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QCD under Extreme Conditions –A Lattice View

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Understanding the phase structure of Quantum Chromodynamics (QCD) is essential for describing the behaviour of strongly interacting matter at high temperatures and densities, such as those present in the early universe or created in heavy-ion collision experiments. Lattice QCD, which formulates QCD on a discrete spacetime lattice, has become the primary non-perturbative tool for studying the properties of strongly interacting matter from first principles. By enabling controlled numerical simulations, lattice QCD provides crucial theoretical input to complement and guide experimental efforts worldwide.
Despite significant progress, the phase diagram of QCD at nonzero baryon density remains poorly understood, mainly due to the notorious sign problem, which renders standard importance sampling techniques ineffective. The QCD phase diagram, plotted as a function of baryon chemical potential (μ) and temperature (T), is believed to exhibit a rich variety of phases, including a possible critical endpoint and colour-superconducting regions.

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