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Cluster structure of neutron-rich beryllium isotopes probed by (p,pα) knockout reactions in inverse kinematics

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The emergence of cluster structures within the nucleus is a fascinating phenomenon that requires a complete understanding of the nuclear structure and the fundamental nuclear interactions. So far α-clustering has dominated cluster state studies among all other possible partitioning due to the large binding energy of the α-particle and its inert character. The famous Ikeda diagram conveyed the idea that cluster states appear near the α threshold in stable N=Z nuclei [1]. However, clustering in the ground-state of exotic nuclei with large imbalance of proton and neutron number is still a question. Neutron-rich beryllium isotopes 10Be,12Be,14Be are the very appealing candidates of clustering studies as being built on the well-developed alpha-alpha rotor of 8Be (N=4, Z=4). It is predicted by calculations in antisymmetrized molecular dynamics model that alpha clustering in the ground-state develops from 10Be going to the dripline [2].
The SAMURAI-12 experiment performed at the Radioactive Isotope Beam Factory (RIBF) in RIKEN aims to investigate the cluster structure of neutron-rich beryllium isotopes using the cluster quasifree scattering reaction (p,pα) in inverse kinematics. The reaction of interest was induced by radioactive 10,12,14Be beams at 150MeV/u impinging on a 2-mm-thick pure solid hydrogen target. Recoil protons were detected using the Recoil Proton Spectrometer (drift chamber, plastic scintillator, and NaI(Tl) rods) in a two-arm configuration, covering an angular range of 50°-70°. Two telescopes composed of silicon strip detectors and CsI(Tl) modules were placed at forward angles for detecting alpha clusters. The detection of helium residues was performed by using the SAMURAI spectrometer and its standard detectors. Experimental results concerning missing mass spectra and triple differential cross-sections will be presented. The latter will be compared to calculations using a microscopic description of the reactions of interest implemented in the distorted wave impulse approximation, allowing to probe the alpha cluster structures directly and quantitatively.

References:
[1] K. Ikeda, N. Takigawa, and H. Horiuchi, Prog. Theor, Phys. Suppl. Extra Number, 464 (1968).
[2] Y. Kanada-En'yo and H. Horiuchi, Phys. Rev. C 68, 014319 (2003).

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