Eigenstate Thermalization to Non-Monotonic Distributions in Strongly-Interacting Chaotic Lattice Gases

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We find non-monotonic equilibrium energy distributions, qualitatively different from the Fermi-Dirac and Bose-Einstein forms, in strongly-interacting many-body chaotic systems [1]. The effect emerges in systems with finite energy spectra, supporting both positive and negative temperatures. General results are obtained for chaotic systems in the regime of quantum ergodicity, assuming the Gaussian local density of states. Orbital occupations for two-dimensional Fermi-Hubbard model (see Fig. 1) and one- and two-dimensional Bose-Hubbard models are considered as examples. The results are supported by exact diagonalization calculations for chaotic Fermi-Hubbard and Bose-Hubbard models, when they have Wigner-Dyson statistics of energy spectra and demonstrate eigenstate thermalization. The proposed effects may be observed in experiments with cold atoms in optical lattices.

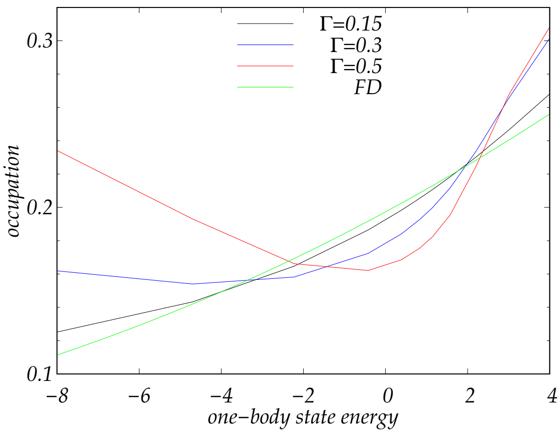

Figure 1: One-body orbital occupations for the two-dimensional Fermi-Hubbard model in comparison with the Fermi-Dirac distribution. The Gaussian width Γ of the local density of states characterizes the system chaotisity

References

[1] V A Yurovsky and A Vardi, arXiv:2501.08967 (2025)