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Sub-diffusion and non-equilibrium probes of phases in Aubry-Andre-Harper model

We consider an open quantum system generalization of the well-known linear Aubry-Andre-Harper (AAH) Model by putting it out-of-equilibrium with the aid of two baths (at opposite ends) at unequal temperatures and chemical potentials. Non-equilibrium steady state (NESS) properties are computed by a fully exact non-equilibrium Green's function method. We find sub-diffusive scaling of NESS current with system-size at the critical point. Below and above the critical point we find ballistic and localized NESS transport respectively. We introduce a novel approach of probing the phase diagram by computing spatial profiles of experimentally accessible NESS quantities. These show remarkably different features below, at and above the critical point therefore proving to be a strong probe of the rich underlying physics. We also make a detailed study of certain closed system quantities such as wavefunction spread, dynamical susceptibility and current auto-correlation functions and find hints of the anomalous transport but no clear evidence of sub-diffusion seen in the open system. Our findings are valid for both the bosonic and fermionic versions.
