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Impact of hadronic interactions and conservation laws on cumulants of conserved charges in a dynamical model

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Understanding the phase diagram of QCD by measuring fluctuations of conserved charges in heavy-ion collision is one of the main goals of the beam energy scan program at RHIC. For a precise measurement of the cumulants it is necessary to grasp the role of charge conservation in heavy-ion collision measurements. Within this work, we calculate the role of hadronic interactions and momentum cuts on cumulants of conserved charges up to fourth order in a system in equilibrium within a hadronic transport approach (SMASH). In our model the net-baryon, net-charge and net-strangeness is perfectly conserved on an event-by-event basis and the cumulants are calculated as a function of subvolume sizes and compared to analytic expectations. This reflects the experimental situation in which e.g. the net-baryon number is conserved in a heavy-ion collision and the results depend on the rapidity window. We find a modification of the kurtosis due to charge annihilation processes in systems with simplified degrees of freedom. Furthermore the result of the full SMASH hadron gas for the net-baryon and net-proton number fluctuations is presented for systems with zero and finite values of baryochemical potential. Additionally the problem of mapping between the net-proton and net-baryon fluctuations is addressed and we find that due to dynamical correlations the cumulants of the net-baryon number cannot be recovered from the net-protons. Finally the influence of deuteron cluster formation on the net-proton and net-baryon fluctuations in simplified system is shown. This analysis is important to better understand the relation between measurements of fluctuations in heavy-ion collisions and theoretical calculation which are often performed in a grand canonical ensemble.

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