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Spin polarization phase in NJL model complemented by a Polyakov loop

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Nowadays, one of the most interesting topics in theoretical physics is to clarify the phase structure of quantum chromodynamics (QCD). The QCD phase structure at high densities has not been understood very well. So far, it is still not possible to test this regime in laboratory and we cannot use the lattice simulation method because of the famous sign problem. Hence, the features of this region of the QCD phase diagram are still uncertain.

Interestingly, the neutron stars can reach this extreme regime of high densities and low temperature, hence different phases of the QCD matter may occur inside of these cold dense matters. Some neutron stars are also characterized by strong magnetic fields which, in turn, modify their properties. But, the origin of these strong magnetic fields are still fully unknown. Because of this, the idea of that the spin of quarks can condensate at high densities and form a quark ferromagnetic phase has received attention. In this talk, I will discuss the possibility of quark ferromagnetic phase at very high densities and finite temperature within of the context where the confinement is implemented by the Polyakov loop.