HOYLE-STATE IN DISSOCIATION OF RELATIVISTIC ^{12}C NUCLEI

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Events of dissociation of relativistic nuclei in nuclear track emulsion (NTE) allow a holistic investigation of "cold" ensembles of lightest nuclei. So far, with regard to fine structure dissociation of relativistic nuclei, the NTE technique remains the only means providing unique completeness of such observations at the best angular resolution and as well as a sufficient statistical provision. Moreover, full-bodied studies of light nuclear structure require reconstruction of relativistic decays of the unstable ^{8}Be and ^{9}B nuclei. Feasibility of such studies in electronic experiments is not visible at all. The cluster structure of light nuclei and the role of the unstable ^{8}Be and ^{9}B nuclei in them is studied in the BECQUEREL project (http://becquerel.jinr.ru) on the basis of NTE layers longitudinally exposed at the JINR Nuclotron to relativistic Be, B, C and N nuclei, including radioactive isotopes [1]. Recent advances are highlighted [2–4]. On the practical side series of experiments with newly reproduced samples NTE has confirmed prospects of NTE in low and high energy nuclear studies [5].

Recently it is suggested to search in relativistic ^{12}C dissociation for α-particle triples in the second excited state 0^{+}_{2} of the ^{12}C nucleus (the Hoyle state). The started study of the Hoyle-state (HS) in dissociation is setting new limit of NTE use. Being performed in contrast to relativistic energy of 3α-ensembles and minimum possible energy stored by them such observations would clearly demonstrated HS as a full-fledged and sufficiently long-lived nuclear-molecular object. Probably, not only single but also pair- and even triple-wise combinations of α-particles that are close to ^{8}Be might be observed to reflecting the HS structure in less distorted way. It can be expected that ^{8}Be and HS will become reference points to search for more complex states of dilute nuclear matter in dissociation of heavier relativistic nuclei. The current experiment task is to search for several hundreds of 3α-events in NTE pellicles and measure the angles of α-particles in the relevant ranges with a resolution allowing reconstructing decays of the unstable ^{8}Be nucleus and HS (example in Fig. 1). HS events are observed in dissociation $^{12}\text{C} \rightarrow 3\alpha$ at 4.5 *A*·GeV/c and 1 *A*·GeV/c ^{12}C nuclei with a contribution preliminary estimated to be of the order of 10%. Thus, the first data on relativistic HS are encouraging.

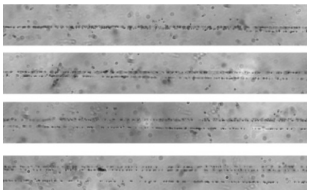

Fig. 1. Sequential shots of coherent dissociation $^{12}\text{C} \rightarrow 3\alpha$ at about 1 A GeV/c (from top to bottom); when moving from the vertex three He fragments can be distinguished. Values of the invariant mass of the α-pairs are 57, 60 and 270 keV. Invariant mass of the α-tiple is 230 keV while its total transverse momentum 111 MeV/c.

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