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Fluctuations and correlations of net baryon number, electric charge and strangeness in a background magnetic field

We study the second-order fluctuations of and correlations among net baryon number, electric charge and strangeness in (2+1)-flavor QCD at non-zero magnetic field. We perform the lattice simulations using the tree-level improved gauge action and the highly improved staggered quark (HISQ) action with a fixed scale approach ($a \simeq 0.117$ fm). The strange quark mass is fixed to its physical quark mass value $m_s^{\rm phy}$ and the light quark mass is set to be $m_s^{\rm phy}/10$ which corresponding to the pion mass is about 220 MeV at vanishing magnetic field. The lattice simulations are performed on $32^3 \times N_\tau$ lattices with 9 values of N_τ varying from 96 to 6 corresponding to temperatures ranging from zero up to 281 MeV. At each nonzero temperature, the magnetic field strength eB is simulated with 15 different values up to $\sim$2.5 GeV^2. We find that quadratic fluctuations and correlations do not show any singular behavior at zero temperature in the current window of eB while they develop peaked structures at nonzero temperatures as eB grows. By comparing the electric charge-related fluctuations and correlations with hadron resonance gas model calculations and ideal gas limits, we find that the changes in degrees of freedom start at lower temperatures in stronger magnetic fields. Significant effects induced by magnetic fields on the isospin symmetry and ratios of net baryon number and baryon-strangeness correlation to strangeness fluctuation are observed, which could be useful for probing the existence of a magnetic field in heavy-ion collision experiments. This talk is based on arXiv:2104.06843.

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