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Dirac fermions under imaginary rotation

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Recent years have seen an increase in the interest to investigate the thermodynamic properties of strongly-interacting systems under rotation. Such studies are usually performed using lattice gauge techniques on the Euclidean manifold and with an imaginary angular velocity, $\Omega = i\Omega_I$. When $\nu = \beta\Omega_I/2\pi$ is a rational number, the thermodynamics of free scalar fields "fractalizes"in the large volume limit, that is, it depends only on the denominator q of the irreducible fraction $\nu = p/q$ [1].

The present study considers the same problem for free, massless, fermions at finite temperature $T = \beta^{-1}$ and chemical potential μ and confirms that the thermodynamics fractalizes when $\mu = 0$. Curiously, fractalization has no effect on the chemical potential μ, which dominates the thermodynamics when q is large. The fractal behavior is shown analytically for the fermionic condensate, the charge currents and the energy-momentum tensor. For these observables, the limits on the rotation axis are validated by comparison to the results obtained in [2] for the case of real rotation. Enclosing the system in a fictitious cylinder of radius R and length Lz allows constructing averaged thermodynamic quantities that satisfy the Euler relation and fractalize.

[1] V. E. Ambruș, M. Chernodub, Phys. Rev. D 108 (2023) 085016.
[2] V. E. Ambruş, J. High Energ. Phys. 2020 (2020) 16.

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