β-decay properties of Co-isotopes

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Motivation

- We want to understand how heavy elements are made via neutron-capture processes
- In neutron-capture processes, it is important to understand β decay
- For exotic nuclei, we rely on models to describe β decay properties

More experimental data is needed to see how good theoretical models describe neutron rich isotopes

For exotic nuclei, we rely on models to describe β decay properties

More experimental data is needed to fully describe neutron capture processes

One property that is important is the β strength, it tells us how probable it is for an isotope to β decay as a function of excitation energy

β strength function can be used to find the combinations of simulations that fit best to the experimental data.

More experimental data is needed to see how good theoretical models describe neutron rich isotopes

Results

For expanding this analysis, it is important to be able to benchmark the new analysis method with existing data.

- Already, there has been an experiment on 57Co where the β strength, I(β) has been found.
- To be sure that the analysis is correct when expanding it to look at 2D histograms instead of just projections, I can compare my expanded analysis with the existing data, as shown in Fig. 3 from Ref. [3].

One thing that has to be taken into account when we move on to 58Co is the β-decayed neutrons. See Fig. 8 and 10.

Expansion of TAS analysis to fitting 2D spectra

Agrees with previous results done by S. Lyons et al [2] for 57Co

Have to fit neutrons to account for β-delayed neutrons in odd-odd Co isotopes, which are 58Co and 59Co

These Co-isotopes are marked in Fig. 11.

Total absorption spectroscopy (TAS)

- Experiment at NSCL in 2017 with a cocktail beam
- Used the Summing NaI (SuN) (Fig. 2) detector together with a double sided silicon strip detector
- With the SuN detector, we can detect the individual γ-rays and sum them up to find the total excitation energy from the nucleus

We can then do total absorption spectroscopy (TAS) as seen in Fig. 3.

We can then do total absorption spectroscopy (TAS) as seen in Fig. 3 from Ref. [1].

- TAS works with the SuN detector, since we can sum up all the individual γ-rays from the segments to find the excitation energy of the nucleus after it has undergone β decay.
- With this information, we can try to simulate the same decay for the range of available excitation energies
- Then we can fit the simulated spectra as a function of:
  - the multiplicity (number of γs seen in the detector)
  - initial excitation energy
  - individual γ-rays
- The weights from this j2 minimization is the β decay intensity and will then be used to find the β strength function as a function of energy

Discussion

- When adding in neutrons, it should possible to recreate the experimental data with the β delayed neutron emission
- This will be important to find the combinations of simulations that fit best to the experimental data.

See Fig. 10 for preliminary simulation results for 56Co.

Summary and future outlook

- Expansion of TAS analysis to fitting 2D spectra

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Sources