Masses and Decay Widths of Heavy Flavor Mesons

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Abstract

We investigate the masses of the pseudoscalar ($D, \bar{D}, D_s^{\pm}$), and vector ($D^*, \bar{D}^*, D_s^{*\pm}$) open charm mesons in isospin asymmetric magnetized nuclear matter, taking into account the effects of Dirac sea. The pseudoscalar mesons interact with the nucleons and the scalar mesons. The free energy of the magnetized vacuum and the Landau energy levels of protons along with the anomalous magnetic moments (AMM) of the nucleons are considered while calculating the Dirac sea contribution to the scalar densities of the nucleons in the magnetized nuclear matter. The (reduction) enhancement of the QCD light quark condensates with magnetic field indicates (inverse) magnetic catalysis. Magnetic field induced phenomena like Pseudoscalar-Vector (PV) mixing between $(D(\bar{D})) - D^{*||}(\bar{D}^{*||})$, and $(D_s - D_s^{*||})$ cause further modification in the masses of the pseudoscalar and vector charm mesons. The lowest Landau Level contribution to the ground state energy of the charged mesons as point particle correction has been considered. For the charmonium state $\Psi(3770)$, the effects of the magnetized Dirac sea are incorporated to the mass modifications through the medium modified scalar dilaton field χ within the chiral model. The masses are used to study the in-medium partial decay widths of $D^* \to D\pi$ ($\bar{D}^* \to \bar{D}\pi$) and $\Psi(3770) \to D\bar{D}, \Psi(4040) \to D_s^+ D_s^-$, using the $^3P_0$ model. The in-medium masses and decay widths of the open charm and charmonium mesons thus obtained should have important observable consequences in the production of the open charm mesons and charmonia in peripheral ultra-relativistic heavy ion collision experiments. Next, we investigate the in-medium masses of the pseudoscalar and vector open bottom mesons (B, $\bar{B}$, B_s and B^*, $\bar{B}^*$, B_s^*) in the magnetized nuclear matter by considering the effects of Dirac sea, within the chiral effective model. The mass modifications arise due to the interactions of the open bottom mesons with the nucleons and the scalar mesons, calculated in terms of the scalar and number densities of the nucleons and the scalar fields fluctuations. The effects of the magnetized Dirac sea lead to the considerable changes in the scalar fields with magnetic field, which are related to the condensates of light quark–antiquark pairs. The contribution of the magnetic field on the Fermi sea of nucleons are taken into account through the Landau energy levels of protons and anomalous magnetic moments of the nucleons. The additional contribution of the lowest Landau level for the charged open bottom

mesons are considered. PV mixing between the states $(B(\bar{B}) - B^{*||}(\bar{B}^{*||}))$, and $(B_s - B_s^{*||})$ are studied, which lead to a level repulsion between their masses with magnetic field. Magnetic fields are observed to have significant contribution on the in-medium masses of the open bottom mesons through the Dirac sea effect as compared to the case when this effect is not considered. In vacuum, considerable changes are obtained only due to the magnetized Dirac sea at zero and finite nucleonic AMM.