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Title: Lyapunov exponents in many-body systems from Loschmidt echoes

Abstract:

Experimental verification of the chaotic character of dynamics in a many-particle system remains one of the outstanding challenges for the foundations of statistical physics. It was shown recently[1], that, for a lattice of interacting classical spins, the primary characteristics of chaos, namely, the largest positive Lyapunov exponent can be extracted from the initial exponential regime of Loschmidt echoes (defined as response of the system to imperfect reversal of system's dynamics). At the same time, it was shown that lattices of quantum spins would exhibit exponential regime only if the value of quantum spin is sufficiently large[2]. We have recently extended the above investigations to Loschmidt echoes for coupled Bose-Einstein condensates in optical lattices[3,4]. We have demonstrated numerically that, to the extent that the above system is describable by the discrete Gross-Pitaevskii equations, the value of its largest Lyapunov exponent can, indeed, be extracted from a Loschmidt echo. We have also proposed an experimental implementation of the above procedure.

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[2] T. A. Elsayed and B. V. Fine, Phys. Scr. 2015 014011, (2015).

[3] A. E. Tarkhov, S. Wimberger, and B. V. Fine, Physical Review A 96, 023624 (2017).

[4] A. E. Tarkhov and B. V. Fine, arXiv:1804.09732