

WalletCraft: database and UI for Nuclear Wallet Cards

Adam Hayes, B. Shu, E.A. McCutchan,
A. Sonzogni, S. Zhu, A. Mattera,
L. Krejci

National Nuclear Data Center, BNL
Nuclear Data Week
2020

Nuclear Wallet Cards (print version)

NUCLEAR WALLET CARDS

Jagdish K. Tuli

National Nuclear
Data Center

www.nndc.bnl.gov

Brookhaven National Laboratory
P.O. Box 5000
Upton, New York 11973-5000
U.S.A.

Nuclear Wallet Cards

Nuclide	Z	El	A	J π	Q (MeV)	T $\frac{1}{2}$, Γ , or Abundance	Decay Mode
92 U	221			(9/2+)	24.6s	700 ns	
	222			0+	24.3s	1.0 μ s +12-4	α
	223				25.84	18 μ s +10-5	α , ϵ 0.2%
	224			0+	25.71	0.9 ms 3	α
	225				27.38	95 ms 15	α
	226			0+	27.33	0.35 s 15	α
	227			(3/2+)	29.02	1.1 m 1	α
	228			0+	29.22	9.1 m 2	α >95%, ϵ <5%
	229			(3/2+)	31.209	58 m 3	ϵ \approx 80%, α \approx 20%
	230			0+	31.613	20.8 d	α , SF $< 1 \times 10^{-10}\%$, $^{22}\text{Ne } 5 \times 10^{-12}\%$
231			(5/2-)	33.807	4.2 d 1	ϵ , α $\approx 4.0 \times 10^{-3}\%$	
232			0+	34.604	68.9 y 4	α , SF $3 \times 10^{-12}\%$	
233			5/2+	36.921	1.592×10^5 y 2	α , $^{24}\text{Ne } 9 \times 10^{-10}\%$, SF $< 6 \times 10^{-11}\%$, $^{28}\text{Mg } < 1. \times 10^{-13}\%$	
234			0+	38.148	2.455×10^5 y 6 0.0054% 5	α , SF $1.6 \times 10^{-9}\%$, Mg $1 \times 10^{-11}\%$, Ne $9 \times 10^{-12}\%$	
235			7/2-	40.921	7.04×10^8 y 1 0.7204% 6	α , SF $7.0 \times 10^{-9}\%$, $^{28}\text{Mg } 8. \times 10^{-10}\%$, Ne $\approx 8. \times 10^{-10}\%$	
235m			1/2+	40.921	≈ 26 m	IT	
236			0+	42.447	2.342×10^7 y 4	α , SF $9.4 \times 10^{-8}\%$	
237			1/2+	45.393	6.75 d 1	β^-	
238			0+	47.310	4.468×10^9 y 3 99.2742% 10	α , SF $5.5 \times 10^{-5}\%$	
239			5/2+	50.575	23.45 m 2	β^-	
240			0+	52.716	14.1 h 1	β^-	
241				56.2s		$\beta^-?$	
242			0+	58.6s	16.8 m 5	β^-	
243				62.4s			

Nuclear Wallet Cards (online)



www.nndc.bnl.gov/wallet

Nuclear Wallet Cards Search

([Help](#))

Download the latest PDF version [here!](#)

To request printed copies, please email lkrejci@bnl.gov.

Specify Nuclei:

Nucleus: *Ex: 232TH or th232 or 232-Th or th-232 or*

Z / Element: **A:** **N:**

$\leq Z \leq$ $\leq A \leq$ $\leq N \leq$

Decay Mode condition:

enabled disabled **Decay Mode**

E(level) condition:

enabled disabled $\leq E(\text{level}) (\text{MeV}) \leq$

$J\pi$ (level) condition:

enabled disabled **J** = **Parity** :

$T_{1/2}$ (level) condition:

enabled disabled $\leq T_{1/2} \leq$

No Upper/Lower limit values

Ordering:

Output:

Web Page Formatted File

Uncertainties:

Nuclear Data Sheets style Standard style

WalletCraft: Motivation

- Need system to speed updates of Nuclear Wallet Cards
- Some quantities are out of sync between ENSDF & WC
- Uniform calculation of mean half-lives, etc.
- Store
 - Source data: measured values from publications
 - Wallet Card evaluation version history
 - Publication history
 - Comments, notes, etc. separated from numerical data; all data in numerical fields
- Version tracking
 - Freeze “evaluation” versions
 - Tag “publication” versions
- Proof of principle for larger projects (e.g. ENSDF, talk later today)

Nuclear Wallet Cards original database

Current storage in MariaDB (relational) database—evaluator's result only

id	line_s
5961	235 92 U Q 7/2- A 100.00 0.0000 4.678 7.04E+8 Y 1 0.7204% 6 40.9210 0.0010 201411 2.22E+16
5962	235 92 U Q 7/2- SF 7.0E-9 0.0000 0.000 7.04E+8 Y 1 40.9210 0.0010 201411 2.22E+16
5963	235 92 U Q 7/2- 28Mg 8.E-10 0.0000 0.000 7.04E+8 Y 1 40.9210 0.0010 201411 2.22E+16
5964	235 92 U Q 7/2- 20Ne 8.E-10 0.0000 0.000 7.04E+8 Y 1 40.9210 0.0010 201411 2.22E+16
5965	235 92 U Q 7/2- 25Ne 8.E-10 0.0000 0.000 7.04E+8 Y 1 40.9210 0.0010 201411 2.22E+16
5966	235M 92 U Q 1/2+ IT 100.00 7.6E-5 0.000 26 M AP 40.9211 0.0010 201411 1.56E+03

Online lookup

Nucleus	E(level) (MeV)	J π	Δ (MeV)	T _{1/2}	Abundance	Decay Modes
²³⁵ ₉₂ U	0.00000	7/2-	40.9188	7.04×10 ⁺⁸ y 1	0.7204% 6	α : 100.00 % SF : 7.0E-9 % ²⁸ Mg : 8.E-10 % 20Ne : 8.E-10 % 25Ne \approx 8.E-10 %
^{235m} ₉₂ U	7.6E-5	1/2+	40.9189	\approx 26 m		IT : 100.00 %

2011 printed version

235	7/2-	40.921	7.04×10 ⁸ y 1	α ,
			0.7204% 6	SF 7.0×10 ⁻⁹ % ,
				²⁸ Mg 8.×10 ⁻¹⁰ % ,
				Ne \approx 8.×10 ⁻¹⁰ %
235m	1/2+	40.921	\approx 26 m	IT

WalletCraft project

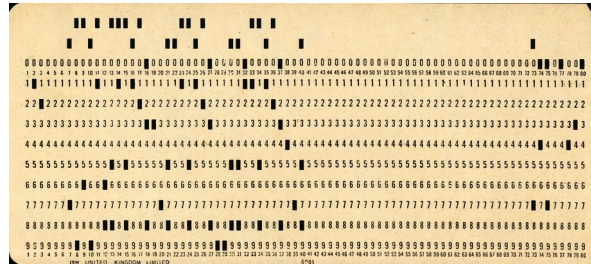
NUCLEAR WALLET CARDS

Jagdish K. Tuli

National Nuclear
Data Center
www.nndc.bnl.gov

Brookhaven National Laboratory
P.O. Box 5000
Upton, New York 11973-5000
U.S.A.

Nuclide	Z	RU	A	Jn	T _{1/2} , T _{1/2} , or (MeV)	Abundance	Decay Mode
92 U	221	(92+)	24.6		700 m		
222	0+	24.26			1.8 m ± 12.4		
223	0+	25.84			18 m ± 10.2		α, ε 0.25
224	0+	25.71			9.9 m ± 2		
225	0+	27.28			95.9 m ± 5		
226	0+	27.33			0.15 ± 16		
227	(3/2+)	29.02			1.1 m ± 2		
228	0+	29.22			9.1 m ± 2		α, β, γ, ε 0.06
229	(3/2+)	31.209			58 m ± 2		α, β, γ, ε 0.05
230	0+	31.413			20.8 d		α, β, γ, ε 1.01%
231	(5/2-)	33.807			4.2 d ± 1		α, β, γ, ε 0.10%
232	0+	34.404			68.9 ± 4		α, β, γ, ε 0.1%
233	5/2+	36.921			1.592 ± 10 ⁻³ y ± 2		α, β, γ, ε 0.10%
234	0+	38.148			2.455 ± 10 ⁻³ y ± 6		α, β, γ, ε 1.10%
235	7/2-	40.921			7.04 ± 10 ⁸ y ± 2		α, β, γ, ε 0.1%
235m	1/2+	40.921			28 m		IT
236	0+	42.447			2.343 ± 10 ³ y ± 2		α, β, γ, ε 9.4 ± 10 ⁻³ %
237	1/2+	43.293			6.75 d ± 2		β, γ, ε 0.1%
238	0+	47.310			4.468 ± 10 ⁹ y ± 2		α, β, γ, ε 99.742% ± 20
239	5/2+	50.515			23.45 m ± 2		β, γ, ε 5.5 ± 10 ⁻³ %
240	0+	52.716			14.1 h ± 2		β, γ, ε
241	5/2+	56.24			56.24 m ± 2		β, γ, ε
242	0+	58.4			16.8 m ± 2		β, γ, ε
243		62.44					



```
"evaluations": {
  "2017, 04, 01, 00, 00, 00, 000000": {
    "tHalfIsLowerLimit": false,
    "tHalfIsUpperLimit": false,
    "tHalfIsUpperEqual": false,
    "tHalfIsLowerEqual": false,
    "tHalfIsApproximate": false,
    "tHalfIsUnknown": false,
    "tHalf": 1.23,
    "tHalfUnit": "s",
    "tHalfInSeconds": 1.23,
```

- Preserve the work of evaluators
- Shorten the time to update (Average 6.5 years between editions since 1972)
- Reduce repetitive work → free up NNDC staff for new projects
- Same **object-oriented DB** ideal for open (binary) data

T_{1/2} & Δs

N/A	+	N/A	-	N/A	d	N/A
300.05	+	15	-	10	s	
312	+	12	-	20	s	
325	+	17.5	-	12.5	s	
302	+	15	-	15	s	

Weighted Average 318.406 s

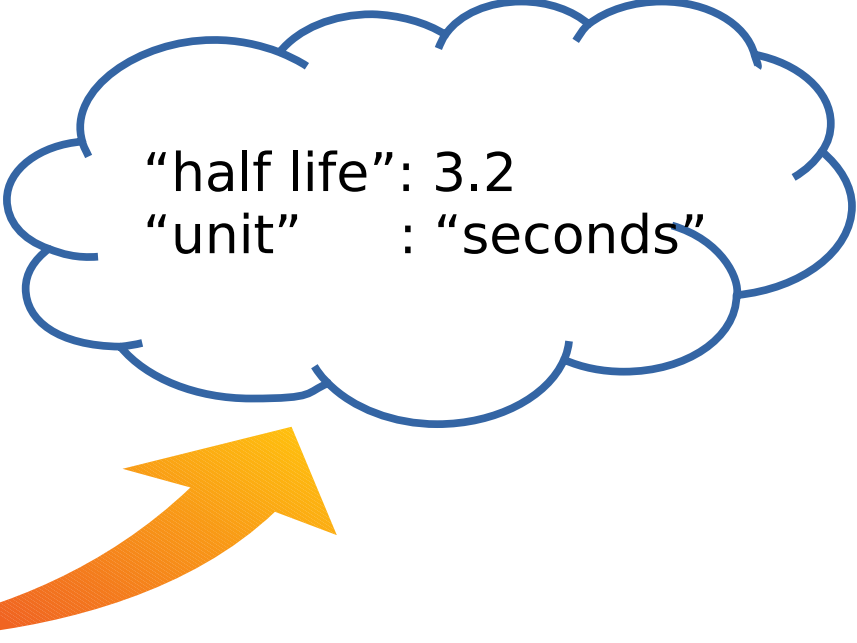
+ 9.850

Write notes here...

Re-calculate
Save evaluation

Why object-oriented database?

- Variety of data types
 - Numerical, text
 - Arrays (changeable size)
 - Documents (e.g. PDF)
 - Images (e.g. plots)
 - Binary data
- Easily made “human-readable”
- Heterogeneous data (ideal for open data)
- Hierarchical records with fewer cross-references
- Simplicity paradigm: “Store together what you access together”
- Less work loading object-oriented *code* objects



“half life”: 3.2
“unit” : “seconds”

Database designed for expansion

- Data in & out in JSON format
- “Everything is a dict”
- Reduce need to change a client for new data unless desired

➤ OK: (Hard to maintain, disruptive changes)

```
{"key":value}
```

Need to change data type to expand:

```
{"key": [value1, value2]}
```

➤ BETTER: (Expandible, but confusing)

```
{"key": [value1, value2, ...]}
```

➤ BEST: (Expand without disrupting users & developers)

```
{"key": {"value1Name": {"attribute1": value1}}}
```

Easily add an attribute:

```
{"key": {"value1Name":
```

```
  {"attribute1": value1, "attribute2": value2...}}}
```


Database “schema”

```
1 {  
2   "_id": "62,163",  
3   "_rev": "1-4b5a0b7904644dab711ce77c6cbb20ea",  
4   "Z": 62,  
5   "A": 163,  
6   "symbol": "163Sm",  
7   "levels": {↔},  
98  "rawLines": ["163  SM  62  101  201704  0.0  
99  "documentType": "nuclide",  
100 "debug": "Inserted with add-ensdf-to-wc.py"  
101 }
```

Database “schema”

```
1 {  
2   "_id": "62,163",  
3   "_rev": "1-4b5a0b7904644dab711ce77c6cbb20ea",  
4   "Z": 62,  
5   "A": 163,  
6   "symbol": "163Sm",  
7   "levels": {  
8     "GS": {↔}  
97  },  
98  "rawLines": ["163  SM  62  101  201704  0.0  
99  "documentType": "nuclide",  
100 "debug": "Inserted with add-ensdf-to-wc.py"  
101 }
```

Database “schema”

```
7 ▾ "levels": {  
8 ▾   "GS": {  
9 ▶     "tHalf": {↔},  
29 ▶     "decayWidth": {↔},  
34 ▶     "massExcess": {↔},  
39 ▶     "abundance": {↔},  
44 ▶     "decayModes": {↔},  
75 ▶     "Jpi": {↔},  
85 ▶     "energy": {↔}  
96     }  
97   },
```

Database “schema”

```
4      -  
5      "Z": 62,  
6      "A": 163,  
7      "symbol": "163Sm",  
8      "levels": {  
9          "GS": {  
10             "tHalf": {  
11                 "published": {},  
12                 "evaluations": {↔},  
13                 "measurements": {}  
14             },  
15         },  
16     },  
17 },  
18 }  
27  
28
```

Database “schema”

```
5      "A": 163,  
6      "symbol": "163Sm",  
7      "levels": {  
8          "GS": {  
9              "tHalf": {  
10                 "published": {},  
11                 "evaluations": {  
12                     "2017, 04, 01, 00, 00, 00, 000000": {↔}  
26                 },  
27                 "measurements": {}  
28             },  
            },  
        },  
    },
```

Database “schema”

```
11 ▾      "evaluations": {
12 ▾          "2017, 04, 01, 00, 00, 00, 000000": {
13             "tHalfIsLowerLimit": false,
14             "tHalfIsUpperLimit": false,
15             "tHalfIsUpperEqual": false,
16             "tHalfIsLowerEqual": false,
17             "tHalfIsApproximate": false,
18             "tHalfIsUnknown": false,
19             "tHalf": 1.23,
20             "tHalfUnit": "s",
21             "tHalfInSeconds": 1.23,
22             "dtHalf": [0.51, 0.47],
23             "stable": false,
24             "measurementsCited": {}
25         }
```

Wallet card updates before WalletCraft

The half-life of ^{137}Cs has been measured 20 times

E(level) [†]	J ^{π‡}	T _{1/2}	XREF	Comments
0.0 [@]	7/2 ⁺	30.08 y 9	A CDEFGH	%β ⁻ =100 $\nu = 2.8412 \text{ } ^- (1989R-17)$; $Q = 0.051 \text{ } ^- (1989R-17)$

T_{1/2}: Deduced by evaluators using the Limitation of Relative Statistical Weights (LRSW) method for analyzing the following set of discrepant ($\chi^2/\nu=18.6$) experimental values: 10970 d 20 (2004Sc04); 11018 d 10 (2002Un02); 10941 d 7 (1992Go24); 10968 d 5 (1990Ma15); 11009 d 11 (1980Ho17); 10906 d 33 (1978Gr08); 11034 d 29 (1973Co39); 11021 d 5 (1973Di01); 11023 d 37 (1972Em01); 10921 d 17 (1970Wa19); 11191 d 157 (1970Ha32); 11286 d 256, 10921 d 183 (1965Fi01); 11220 d 47 (1965Le25); 10665 d 110 (1963Ri02); 10840 d 18 (1963Go03); 10994 d 256 (1962Fi09); 11103 d 146 (1961Fa03); 10957 d 146 (1955Br06); and 9715 d 146 (1955Wi21). [1 y = 365.2422 d].

Recommended value in formatted field

All source data comes in free-text comment

Then...

- Evaluator needs to repeat manual lookups and calculations
- Repetitive, inefficient and error prone
- Almost impossible to implement automation or AI

Now

WalletCraft

Add Nuclide

Search Nuclide

Nucleus ID:

Proton # (Z):

Atomic # (A):

Search

Show all Z

Show all A

Committed Versions

^{22}Na

Request edit permission

Commit changes

Cancel

Delete document

Reserve this document

End reservation

Last published on: -

Published Entries

E_{level}

J^{π}

$T_{1/2}$

Mass Excess

Decay Modes

Abundance

Decay Width

Evaluated Level Information

+ Add Level

E_{level}

J^{π}

$T_{1/2}$

Mass Excess

Decay Modes

Abundance

Decay Width

GS

0 keV

3+

2.6018 y +/- C

--- None ---

EC+B+: 100%

--- None ---

--- None ---

M1

583.05 keV +/-

1+

2015-07-01

None ---

--- None ---

--- None ---

2.6018 y +/- 0.0022 y

Publish latest evaluations

Ben Shu (NNDC)

Nuclear Wallet Cards interface with evaluator's history

Video:
Web interface
developed by Ben Shu

- ~3000 nuclides with partial data
- In use at NNDC
- Will be used for next version of WC

WalletCraft

Search Nuclides

Nucleus ID: Proton # (Z): Atomic # (A):

WalletCraft Status

WalletCraft Project:

E.A. McCutchan
A. Sonzogni
B. Shu
S. Zhu
A. Mattera
L. Krejci
A.B. Hayes

- Ben Shu (NNDC) lead developer on UI (HTML + JavaScript)
 - already in use by NNDC staff
- Finished server-side:
 - Create, Read, Update, Delete
 - Lock management (prevent conflicts between users)
 - Basic search (by Z, A, Symbol)
- L. Krejci leading data entry:
expect fully populated by end of calendar year
- Displays all measurements, evaluations, etc. for selected nuclide (earlier slide)
- *Runs in web browser – no software download necessary. Users do not need to find, install, or update any software to run WalletCraft.
- Will be used internally for next version of Wallet Cards
- ***Will enable significant reduction from average ~6.5 years between editions***

END