WalletCraft: database and UI for Nuclear Wallet Cards

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National Nuclear Data Center, BNL
Nuclear Data Week
2020

Nuclear Wallet Cards (print version)

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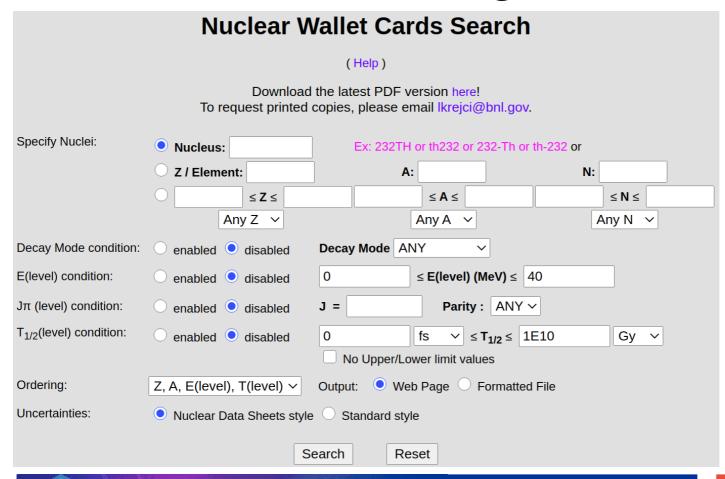A.B. Hayes

Nuclear Wallet Cards (online)

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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)

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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 |
+------+------------------------------------------------------------------------------------------------------------+
```
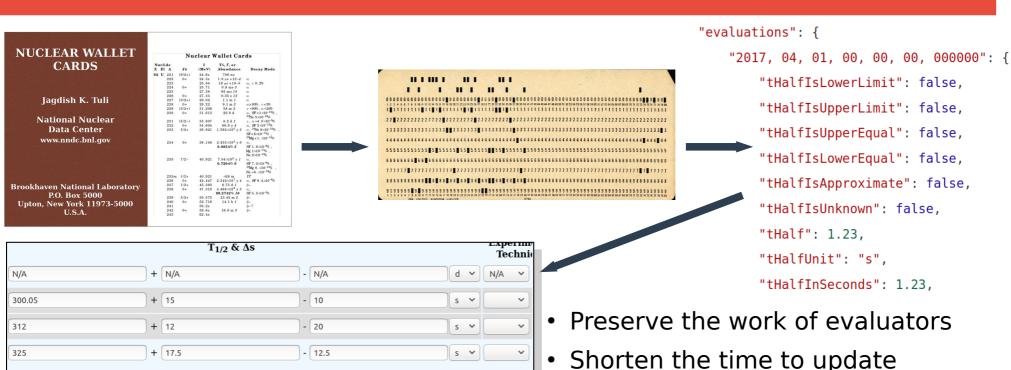
Online lookup

Nucleus	E(level) (MeV)	Jπ	Δ(MeV)	$T_{1/2}$	Abundance	Decay Modes
$^{235}_{92}$U	0.0000	7/2-	40.9188	$7.04 \times 10^{+8}$ y 1	0.7204% 6	α : 100.00 % SF : 7.0E-9 % ^{28}Mg : 8.E-10 % 20Ne : 8.E-10 % 25Ne ≈ 8.E-10 %
$^{235m}_{92}$U	7.6E-5	1/2+	40.9189	≈ 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 $8. \times 10^{-10}$% ,	
				Ne $\approx 8. \times 10^{-10}$%	
235m	1/2+	40.921	≈26 m	IT	

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WalletCraft project

"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

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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"

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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…}}}

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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   }
```

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Database "schema"

```json
{
    "_id": "62,163",
    "_rev": "1-4b5a0b7904644dab711ce77c6cbb20ea",
    "Z": 62,
    "A": 163,
    "symbol": "163Sm",
    "levels": {
        "GS": { ↔ }
    },
    "rawLines": ["163  SM   62   101   201704     0.0
    "documentType": "nuclide",
    "debug": "Inserted with add-ensdf-to-wc.py"
}
```

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Database "schema"

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

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Database "schema"

```
 4      "Z": 62,
 5      "A": 163,
 6      "symbol": "163Sm",
 7 ▾    "levels": {
 8 ▾        "GS": {
 9 ▾            "tHalf": {
10                  "published": {},
11 ▸                "evaluations": {↔},
27                  "measurements": {}
28              },
```

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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                  },
```

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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                          }
```

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Wallet card updates before WalletCraft

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

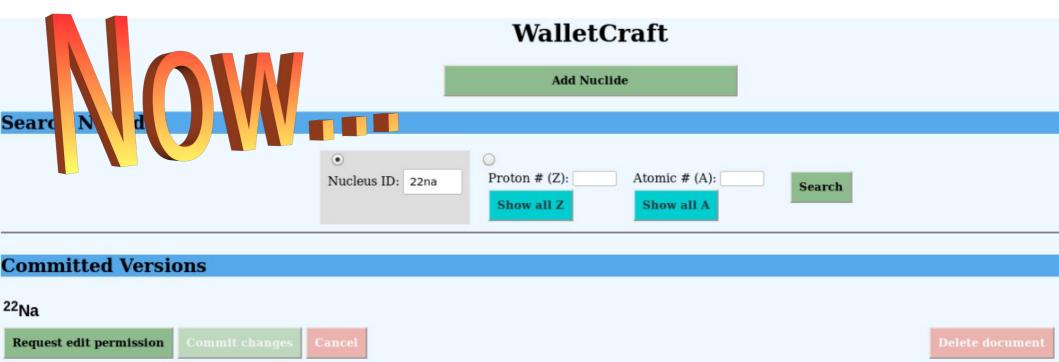| E(level)†	J$^{\pi\ddagger}$	T$_{1/2}$	XREF	Comments
0.0$^@$	7/2$^+$	30.08 y 9	A CDEFGH	%β^-=100

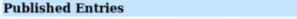T$_{1/2}$: Deduced by evaluators using the Limitation of Relative Statistical Weights (LRSW) method for analyzing the following set of discrepant (χ^2/ν=18.6) experimental values: 10970 d *20* (2004Sc04); 11018 d *10* (2002Un02); 10941 d *7* (1992Go24); 10968 d *5* (1990Ma15); 11009 d *11* (1980Ho17); 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* (1965Fl01); 11220 d *47* (1965Le25); 10665 d *110* (1963Ri02); 10840 d *18* (1963Go03); 10994 d *256* (1962Fl09); 11103 d *146* (1961Fa03); 10957 d *146* (1955Br06); and 9715 d *146* (1955Wi21). [1 y = 365.2422 d].

Recommended value in formatted field

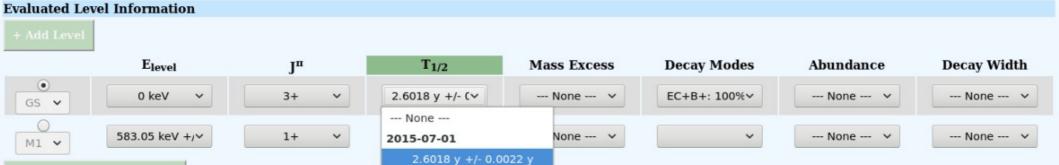All source data comes in free-text comment

Then....

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

Slide:
E.A. McCutchan

A.B. Hayes

WalletCraft

Now....

Add Nuclide

Search Nuclide

- ⦿ Nucleus ID: `22na`
- ○ Proton # (Z): [ ] Atomic # (A): [ ]
  - **Show all Z** **Show all A**

Search

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 +/- 0 ⌄	--- None --- ⌄	EC+B+: 100% ⌄	--- None --- ⌄	--- None --- ⌄
○ M1 ⌄	583.05 keV +/ ⌄	1+ ⌄	--- None --- **2015-07-01** 2.6018 y +/- 0.0022 y	None --- ⌄	⌄	--- None --- ⌄	--- None --- ⌄

Publish latest evaluations

Ben Shu (NNDC)

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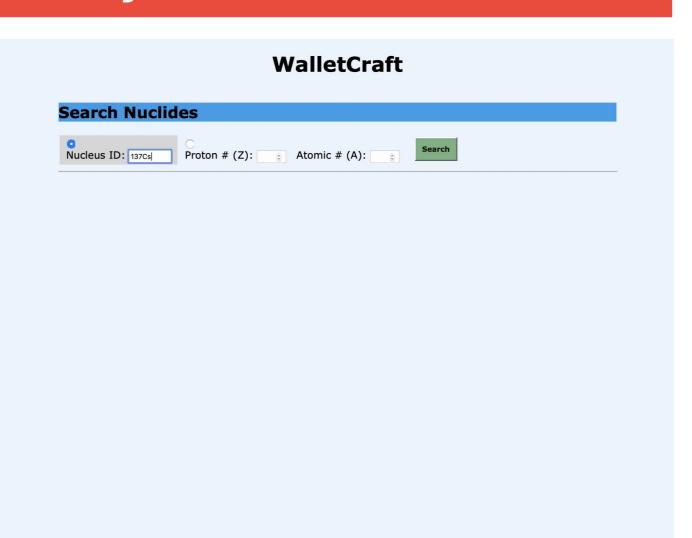
Nuclear Wallet Cards interface with evaluator's history

Video:
Web interface developed by Ben Shu

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

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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

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