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Testing three-body forces in the oxygen region via lifetime measurements

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The investigation of the three-body forces influence in the structure of light nuclei has gained a lot of interest in recent years.
In this context, the oxygen isotopic chain is a perfect playground.
In fact, the introduction of three-body forces in the interaction explained the change in neutron shell closure from $\nu d_{3/2}$ ($N = 20$) to $\nu s_{1/2}$ ($N = 16$), as observed experimentally.
While the importance of three-body forces in this region is established, their contribution has yet to be quantified.
The ^{20}O represents an interesting study case.
In fact, the 2_2^+ and 3_1^+ states are based on a mixed $(d_{5/2})^3(s_{1/2})^1$ neutron configuration.
These orbitals are influenced by the contribution of 3N forces.
Hence, electromagnetic properties of the 2_2^+ and 3_1^+ states, such as excitation energies, branching ratios and reduced transition probabilities, provide meaningful information on the position of the $d_{5/2}$ and $s_{1/2}$ orbitals.

An experiment aimed at measuring the lifetime of these states was performed at GANIL (France).
The ^{20}O was populated via a (d,p) reaction, using a post-accelerated radioactive beam of ^{19}O provided by the SPIRAL complex and a deuterated polyethylene target deposited on a gold degrader.
The beam-like and target-like partners were detected using the VAMOS spectrometer and the MUGAST array, respectively.
The chosen reaction allowed the reconstruction of the excitation energy spectrum of the nucleus of interest from the information on the detected protons, as well as the use of selective gates to perform spectroscopy measurement of weakly populated states.
Finally, the γ rays emitted by the ^{20}O were detected by the AGATA array at backward angles.

The level scheme of the ^{20}O, obtained from γ-particle coincidence measurements, was reconstructed.
Then, the lifetimes of the 2_2^+ and 3_1^+ states were measured using the Doppler-Shift Attenuation method.
In particular, the experimental lineshapes of the $2_2^+ \rightarrow 2_1^+$ and $3_1^+ \rightarrow 2_1^+$ transitions at 2396 keV and 3552 keV respectively have been compared to realistic Monte Carlo simulations, optimized in order to reduce the sources of systematic errors.

In this contribution, the results of the γ-particle spectroscopy and the lifetime measurements of the 2_2^+ and 3_1^+ states is be presented.
A preliminary interpretation of the results is also presented.

Topic

Experiment

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