Comments on the draft
"BECQUEREL experiment on the Nuclotron accelerator complex/NICA»

Noting the variety and value of the proposed problems, I want to focus on the significance of the proposed project for testing the theoretical concept of The Bose-Einstein condensate as a condensate of alpha particles - the predicted counterpart of ultracold quantum gases. The status of development of the alpha-condensate concept is presented in detail in the review by Tohsaki, H. Horiuchi, P. Schuck and G. Roepke "Status of α-particle condensate structure of the Hoyle state" Review of Modern Physics 89 (2017) 01100. The review notes a proposal to search for condensate states in the dissociation of relativistic nuclei. The proposal is also noted in W. Von Oertzen's lecture review "Alpha-cluster condensations in nuclei and experimental approaches for their studies" Clusters in Nuclei, Lecture Notes in Physics 818, 109 (2010). In this concept, the degrees of freedom of alpha-multiple nuclei near collapse thresholds are predicted based on the boson-type mean field formed by the alpha particle gas. Coexisting with ordinary fermionic excitations, such states are possible because the alpha particle has the properties of an almost ideal boson. They occur at an average density similar to the core ^{8}Be, which is 4 times smaller than the usual nuclear. Being bosons, alpha particles can condense in the 0S orbit of their own cluster field. The Hoyle state with its three alpha particles is regarded as the lightest alpha condensate and as an ^{8}Be core with one additional alpha particle in 0S orbit.

It is worth noting that the ^{12}C nucleus can transition from the ground state to an unbound but very long-lived one at 7.65 MeV, named after the astrophysicist F. Hoyle, who predicted the existence of this resonance more than 60 years ago to explain the prevalence of the ^{12}C isotope. The transition to the Hoyle state in fusion reactions can serve as an "entrance gate" for the synthesis of heavier nuclei. A theoretical description of the experimental data extracted from the inelastic electron excitation of the ^{12}C nucleus indicates that the Hoyle state has a volume 3-4 times larger than the ground state. However, pointing to the exotic structure of the state these measurements do not answer questions about its internal structure. This may be possible in the proposed experiment, where an indication of the origin of the Hoyle state has already been found. The assumption that condensate decay can be detected in the decay of an alpha partial gas along the cascade chain ^{16}O $(0^{+}{}_{6}) \rightarrow {}^{12}$C $(0^{+}{}_{2}) \rightarrow {}^{8}$Be $(0^{+}{}_{2}) \rightarrow 2\alpha$ is very interesting.

The results and proposals for the new Becquerel project were presented by its leader in the invited report at the workshop "Light clusters in nuclei and nuclear matter: nuclear structure and decays, heavy ion collisions and astrophysics" (2-6, September 2019, Trento, Italy). It is remarkable that the search for ever-increasing complexity can be carried out in the same experimental approach.

In general, the use of the phenomenon of dissociation of relativistic nuclei in a nuclear emulsion to generate quantum condensate states provides an alternative to the search in this direction by methods of low-energy physics. These ideas can be applied to explain phenomena in nuclear astrophysics and cosmic ray physics. For all these reasons, the project deserves support. The scientific significance of the project is high. The requested resources correspond to the project objectives.

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