OBSERVATION OF THE TETRA NEUTRON IN THE *p*(*p*,*α*) REACTION AT LARGE MOMENTUM TRANSFER*

Thomas Aumann, for the SAMURAI Collaboration
[1]*TU Darmstadt, Physics Department, 64289 Darmstadt, Germany*

The experimental search for the existence of a tetra neutron state has a long history, and the situation remained unclear until recently, and a possible explanation of our experimental finding is still open. On the theoretical side, large efforts have been undertaken as well recently, with results and predictions scattering over wide range in energy, including the prediction for the non- existence of a bound or resonance state. The experimental challenge is to create an isolated 4-neutron system in the final state, without low-energy final-state interaction with other particles involved in the reaction. We have employed a new experimental approach for the search of a possible tetra neutron, the quasi free ^{8}He(*p*,*pα*)4*n* reaction at high beam energy. The experiment selected the knockout of the alpha particle at very large momentum transfer, corresponding to 180° *p* − *α* scattering in the c.m. frame, separating the charged particles from the neutrons in momentum space.

The experiment has been carried out at the SAMURAI setup located at the RIBF. The scattered charged particles have been detected and momentum analysed, from which the missing mass spectrum has been reconstructed in a wide energy window accepted by the experiment. In case of the absence of any interaction among the neutrons in the final state, a wide distribution centred around 30 MeV relative energy was expected, which reflects the internal relative motion of the neutrons in 8He. It was indeed found, that the largest fraction of the cross section corresponds to this shape. In addition, a well pronounced resonance-like peak at 2 MeV energy with a width of about 2 MeV has been observed with a larger than 5 sigma significance, providing clear evidence for strong four-neutron correlations in the final state. The results have been published recently in Nature [1]. The experiment and results will be presented and discussed.

*This work was supported by the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation) Project-ID 279384907 - SFB 1245, the GSI-TU Darmstadt cooperation agreement, and by the German Federal Ministry of Education and Research - BMBF project numbers 05P15RDFN1.

1. M. Duer et al., Nature **606,** 678 (2022).