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Testing ab-initio calculations in light nuclei via high-precision spectroscopy

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The development and improvement in terms of performances of accelerator facilities and detectors has paved the way for extending the study of nuclear structure towards more exotic nuclei and experimental quantities that have been, until now, less accessible.
In parallel, theoretical methods have advances in precision and prediction capabilities.
In recent years, \textit{ab-initio} calculations in particular have proven to be powerful tools to address open questions in nuclear structure; one example is the role of three-body forces in the evolution of nuclear structure far from stability.
The importance of their contribution is evident in the case of the oxygen isotopic chain.
In fact, only by including these forces in the calculations it is possible to correctly reproduce the neutron dripline in correspondence of ^{24}O, instead of ^{28}O as predicted by standard calculations.
However, in order to quantify the contribution of these forces, spectroscopic information is crucial.

In this context, the ^{20}O nucleus is a perfect playground for these measurements; in fact, the properties of the 2^+_2 and 3^+_1 states of this nucleus are expected to be influenced by three-body forces.
By measuring the spectroscopic properties of these nuclei, such as the excitation energy, the branching ratio and the lifetime, and comparing them to theoretical calculations, it is possible to understand the depth of their influence.

For these reasons, an experiment aimed at studying the ^{20}O was performed in GANIL. The radioactive beam of ^{19}O, provided by the SPIRAL1 complex, impinged on a deuterated target, populating the nucleus of interest by means of a (d,p) reaction.
The target was deposited on a layer of gold in order to measure the lifetime of the states by using the Doppler-Shift Attenuation Method.
The recoils of the binary reaction were detected using the MUGAST array and the VAMOS++ magnetic spectrometer, while the γ rays emitted were detected using AGATA.

The nucleus was first investigated via particle-γ spectroscopy to reconstruct the level scheme and measure the branching ratios.
Then the lifetimes of the 2^+_2 and 3^+_1 states were measured. To do so, the experimental lineshapes were compared to realistic Monte Carlo simulations and the lifetimes were extracted by using the least-χ^2 method.
Finally the reduced transition probabilities, B(E2) and B(M1) deduced from the lifetime measurements, were compared to \textit{ab-initio} calculations.

In this contribution, the results of the particle-γ spectroscopy and the lifetime measurements of the 2^+_2 and 3^+_1 states are reported.
An interpretation of the nature of the excited states of ^{20}O is presented as well as the future perspectives for further investigation in this region.

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