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Determining the thermodynamics of deconfined matter from QCD inequalities and the lattice

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Content

A longstanding obstacle to mapping the phase diagram of quantum chromodynamics (QCD) in the temperature–baryon density plane is the Sign Problem of lattice Monte Carlo—the only reliable nonperturbative, first-principles approach to QCD. However, nonperturbative inequalities bound the thermodynamic pressure of QCD matter by that of its phase-quenched (PQ) version—a Sign-Problem-free theory amenable to lattice treatment.

Recently, it was shown that in the high-density regime, the leading perturbative difference between the pressures of QCD and PQ reduces to a single four-loop Feynman diagram. This makes it possible to determine the thermodynamics of QCD from PQ lattice simulations with high accuracy across a large region of the phase diagram, where this correction remains small.

This talk reports on ongoing efforts to tackle this demanding computation in perturbative thermal QCD, estimate the size of nonperturbative quark-pairing corrections, and discuss the general structure of the weak-coupling expansion, thereby enabling the computation to be pushed to unprecedented order in the strong coupling constant.

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