

Search for multineutron clusters and other ultra-neutron-rich nuclei via ^8He -induced transfer reactions

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Reactions induced by light neutron-rich RNB offer the opportunity to investigate unbound exotic few-nucleon systems with particularly high N/Z ratio, as well as eventual multineutron clusters ($Z=0$). The discovery of resonant states and subsequent determination of their energies and widths constitute an important challenge for the existing models of nuclear forces, as these properties may bring strong constraints on the poorly-known neutron-neutron and 3- and 4-body interaction parameters.

The main goal of the present work was to search for resonances in the 4-neutron system and eventually confirm the existence of the bound “tetra-neutron” $4n$, suggested by the analysis of recent data¹⁾. The ^8He beam at 15.3 MeV/u from GANIL-SPIRAL was used to perform a missing mass measurement of the 4-neutron system, using the α -transfer reaction $^8\text{He}(d, ^6\text{Li})4n$ in inverse kinematics. Kinetic energies and emission angles of ^6Li and other light ejectiles were measured by the array of Silicon strip detectors MUST²⁾ coupled with thinner (0.07 mm) Si detectors for particle identification. Neutrons emitted in coincidence were detected by thick plastic scintillators for background reduction. The possible existence of a resonance at ~ 2.5 MeV in the $4n$ spectrum was suggested by the results of a preliminary experiment³⁾ with rather low statistics. New results have been recently obtained with increased statistics and better background estimation. The existence of this low-energy resonance is not confirmed but data are consistent with the presence of strong correlations in the $4n$ system.

During the course of this study, results were also obtained concerning the very exotic ^7H and ^9He unbound systems. The ^9He spectrum from the $^8\text{He}(d,p)$ reaction has been obtained by measuring protons emitted at backward lab angles. In addition to low-lying narrow resonant states, the (d,p) reaction populates a peak just above neutron threshold, which could correspond to the $s_{1/2}$ ground state of ^9He . On the other hand the $^8\text{He}(d, ^3\text{He})$ reaction was used to search for resonances in the ^7H continuum. A resonant state was observed at ~ 1.6 MeV above the $t+4n$ threshold, in agreement with the results of ref.⁴⁾

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3) *E.Rich et al, Proceedings Exon2004, World Scientific(2004)*

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