Superfluidity and quantum metric

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Fermions in flat energy bands are predicted to reach non-zero pairing gaps at high temperatures. Superfluidity, however, has been an open question in flat bands since the usual group velocity is zero. We provide a general expression for the superfluid weight of a multiband superconductor [1-4]. In addition to the conventional part, we identify a geometric contribution to the superfluid weight. This contribution can be non-zero even in a flat band, provided that the band has non-zero Berry curvature, which is guaranteed by a non-zero Chern number. Intriguingly, we find that the superfluid density is connected to the quantum geometric tensor and quantum metric. Thus, even a flat band can carry finite supercurrent, provided that it has a non-trivial quantum geometry.

References

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