Dirac fermions under imaginary rotation

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Outline of the setup

- Growing interest in studying strongly-interacting systems under rotation, usually by lattice simulations $\implies$ Sign problem
- Sign problem can be solved by using imaginary rotation $\Omega \mapsto i\Omega_I$.
- Present work : Free massless fermions with chemical potential μ.
- Density operator given by :

$$\hat{\rho} = \exp\left\{-\beta\left(:\hat{H}: -\mu:\hat{Q}: -\Omega:\hat{J}_z:\right)\right\}.$$

- Thermal expectation values $\langle\hat{A}\rangle = Z^{-1}\,\mathrm{Tr}(\hat{\rho}\hat{A})$ with $Z = \mathrm{Tr}(\hat{\rho})$.

Results

- Studied t.e.v. $A_\beta^{i\Omega_I} \equiv \langle : \widehat{A} : \rangle_\beta^{i\Omega_I}$ for the femionic condensate $\bar{\Psi}\Psi$, the currents J_V, J_A, J_H and the energy-momentum tensor T.
- Interesting behavior in systems undergoing imaginary rotation : FRACTALIZATION far away from the rotation axis. This is defined as a $1/q^n$ dependence for rational values and 0 for irrational values.
- The chemical potential term breaks fractalization (it is q-independent).
- Consequence : there is no analytic continuation to real rotation, outside of the rotation axis.