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Study of intruder states towards ^{78}Ni with lifetime measurements following ^{82}Se(d,p)^{83}Se

Quadrupole interaction between protons and neutrons drives the nucleus into deformed configurations at low excitation energies. Around the N=50 shell gap, intruder states with spins $1/2^+$ and $5/2^+$, originating from the $s_{1/2}$ and $d_{5/2}$ orbitals were first observed in ^{83}Se and, later on, in the other N=49 isotones ^{87}Kr, ^{81}Ge and ^{79}Zn. In ^{83}Se these intruder states reach energies of around 500 keV, the lowest among the other N=49 isotones. The ^{83}Se nucleus is at the mid of the proton fp-shell and it should have the maximum of quadrupole correlations which makes it a good candidate to understand the collectivity of the particle-hole intruder states in this region, lowered in energy by large quadrupole correlations. Indeed, large-scale shell model calculations predict a quenching of the energy of the intruder states in ^{83}Se, at variance with the experimental data [1]. Lifetime measurements of the intruder states of ^{83}Se would give an indication about their wave function and would allow estimating the degree of the N=50 core breaking in the ground state of Se isotopes. Moreover, such measurements could shed light on the behavior of the N=50 shell gap towards ^{78}Ni, a double-magic nucleus in which intruder configurations competing in energy with the spherical ones have also been found [2].

We will report on the results obtained from a recent experiment performed in Laboratori Nazionali di Legnaro, where lifetimes of the intruder-state band were measured using Recoil Distance Doppler-Shift Method and Doppler-Shift Attenuation Method. A beam of ^{82}Se, with intensity 0.02 pnA, accelerated at 270 MeV by the ALPI-TANDEM accelerator at LNL-INFN, impinged into a deuterated polyethylene (C_2D_4) target which was evaporated on a 6 mg/cm^2 thick gold layer. The GALILEO γ-array was coupled to the SPIDER silicon-array, allowing to obtain the needed channel selectivity through coincidence measurements between γ rays and protons coming from the (d,p) transfer reaction. The results on lifetimes will be discussed in the framework of large-scale shell-model calculations and mean-field approaches, pointing out the role of the collectivity of low-lying intruder configurations.

[1] C. Wraith et al., Nature, 569, 53-58 (2019).
[2] R. Taniuchi et al., Phys. Lett. B. 771, 385-391 (2017).

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