We investigate the modification of the pion self-energy at finite temperature due to its interaction with a low-density, isospin-symmetric nuclear medium embedded in a constant magnetic background.

**Nuclear matter in strong magnetic fields**

The study of nuclear matter under strong magnetic fields has acquired a lot of attention during the last years in the contexts of heavy ion collision physics and lattice QCD [1]. In Ref. [2] we investigate some properties of isospin-symmetric nuclear matter in the limit of low density and temperature, embedded in a strong magnetic background. In particular, we compute the in-medium pion effective mass in the presence of a constant magnetic field to one loop. For this purpose, we consider fully relativistic chiral perturbation theory as a framework for our computation. This is needed to define consistently the fermion propagators in a magnetic background.

**Pion self-energy in strong magnetic fields**

The leading order interaction Lagrangian, which describe the low-energy phenomenology of nuclear matter, \( \mathcal{L}_{\pi N}^{(1)} \), reads [3]

\[
\mathcal{L}_{\pi N}^{(1)} = - \bar{\psi} \left( \frac{g_A}{2 f_\pi} \gamma^\mu \gamma_5 \tau \cdot \partial_\mu \pi + \frac{1}{4 f_\pi^2} \gamma^\mu \tau \cdot (\pi \times \partial_\mu \pi) \right) \psi.
\]  

(1)

Here \( \tau \) is the vector of Pauli matrices in isospin space, \( \pi \) is the isotriplet of pions, \( f_\pi \) the pion decay constant and \( g_A \) is the axial-vector coupling.

The effective pion mass is defined as:

\[
m_{\pi}^* = m_{\pi}^2 - \text{Re} \Pi(m_{\pi}^2, q = 0; B) + (2n + 1)|eB|,
\]

(2)

where \( \Pi(q) \) is the pion self-energy, \( B \) is the magnetic field and \( n \) is the index of the Landau level. The following results are computed within the lowest-Landau-level (LLL) approximation, which is valid for very intense magnetic fields.

**Results**

Fig. 2 displays our results for the pion effective mass, \( m_{\pi}^* \), as a function of the magnetic field, normalized to the trivial \( |eB| \) shift in Eq. (2).

![Figure 2: Effective pion mass as a function of the magnetic field.](image)

We find that the effective mass of the negatively charged pion drops by \( \sim 10\% \) for a magnetic field \( |eB| \sim m_{\pi}^2 \), which favors pion condensation at high density and low temperatures.

**References**

