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QCD at nonzero isospin asymmetry: the Dirac spectrum and the BEC-BCS crossover

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We investigate the complex spectrum of the Dirac operator in 2+1-flavor QCD, at nonzero temperature and isospin chemical potential, using the extension of the Banks-Casher relation to the case of Complex Dirac eigenvalues (derived for the zero-temperature, high-density limits of QCD at nonzero isospin chemical potential), as a prescription to obtain information on the BCS gap from the 2d density of the complex Dirac eigenvalues.
Such study is motivated by the prediction, from perturbation theory, of a superfluid state of u and $\bar{d}$ Cooper pairs (BCS phase) at asymptotically high isospin densities, plausibly connected via an analytical crossover to the a phase with Bose-Einstein condensation of charged pions at $\mu_I >= m_\pi/2$.
Further motivation comes from recent lattice observations (renormalized Polyakov loop measurements) that indicate a decrease of the deconfinement transition temperature as a function of \mu_I, suggesting that the deconfinement crossover smoothly penetrates into the pion condensation phase and thus favoring a scenario where the deconfinement transition connects continuously to the BEC-BCS crossover in the (T, μ_I) phase diagram.

Primary author: CUTERI, Francesca (Goethe Universität - Frankfurt am Main)

Presenter: CUTERI, Francesca (Goethe Universität - Frankfurt am Main)

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