Fluctuations of conserved charges and the connection to the chiral phase transition

Anar Rustamov

One of the key goals of nuclear collision experiments is to map the phase diagram of strongly interacting matter. The most challenging part is the determination of the QCD phase structure and the possible existence of a chiral critical end point of a first order phase transition line, at which the matter undergoes a second-order phase transition. At LHC energies there would be, for vanishing light quark masses (u and d quarks), a temperature-driven genuine chiral phase transition of second order between the hadron gas and the quark-gluon plasma. For realistic quark masses this transition becomes a smooth cross over. However, due to the small masses of current quarks one can still probe critical phenomena at LHC energy. In general, phase transitions and critical phenomena can be addressed by investigating the response of the system to external perturbations. For example, the liquid gas phase transition can be probed by the response of the volume to a change in pressure, which is encoded in the isothermal compressibility and directly related to density fluctuations. In a similar way, phase transitions in strongly interacting matter can be addressed via measurements of fluctuations of conserved charges such as baryon number or electric charge. The current measurements by the STAR collaboration at RHIC and by ALICE at the LHC have provided interesting and stimulating results. After providing the experimental details of the event-by-event fluctuation measurements, the results will be discussed within the framework of statistical physics, which is successfully exploited to describe the bulk properties of the heavy-ion collisions. Moreover, several aspects will be addressed on the non-dynamical origins of fluctuation measurements. Importantly, our recent investigations will be demonstrated to underline the role of global conservation laws on measured fluctuation signals.