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Net quark number gain and the QCD phase diagram

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Content

QCD is controlled by different degrees of freedom in the various sections of its phase diagram, notably hadrons at low temperatures (and chemical potentials) and quarks and gluons at high temperatures. However, studying the relevant content of a QCD medium across the phase diagram is challenging. Recently, we proposed an observable, that appears sensitive to the quark content of the active degrees of freedom, the net quark number gain. It correlates the Polyakov or anti-Polyakov loops to the medium's net quark number, providing information on how the thermal bath reacts to adding a static quark or antiquark probe. While insignificant at high temperatures, it shows the bath's tendency to form hadron-like configurations at low temperatures, which would screen the probe's color charge. Interestingly, it allows one to distinguish meson-like and baryon-like configurations. This net quark number gain also helps explain how a single quark/antiquark can be added to a supposedly confining medium in the first place: the latter provides the missing quarks/antiquarks to form hadron-like states.

We sketch the derivation of this result for temperatures much smaller than the quark masses. As a first step towards applying it to full QCD, we study a PNJL model, discussing the resulting phase diagram and what the net quark number reveals about its various regions.

[2504.06459, 2509.26178]

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