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Easing the sign problem in many-body physics

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The sign problem is a well-known challenge in quantum many-body physics. It presents significant obstacles for Monte Carlo sampling methods, which are otherwise powerful tools in the field. Specifically, when a system exhibits a sign problem, these methods struggle to perform efficiently. However, it is important to note that the sign problem is basis-dependent. In this talk, we will explore the computational complexity of easing the sign problem [1]. Along the way, we will examine key insights, introduce a figure of merit, and provide a rigorous proof regarding the computational complexity. Looking ahead, we will discuss how tensor network methods might help alleviate the burden of the sign problem [2], investigate lower bounds for ground state energies [3], and explore the connection between the phenomenon of pseudo-quantum chaos and the sign problem [4].

Science Advances 6, eabb8341 (2020).
Phys. Rev. B 104, 075137 (2021).
Phys. Rev. A, in press (2025).
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