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Lifetimes of the 4+ states in 72 and 74Ni

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The seniority scheme was introduced by Racah, initially to identify multiparticle configurations in the atomic spectrum, latter was extended for the atomic nucleus, where is useful to classify the jn states in the jj-coupling. The concept of seniority in bound to the pairing. The seniority is generally conserved up to a large extend and it is well known the conditions that need to satisfy the interaction to preserve it [1].
In the mid 90´s isomeric states in the nuclei with N = 50, 40 < Z < 50 were investigated [2]. The isomerism in this region is due to the occupation of the proton ⊠g9/2 orbital, forming seniority isomers in stretched ⊠gn9/2 configurations. This discovery was shortly followed by the discovery of another island of isomerism in the corresponding Z=28 valence mirror nuclei 69Ni and 70Ni, originating from neutron ⊠gn9/2 configurations and that allowed to deduce the (⊠g9/2)2 effective interaction for the neutron-rich nickel isotopes [3].
Already these early results suggested that the (⊠g9/2)2 effective interaction might not preserve the seniority with significant implications for the valence-mirror symmetry between the Z = 28 isotopes with A = 70 to 76 and N = 50 isotones with A = 92 to 98 [4]. This suggestion was reinforced by the experimental results on the ⊠-decay of Co isotopes towards the middle of the g9/2 shell (mass 72 and 74), where it has been suggested that the 8+ seniority isomer is not present [5] [6]. Nevertheless, the ⊠-decay of Co isotopes high spin isomer are expected to have I⊠ = 5-,6- and 7-, being the population of the 8+ isomeric state in the Ni isotopes an indirect process. Moreover, A.I.Morales in Ref. [6], points out the inconsistence of the level-scheme de-excitation branching ratios with an interaction inverting the seniority scheme (see also Ref. [7]).
In this LoI we propose the measurement of lifetimes of the 4+ states (possibly also the 6+ states in some case) in 70Ni, 72Ni and 74Ni, that will help to shed light on the seniority scheme validity in the (⊠g9/2)n configurations. The present results on the 72Ni 2+ lifetime corresponds to half the B(E2) compared with the neighbouring 70Ni and 74Ni and, therefore, a short measurement could help to shed light on the systematics of the 2+ B(E2) values in the isotopic chain [8]. The expected lifetimes are in the range of tens of ps, thus, the lifetime measurement can be perform with lineshape analysis or with plunger measurement (see for example Ref.[8]).
The production of the secondary beam will be done by the fission of a 238U primary beam at 345 MeV/u and with an intensity of about 40 pnA. The intensities of the corresponding secondary beams will be about 106 for 71Cu, 2x105 for 73Cu and 3x104 for 75Cu. The one proton knock-out reactions are expected to have cross sections of the order of 6 mb, and the population of the 4+ state in the final Ni isotopes is expected to be of the order of 35%. In our most unfavourable case (74Ni) we expect about 120 gamma-Ion coincidences in 1 hour.

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