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Spin-orbit coupling in the presence of strong atomic correlations[1]
AYAKA USUI, THOMÁS FOGARTY, Okinawa Inst of Sci Tech, STEVE CAMPBELL, University College Dublin, SIMON GARDINER, Joint Quantum Centre (JQC) Durham-Newcastle, THOMAS BUSCH, Okinawa Inst of Sci Tech — The synthetic spin-orbit coupling in cold atoms provides coupling between momentum and internal state degree. The ground state of the spin-orbit coupled system is well-studied in the mean-field regime [1], but not in strong interaction regime. We investigate two interacting bosons with synthetic spin-orbit coupling in one dimension and explore the influence of contact interactions on the system [2]. The system is tractable since it is solvable exactly for some sets of parameters and allows to study what happens without any approximations. Even though the system we consider is bosonic, we show that a regime exists in which the competition between the contact and spin-orbit interactions results in the emergence of a ground state that contains a significant contribution from the anti-symmetric spin state. This ground state is unique to few-particle systems and does not exist in the mean-field regime. The transition to this state is signalled by an inversion in the average momentum from being dominated by centre-of-mass momentum to relative momentum and also affects the global entanglement shared between the real- and pseudo-spin spaces. [1] Y. Li, et al., Phys. Rev. Lett. 108, 225301 (2012). [2] A. Usui, et al., arXiv:1910.02399 (accepted in New Journal Physics).

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