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Quantum geometry in superfluidity and quantum transport

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We will discuss our recent results on how quantum geometry affects various physical observables. For flat bands, we show that superfluidity [1,2] as well as stability of a Bose-Einstein condensate [3] is solely given by quantum geometric effects, such as finite quantum metric (Fubini-Study metric). Examples of prominent flat band systems are the Lieb lattice, the saw-tooth ladder, and moire materials. We find that, strikingly, quasi-particles do not move in flat band superconductors/superfluids even under non-equilibrium conditions [4], which can be important for quantum devices. Finally, we show that superfluidity and transport of interacting bosons in a one-dimensional flat band systems is governed by the many-body quantum metric [5], showing that also the many-body version of the quantum metric can have physical significance. We discuss various ultracold gas systems where these new quantum geometry effects could be observed.
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