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Study of the 14B nuclear structure and the tensor force contribution in the O isotopic chain using QFS reactions

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The motivations for studying nuclei far from the valley of stability are manifold: from the study of the role played by the different parts of the nuclear force in the evolution of shell gaps, to the appearance of halo nuclei and clusters in a variety of isotopic chains linked to the proximity of the continuum, including the reordering of the neutron/proton shells as we move toward the corresponding drip line.

An experiment has been recently performed using the R^3B setup at GSI, within the FAIR Phase-0 program. Some of the scientific goals are to study the role of the tensor force when approaching the neutron drip line and the complex facets of neutron rich boron isotopes such as the weakly bound halo nucleus candidate ^{14}B. During this experiment 2 different "cocktail" of nuclei, among which ^{22}O, ^{14}B and ^{15}B were sent on a 5 cm LH2 target surrounded by tracking detectors and the CALIFA calorimeter [1]. This calorimeter allows to detect gamma-rays and light particles from the QFS reactions in inverse kinematics. To study the spectroscopy of unbound states with an unprecedented energy resolution, this new setup includes the high resolution and granularity neutron detector NeuLAND [2].

In the first part of this work, we focus on the evolution of the proton $0p_{1/2}$-$0p_{3/2}$ SO splitting in the O chain, when the neutron $0d_{5/2}$ orbital is filled by 6 neutrons, from ^{16}O to ^{22}O. The vast majority of studies performed so far in stable nuclei of the chart of nuclides shows that the amplitude of the SO splitting scales with approximately $A^{2/3}$ [3], due to the surface-dominant term of the spin-orbit force. The present study, that goes well beyond stability, should demonstrate if such a decrease of the SO splitting between ^{16}O and ^{22}O is found and if it is larger than expected. Indeed, the action of tensor forces should lead to a further decrease of the SO splitting, added to the role of SO force.

The ^{22}O$(p, 2p)$ QFS knockout reaction provide information on the tensor force contribution to the $0p_{1/2}$-$0p_{3/2}$ SO splitting in the O isotope chain, from N=8 to N=14 shell closure, when the neutron $0d_{5/2}$ orbital is filled. The SO orbit splitting amplitude is planned to be obtained from the energies and spectroscopic factors of the $1/2^-$ and $3/2^-$ states in ^{21}N. In addition, the ^{22}O(p, pn) reaction has also been studied in order to determine if 6 neutrons are indeed added in the $0d_{5/2}$ orbital from ^{16}O to ^{22}O, or if a fraction of them are occupying the nearby $1s_{1/2}$ orbital.

In the second part of this analysis, we use the ^{14}B(p, pn) and ^{15}B(p, pn) QFS knockout reactions to probe the neutron's orbitals occupancies when moving from the magic, N=8, ^{13}B nucleus [4] to the neutron drip line in the B chain. A dominant s-wave contribution for the neutrons added to the ^{13}B magic nucleus [4] would indicate the halo nature of ^{14}B (Sn<1MeV) and ^{15}B, as suggested by new nuclear radius measurements for these nuclei, the neighboring ^{14}Be and the more neutron-rich ^{17}B and ^{19}B nuclei [5,6].
Furthermore, the ^{15}B$(p, pn)^{14}$B reaction populating the bound and unbound states originating from the $\pi(0p_{3/2})^{-1} \times \nu(1s_{1/2})^1$ and $\pi(0p_{3/2})^{-1} \times \nu(0d_{5/2})^1$ couplings allows the identification of the last unbound state from the corresponding multiplet (1_2^-), which wasn't observed in the previous studies using transfer reactions [7,8]. Finally, the coupling between states of the same J across the continuum is determined using the momentum distribution study.

Preliminary results from these studies will be presented.

[1] A. Knyazev et al., Nucl. Instr. and Meth. A **940**, (2019) 393-404.
[2] K. Boretzky et al., Nucl. Instr. and Meth. A **1014**, (2021) 165701.
[3] G. Mairle, Phys. Lett. B **304**, (1993) 39.
[4] W. Liu et al., Phys. Rev. C **104**, (2021) 064605.
[5] Isao Tanihata J. Phys. G: Nucl. Part. Phys. **22**, (1996) 157.
[6] M. Tanaka et al., Acta Phys. Pol. B **48**, (2017) 461.
[7] S.Beedor et al., Phys. Rev. C **88**, (2013) 011304.
[8] S.Beedor et al., Phys. Rev. C **93**, (2016) 044323.

Primary author(s) : Mr. BARRIÈRE, Antoine (GANIL); Mr. MOZUMDAR, Nikhil (Technische Universität

Darmstadt, Helmholtz Forschungsakademie - Hessen für FAIR); Ms. FEIJOO FONTÁN, Martina (University of Santiago de Compostela); Dr. SORLIN, Olivier (GANIL); „ and the R3B Collaboration

Presenter(s) : Mr. BARRIÈRE, Antoine (GANIL)

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