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Towards Measuring the Many-Body Entanglement from Fluctuations[1]

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The degree of entanglement in a many-body quantum system is often characterized using the bipartite entanglement entropy. We propose that bipartite fluctuations are also an effective tool for studying many-body physics [1] particularly its entanglement properties, in the same way that noise and full counting statistics have been used in mesoscopic transport and cold atoms. We apply some concepts underlying the field of full counting statistics to the study of the ground states of many-body Hamiltonians, with the boundary introduced by the bipartition playing the role of the scattering or interacting region. For systems that are equivalent to non-interacting fermions, we show that fluctuations and higher-order cumulants fully encode the information needed to determine the entanglement entropy [1-3]. In the context of quantum point contacts, measurement of the second charge cumulant showing a logarithmic dependence on time [2] then would constitute a strong indication of many-body entanglement [1]. Here, the measurability of the entanglement entropy, while suggestive, is particular to the nature of non-interacting particles [4,5].

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