Research program

"Studying strongly interacting dense baryonic matter to search for a mixed phase in heavy ion collisions at the JINR Nuclotron"

Modeling estimates done recently show that the temperature and baryon number density of the matter reached at the collisions of nuclei with atomic numbers ~ 200 at the collision energy ~ 5 GeV/nucleon, maximal values of the Nuclotron, could be sufficient to see the manifestations of strongly interacting matter phase structure. Thus, the JINR Nuclotron could be a reasonable source of information on the new states of dense matter, the formation process of the mixed phase of chiral symmetric and non-symmetric phase, and the properties of hadrons in the corresponding hot and/or dense baryonic matter. In this regard the following theoretical and experimental researches at JINR are considered perspective:

1) researching the hadron properties in hot and/or dense baryonic matter. A spectral change is expected, first of all of the sigma-meson as the chiral partner of pions, which characterizes a degree of chiral symmetry violation and could play a role of a "signal" of its restoration. The rare specific channels of rho-meson decays are also quite attractive. To derive, then to prove or disprove quantitative predictions is the aim of this investigation.

Solving these issues assumes a proper understanding of reaction mechanisms of high-energy colliding ions, knowledge of properties of interacting matter and its equation of state. In this respect more general researches are in order:

2) analyzing multiparticle hadron interactions, targeted to the development of new statistical treatment as well as codes for space-time evolution of heavy nuclei collisions at high energies. Particular attention should be paid to "signals" of new phases formation during this evolution;
3) studying the system size, lifetime, freeze-out duration, expansion time in the HBT analysis (noticeable volume expansion is expected if the mixed phase is formed), scanning in atomic number and energy;
4) analyzing the energy and centrality dependences of the pion, hadron resonances and strange particle multiplicities, and the ratio of their yields, together with the transverse momentum, including K-, K*- and phi-meson spectra as well as manifestation of baryon repulsion effects on hadron abundances;
5) studying di-leptons (electron and muon pairs) production to see in-medium modification of hadron properties at high baryon densities;
6) studying the behaviour of angular correlations as well as radial, directed and elliptic flows (their different behaviour as compared to hadron-hadron interactions is expected);
7) analyzing fluctuations of multiplicities, electric charge and transverse momenta for secondary particles (their energy dependences could give information on the phase transition range);
8) analyzing nuclear fragments characteristics versus the centrality (change of behaviour comparing to the peripheral collisions is expected), universality of nuclear fragmentation;
9) energy and atomic number scanning for all characteristics of central heavy nuclei collisions (this might allow one to obtain information on the equation of state of strongly interacting matter in the transition area), difference between central collisions of light nuclei and peripheral heavy ion collisions.