Half-lives: databases, calculation

The code operates under MS Windows environment and provides a highly user-friendly interface. It can be freely downloaded from the following internet addresses:

http://www.nscl.msu.edu/lise

version 8.3.140

To estimate FRIB potential it is necessary to know half-lives and drip-lines locations

http://groups.nscl.msu.edu/frib/rates/

---

A) The rates are estimated based on the EPAX 2.1s cross section parameterization for fragmentation and the LISE++ 3EER model[2–3] for in-flight fission.
B) Reaccelerated and stopped beam rates above 1E+9 are very uncertain. The use of solid catchers may yield higher rates in some cases.
C) Estimated rates may change as the various assumptions are tested and refined.

Experimental values: AME2003

Calculations:

Beta- & Beta+ database in LISE++ package
"bin\beta_halflives.ltime"

Alpha database in LISE++ package
"bin\alpha_halflives.ltime"

Proton emission - calculated in LISE++ based on the tools provided by B.A.Brown
Proton decay

Recommended (default) values

About "TunnelF"

The program tunnelF was written by T. Kajino and B. A. Brown to calculate the single-particle width for charged particle decay.

It uses the Coulomb wavefunction program tunn [1] to calculate the barrier penetration probability and multiply this with the Wigner single-particle estimate to obtain the total width and lifetime [2].


Proton decay: final result

Proton Radioactivity

A  Element  Z
35  Sc  21

Doesn't exist!

Value [MeV]
S_1p -2.206
S_2p -1.307
S_1p + CB 2.381
S_2p + CB 6.999

R = 1.17 fm

Assume the next momentum for decays
1p - emission Calculation (spherical case)
2p - emission L = 0

Result being used in the code
Use both 1p and 2p cases
Final result for p-emission 5.3e-19 T1/2 sec

One-particle Proton levels (spherical case)
Configuration = 1 f 7/2 [1/8]
L = 3

Width and lifetime
1p-emission
<table>
<thead>
<tr>
<th>L</th>
<th>Width (MeV)</th>
<th>T (sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1.7e-01</td>
<td>2.7e-02</td>
</tr>
<tr>
<td>1</td>
<td>6.6e-02</td>
<td>6.9e-21</td>
</tr>
<tr>
<td>2</td>
<td>1.1e-02</td>
<td>4.3e-20</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>2p-emission</th>
</tr>
</thead>
<tbody>
<tr>
<td>L</td>
</tr>
<tr>
<td>---</td>
</tr>
<tr>
<td>3</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

minimum
Proton decay: 1p & 2p cases

Masses from:
User's ME file [kluy] + LDM#2

Use only 1p case
Use only 2p case

Protons (Z)

T_1/2 (sec)
<Proton decay>

Isospin (N-Z)

1p

2p

Protons (Z)

T_1/2 (sec)
<Proton decay>

Isospin (N-Z)
Both codes have been transported to C++ and implemented in LISE++

v.8.3.138
Half-lives plots

Choose a Plot Type

Select a data set to plot:
- Experimental values

- Compilation set:
  - min(Beta, Alpha, Proton)
  - Include "unbound" isotopes

0 - Experimental values
2 - Alpha decay: P.Moller et al., ADNDT 159(1998)
3 - Proton decay: see FISON Radioactivity dialog

Function of the plot:
- One-dimensional
- Two-dimensional

Plot type:
- Isotopes, Z=const
- Isotopes, A=const
- Isotopes, N=const
- Isospin, N-Z=const
- Isospin, N-ZZ=const
- Z (protons)
- A (nucleons)
- N (neutrons)
- N-Z (isospin)
- N-ZZ

T_{1/2} (sec)

Z=16

Z_{min} = 16
Z_{max} = 16
If $T_1/2 > 1e20$ sec, or isotope is stable then the code plots $1e20$.

If beta-decay energy $> 0$, but $T_1/2$ value is absent in the database, then value $1e-4$ sec is used.

If $Q$-alpha $> 6MeV$, but $T1/2$ value is absent in the database, then value $1e-5$ sec is used.
2D half-lives plots: decays

- T_1/2 (sec) <Experiment>
- T_1/2 (sec) <Alpha decay>
- T_1/2 (sec) <Beta decay>
- T_1/2 (sec) <Proton decay>
Half-life compilation

T_{1/2} (sec) (compilation)

- All methods
- Z=90

Decays

If T1/2_experiment exist then T1/2_experiment is used else Min (T1/2 beta, T1/2 alpha, T1/2 proton)

Min (T1/2 beta, T1/2 alpha, T1/2 proton)
2D half-life compilation

With KTYU mass model
Total revision of decay modes and half-lives

version 8.3.135

Based on AME2003 experimental half-lives have been updated.

Decay modes have been revised for the table of nuclides, As well as for Observed / Non-observed case
Unknown isotopes in the Table of nuclides for version 8.3.138 have been generated with the KTUY mass model including proton emitters (threshold > 1ns)
Thanks to
Prof. B.A. Brown, Prof. M. Thoennessen,
Dr. A. Lisetsky, Prof. A. Gade
(NSCL/MSU)
for fruitful discussions