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The effects of quark anomalous magnetic moment in the magnetized QCD phase diagram

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Recently, the quark anomalous magnetic moment (AMM) has been applied in the context of the two-flavor Nambu–Jona-Lasinio model to explore different aspects of the magnetized phase diagram of quantum chromodynamics. By means of the Schwinger ansatz, the quark AMM has been considered a new parameter, chosen to reproduce the proton and neutron magnetic moments. Then, in the mean field approximation, some of the model predictions suggest inverse magnetic catalysis at low temperatures and first-order phase transitions at magnetic fields $\mathrm{eB} < 1\mathrm{GeV}^2$. However, these effects are not observed by lattice QCD. In this work, we show analytically and numerically that the model results are due to regularization prescriptions which entangle vacuum and magnetic field contributions in the thermodynamical potential. To avoid these problems, we apply the vacuum magnetic regularization scheme, which enables us to properly separate all the contributions in the thermodynamical potential. We also show that the Schwinger ansatz is valid only in the limit where $eB/M_0^2 \ll 1$, in which M_0 is the vacuum effective quark mass.

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