Project Review
“BECQUEREL experiment at the NUCLOTRON / NICA accelerator complex”

The phenomenon of dissociation of relativistic nuclei observed with a unique completeness in the nuclear track emulsion (NTE) makes it possible to study ensembles of nucleons and lightest nuclei of interest to nuclear physics and nuclear astrophysics. Individual features of the nuclei under study are manifested in probabilities of dissociation channels. Advantages of the NTE technique include unsurpassed resolution in determining emission angles of relativistic fragments and possibility of identification of He and H isotopes among them by multiple scattering measurements.

The motivation of the project is the search for metastable states of multiple ensembles of the lightest nuclei and nucleons. Such states can serve as an intermediate substance in astrophysical processes of nucleosynthesis. The possibility of such a phase of baryonic matter as extremely rarefied and cold on a nuclear scale is predicted by theorists and has undoubted fundamental significance. Although at first glance, an experimental study of such a phase is impossible, a hypothesis has been put forward in the project about its reproduction in the narrow cone of dissociation of relativistic nuclei.

The project is aimed at the intensive application of this technique to study the fragmentation of medium and heavy nuclei in the unified approach. It is a logical development of the approximately 15-year cycle of research on the BECQUEREL experiment at the JINR Nuclotron, and even earlier work on relativistic nuclear physics. The project is based on the fact that, in relation to multiple fragmentation of relativistic nuclei, nuclear emulsion remains the only means of observation that provides not only observations that are unique in resolution and sensitivity, but also provide reasonable statistics and also identification of the lightest nuclei. Possession of the method by the authors in all aspects is not in doubt. In the respect of the analysis an invariant mass method based on record resolution is developed and tested widely enough in application to relativistic fragmentation, which made it possible to identify unstable ^{8}B and ^{9}B nuclei, as well as the Hoyle state. Demonstrating the resolution of the method, these results become milestones for determining the universal role of these metastable objects in the dissociation of heavier nuclei and the search for more complex states corresponding to the predicted alpha-particle condensate. The search for such states is possible in the narrowest components of fragment jets. All this is well described in the project. A clear research program has been formulated. There is material for the immediate start of research and suggestions for the future. On this path there is the prospect of unexpected discoveries in nuclear physics.

The project results will substantiate new proposals for nuclear physics research at the NICA complex. The project will contribute to the preservation of the method and the training of young scientists who own it, its use in nuclear experiments, dosimetry, radiation medicine and ecology. The active use of this method is particularly important in connection with the promising development of automatic microscopes and the progress of image recognition programs (artificial intelligence). Such a development will be at the forefront of today's time - the classic nuclear emulsion. Thus, the BECQUEREL project undoubtedly deserves full support.

V.A. Nikitin
Chief Researcher, VBLHEP, JINR
Doctor of Physical and Mathematical Sciences
Professor