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Charm mesons in magnetized nuclear matter – effects of (inverse) magnetic catalysis

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The in-medium masses of the pseudoscalar ($D, \bar{D}, D_s^{\pm}$), and vector ($D^*, \bar{D}^*, D_s^{*\pm}$), open charm mesons are studied in isospin asymmetric magnetized nuclear matter, accounting for the effects of the magnetized Dirac sea. The in-medium masses of the open charm mesons are calculated from their interactions with the nucleons and scalar mesons within the generalized chiral effective model, in terms of the scalar ($\rho_{p,n}^s$) and number ($\rho_{p,n}$) densities of nucleons and the scalar field fluctuations of $\sigma' \sim (\sigma - \sigma_0)$, $\delta' \sim (\delta - \delta_0)$ in the chiral effective model. For the strange charm mesons D_s, it depends on the fluctuations of the strange quark condensates $\zeta' \sim (\zeta - \zeta_0)$. The free energy of the magnetized vacuum with Landau energy levels and anomalous magnetic moments (AMM) of the charged fermions in the single fermion energies are taken into account in the Dirac sea contribution. The effects of Landau energy levels of protons and AMM of the nucleons are also considered in the magnetized nuclear matter. The light quark condensates are modified considerably with magnetic field, leading to (inverse) magnetic catalysis due to the magnetized Dirac sea effects. The magnetic field causes modifications to occur due to the mixing of the pseudoscalar and the longitudinal component of the vector mesons, along with the lowest Landau level contribution to the ground state energy of the charged mesons as point particle correction. The in-medium partial decay widths of the charmonium states $\Psi(3770) \to D\bar{D}$, and $\Psi(4040) \to D_s^+ D_s^-$ are studied where the effects of the magnetized Dirac sea are incorporated to the mass modifications of the charmonium states through the medium modified scalar dilaton field χ within the chiral model. The in-medium masses and decay widths of the open charm and charmonium mesons thus obtained should have considerable observable consequences in the production of the open charm mesons and charmonia in non-central ultra-relativistic heavy ion collision experiments, where huge magnetic fields are expected to be created in the early time of collisions. The heavy flavor mesons are also created during early stages of the collisions, hence study of the effects of magnetic field on heavy flavor mesons properties are important in this context.

References:

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