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Strong neutron pairing in the core+4n 18C and 20C nuclei

Pairing correlations play crucial roles in atomic nuclei and in quantum many-body physics in general. They are responsible for the odd-even staggering observed in the binding energy of atomic masses, for the fact that all even nuclei have a J=0+ ground state, and for their small moment of inertia as compared to a rigid body. More generally, pairing correlations imply a smoothing of the level occupancy around the Fermi energy surface, an enhancement of pair transfer probabilities, as well as a superfluid behaviour in the nuclear rotation and vibration. Transition from BCS (Bardeen Cooper-Schrieffer) to BEC (Bose-Einstein Condensation) pairing correlations has been evoked from the modelling of the interior to the surface, respectively, of some neutron-rich nuclei.

Recently, the existence of quasi-bound tetra-neutron resonances, formed as an ensemble of four interacting neutrons, was proposed on the basis of experimental results. Even if a quasi-bound resonance would not be confirmed, the coupling of four neutrons can, as for two neutrons, play a significant role inside atomic nuclei to account for its superfluidity. Despite its tremendous importance, the real observation of the decay of paired or tetra nucleons is still lacking or very scarce, as difficult to evidence.

In the present work, we used the high-energy nucleon knockout reactions 19N(-1p)18C*and 21N(-1n)20O* as a 'piston' (possibly via the coupling to giant modes) to suddenly promote neutron pairs of 18C and 20O respectively into the 16C+n+n and 18O+n+n continuum. Dalitz plots and correlation functions are used to analyze triple correlations in these systems over a decay energy up to 12~MeV above the corresponding two-neutron emission thresholds. An attempt is made to link these observables to the role of the reaction mechanism and to the pairing configurations of 18C and 20O, where the four neutrons above the 14C and 16O cores may be coupled in pairs or in tetraneutron configurations.

Future perspectives and preliminary results on similar 2n correlations observed in the unbound 28F nucleus, obtained at the RIKEN-SAMURAI facility, will be also presented, if enough time.

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