Argonne NATIONAL LABORATORY

Member of the US Nuclear Data Program

The latest AME & NuBase nuclear data tables: how well do we know the basic nuclear physics properties?

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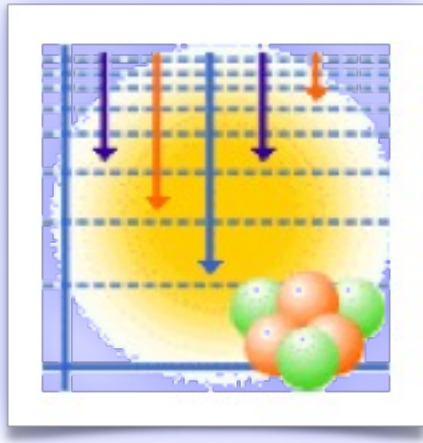


U.S. DEPARTMENT OF ENERGY | Office of Science

Nuclear Physics

Nuclear Data WG session at the NSAC LRP Town Hall meeting on Nuclear Structure, Reactions & Astrophysics, ANL, November 14-16, 2022

U.S. DEPARTMENT OF ENERGY

Atomic Mass Evaluation & NuBase

- Correlations
  - ✓ pairing
  - ✓ p-n
- Binding energy
  - ✓ mass models
  - ✓ shell structure

- Nuclear Data
  - ✓ Q values
  - ✓ reaction probabilities

- The limits of existence
  - ✓ drip lines

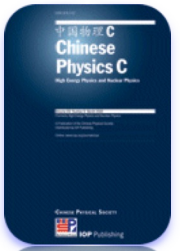
- Nuclear astrophysics
  - ✓ nucleosynthesis pathways & scenarios

- Fundamental symmetries

- Applications of Nuclear Science

AME2020 & NUBASE2020

coordinated by M. Wang (AME) and F.G. Kondev (NuBase)



The NUBASE2020 evaluation of nuclear physics properties**

F.G. Kondev [1,*], M. Wang (王猛)[2,3,*], W.J. Huang (黄文嘉)[2,4,5,6], S. Naimi[7], G. Audi (欧乔治)[6]

The AME2020 atomic mass evaluation **

(I). Evaluation of input data, and adjustment procedures

W.J. Huang (黄文嘉)[1,2,3,4] Meng Wang (王猛)[1,5,*] F.G. Kondev[6] G. Audi (欧乔治)[3] S. Naimi[7]

The AME2020 atomic mass evaluation **

(II). Tables, graphs and references

Meng Wang (王猛)[1,2,*] W.J. Huang(黄文嘉)[1,3,4,5] F.G. Kondev[6] G. Audi (欧乔治)[5] S. Naimi[7]

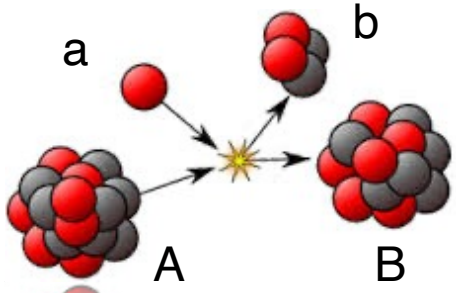
IOP science

since March 5, 2021

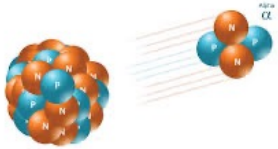
- 30000 downloads
- 650 citations

Data coverage

- **Direct methods - mass spectrometry**
  - **TOF & MR-TOF** (very fast BUT low precision & resolution)
  - **Storage Rings** (fast & many nuclei at once)
  - **Penning Traps** (relatively "slow" BUT high precision and high resolution)



$$Q_r = M_A + M_a - M_b - M_B$$



$$Q_d = M_P - M_D - m_{p(\alpha)}$$

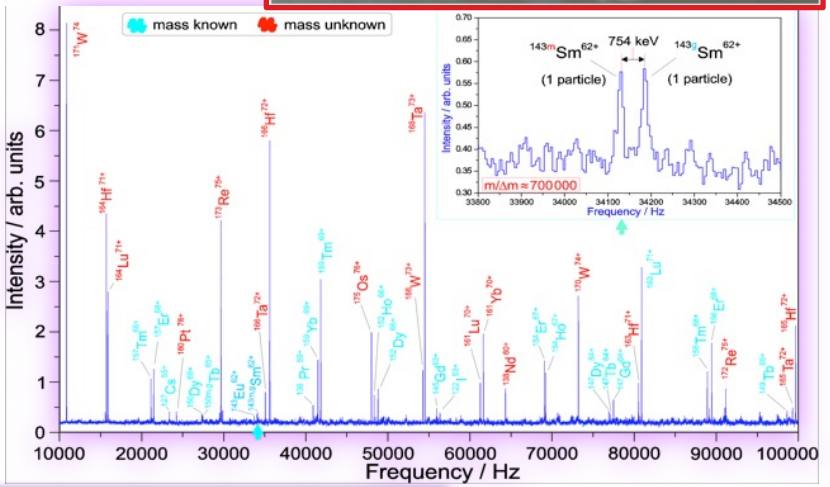
- **Indirect methods - reaction and decay energies**
  - **Reaction Energies**
    - (n,γ) and (p,γ) are the backbone
    - self-calibrated - A(a,b)B vs. C(a,b)D
    - close to stability
  - **Decay Energies** in β^-,β^+, α and p decays
    - far from stability - α and p (heavy or proton-rich nuclei) & Q_{β^-} neutron-rich nuclei

Connection to Nuclear Structure

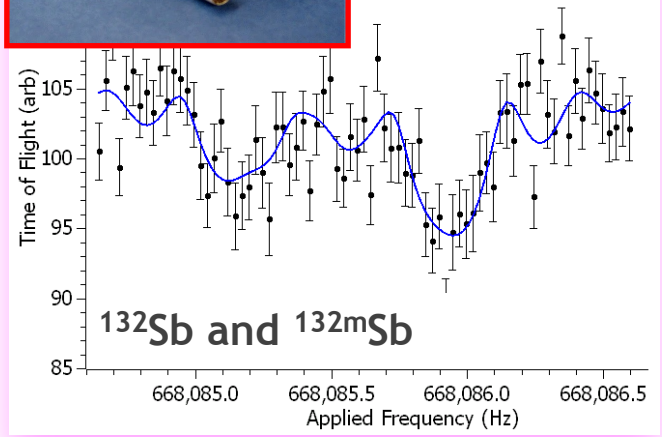
Beware of Isomers

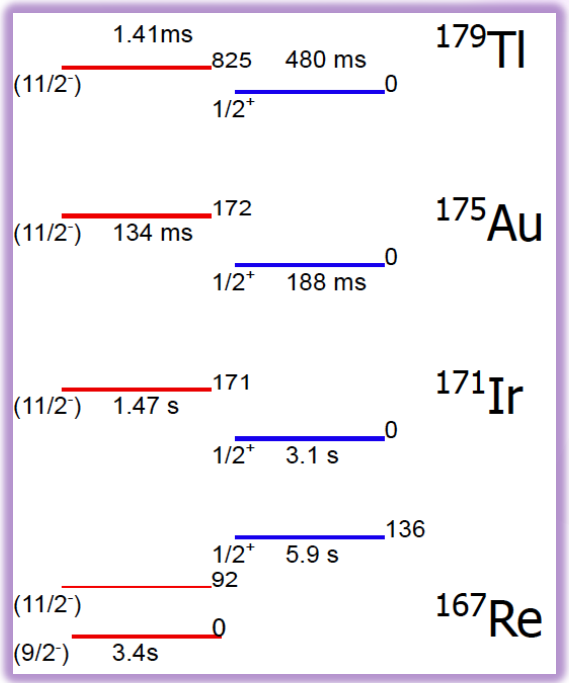
Do we have the right relation?

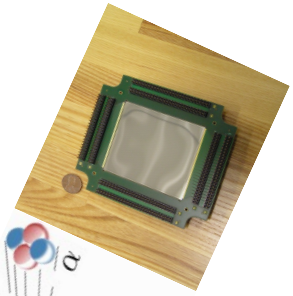
- Excitation energy
- Lifetime
- Decay mode

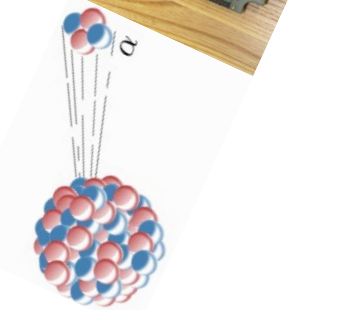


J. Van Schelt et al., PRL111 (2013) 061102









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The NUBASE2020 evaluation of nuclear physics properties**

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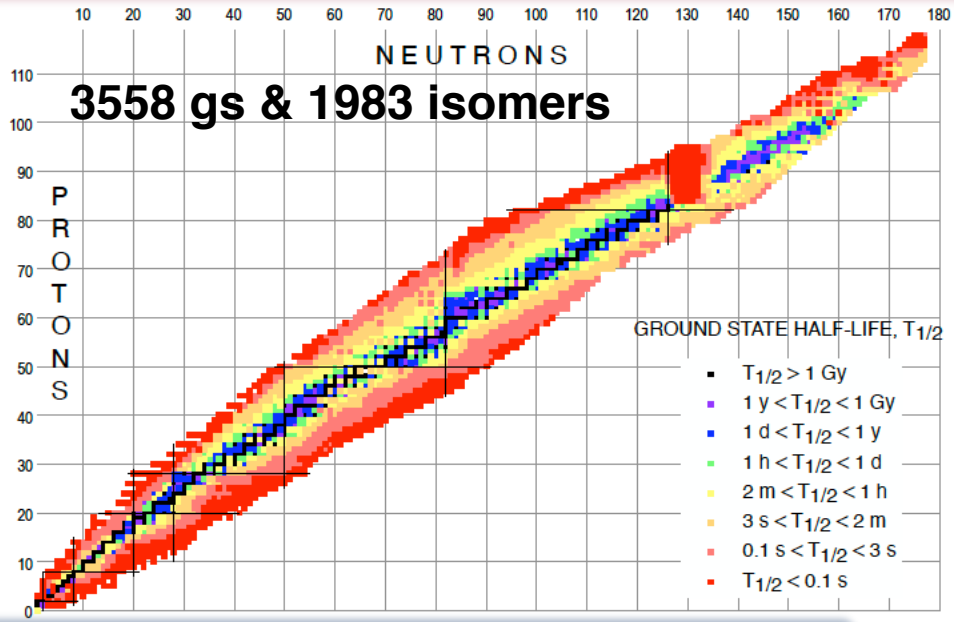
What is included in NuBase?

- masses (Ex) for isomers ($T_{1/2}$>100 ns) and their method of deduction – integral part of AME
- $T_{1/2}$, Jπ, decay modes and BR for both ground states and isomers
- properties of **205** Isobar Analog States (IAS)



Why NuBase?

- **complete** - include all measured quantities and their uncertainties
- **up-to-date** - include results from all recent publications
- **credible and reliable** - identify and resolve contradictory results that exist in the scientific literature, as well as in other nuclear physics databases
- **properly referenced** - provide comprehensive bibliographical information for all included properties.

Conclusions & Outlook

- AME2020 & NUBASE2020 evaluations have been released – complete, up-to-date & reliable information about the basic NP properties

pdf & ascii: https://www.anl.gov/phy/atomic-mass-data-resources (ANL)

https://www-nds.iaea.org/amdc/ (IAEA)

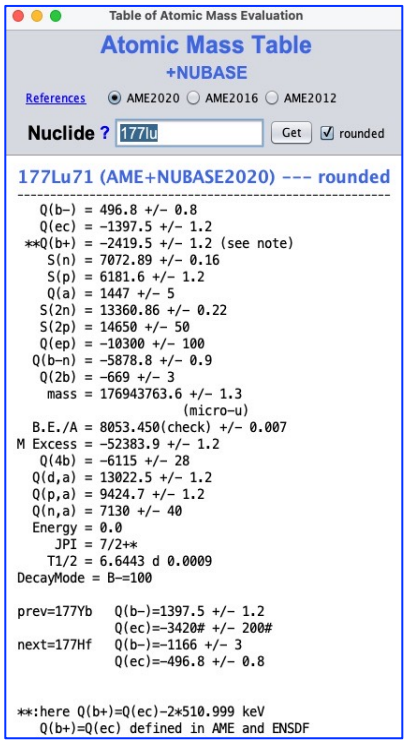
http://amdc.impcas.ac.cn (IMP)

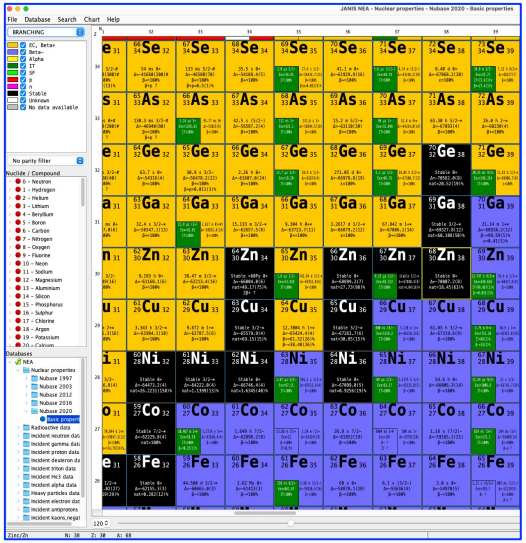
JAVA-AME
J. Chen

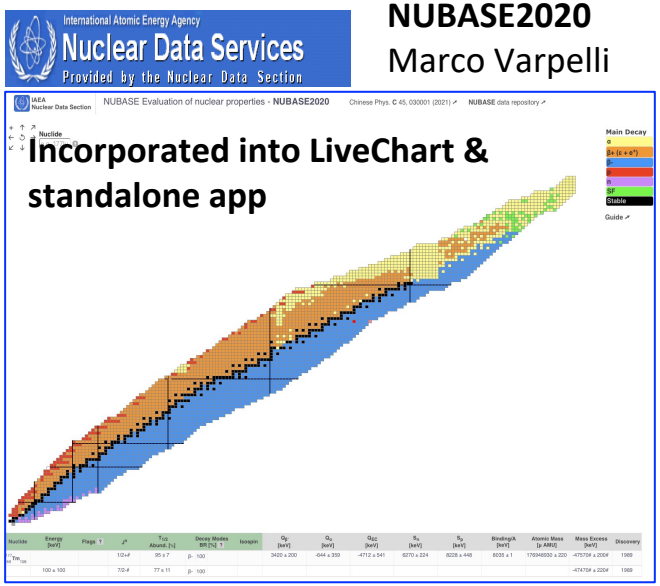
stand-alone & www

JANIS
NUBASE1997-2020
Nicolas Soppera

NUBASE2020
Marco Varpelli







- work on the next next tables started – aim to be completed in 2024