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Relaxation time for the alignment between quark spin and angular velocity in a rotating QCD medium

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Abstract

We compute the relaxation times for massive quarks and anti-quarks to align their spins with the angular velocity in a rigidly rotating medium at finite temperature and baryon density. The rotation effects are implemented using a fermion propagator immersed in a cylindrical rotating environment. The relaxation time is computed as the inverse of the interaction rate to produce an asymmetry between the quark (anti-quark) spin components along and opposite to the angular velocity. For conditions resembling heavy-ion collisions, the relaxation times for quarks are smaller than for anti-quarks. For semi-central collisions the relaxation time is within the possible life-time of the QGP for all collision energies. However, for anti-quarks this happens only for collision energies $\sqrt{s_{NN}} \geq 50$ GeV. The results are quantified in terms of the intrinsic quark and anti-quark polarizations, namely, the probability to build the spin asymmetry as a function of time. Our results show that these intrinsic polarizations tend to 1 with time at different rates given by the relaxation times with quarks reaching a sizable asymmetry at a faster pace. These are key results to further elucidate the mechanisms of hyperon polarization in relativistic heavy-ion collisions.

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