Shell evolution and neutron halo formation in heavy sodium isotopes

Jagjit Singh[1], Jesús Casal[2], Lorenzo Fortunato[3], and Niels Walet[1]
[1]The University of Manchester, UK, [2]Universidad de Sevilla, Spain, [3]Università degli Studi di Padova, Italy

The latest generation of radioactive ion beam facilities provides unparalleled access to neutron-rich unstable isotopes. One of the areas of active investigation is the study of the shell evolution between the neutron magic numbers N=20 and N=28 [1-5] for such unstable nuclei. The nuclei between these magic numbers display exotic structural features such as dampening of shell gaps, formation of halos, and deformed structures.

In this talk, I will discuss our new results on how the inversion of the 2p3/2 and 1f7/2 single-particle orbits influences the formation of neutron halos in the ground states of neutron-rich sodium isotopes 34,37,39Na [6]. Using tailored two- and three-body core–neutron models with effective interactions informed by existing experimental trends and theoretical inputs, we demonstrate that a weakened shell gap and orbit inversion can drive the development of one-neutron halo structure in 34Na and Borromean-like halos in 37,39Na. Additionally, we show that the electric dipole response serves as a sensitive observable for identifying halo characteristics in these systems. Our results show that heavy sodium isotopes are an interesting area to study shell evolution and halo phenomena [6].

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