

Search for Excited ^{12}Be Cluster States with Isospin $T=2$ on RADEX Cascade Neutrons

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Abstract: Calculations using the antisymmetric model of molecular dynamics revealed the α -cluster structure of the isotopes Be, B, and C, which weakly depends on the number of neutrons [1]. The excited state ^{12}C , 7.65 MeV is an example of the α -cluster state of ^8Be , as well as the state of ^{13}C , which has an increased radius, 3.09 MeV ($1/2^+$). Possible collective resonance α -cluster states 1^- and 3^- with isospin $T = 2$ have been found in the spectrum of highly excited states of ^{12}C in the photonuclear reaction. Similar analog states are found in the spectrum of ^{12}Be and ^{12}B nuclei. In the paper considers the possibility of excitation of α -cluster resonance state in ^{12}Be with the formation of ^8Be and a $4n$ -correlated cluster [2]. Monte Carlo calculations by using three-nucleon potential that good descript of $1p$ shell nuclei predicts the existence of a $4n$ -correlated cluster in a nuclear field < 9 MeV with a radius of 3-5 fm or as a resonance with an energy of 2 MeV in the continuous spectrum. We consider the possibilities of searching for excited analog cluster states ($T = 2$) in the $^{13}\text{C}(n,2p)^{12}\text{Be}^*$ charge exchange reaction on the cascade neutron of the RADEX pulsed source (Fig. 1). Estimated parameter of the pulsed source of cascade neutrons at an energy of 40-60 MeV is 10^{13} n/s. Excitation of the α -cluster states in ^{12}Be is possible when a proton pair is quasi-elastically knocked out of ^{13}C at an angle of $\sim 10^\circ$ by a cascade neutron with an energy of ≤ 40 MeV or in an n - p charge exchange reaction followed by rescattering by a proton at an energy > 50 MeV.

Calculations show that registration of 2 protons with the formation of an excited state of $^{12}\text{Be}^*$ is possible in a narrow cone. The decay of the α -cluster excited state of $^8\text{Be}+4n$ should be recorded at the widest solid angle. The registration of 4-particle coincidence must suppress the background. According to calculations and taking into account the available detecting equipment, even when registering 4 particles in coincidence the counting rate will be about 10 events per hour at an estimated neutron flux.

Keywords: $^{13}\text{C}(n,2p)^{12}\text{Be}^*$, cascade neutron, α -cluster state, $4n$ correlation

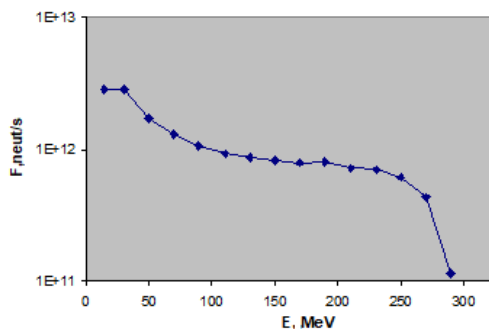


Fig. 1. Spectrum of RADEX cascade neutrons in the forward direction.

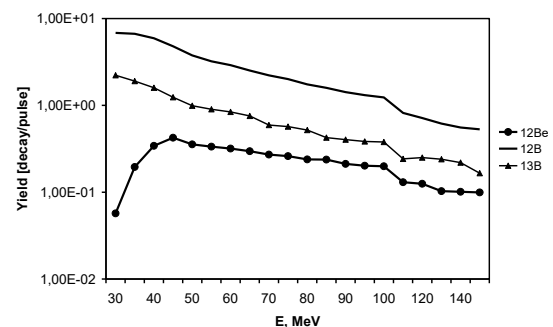


Fig. 2. Yields of the main charge exchange reactions.

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