

論文の内容の要旨

論文題目 Study of tetra-neutron system via exothermic double-charge exchange reaction ${}^4\text{He}({}^8\text{He}, {}^8\text{Be})4n$

(発熱型2重荷電交換反応 ${}^4\text{He}({}^8\text{He}, {}^8\text{Be})4n$ による4中性子系の研究)

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Tetra-neutron systems have attracted considerable attention since candidates of bound tetra-neutron system were reported. While recount of latest theoretical paper using ab-initio calculations suggests that bound tetra-neutron does not exist, the possibility of the tetra-neutron system forming a resonance state is still an open and fascinating question. We performed missing-mass spectroscopy of the four-neutron system via an exothermic double-charge exchange reaction ${}^4\text{He}({}^8\text{He}, {}^8\text{Be})4n$. The experiment was carried out at the RI Beam Factory at RIKEN using the SHARAQ spectrometer and the liquid He target system. The secondary beam, ${}^8\text{He}$ at 186 MeV/u, had a large mass excess, since it was possible to produce the $4n$ system in small momentum transfer of less than 20 MeV/c. In order to obtain the missing-mass spectrum, we measured momentum of the incident beam of ${}^8\text{He}$ with the High-Resolution Beamline and momenta of outgoing two alpha particles, which were the decay products of the ${}^8\text{Be}$ ejectile, with the SHARAQ spectrometer.

We selected the events produced by ${}^4\text{He}({}^8\text{He}, {}^8\text{Be})4n$ reaction in precise analysis to detect two alpha-particle in coincidence at the final focal plane of the SHARAQ spectrometer. Further more, a method for treating trajectory reconstruction for more than two particle under high beam rate condition (2 MHz) was developed.

We obtained 38 events in the the missing-mass spectrum of four-neutron system. The spectrum had a strength of at low excitation energy region at $0 < E_{4n} < 2$ MeV, which consist of 4 events. The other events made an continuum spectrum at the $0 < E_{4n} < 60$ MeV region. The estimated background events in the spectrum were 2.32 ± 1.01 events, which was small enough. We discussed the shape of the spectrum in comparison a theoretical calculation assuming the effective range theory including the correlation between di-neutron clusters. There was an possibility of the resonance state of the tetra-neutron system.