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Phase diagram of QCD with helically imbalanced quarks

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Due to the recent STAR data on the polarization of the Λ hyperons produced in heavy ion collisions, it is interesting to consider the QCD phase transition in a medium exhibiting persistent polarization. Since during the chiral phase transition, the quarks acquire dynamical mass and the conservation of the axial charge current J^μ_A is broken, the chiral chemical potential μ_A is not suitable to thermodynamically account for the fermion polarization. Noting that the helicity current J^μ_H remains conserved even at finite fermion mass, we propose to model the fermion polarization via the helicity chemical potential μ_H. In the framework of the linear σ model with quarks, LSM$_q$, we show that the vector and helical chemical potentials μ_V and μ_H form a dual pair, due to the symmetry of the free energy $\Omega(\mu_V, \mu_H) = \Omega(\mu_H, \mu_V)$. In this talk, we discuss on the impact of a finite μ_H on the phase diagram associated with the chiral phase transition with a particular focus on the new critical points that emerge at sizable μ_H.

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