Condensed Matter Physics & Materials Science

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Dear Editor,

Please find enclosed our manuscript entitled “Detecting Multipartite Entanglement Patterns using Single Particle Green's Functions” for consideration in Physical Review Letters.

Experimental detection of multipartite entanglement using accessible tools in various spectroscopic set up is of fundamental interest from both many-body physics as well as quantum information science prospects. Recently, a few promising protocols have been developed to measure the multipartite entanglement in spin chains using inelastic neutron scattering experiments. The existing approaches however do not extend to experimentally accessible tools that measure single electron response functions in itinerant electronic systems. In our submitted manuscript, we introduce new protocols that address this omission.

We propose a novel protocol for detecting multipartite entanglement in itinerant many-body electronic systems using single-particle Green’s functions by establishing a connection with the quantum Fisher information (QFI). A naïve extension of the previous protocols, when applied to single-particle Green’s functions approach, fails to detect the entanglement. We identify a set of non-trivial witness operators that are constructed by employing a doubling of the system wherein we introduce two identical copies of the original model. While the witness operator hops electrons between copies, the copies do not interact with one another. We apply this methodology to a finite-sized fermionic system and showcase its effectiveness in detecting entanglement in spinless itinerant electron models. Our protocol paves the way for detecting entanglement in many-body systems using scanning tunneling microscopy and angle-resolved photoemission spectroscopy, thus offering exciting prospects beyond the detection of entanglement via the dynamical spin response accessed in neutron scattering experiments.

Our protocol in this work presents a path forward for a new way of measuring multipartite entanglement in iterant electronic system which will be extremely beneficial to the field of many-body physics, quantum information science, as well as quantum metrology. We are confident that our manuscript meets all the criteria for the audience of Physical Review Letters.

Sincerely,

Rajesh K Malla, Ph.D. on behalf of all the authors

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