On unifying the definition of discrete, excited and isomeric states across the nuclear data model and form frames

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Objectives

- One impediment of the traditional ENDF-6 format, as a recipient of a nuclear data evaluation, has always been its inability to have a unified, robust **unique** way to identify, distinguish clearly discrete, excited or isomeric states in the model and data form frames:

  - Definition: ZA +, IsoA +
  - Cross section: as target and daughter product
  - Decays properties
  - Fission, transmutation yields

Actual metrics

- Difficulty in form recording, accounting and interpretation arises:
  - when more than two states are present
  - with definitions
    - such as an isomeric state is a “long-lived” excited state of the nucleus
    - sequence number I1: 1, 2, 3, 4, … so 9 is the maximum
    - ZA +300, +600, +900
    - alphabetic order starting with g for ground then m, n, o, p, ...
    - discrete states in the continuum
    - maximum number of states set to 40 for n’ emission
  - subtle difference, bookkeeping between discrete level, excited and isomeric state
  - the use of different, non-concordant flag, definition across the models and MF’s frame (LIS, LISO, LIP, LFS, $ZA=(1000.0*Z+I) + A$)

GNDS proposal

- The proposed solution moving forward in the GND Structure should be kept simple, able to accommodate the tempo of the phenomena of the physics at play when in its most physical sense a discrete level, excited or isomeric state should be uniquely defined by:

  - ZA
  - ELFS its excitation energy in eV
  - HL its half life in seconds

- Accompanied with an understanding that all non-defined, definable or accounted for levels, states would have been accumulated in the lowest (energy wise) recorded one

Key elements

- A subtle distinction between discrete level and excited state could be made with regards to the tempo of the phenomenon studied, whereby
  - discrete is considered instantaneous: HL = 0.0 and gamma emission only
  - While excited is having a half-life greater than a given value

  ($T_{½}$ > 1 ms) and more complex deexcitation, decaying scheme if and when needed.

- A minimal ($T_{½}$ > 1 ms) reference database of the above metrics should be compiled, recorded and updated when needed. For those that want, need to go below that minimal HL they can always build from the above

Key elements

- Am242_e#

- # need to be an integer number corresponding to a level, excited states of the database, uniquely relating to ELFS and $T_{1/2.}$ A third level may not always be the third depending on the tempo of the phenomena studies or when physicist consider anything above x seconds as stable or non-interacting

- Am242_e5 or 95242_e5 would mean the 5^{th} level accounted for in the simulation from the database. Levels populating the continuum are permitted when needed

Conclusions

- It should be noted that the proposed solution will lead to some difficulty to have backward compatibility with the ENDF-6 frame(s), having made the assumption that the latter frame(s) were always sufficient:
  - whatever the physics
  - whatever the application
  - whatever the interpretation
- which undoubtably never was the case