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Shape Coexistence in the 78Ni Region: Intruder Second 0+ State in 80Ge

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The coexistence of normal and intruder nuclear states close in energy is a characteristic feature of nuclear structure [1]. The lowering in energy of states originating from excitations across the shell closures is a delicate balance between the energy cost to break the shell gap, and the gain in pairing and quadrupole energy. A region of great interest for these studies is the N = 50 isotonic chain, down to 78Ni. On the one hand, the size and reduction of the N = 50 gap in exotic nuclei are a much debated issue, impossible to reproduce with two-body forces from first principles.
On the other hand, the presence of the g9/2 d5/2, s1/2 neutron shells across the gap determines a large quadrupole interaction. Therefore, the search for excited 0+ states from two-particle two-hole (2p - 2h) excitations in the region can help to set benchmarks for nuclear models in the region.
The N = 48 80Ge nucleus was studied by means of beta-delayed electron-conversion spectroscopy at ALTO [2]. The radioactive 80Ga beam was produced through the ISOL photofission technique and collected on a movable tape for the measurement of and e- emission following decay. An electric monopole E0 transition which points to an intruder second 0+ state was observed for the first time.
This new 639 keV state is lower than the first 2+ level in 80Ge (659 keV), and provides evidence of shape coexistence close to 78Ni. This result will be compared with theoretical estimates, helping to explain the role of monopole and quadrupole forces in the weakening of the N = 50 gap at Z = 32. The evolution of intruder 0+ states towards 78Ni will be discussed. It will also be pointed out how these and other findings [3] may hint to a “s1/2 physics” in this region, and how this relates to recent measurements of unexpected high-energy gamma radiation following beta decay beyond N=50 [3].
References:
[1] K. Heyde and J. L. Wood, Rev. Mod. Phys. 83, 1467 (2011)
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