

Plans for the analysis of multiplicity fluctuations in the MPD experiment

Abstract:

Collisions of relativistic nuclei have been intensively analyzed for over two decades. The main goal of these efforts is to understand properties of strongly interacting matter at high energy collisions. In such conditions the transition from hadronic matter to a new state - quark-gluon plasma (QGP) is expected. Fluctuations of physical observables in collisions of ions have become in recent years one of the main topics of interest, as they can provide some important signals for the formation of QGP.

Near the border energy characterizing phase transition a different critical phenomena may appear. Fluctuations and correlations may help to localize the critical point of strongly interacting matter – a phenomenon similar to the critical opalescence observed in most liquids. The QCD critical point of strongly interacting matter (CP) can be found in heavy-ion collision experiments via the nonmonotonic behavior of many fluctuation observables as a function of the collision energy. The event-by-event fluctuations of particle multiplicities are enhanced in those collisions that freeze-out near the critical point. Higher, non-Gaussian, moments of the event-by-event distributions of such observables are particularly sensitive to critical fluctuations, since their magnitude depends on the critical correlation length to a high power.

The possibility of inclusion of dynamical fluctuations in the study of the energy of phase transition and the search for CP has become a motivation for extensive program of fluctuations analyzes at the SPS, LHC as well as at RHIC. The NA49 experiment found a non-monotonic behavior of the fluctuations in transverse momentum and multiplicity as a function of centrality of the collision at the highest SPS energy. This intriguing result may be the first sign of the presence of the critical point. Therefore, the NA49 efforts will be continued in the NA61/SHINE experiment, where the two-dimensional (energy and system size) studies of the phase diagram are planned.

We plan to extend the search of CP by the analysis of data obtained within The Multi Purpose Detector (MPD) experiment at Nuclotron-based Ion Collider fAcility (NICA) build at the Joint Institute for Nuclear Research. The planned energy range of the colliding ions and the broad range of available ions allows for detailed study of the dynamical fluctuations and correlations in the unique experimental conditions.

We want to carefully analyze the multiplicity fluctuations present in the collisions of relativistic ions. We focus on detailed analysis of the moments of distribution of the number of charged particles produced in the collisions. We expect that such studies done with use of the new and unique experimental possibilities offered by MPD detector provide a very valuable new information in the question of the onset of deconfinement.