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Effects of the Medium Separation Scheme on Cold, Magnetized Two-Flavor Color Superconducting Quark Matter

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In this study, we investigate the interplay between chiral and diquark order parameters in cold, dense quark matter subjected to an external magnetic field, using an SU(2) version of the Nambu–Jona-Lasinio (NJL) model. We analyze the impact of the magnetic field on the phase diagram, addressing model divergences through various regularization strategies. These include the combined application of the Magnetic Field Independent Regularization (MFIR) method and the Medium Separation Scheme (MSS), as well as the conventional approach using form factors. This approach ensures a clear separation between finite magnetic contributions and model divergences. Additionally, we examine the effect of the MSS on two-flavor color superconducting (2SC) dense quark matter in the presence of a finite external magnetic field. Within this framework, we investigate how the external magnetic field and density influence the quark Bardeen-Cooper-Schrieffer (BCS) gap and the dynamically generated quark mass. Our findings highlight the importance of separating medium effects from vacuum contributions, which suppresses artificial oscillatory behavior often misinterpreted in the literature as the van Alphen–de Haas (vA-dH) effect.

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