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Firewall boundaries for rotating quark matter in the linear sigma model

We study the linear sigma model coupled with dynamical quarks undergoing rigid rotation in unbounded Minkowski spacetime under the Tolman-Ehrenfest approximation. The thermodynamics of this rigidly rotating system induces, kinematically, an infinite local temperature state at the light cylinder, where the velocity of the system equals the speed of light. We show that the infinite-temperature cylinder serves as a barrier (literally, a "firewall") characterized by emerging boundary conditions that protect the system from artifacts of superluminal motion outside of the cylinder. In particular, the local (differential) formulation of the gap equation naturally imposes that chiral symmetry is always restored at the light-cylinder. As a consequence, the rigidly rotating system cannot host a single chirally broken phase in the whole space. On the contrary, the system in a thermodynamic ground state resides in a mixed phase that comprises dynamically broken and dynamically restored phases located at different distances from the rotation axis. The existence of such mixed inhomogeneous phases is demonstrated explicitly.

Category

Theory

Collaboration (if applicable)

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