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Multineutron correlations in the decay of heavy Helium isotopes

Since the discovery of the neutron in 1932 [1], extensive experimental campaigns and calculations have been carried out to explore the possible existence of multineutron systems [2]. The dineutron being unbound, particular attention has been paid to the next even candidate, the tetraneutron, a system made up of four neutrons. Its few-body character and the absence of Coulomb interaction make of this system a perfect case to test nuclear models and the nucleon-nucleon nuclear force. After sixty years of experimental search, with only two promising signals [3,4], the observation of a resonance-like four-neutron structure using a missing-mass approach [5] has rekindled the interest in this field. In this context, the SAMURAI34 experiment aimed at measuring the invariant mass of the four-neutron system using several breakup reactions of an ⁸He beam. The direct detection of the four neutrons in different reaction channels will be presented. Preliminary results of several four-neutron observables, and their potential implications, will be discussed.

[1] Chadwick, James. "Possible existence of a neutron." Nature 129.3252 (1932): 312-312.

[2] Marqués, F. Miguel, and Jaume Carbonell. "The quest for light multineutron systems." The European Physical Journal A 57.3 (2021): 105.

[3] Marqués, Francisco Miguel, et al. "Detection of neutron clusters." Physical Review C 65.4 (2002): 044006.
[4] Kisamori, K., et al. "Candidate resonant tetraneutron state populated by the he 4 (he 8, be 8) reaction." Physical review letters 116.5 (2016): 052501.

[5] Duer, M., et al. "Observation of a correlated free four-neutron system." Nature 606.7915 (2022): 678-682.

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