EFFECTIVE GRAND-CANONICAL DESCRIPTION OF CONDENSATION IN NEGATIVE-TEMPERATURE REGIMES

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ABSTRACT

The observation of negative-temperature states in the localized phase of the Discrete Nonlinear Schrödinger (DNLS) equation has challenged statistical mechanics for a long time. This model has applications in several physical setups involving propagation of nonlinear waves in discrete media, from ultracold gases in optical lattices to arrays of optical waveguides. Negative temperatures are formally unstable in grand-canonical setups, being associated to an unlimited growth of the condensed fraction. Dynamically, the condensate is realized by a tall discrete breather, i.e. a spatially localized nonlinear excitation. Here, we show that negative-temperature states in open setups are metastable and their lifetime is exponentially long with the absolute value of temperature. The presence of an adiabatic invariant makes the instability mechanism even weaker than the thermodynamic prediction because of the resulting freezing of the breather dynamics.

REFERENCES

[1] S. Iubini, and A. Politi, Effective grand-canonical description of condensation in negative-temperature regimes, *ArXiv 2406.15140* ,2024.