Angular Momentum Fractionalization for Attracting Bosons in Ring-Shaped Potentials

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Quantum mechanics is characterised by quantum coherence and entanglement. After having discovered how these fundamental concepts govern the physical reality, scientists have been devoting intense efforts to harness them to shape future science and technology. This is a highly nontrivial task because most often quantum coherence and entanglement are difficult to access. Here, we present a quantum many-body system in which quantum coherence and entanglement explicitly demonstrate the quantum advantage of quantum technology over the classical one. Our physical system is made of strongly correlated, attracting neutral bosons flowing in a ring-shaped potential of mesoscopic size. Quantum analogues of bright solitons are formed in the system by the attractive interactions, and, as a genuine quantum-many-body feature, we demonstrate that an angular momentum fractionalization occurs. As a consequence, the matter-wave current in our system is able to react to very small changes of rotation or other artificial gauge fields. We discuss how our results put the basis to devise rotation sensors and gyroscopes with enhanced sensitivity.