

Leading-order dynamical QED corrections to the thermodynamics of isospin-asymmetric QCD

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At large isospin chemical potential μ_I and low temperature, QCD undergoes a second-order transition to a Bose-Einstein condensate of charged pions, whose order is encoded in the non-analytic μ_I -dependence of the pressure and of the isospin density derived from it. Including dynamical photons is expected, on general grounds, to drive this transition first order. Since unequal quark charges render the QCD+QED action complex, we avoid the sign problem by expanding the pressure to $\mathcal{O}(e^2)$ around $e = 0$, with the leading contribution governed by the second charge-derivative of the free energy density, $\partial^2 f / \partial e^2|_{e=0}$. We evaluate it directly on existing isospin-asymmetric pure-QCD ensembles as a spacetime convolution of the Feynman-gauge photon propagator with the vector current-current correlator at nonzero μ_I and pion source λ . The full correlator is computed using a point source and a newly proposed two-dimensional planar source. We report progress toward the first lattice determination of $\partial^2 f / \partial e^2|_{e=0}$ as a function of μ_I , which captures, at leading order, the imprint of dynamical photons on the thermodynamics across the transition.

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