The properties of magnetized color superconducting cold dense quark matter under compact star conditions are investigated using an SU(2)f Nambu Jona-Lasinio (NJL)-type model in which the divergences are treated using a magnetic field independent regularization (MFIR) scheme in order to avoid unphysical oscillations. We study the phase diagram for several model parametrizations. We analyze the behavior of the chiral and superconducting condensates together with the different particle densities for increasing chemical potential or magnetic field. With respect to previous studies, we show how the phases are modified in the presence of β-equilibrium as well as color and electric charge neutrality conditions.

The model: SU(2)f NJL + 2SC + B + μ + β-equilibrium + color and charge neutrality + T=0 + MFIR scheme

When dipquark interaction channels and a magnetic field are introduced in the NJL model, we must work in a rotated base where modified charges appear, which is a combination of electric and color charges.

\[ Q = Q_f + B \]

Due to the B field, the 1-2 plane is quantized in Landau levels (LL) of index k.

\[ Q_{1-2} = \frac{(M - m_f)^2}{4G} + \frac{\Delta^2}{4B} \]

We regularize using the MFIR scheme. Gap equations:

\[ \frac{\partial G_{\mu\nu}}{\partial \rho} = 0, \quad \xi = M, \Delta, \mu, n_s \]

We will consider H/G=0.75 and 1, and the following parameterization sets

<table>
<thead>
<tr>
<th>M0</th>
<th>m0</th>
<th>G^2</th>
<th>\Lambda</th>
<th>n_s</th>
</tr>
</thead>
<tbody>
<tr>
<td>340 MeV</td>
<td>5.59 MeV</td>
<td>2.21</td>
<td>621 MeV</td>
<td>241 MeV</td>
</tr>
<tr>
<td>800 MeV</td>
<td>5.83 MeV</td>
<td>2.41</td>
<td>588 MeV</td>
<td>241 MeV</td>
</tr>
</tbody>
</table>

The conventions for the different phases can be summarized as

<table>
<thead>
<tr>
<th>Phase</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>B-Vacuum Phase</td>
<td>( \psi ) symmetry broken, ( M = B = 0 ), MC, ( \mu = 0 ), ( \Delta = \mu ), (</td>
</tr>
<tr>
<td>A-CSC Phase</td>
<td>( \psi ) symmetry almost restored, EMC, big ( \mu ), ( \Delta, \mu ), positive ( \Delta, \mu ), ( \beta )-equilibrium</td>
</tr>
<tr>
<td>D-Mixed Phase</td>
<td>( M_0 &gt; M_0 &gt; M_0 ), EMC, ( \Delta, \mu ), (</td>
</tr>
<tr>
<td>2SC Phase</td>
<td>Present in D and A phases</td>
</tr>
<tr>
<td>g2SC-Cusp Phase</td>
<td>( \Delta &gt; 4\mu_B ), bare gapped, ( n_s = n_f )</td>
</tr>
</tbody>
</table>

\[ \Delta > 4\mu_B, \text{ bare gapped} \]

\[ n_s = n_f \]

We define:

\[ \mu = \mu_B + T\mu_B \]

\[ \xi = M, \Delta, \mu, n_s \]

Fixed \( \mu \) – two values of H/G and three of \( \mu \), Set 1

Phase diagrams

Conclusions

- Presence of chirally broken B, almost restored A and mixed D phases, the latter two composed of g2SC and/or 2SC regions.
- Based on a B=0 study, for H/G<0.75 the A and D phases are expected to become g2SC and eventually have \( \Delta=0 \) for H/G<0.65, recovering the C phase.
- The introduction of compact star conditions induces the existence of g2SC and 2SC modes, diminishes the maximum LL reached in the A-D transitions and reduces the superconducting effect. The value of the critical \( \mu_B \) is increased and the magnetic catalysis (MC) effect is attenuated, diminishing the depth of the IMC well and moving the phase diagram upwards.

REFERENCES