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Study of the full electric dipole strength of the double halo nucleus ^{11}Li using proton inelastic scattering

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Over the years there have been many efforts put in trying to understand the electric dipole (E1) strength of atomic nuclei. It is known that the nuclear E1 response is mostly dominated by the IsoVector electric Giant Dipole Resonance (IVGDR), which can be understood as a collective harmonic motion of protons against neutrons [1].

In neutron rich-nuclei, part of the E1 strength is redistributed around the neutron separation energy, producing a concentration of low energy dipole excitations known as a Pygmy Dipole Resonance (PDR), which instead consists in an oscillation of a neutron skin against an isospin symmetric core. The closer we are to the neutron drip-line, the more complex the PDR becomes, heavily affecting its properties [2].

This study focuses in the double neutron halo nuclei ^{11}Li . The PDR in ^{11}Li is significantly different from a regular PDR due to the very low neutron separation energy of ^{11}Li , which produces a large imbalance of neutrons in the neutron skin with pairing energy playing an important role in it. Although the PDR for ^{11}Li was initially observed in [3], this observation only accounts for a small part of the total E1 response in ^{11}Li . Recent theoretical studies have predicted the presence of an IVGDR in ^{11}Li that was not observed before, which accounts for most of its E1 strength [4].

In order to experimentally study the complete E1 strength of ^{11}Li , an inelastic scattering experiment in inverse kinematics was performed at the Facility for Rare Isotope Beams (FRIB) in July 2024. A 53.4 MeV/u ^{11}Li beam was sent into the Active Target Time Projection Chamber (AT-TPC) [5] which acted as the proton active target, as well as the tracking detector for the scattered protons from the reaction. Additionally, the S800 spectrometer [6] was used at the end of the beam line in order to study the decay products of the excited ^{11}Li .

Although the PDR in ^{11}Li was already observed previously [3, 7, 8], the results from this experiment provide a preliminary measurement of an IVGDR in ^{11}Li , which to our knowledge is a first for double halo nuclei. These results are of importance to fully understand the E1 response of ^{11}Li , and may provide useful insight into the E1 properties of halo nuclei in general.

References:

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Consent

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