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Approaching the Fifth Island of Inversion from the north

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Islands of inversion (IoIs) appear close to semi-magic or even doubly magic nuclei and are certain areas of the nuclear chart where the nuclei expected to be spherical in their ground states become deformed. They are interpreted as strong nuclear quadrupole-quadrupole interactions producing a shape transition with highly correlated many-particles-many-holes configurations. When reducing the proton number along the *N=50* chain towards and beyond the 78Ni doubly-magic nuclei, a competition between the single-particle and collective characteristics with the isotones is expected, thus forming the Fifth IoI of the nuclear chart [1]. To date, experimental approaches have reached the western and northern ends of this region. In the former study, the constantly low 2+ excitation energies of 66Cr and 70,72Fe, measured by means of the in-beam gamma-ray spectroscopy technique, revealed the possibility of the extension of the island of inversion at *N=40* towards *N=50* [2]. For the latter, investigating the doubly magic nature of 78Ni implied a possible shape co-existence composed of competing spherical ground-state and deformed bands. This study reinforced the hypothesis of the collapse of the *N=50* (, and even *Z=28*,) shell gap(s) beyond the anchor point, 78Ni.

In this presentation, I would like to discuss the physics case and the feasibility of an experimental study on the lifetime measurement of the excited states in 80Zn to investigate indications of disruption of the *N=50* shell-closure by approaching from the northern side of the proposed Fifth IoI. While the first measurement of the first excited states by Coulomb excitation [4] indicated a high excitation energy and a low transition probability of 2_1+ state, which supports the doubly magic nature towards 78Ni, a more recent study performed at the RIBF facility illustrates rather complicated levels in the isotope. By reflecting the discussion of the measurement of 78Ni [3], such entangled states in 80Zn can be considered as the competition between the persisting spherical magic ground-state band and the descending intruder deformed band. In the case of 80Zn, the level at 2627 keV, feeding directly to the ground state [5] may be equivalent to the one at 2910 keV in 78Ni, which is assigned as a (2_2+) deformed state decaying into the ground state directly [3].

More specifically, the lifetime of the 2_2+ level is assumed to be an order of 10 ps because of the low transition probability B(E2) between the spherical ground state and the deformed excited state. The (p,2p) and (p,3p) reactions are better to be compared as well since the different population of the states was observed in the case for 78Ni. To achieve the lifetime measurement, the thickness of the target to be optimized, which will be discussed in the presentation as well.

[1] F. Nowacki et al., PRL 117, 272501 (2016).
[2] C. Santamaria et al., PRL 115, 192501 (2015).
[3] R. Taniuchi et al., Nature in press. / R. Taniuchi, PhD thesis, The University of Tokyo.
[4] J. Van de Walle et al., PRL 99, 142501 (2007).
[5] Y. Shiga et al., PRC 93, 024320 (2016).

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