Detecting the nonlocality of many-body quantum states

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One of the most important steps in our understanding of quantum many-body physics stems from the intensive studies of their entanglement properties. Much less, however, is known about the role of quantum nonlocality in these systems. This is because standard many-body observables involve correlations among few particles, while there is no multipartite Bell inequality for this scenario. In my lecture I will review the current status of our understanding of the role of entanglement in many body systems and focus then on the recent paper [1], in which we provide the first example of nonlocality detection in many-body systems using two-body correlations. In order to do so, we first construct families of multipartite Bell inequalities that involve only second order correlations of local observables. We then provide examples of systems, relevant for nuclear and atomic physics, whose ground states violate our Bell inequalities for any number of constituents. Finally, we show how some of these inequalities can be tested by measuring global spin components, opening the way to its experimental detection, for instance with atomic ensembles.

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[1] J. Tura, R. Augusiak, A. B. Sainz, T. Vrtesi, M. Lewenstein, A. Acń, arXiv:1306.6860.