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Study of the structure of neutron-rich isotopes 23, 24, 25F in inverse kinematics with the R3B experimental setup at GSI/FAIR

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The atomic nuclear structure is still one of the most complex problems in modern physics. This is due to the fact that many-body correlations beyond the symmetries of the nucleon-nucleon potential leads to the existence of a large number of nuclear systems whose properties differ significantly from what can be expected based on the simple addition of nucleons. An example of these phenomena is the drastic extension of the neutron drip line for compared with isotopes [1, 2]. The neutron drip line is the limit of nuclear binding from which adding more neutrons is no longer possible, resulting in the spontaneous emission of neutrons (dripping). In order to understand the drip line phenomena, studying and characterizing the structure of and isotopes through one nucleon removal reactions is fundamental.

In particular, our study aims to deploy the reaction F(p,2p)O, in inverse kinematics, in order to characterize the final states of the residual O core, similar to what was done in [3], but with significantly higher resolution, statistics, and acceptance provided by the R3B (Reactions with Relativistic Radioactive Beams) experimental setup at GSI/FAIR. More thoroughly, an incoming F-beam with an energy of MeV/nucleon will impinge onto a LH-target of 15 cm length. The outgoing heavy fragments of O will be measured in coincidence with the (p,2p) reaction, providing an indication of populated excited or ground states of O. Furthermore, since there are no bound excited states of O, the de-excitation process will proceed through one or two neutron emissions, which will be measured with high resolution in the neutron detector NeuLAND, allowing us to resolve and study the excited states of O. The cross-sections to populate individual final states together with the reconstructed momentum distribution of the decaying O system would help to accurately determine the configuration of the excited O core in F.

[1] D. S. Ahn et al. "Location of the Neutron Dripline at Fluorine and Neon". In: Phys. Rev. Lett 123.21, 212501 (Nov. 2019), p. 212501. doi: 10.1103/PhysRevLett.123.212501.

[2] C. Caesar et al. "Beyond the neutron drip line: The unbound oxygen isotopes 25O and 26O". In: Phys. Rev. C 88.3, 034313 (Sept. 2013), p. 034313. doi: 10.1103/PhysRevC.88.034313. arXiv: 1209.0156 [nucl-ex].

[3] T. L. Tang et al. "How Different is the Core of F 25 from O\textsubscript{g.s.} 24 ?" In: Phys. Rev. Lett 124.21, 212502 (May 2020), p. 212502. doi: 10.1103/PhysRevLett.124.212502.

Abstract

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