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Chiral and magnetic effects on the heavy quark dynamics in the hot and dense medium

Relativistic viscous hydrodynamics has been a major breakthrough in describing QGP evolution, and now, data-driven methods are gaining attention as QGP research moves into a high-precision era [1]. Hard probes, on the other hand, like jets and heavy quarks, provide insight into the QGP due to their interaction with its constituent as they travel through it, which is key to understanding the experimental observable jet quenching. Recent interest has also grown around chiral anomalies and parity-violating effects, where interactions between chiral quarks and gluonic fields create an imbalance between left- and right-handed fermions [2]. Additionally, the strong magnetic field present in the early stages of heavy-ion collisions has been shown to induce medium anisotropy [3,4], affecting QCD properties and spurring phenomena like the Chiral Magnetic Effect (CME), which is one of the active areas of ongoing studies in contemporary physics [5]. Both magnetic fields and chiral asymmetry influence parton energy loss and motivate to explore these effects on parton behaviour in the QGP.

We investigate how chiral imbalance, as well as the strength and direction of the magnetic field, influence the soft contribution of parton energy loss. Using a semi-classical framework, we develop a formalism to describe the energy loss of an energetic parton as it interacts with chromodynamic fields in the QCD medium. The parton's motion within the plasma is modelled using Wong's equations, treating it as a classical particle with SU(Nc) color charge. The effect of the parton on the color field configuration is incorporated via the linearized Yang-Mills equations. Our findings indicate that both chiral asymmetry and the magnetic field shape the mechanisms of parton energy loss.

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