Contribution ID: **73** Type: **Oral**

Search for unstable nuclear states in the fragmentation of Kr nuclei at 950 MeV/nucleon

Tuesday 2 July 2024 12:20 (20 minutes)

Author: A.A. Zaitsev (JINR)

Abstract: Since the discovery of the nuclear component of cosmic rays, the nuclear photoemulsion (NTE) method has made it possible to study the composition of relativistic fragmentation of nuclei at high-energy accelerators. The promising potential of the relativistic approach to the analysis of ensembles of fragments manifested itself in layers of NTE exposed by beams at energy of several GeV per nucleon, accelerated at the Synchrophasotron of JINR and Bevalak (USA) in the 1970s. Since the 2000s, the NTE method has been used in the BECQUEREL experiment at the JINR Nuclotron in relation to the cluster structure of nuclei, including radioactive ones, as well as in the search for unstable nuclear-molecular states. Due to its unique sensitivity and spatial resolution, application of the NTE method makes it possible to study in a unified approach many final states that appear while the dissociation of relativistic nuclei. In this aspect, it seems possible to search in α relativistic approach for an α-particle Bose-Einstein condensate (αBEC), an unstable state of S-wave α particles. The extremely short-lived ^{8}Be nucleus is described as 2αBEC, and the ^{12}C(0_2^+) excitation or Hoyle state (HS) is described as 3αBEC. The feasibility of more complex states is important in nuclear astrophysics. Using NTE layers longitudinally exposed by beams of relativistic nuclei, it is possible to determine the invariant mass of ensembles of He and H fragments from the emission angles in the approximation of conservation of the initial momentum per nucleon. The decays ^{8}Be and HS, as well as the decays ^{9}B $\rightarrow$ ^{8}Bep, are identified during the fragmentation of light nuclei according to the upper limit on the invariant mass [1]. This approach was used to identify ^{8}Be and HS and search for more complex αBEC states in the fragmentation of medium and heavy nuclei. Recently, the probability of reconstructed ^{8}Be was found to increase with increasing number of associated α particles [2]. The exotically large sizes and lifetimes of ^{8}Be and HS suggest the possibility of synthesis of αBEC by sequential combination of the resulting α-particles 2α $\rightarrow$ ^{8}Be, ^{8}Beα $\rightarrow$ ^{12}C(0_2^+), ^{12}C(0_2^+)α $\rightarrow$ ^{16}O(0_6^+), 2^{8}Be $\rightarrow$ ^{16}O(0_6^+) and further with decreasing probability at each step while the emission of γ-quanta or recoil particles. Ongoing research is aimed at measuring the nα fragmentation channels of ^{84}Kr at energies up to 950 MeV/nucleon to determine the contributions of the 2α decay of ^{8}Be, the 3α Hoyle state and the search for the condensate state of 4α particles [3]. In this report discusses new results on the search for unstable nuclear states in the fragmentation of ^{84}Kr and the prospect of analyzing recent exposure of NTE in beams of Xe nuclei at 3.9 GeV/nucleon at the Nuclotron/NICA accelerator complex.
Keywords: relativistic dissociation, α-fragmentation, nuclear emulsion, unstable nuclei

References

[1] D.A. Artemenkov et al., Eur. Phys. J. A 56 (2020) 250; arXiv:2004.10277.

[2] A.A. Zaitsev et al., Phys. Lett. B 820 (2021) 136460; arXiv: 2102.09541.

[3] D.A. Artemenkov et al., Phys. At. Nucl., 85, 528 (2022); arXiv: 2206.09690.

Section

Heavy ion collisions at Intermediate and high energies

Primary authors: ZAITSEV, Andrei (JINR, LHEP); ZARUBIN, Pavel (JINR Laboratory of High Energy Physics)

Presenter: ZAITSEV, Andrei (JINR, LHEP)

Session Classification: Heavy ion collisions at Intermediate and high energies