## The 7th international conference on particle physics and astrophysics



Contribution ID : 22

Type : Oral talk

## Alpha-particle states in relativistic nuclear fragmentation

Wednesday, 23 October 2024 09:30 (15)

Ensembles of He and H isotopes can be studied with unique completeness and resolution in nuclear emulsion layers longitudinally exposed to relativistic nuclei [1,2]. Determination of the invariant mass of their pairs or triplets by emission angles in the velocity conservation approximation is sufficient to identify a number of unstable states  $- {}^{8}Be(0^{+})$ ,  ${}^{8}Be(2^{+})$ ,  ${}^{9}B$ ,  ${}^{12}C(0_{2}^{+})$ ,  ${}^{12}C(3^{-})$ ,  ${}^{6}Be$ .

The BECQUEREL experiment [3,4], using this approach, is aimed at searching for the  $\alpha$ -particle Bose-Einstein condensate ( $\alpha$ BEC), an unstable of S-wave  $\alpha$ -particle state. <sup>8</sup>Be(0<sup>+</sup>) is associated with 2 $\alpha$ BEC, and <sup>12</sup>C(0<sub>2</sub><sup>+</sup>) or the Hoyle state with 3 $\alpha$ BEC. In the relativistic fragmentation of heavy nuclei, an enhancement of <sup>8</sup>Be, <sup>9</sup>B and <sup>12</sup>C(0<sub>2</sub><sup>+</sup>) is detected, suggesting their synthesis in the fusion of associated  $\alpha$ -particles. The focus of the search is the 4 $\alpha$ BEC state of <sup>16</sup>O(0<sub>6</sub><sup>+</sup>) at 660 keV above the 4 $\alpha$  threshold, decaying into  $\alpha$ <sup>12</sup>C(0<sub>2</sub><sup>+</sup>) or 2<sup>8</sup>Be. In this context, the status of the analysis of  $\alpha$ -particle fragmentation in a nuclear emulsion exposed to <sup>84</sup>Kr nuclei at 950 MeV per nucleon is presented. Secondary stars produced by relativistic neutrons are observed in the nucleus fragmentation cone [4]. The neutron average energy in the parent nucleus system is estimated to be 1.3 MeV [5].

The  $\alpha$ BEC search leads to the study of nuclear matter in the region of temperature and density from red giants to supernova. It is characterized by the ratios of <sup>1,2,3</sup>H and <sup>3,4</sup>He. Nuclear emulsion layers exposed to heavy nuclei of several GeV per nucleon at the NICA accelerator complex are optimal for identifying H and He isotopes by multiple scattering, searching for unstable states, and assessing neutron accompaniment. An exposure to <sup>124</sup>Xe nuclei of 3.8 GeV per nucleon, performed at the NICA/Nuclotron accelerator complex, allows the use of proven approaches. Parameters of the beam are determined using the CR-39 track detector by direct crater counting on the Olympus BX63 microscope.

[1] P.I. Zarubin, Lect. Notes in Phys. 875, Clusters in Nuclei, Volume 3. Springer Int. Publ., 51 (2013); arXiv: 1309.4881.

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

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

[4] D.A. Artemenkov et al., Phys. At. Nucl. 85, 528 (2022); arXiv: 2206.096.

[5] A.A. Zaitsev et al., Phys. At. Nucl. 86, 1101 (2023); arXiv: 2307.16465.

Primary author(s): ZARUBIN, Pavel (Joint Institute for Nuclear Research); ZAITSEV, Andrei

**Presenter(s) :** ZAITSEV, Andrei

Session Classification : Nuclear

Track Classification : Nuclear physics