New \( \beta \)-Decay Studies of Deformed, Neutron-Rich Nuclei in the A\( \sim \)160 Region

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Motivation

- Unusual structure effects in N-rich, rare-earth nuclei
  - Especially near $N = 98$

- Understanding the pygmy rare-earth peak depends on nuclear structure input

$^{156}\text{Pm, }^{160}\text{Eu, } & ^{162}\text{Eu Decay Studied: Focus on }^{160}\text{Eu}$

CARIBU at Argonne National Laboratory provided the beams

**Mass Measurement**

**β Decay Spectroscopy**

- Previously for $^{160}\text{Eu}$: Only a (1-) isomer with $t_{1/2} = 38(4)$ s
- Tape/Beam Cycle: 180 s beam on, 180 s beam off
- $\beta$-gated $\gamma$ vs. time matrix: Measure lifetimes
- $\beta$-gated $\gamma$-$\gamma$ coincidence matrix in beam off condition
Mass Measurement of $^{160}$Eu

- The new phase-imaging ion-cyclotron-resonance (PI-ICR) technique was used
  - Method tested in CPT with well-known energy of $^{156}$Pm

- Cyclotron frequency determined by measuring the accumulated phase during a period of free motion ($t$)
  - Measured phase difference between the states gives the excitation energy
  - AME12 value for $^{160}$Eu is an unknown mixture of these two states
β-Decaying States in $^{160}$Eu

- Previous $t_{1/2}$: 31(4) s, 41(4) s, 50(10)s, 53(10)s
  - Assumed single low-spin, β-decaying state
- Lifetimes of γ's fell into 2 values (2 isomers)
- γ’s with $t_{1/2}$=42 s from, or fed, high-spin states
- $\pi[413]5/2 \nu[523]5/2 \rightarrow K^\pi = 5^- & 0^-$
- Nuclear structure of $^{160}$Gd states assist in configuration assignment
- Two different level schemes proposed for $^{160}$Gd
  - Ours differs from both!
- 1999-keV state most strongly fed by $K^\pi = 5^-$
  - $t_{1/2}$=42 s isomer; log$ft \approx$ 5.0 -> related configs
- More to come…