Contribution ID : **17** Type : **not specified**

Thermomagnetic effects on light pseudoscalar meson masses

Tuesday, 25 November 2025 10:30 (0:45)

Content

In this work we use the $SU(3)$ formulation of the Nambu–Jona-Lasinio model, with the introduction of the 't Hooft determinant as a six-point interaction to reproduce the breaking of the $U_A(1)$ symmetry. The Schwinger proper-time method is used to include constant magnetic fields, while the temperatures are included by the imaginary-time formalism in terms of the Matsubara frequencies. For the charged mesons, the Ritus eigenfunction method is used to diagonalize the polarization functions, while for the neutral mesons we apply the usual momentum basis. As the NJL model is not renormalizable, the Magnetic Field Independent Regularization (MFIR) scheme is used to regularize it by separating the magnetic and thermal contributions to the vacuum ones, which avoids nonphysical oscillations in the quark condensates. Numerical results are obtained by considering the coupling constant given by the usual parametrization of the model, as well as a magnetic field-dependent coupling, fitted in order to emulate the inverse magnetic catalysis (IMC).

The addition of an external magnetic field causes a splitting in the screening masses of the neutral mesons in a perpendicular and a parallel part, where $m_{scr,\perp} > m_{scr,\parallel}$. For the parallel masses of neutral mesons, we find that they increase with the temperature when we consider a coupling depending on the magnetic field, while they decrease when we consider a constant coupling. Considering a constant coupling, the perpendicular masses exhibit a nonmonotonical magnetic behaviour until they reach temperatures below $T < 500$ MeV, and after this they increase. Otherwise, for a coupling depending on eB, they always increase with the magnetic field. We only find the parallel masses for the charged mesons, that always increase with eB.

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