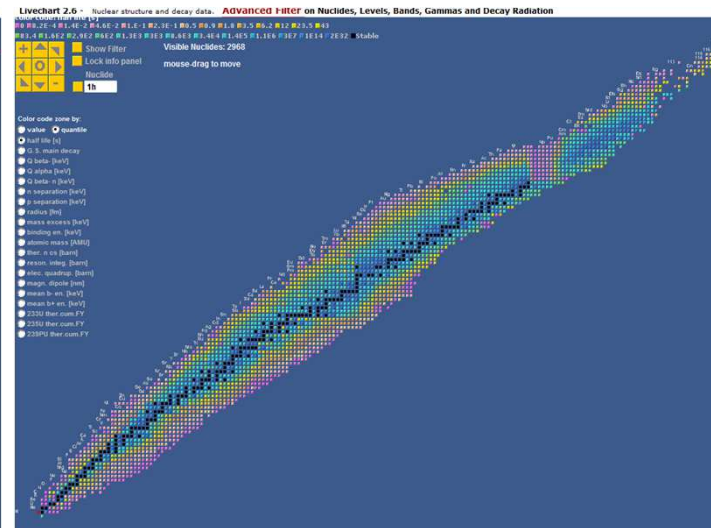
Mass excess



Decay mode



Half-life



LiveChart: nuclide data - detail

Nuclide	Levels	Gammas	Bands	Decay Radiation	Magn. Mom.	El. Mom.	Ther.
Click on nuclide symbol to show the level schema and ENSDF dataset							
Nuclide	Q_{β^-} [keV]	Q_{α} [keV]	Q_{EC} [keV]	$Q_{\beta^- n}$ [keV]	S_n [keV]	S_p [keV]	
¹³⁵ Xe ₅₄ ⁸¹	1164.218 4456	-3631.54 457	-2626.312 8758	-7597.80 457	6364.46 463	9634	
Metastable states							
Nuclide	Energy (keV)	J ^π _{order}	Band	T _{1/2}	T _{1/2} [s]	Decays	Isospin
¹³⁵ Xe ₅₄ ⁸¹	526.551 13 m	11/2-		15.29 min 5	9.17 x 10 ²	IT > 99.4 β- < 0.6	

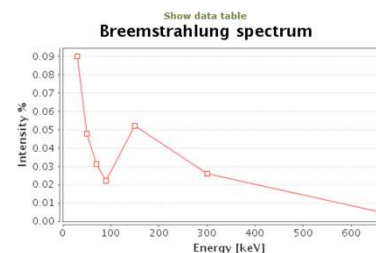
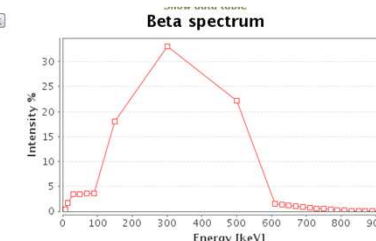
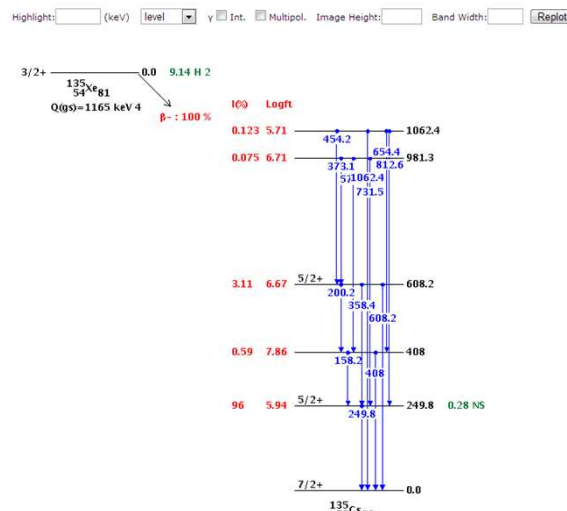
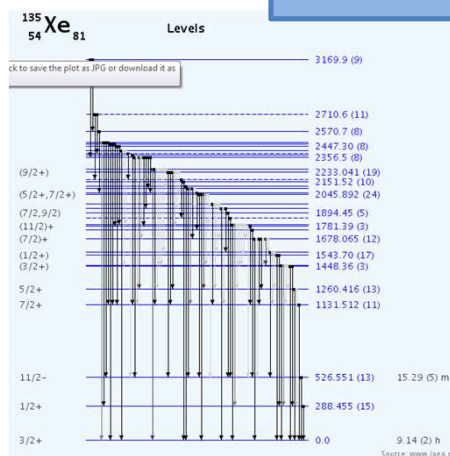
Plots:

- level schemes and γ
- decay schemes
- beta spectra
- Bremsstrahlung spectra

Ground and metastable states

ENSDF data:

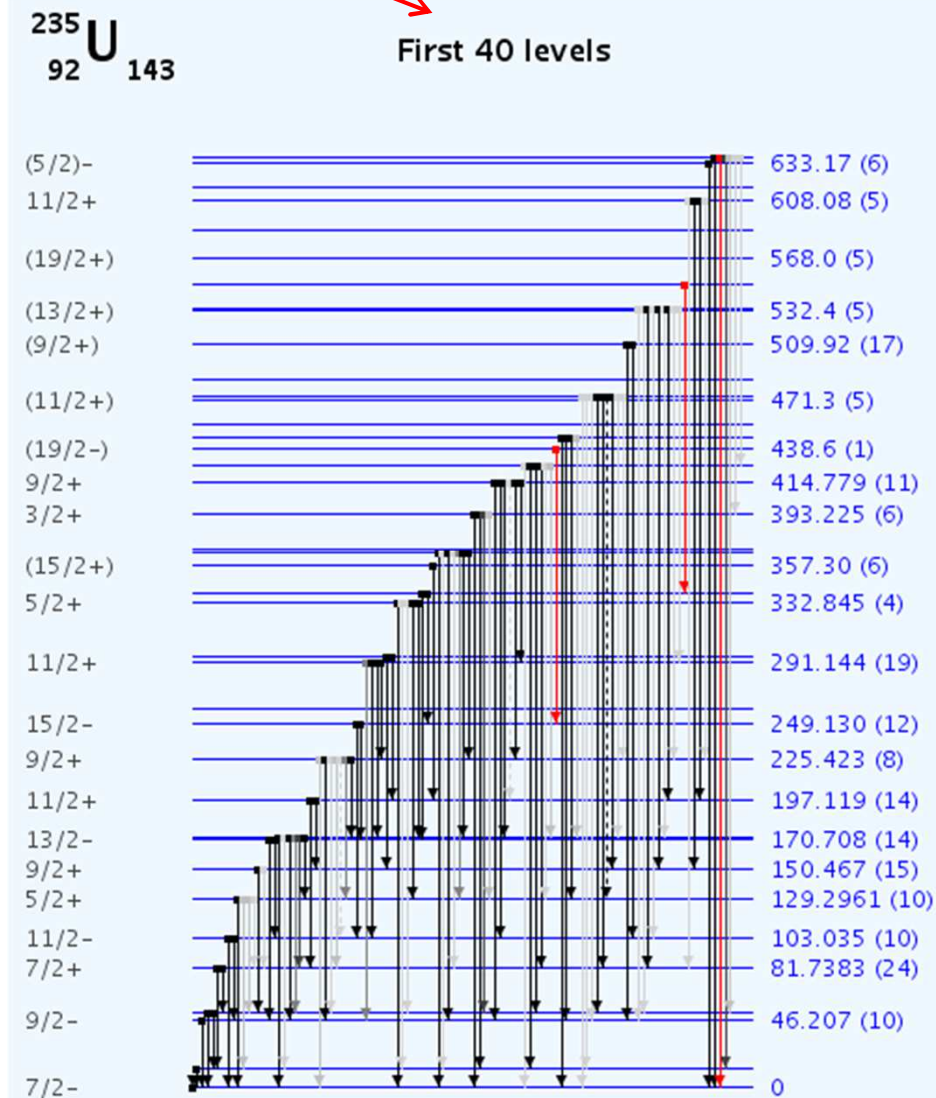
- levels and bands
- Gamma transitions and emissions
- decay radiation
- +
- AMDC data
- nuclear radii → Angeli
- nuclear moments → Stone
- fission yields
- thermal-neutron cross sections



< Energy (keV) <
 Image height:
 Level width:

☒ Show level energy
 ☒ Show spin-parity
 ☒ Show half life

Plot separately the first levels
 ☒ Non-band
 ☒ Band 1
 ☒ Band 2
 ☒ Band 3
 ☒ Band 4
 ☒ Band 5
 ☒ Band 6
 ☒ Band 7

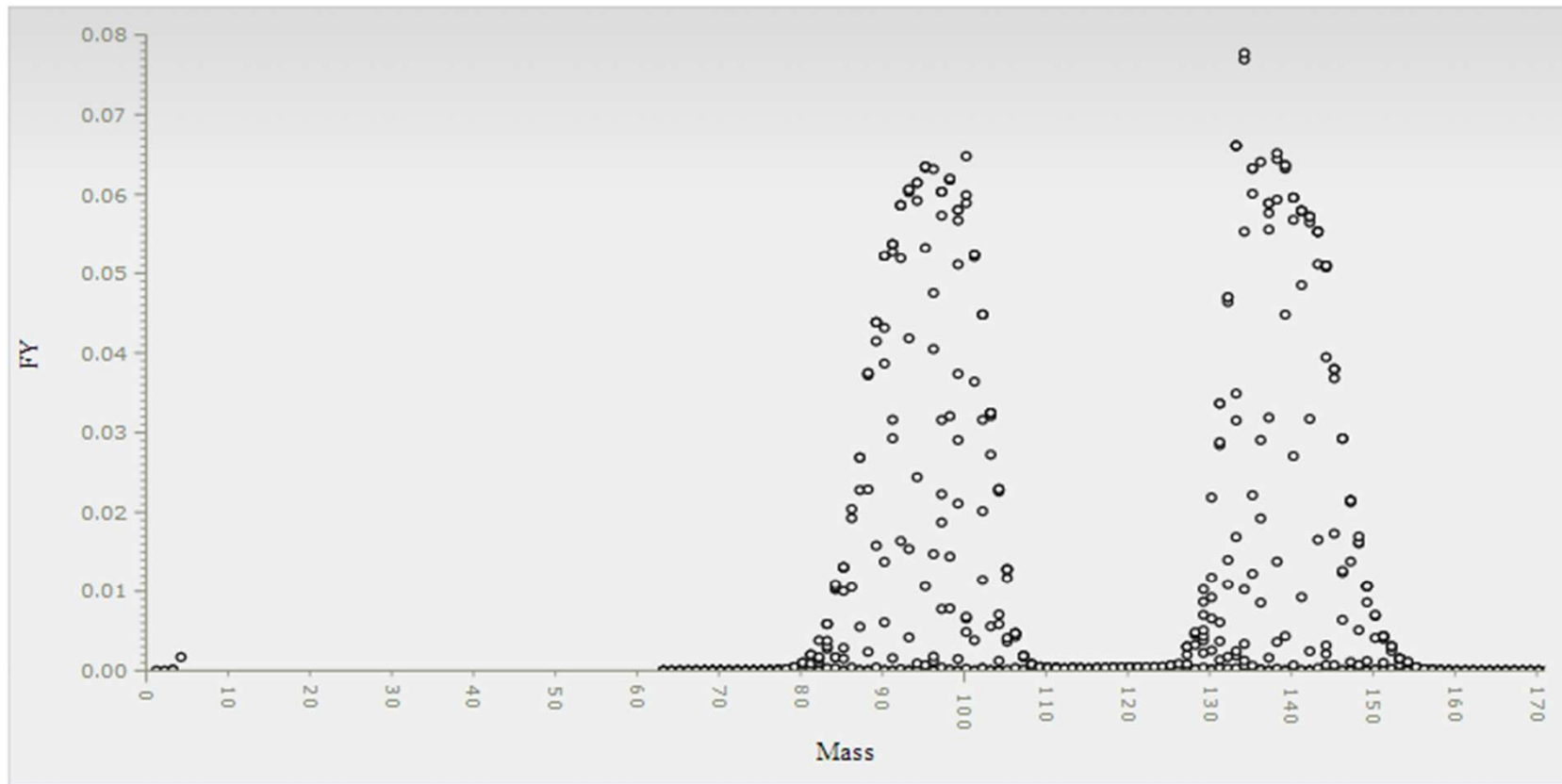


Level scheme plotting options:

- level number
- energies
- bands



Fission yields



■ ^{235}U Cumulative Fast

0 < X < 171 0 < Y < 0.08 Indep. ☐ Cumul. ☒ Ther. ☐ Fast ☒ 14 MeV ☐ Redraw Reset

Choose mass and value range

Choose type

Examples of queries

Selection of nuclides with half-lives between 1 and 10 mins, emitting β^+ with energy between 1 and 2 MeV

LEVELS - Bands - Decay Radiations

☐ Energy $0 \leq \text{keV} \leq 47,300$
☐ Decays B.R. $\leq \% \leq$ ☐ Only Ground State and Metastables
☒ Half Life $1 \text{ min} \leq T_{1/2} \leq 10 \text{ min}$ ☐ Stable
☐ Magn. dipole μ $-20 \leq \mu_N \leq 38$ ☐ Electr. quadrupole Q $219 \leq \text{barn} \leq 64$
☒ Decay radiation Energy $1000 \leq \text{keV} \leq 2000$ ☐ key 2 ☒ Intensity $60 \leq \% \leq 100$ type β^+ process - shell -
☐ R End point $0 \leq \text{keV} \leq 8,723$ ☐ $1.2 \leq \log FT \leq 24.3$ ☐ $0.077 \leq \text{Hindrance} \leq 6.077$

Electron Capture and Beta+

Fed level	Jp	Energy EC	Avg Energy β^+	Intensity EC	Intensity β^+	LogFT	Unforb.	Parent	$T_{1/2}$	E [keV]	Jp order	Decay	Q _{gs → gs}	Daughter
498.01 5	3/2+	(3415.285) 17	1076.7 79	26.7 9	60.3 19	4.691 18		¹¹³ Sb 51 62	6.67 min 7	0.0	5/2+	ec β^+ 100 %	3913.295 17402	¹¹³ Sn 50 63
670.1 3	1+	(3500.721) 2	1099 6	2.80 24	70 6	4.4 1		⁶⁰ Zn 30 30	2.38 min 5	0.0	0+	ec β^+ 100 %	4170.821 1769	⁶⁰ Cu 29 31
0.0	0+	(3573.784) 3585	1142.7 19	5.49 6	80.9 4	4.75 1		⁷⁸ Br 35 43	6.45 min 4	0.0	1+	ec β^+ ≥ 99.99 %	3573.784 3585	⁷⁸ Se 34 44
0.0	0+	(3656.639) 3059	1188.6 14	24.3 2	73.2 3	4.525 13		¹¹⁸ Sb 51 67	3.6 min 1	0.0	1+	ec β^+ 100 %	3656.639 3059	¹¹⁸ Sn 50 68
2167.5 3	2+	(3746.555) 500	1212.08 20	0.516 5	99.333 13	4.9746 11		³⁸ K 19 19	7.636 min 18	0	3+	ec β^+ 100 %	5914.055 347	³⁸ Ar 18 20
0.0	0+	(3731.489) 19933	1224.4							0.0	1+	ec β^+ 100 %	3731.489 19933	¹³⁴ Ba 56 78
3189.33 14	6+	(3853.051) 300	1264.00							616.28 6 m	(7)+	ec β^+ 100 %	6426.101 225	⁴² Ca 20 22
0.0	0+	(3958.896) 872	1316.0 24							0.0	1+	ec β^+ 100 %	3958.896 872	⁶² Ni 28 34

Selected nuclides visualised on Livechart

Gamma spectroscopy : peak identification

Nuclides with half-lives between 10 and 100 days, emitting γ with energy between 450 and 500 keV. The γ must be the most intense line (key-line)

key-line condition

☒ Half Life 10 d $\leq T_{1/2} \leq$ 100 d ☐ Stable ☐ J^π ☐ weak order ☐ π any

☐ Magn. dipole μ -20 $\leq \mu_N \leq$ 38 ☐ Electr. quadrupole Q -219 $\leq \text{barn} \leq$ 64

☒ Decay radiation Energy 450 $\leq \text{keV} \leq$ 500 ☒ key lines 1 Intensity 0 $\leq \% \leq$ 100 type γ process any shell any

β End point 0 $\leq \text{keV} \leq$ 8,723 1.2 $\leq \log FT \leq$ 24.3 α 0.077 $\leq \text{Hindrance} \leq$ 6,077

Gamma



Start level	Jp	Final Level	Jp	Energy	Intensity	Mixing	Multipol.	Tot. Conv. Coeff.	Parent	T _{1/2}	E [keV]	Jp order	Decay	Q _{gs → gs}	Daughter
1084.85 17	21/2+	631.33	15/2+	453.59 20	68 3		E2	0.0248	¹⁷⁹ Hf 72 107	25.05 d 25	1105.74 16 m2	25/2-	IT 100 %	1105.74	¹⁷⁹ Hf 72 107
477.612 3	1/2-	0.0	3/2-	477.6035 20	10.44 4	0.20	M1(+E2)	7.3E-7 11	⁷ Be 4 3	53.22 d 6	0.0	3/2-	ec 100 %	861.893 71	⁷ Li 3 4
400.40 4	5/2+	0.0	7/2+	400.40 0	64 0	1.70	M1+E2	0.0005 0	¹⁸¹ Lu 71 107	10.00 d 0	0.0	4/2-	0.400 0%	400.400 0000	¹⁸¹ Ta 71 107


All mass chains on one web-page

With separation energies, intermediate states, and data for metastable and ground states:
 J_p , decays, half-lives and Q-values.





Clicking on a nuclide opens a detailed page



Isotope Browser
 IAEA Nuclear Data Section
 


Elements

Na


Go


Clear


Advanced

N

A

Jp

☒ **Stable**

S

▼

<T_{1/2}<

Y

▼

Decay and Main Radiations

Decay

▼

0

< % <

100

Decay Rad.

▼

0

<keV<

100

²⁰Na ¹¹	447.9 (23) ms	2+	ec 100.0%
²¹Na ¹¹	22.49 (4) s	3/2+	ec β+ 100.0%
²²Na ¹¹	2.6027 (10) Y	3+	ec β+ 100.0%
²³Na ¹¹	Stable	3/2+	
²⁴Na ¹¹	14.997 (12) H	4+	β- 100.0%

1 H Hydrogen																	2 He Helium				
3 Li Lithium	4 Be Beryllium															5 B Boron	6 C Carbon	7 N Nitrogen	8 O Oxygen	9 F Fluorine	10 Ne Neon
11 Na Sodium	12 Mg Magnesium															13 Al Aluminum	14 Si Silicon	15 P Phosphorus	16 S Sulfur	17 Cl Chlorine	18 Ar Argon
19 K Potassium	20 Ca Calcium	21 Sc Scandium	22 Ti Titanium	23 V Vanadium	24 Cr Chromium	25 Mn Manganese	26 Fe Iron	27 Co Cobalt	28 Ni Nickel	29 Cu Copper	30 Zn Zinc	31 Ga Gallium	32 Ge Germanium	33 As Arsenic	34 Se Selenium	35 Br Bromine	36 Kr Krypton				
37 Rb Rubidium	38 Sr Strontium	39 Y Yttrium	40 Zr Zirconium	41 Nb Niobium	42 Mo Molybdenum	43 Tc Technetium	44 Ru Ruthenium	45 Rh Rhodium	46 Pd Palladium	47 Ag Silver	48 Cd Cadmium	49 In Indium	50 Sn Tin	51 Sb Antimony	52 Te Tellurium	53 I Iodine	54 Xe Xenon				
55 Cs Cesium	56 Ba Barium			72 Hf Hafnium	73 Ta Tantalum	74 W Tungsten	75 Re Rhenium	76 Os Osmium	77 Ir Iridium	78 Pt Platinum	79 Au Gold	80 Hg Mercury	81 Tl Thallium	82 Pb Lead	83 Bi Bismuth	84 Po Polonium	85 At Astatine	86 Rn Radon			
87 Fr Francium	88 Ra Radium			104 Rf Rutherfordium	105 Db Dubnium	106 Sg Seaborgium															
57 La Lanthanum	58 Ce Cerium	59 Pr Praseodymium	60 Nd Neodymium	61 Pm Promethium																	
89 Ac Actinium	90 Th Thorium	91 Pa Protactinium	92 U Uranium	93 Np Neptunium																	

26Na Sodium

More about 26NA on [on NDS web](#)

^{26}Na Sodium

More about 26NA on [on NDS web](#)

Uncertainty applies to the least significant digit(s)

Z 11 N 15 J π 3+

Half life 1.077 (5) s

Decays

3- 100.0 %

Qa -12079.07 (1288) MeV

Qβ 9353.766 (3502) MeV

Qec -7340.225 (1852) MeV

Sn 5574.28 (370) MeV

Sp 12089.95 (4486) MeV

Electric Momoment -0.08 5 barn

Magnetic Moment +2.851 2 μ_N

Binding/A 8004.201 (135) MeV

Mass 25.992634649 (3759) AMU

Charge radius 2.9928 (0.0331) rms fm

Decay radiations

From β^- decay

3- 3514 (8) keV 88.1 (4) %

2026 (8) keV 2.7 (2) %

2263 (8) keV 2.7 (3) %