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New insight into the structure of 4He nuclei

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Until recently, 4He's transition from its ground state to 0+ first excited state was seen as a what we may term as a breathing mode [1]. This mode, known as monopole excitation, involves the nucleus expanding and contracting symmetrically, like a balloon inflating and deflating. During this motion, the spherical shape of the nucleus remains intact.
More recent calculations using NCGSM (No Core Gamow Shell Model), which treats the 4He nucleus as an open quantum system, contradict the previous explanation. This new approach takes into account different reaction channels, such as [1H+ 3H], [3He + n] , and [2H + 2H]. This
makes it possible to solve the N-body problem more accurately, and to predict the excitation function of 4He decay in all three channels. We therefore decided to perform correlation functions of the [1H + 3H] and [2H + 2H] channels in Ni+Ni reactions measured at two incident energies, 32 and 52 MeV/A with the FAZIA+INDRA apparatus, to give an insight into the structure of 4He. We will show the limitations of the apparatus, as well as limitations of correlation function methods. We also give an alternative experimental method for extracting the branching ratio of the three decay channels of 4He nuclei as a function of excitation energy.

References:
[1] S. Kegel et al., Measurement of the -particle monopole transition form factor challenges theory: A low-energy puzzle for nuclear forces, Phys. Rev. Lett., 131, (2021).
[2] Michel, N. and Nazarewicz,W. and Pøoszajczak, M., Description of the Proton-Decaying 0+2 Resonance of the Particle, Phys. Rev. Lett., 130, (2023).

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