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QCD phase diagram in strong magnetic fields from competition between the magnetic catalysis and the QCD Kondo effect

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We discuss the QCD phase diagram in the presence of strong magnetic fields. It is known that the chiral symmetry is inevitably broken via the celebrated mechanism of the "magnetic catalysis"; the quarks confined in the cyclotron orbits are forced to form the chiral condensate due to the effective low dimensionality. In addition, we take into account the existence of heavy quarks as impurities embedded in the light-quark matter. Then, the dimensional reduction also inevitably gives rise to the formation of the heavy-light mixed quark condensate, leading to the "QCD Kondo effect" [1, 2].

Therefore, we discuss the competition between the "magnetic catalysis"and the "QCD Kondo effect"to determine the true ground state within the mean-field approximation [3]. We find a critical magnetic-field strength that defines the phase boundary. While the Kondo condensate is excluded in the lower strength, a coexistence phase is realized in the higher strength. The growth of the Kondo condensate makes the chiral condensate saturate to a constant magnitude in the coexistence phase.

[1] K. Hattori, K. Itakura, S. Osaki, and S. Yasui,Phys.Rev.D 92 (2015) 065003 [1504.07619 [hep-ph]]
[2] S. Ozaki, K. Itakura, and Y. Kuramoto, Phys.Rev.D 94 (2016) 074013 [1509.06966 [hep-ph]]
[3] K. Hattori, D. Suenaga, K. Suzuki, S. Yasui, In preparation.

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