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Chiral condensates and screening masses of neutral pseudoscalar mesons in thermomagnetic QCD medium

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We point out that chiral condensates at nonzero temperature and magnetic fields are in strict connection to the space-time integral of corresponding two-point neutral meson correlation functions in the pseudoscalar channel via the Ward-Takahashi identity. Screening masses of neutral pseudoscalar mesons, which are defined as the exponential decay of the corresponding spatial correlation functions in the long distance, thus are intrinsically connected to (inverse) magnetic catalysis of chiral condensates. To study this we performed lattice simulations of $(2+1)$-flavor QCD on $32^3 \times N_t$ lattices with pion mass $M_\pi \simeq 220$ MeV in a fixed scale approach having temperature $T \in [17, 281]$ MeV and magnetic field strength $eB \in [0, 2.5]$ GeV^2.
We find that screening lengths, i.e. inverses of screening masses of π^0, K^0 and $\eta^0_{s\bar{s}}$, turn out to have the similar complex eB and T dependences of the corresponding chiral condensates. Although the transition temperature is found to always decrease as eB grows, we show that the suppression due to magnetic fields becomes less significant for hadron screening length and chiral condensates with heavier quarks involved, and ceases to occur for $\eta^0_{s\bar{s}}$ and strange quark chiral condensate. The complex eB and T dependences of both screening masses and chiral condensates, reflecting the crossover nature of the QCD transition, are attributed to the competition between sea and valence quark effects. These findings could be useful to guide low-energy models and effective theories of QCD. This talk is based on [1].
[1] Phys.Rev.D 105 (2022) 3, 034514

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