

78Ni: Doubly magic nuclei at the onset of deformation

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⁷⁸Ni, which has 28 protons ($Z = 28$) and 50 neutrons ($N = 50$), 14 additional neutrons to the last stable nickel isotope ⁶⁴Ni, is one of the most intriguing isotopes in the chart of nuclei. It is the most neutron-rich, exotic “doubly magic” nucleus that can be produced at present state-of-the-art facilities. The excited states of ⁷⁸Ni have been investigated at the Radioactive Isotope Beam Factory, RIBF, by measuring their de-excitation γ rays after one and two-proton knock-out reactions from ⁷⁹Cu and ⁸⁰Zn beams. A 10 cm-thick liquid hydrogen target with a recoil proton tracking system, MINOS, and a surrounding NaI(Tl) based γ -ray detection array, DALI2 were employed. Eventually, 310 and 222 events with at least one detected γ -ray with more than 300 keV with the (p,2p) and the (p,3p) reactions, respectively, were obtained. As a result, at least two excited 2+ states and other higher-lying states were found. This casts a question about the nature of the shell closure in ⁷⁸Ni and implies the possibility of shape coexistence.

The experimentally deduced level scheme was interpreted by comparison with several state-of-the-art theoretical predictions: Large-scale shell model, beyond mean-field, and ab initio calculations. Though the doubly magic nature was confirmed, at the same time, the shell gap is anticipated to vanish beyond ⁷⁸Ni. In addition to the γ -ray analysis, particularly small inclusive cross sections of ⁷⁹Cu(p,2p)⁷⁸Ni and ⁸⁰Zn(p,3p)⁷⁸Ni were observed compared to neighbouring nuclei. To investigate this phenomenon, the cross sections to the excited states and the ground state deduced experimentally were compared with reaction theory based on a DWIA formalism.

In this presentation, the structural information of ⁷⁸Ni will be discussed in detail with the obtained level scheme and the recent theoretical calculations.

[1] R. Taniuchi et al., *Nature* **569**, 53-58 (2019).

Primary author: TANIUCHI, Ryo (Department of Physics, University of York)

Presenter: TANIUCHI, Ryo (Department of Physics, University of York)

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