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Unwelcome intruders: Getting a nucleus to come out of its shell (in ab initio calculations)

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Intruder states, involving shell model configurations in which nucleons are excited out of the valence shell, feature prominently in the excitation spectra of nuclei across the nuclear chart. In comparison to "normal" states, for which the structure is well described by valence space configurations, "intruder"states have access to a much larger configuration space, allowing them to develop highly collective structure and greater deformation. They thereby attain greater correlation energy, which permits them to "intrude"into the low- lying spectrum. The proximity of weakly deformed normal states and highly deformed intruder states in the spectrum gives rise to shape coexistence, with the concomitant possibility of shape mixing. In so-called "islands of inversion", an intruder can even take over as the ground state.

Intruder states are notoriously challenging to describe in ab initio calculations, appear- ing too high in the excitation spectrum, if at all. However, with suitably soft interactions and sufficiently large-scale calculations, it becomes possible to welcome these intruders to their rightful place in the low-lying spectrum. In this talk, we will explore low-lying intruder structure in ab initio no-core configuration interaction calculations, for nuclei near the N = 8 shell closure, and examine the consequences for E0 and E2 transitions. We will find that mixing between normal and intruder configurations can take on the form of simple two-state mixing, permitting extraction of a consistent mixing matrix el- ement from the ab initio calculations, even though this mixing is entirely an emergent phenomenon.

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Presenter: CAPRIO, Mark (University of Notre Dame)

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