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Chiral properties of (2+1)-flavor QCD in background magnetic fields at zero temperature

Wednesday, 28 July 2021 22:00 (15 minutes)

We show our lattice QCD results for masses and magnetic polarizabilities of light and strange pseudo-scalar mesons, chiral condensates, decay constants of neutral pion and neutral kaon in the presence of background magnetic fields with eB ranging up to around 3.35 GeV^2 ($\sim$ 70 M_π^2) in the vacuum. We performed (2+1)-flavor QCD lattice simulations using the Highly Improved Staggered Quarks (HISQ) action with $N_\tau = 96$. In the simulation the strange quark mass is fixed to its physical quark mass $m_s^{\rm phy}$ and light quark mass is set to $m_s^{\rm phy}/10$ which corresponds to $M_\pi \approx 220$ MeV at zero temperature. We find that as the magnetic field strength grows, the masses of neutral pseudo-scalar mesons monotonously decrease and then saturate at a nonzero value, while there exists a non-monotonous behavior of charged pion and kaon masses as magnetic field grows. We observe a qB scaling of the up and down quark flavor components of neutral pion mass, neutral pion decay constant as well as the up and down quark chiral condensates at 0.05 eB 3.35 GeV^2. We show that the correction to the Gell-Mann-Oakes-Renner relation involving neutral pion is less than 6\%, and the correction for the relation involving neutral kaon is less than 30\% at eB 3.35 GeV^2.
We further find that the Ward Identity involving the space-time sum of the pseudo-scalar correlation functions and the chiral condensates, together with the GMOR relation, naturally reconciles magnetic catalysis at zero temperature and the reduction of transition temperature in a background magnetic field. This talk is based on arXiv:2008.00493.

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