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## Twisted kink crystals in the external magnetic field

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### Abstract:

There have been theoretically and experimentally explored the QCD phase diagram. Usually the phase structure is studied by assuming the spatially and temporally constant order parameter. Recently the possibility of inhomogeneous chiral phase has attracted much interest in the light of progress in heavy-ion collisions or observation of compact stars.

We study the chiral transition in the presence of the magnetic field by using the NJL model. We focus here on the inhomogeneous chiral phase. For the analysis of the inhomogeneous chiral phase the complex order parameter  $\Delta := -2G \left[ \langle \bar{\psi}\psi \rangle + i \langle \bar{\psi}i\gamma^5\tau^3\psi \rangle \right]$  is used; dual chiral density wave (DCDW)  $[\Delta(x) = me^{iqx}]$  and real kink crystal (RKC)  $[\Delta(x) = \frac{2m\nu}{1+\sqrt{\nu}} \text{sn}\left(\frac{2mz}{1+\sqrt{\nu}}, \nu\right)]$  have been commonly used as typical configurations. The properties of DCDW has been studied by Frolov et al. in the presence of the magnetic field. They found that DCDW phase develops in a wide density region at  $T = 0$ . They also found some peculiar behaviour of the amplitude and the wavevector. However, they did not take into account the possibility of RKC, while RKC has been suggested to be favored in the absence of the magnetic field. Here we introduce the hybrid configuration  $[\Delta(x) = \frac{2m\nu}{1+\sqrt{\nu}} \text{sn}\left(\frac{2mz}{1+\sqrt{\nu}}, \nu\right) e^{iqz}]$ , which smoothly connects both DCDW and RKC, and demonstrate that the magnetic field favors the phase modulation: it is found through the analysis of the thermodynamic potential that the wavevector  $q$  takes a nonzero value in the presence of the magnetic field and DCDW and RKC coexist in the weak magnetic field at moderate densities. In the high magnetic field, pure DCDW appears over all density region. It is also shown that there is a first order phase transition between inhomogeneous phases in the presence of magnetic field. Such hybrid phase may appear in compact stars.