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^{8}Be and ^{9}B nuclei in dissociation of relativistic ^{10}C and ^{11}C nuclei

D. A. Artemenkov[1,2], V. Bradnova[1], E. Firu[3],
N. K. Kornegrutsa[1], M. Haiduc[3], K. Z. Mamatkulov[1],
R. R. Kattabekov[1], A. Neagu[3], P. A. Rukoyatkin[1],
V. V. Rusakova[1], R. Stanoeva[4], A. A. Zaitsev[1,5], P. I. Zarubin[1,5*]
and I. G. Zarubina[1,5]

[1]Joint Institute for Nuclear Research, Dubna, Russia
[2]National Research Nuclear University MEPhI (Moscow Engineering Physics Institute), Moscow, Russia
[3]Institute of Space Science, Măgurele, Romania
[4]South-Western University, Blagoevgrad, Bulgaria
[5] P. N. Lebedev Physical Institute of the Russian Academy of Sciences, Moscow, Russia

Abstract

Progress in the study of nuclear clustering in the relativistic ^{10}C and ^{11}C nuclei dissociation in nuclear track emulsion is presented. The contribution of the unbound ^{8}Be and ^{9}B nuclei to their structure is determined on the basis of measurements of the emission angles of relativistic He and H fragments.

Nuclear track emulsion (NTE) is exposed at the JINR Nuclotron to relativistic nuclei ^{7,9}Be, ^{8,10}B, ^{10,11}C and ^{12}N for the experimental study of the evolution of the cluster structure of light nuclei [reviewed in ref. [1], [2]]. Virtual cluster configurations in an incident nucleus are completely captured in coherent dissociation in which the target nucleus is not destroyed visibly ("white"stars). Therefore, the contributions of cluster states to the structure

*e-mail: zarubin@lhe.jinr.ru

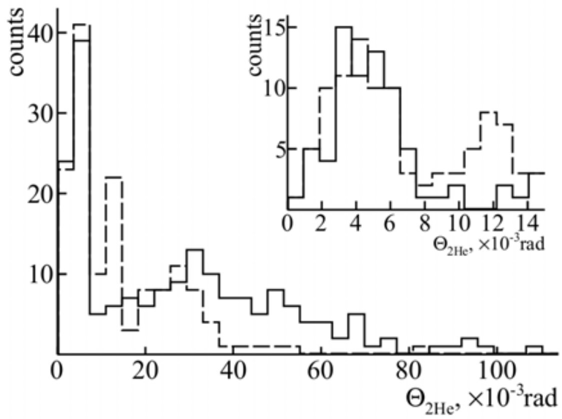

Figure 1: Distributions over the opening angle Θ_{2He} of α-particle pairs in "white"stars ^{10}C $\rightarrow$ 2He + 2H (solid histogram) and ^{9}Be $\rightarrow$ 2He (dashed histogram) at 1.2 A GeV; insertion part of the distribution in an interval Θ_n.

of the nucleus in question can be estimated by the probability of appearance of respective fragment ensembles. The nuclei ^{7}Be, ^{8}Be in the ground (^{8}Be$_{g.s.}$) and first excited states (^{8}Be$_{2+}$), as well as the ^{9}B may serve as a basis for the neighboring nuclei contributing to them with particular probabilities. Verification of this concept can be carried out on the sequence of the nuclei ^{9}Be, ^{10,11}C and ^{12}N.

Reconstruction of the decays of relativistic ^{8}Be and ^{9}B nuclei is possible by the energy variable Q = M* - M, where M^{*2} = $(\Sigma P_j)^2$ = $\Sigma(P_i \cdot P_k)$, M the total mass of fragments, and their $P_{i,k}$ 4-momenta defined under the assumption of conservation of an initial momentum per nucleon by fragments. For the "white"stars of ^{9}Be and ^{10}C nuclei the assumption that He fragments correspond to ^{4}He, and H ones in ^{10}C – ^{1}He is justified. Then ^{8}Be and ^{9}B identification is reduced to measurements the opening angles of between the directions of fragment emission.

Distributions over the opening angle Θ_{2He} for pairs of He fragments of "white"stars ^{9}Be$\rightarrow$2He and ^{10}C $\rightarrow$ 2He + 2H (82% of the ^{10}C statistics) produced at energy of 1.2 A GeV are presented in Fig.1. In both cases the values of Θ_{2He} of 75-80% of the pairs are distributed about equally in the intervals of $0 < \Theta_{n(arrow)} < 10.5$ mrad and $15.0 < \Theta_{w(ide)} < 45.0$ mrad. The remaining pairs are attributed to a "medium"$10.5 < \Theta_m < 15.0$ and "widest"of $15.0 < \Theta_{vw} < 45.0$ intervals. The Q distribution directly

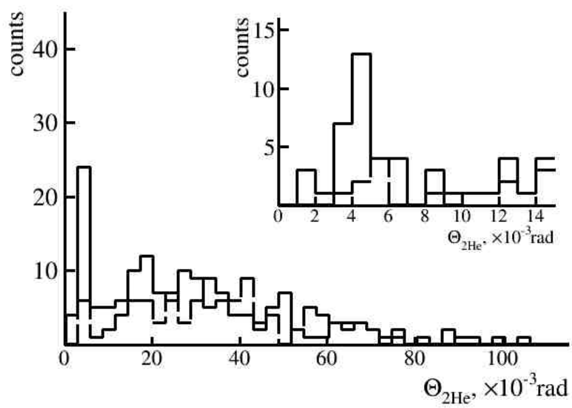

Figure 2: Distribution over the opening angle Θ_{2He} of α-particle pairs in "white"stars ^{11}C $\rightarrow$ 2He + 2H (solid histogram), ^{11}C $\rightarrow$ 3He (dashed histogram) at 1.2 A GeV at 1 A GeV; insertion part of the distribution in interval Θ_n.

connected with Θ_{2He} point out that "narrow"pairs of Θ_n are produced via ^{8}Be$_{g.s.}$ while pairs Θ_w via ^{8}Be$_{2+}$. There is a peak in the interval Θ_m reflecting the level 5/2- (2.43 MeV) of ^{9}Be. Fractions of events in the intervals Θ_n and Θ_w are equal to 0.56 $\pm$ 0.04 and 0.44 $\pm$ 0.04 for ^{9}Be, while for ^{10}C 0.49 $\pm$ 0.06 and 0.51 $\pm$ 0.06, i. e. they practically coincide. They indicate to a simultaneous presence of virtual ^{8}Be$_{g.s.}$ and ^{8}Be$_{2+}$ states in the ground states of the ^{9}Be and ^{10}C nuclei. Earlier, basing on the Q$_{2\alpha}$ energy distribution of the triples $2\alpha + p$ from the "white"stars ^{10}C $\rightarrow$ $2\alpha + 2p$ it was concluded that in the structure of the ^{10}C nucleus the core ^{9}B is manifested with a probability of around (30 $\pm$ 4)%, and the ^{8}Be$_{g.s.}$ decays are arise only through the ^{9}B decays. These conclusions allow one to interpret a significant fraction of "white"stars produced by ^{11}C nuclei only on the basis of angular measurements.

It is already established that 144 "white"stars produced by the ^{11}C in NTE are distributed over the charge channels in the following way: 2He + 2H (50%), 3He (17%), ^{7}Be + He (13%), He + 4H (11%), B+H (5%), Li + He + H (3%), 6H (2%). The distributions of He fragments over the opening angle Θ_{2He} (Fig.2) show that ^{8}Be$_{g.s.}$ decays are presented in 21% 2He + 2H and 19% in the 3He events. These distributions allow one to assume a strong contribution of ^{8}Be$_{2+}$ decays but it is a subject of future consideration.

The ^{9}B nucleus can exist in ^{11}C as an independent virtual component. Decays ^{9}B$_{g.s.}$ in "white"stars ^{10}C $\rightarrow$ 2He + 2H are identified in accordance with a limitation on the opening angle between directions of ^{8}Be$_{g.s.}$ and each

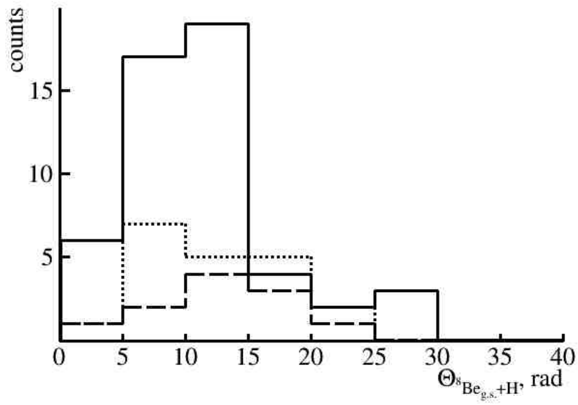

Figure 3: Distributions over the opening angle $\Theta(^8\mathrm{Be}_{g.s.}$ + H) in "white"stars ^{10}C → $^8\mathrm{Be}_{g.s.}$ + 2H (solid histogram), ^{11}C → $^8\mathrm{Be}_{g.s.}$ + 2H (dashed histogram) all found stars ^{11}C → $^8\mathrm{Be}_{g.s.}$ + 2H (dotted histogram).

H fragments $\Theta(^8\mathrm{Be}_{g.s.}$ + H) < 40 mrad (Fig.3) [3]. Application of such a condition the "white"stars ^{11}C → 2He + 2H allows one to identify 20 $^9\mathrm{B}_{g.s.}$ decays (Fig.3) constituting 30% of events in this charge channel or 18% of the ^{11}C "white"stars.

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