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Spying on Intruders in the 68Ni Region with Fast Timing

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The nucleus 68Ni is the portal to the understanding of the modification of shell structure in the Z=28 and N=40 region and the appearance of collective phenomena. In spite of showing some of the characteristics of a doubly magic nucleus, the two-neutron separation energy does not show evidence for an enhanced N=40 harmonic oscillator shell gap, and collectivity emerges for 66Fe and 64Cr with just one and two proton pairs less than 68Ni.

The changes in shell structure around 68Ni are driven by excitations across the Z=28 and N=40 shell gaps, where the neutron g9/2 and d5/2 configurations and the proton p3/2 orbital play a key role. This scenario provides the breeding ground for shape-coexistence. Indeed, several 0+ states have been observed in 68Ni below 3 MeV [1,2]. They can be explained in the framework of Monte Carlo shell model calculations [3], which yield prolate bands built on strongly deformed 0+ states appear for several eve Ni Isotopes, and by multiple particle-hole excitations in the shell model framework [4]. A similar picture is observed for 66Ni, where three excited 0+ states have been identified [5]. The coexistence of configurations has been observed in the Z=27 Co isotopes, for which low-lying proton intruders have been reported in 65,67Co [6].

In this paper we investigate of intruder configurations via the fast timing ATD bgg(t) measurement of excited level lifetimes in nuclei around 68Ni. The nuclides under study were populated in the beta-decay chains of Mn isotopes, strongly produced at ISOLDE on a UCx target, and selectively ionized by RILIS. We report on level lifetimes in 68Ni, in particular on investigation of the transition connecting the third 0+ with the first 2+, and compare it to the recent result by Crider et al. [4]. We provide information on the lifetime of the third 0+ 2671-keV level in 66Ni, and on the transition connecting it to the first excited 2+ level. We interpret these supposedly similar configurations in 66Ni and 68Ni in the shell model framework. We also investigate the role of proton intruders by examining the state at 1095 keV in 65Co, whose lifetime has also been measured.

References:

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