Quantum Geometry and disorder in topological materials

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During the last decades, the Berry curvature has been the cornerstone of topological matter. But recently, it has been shown that it is only one of the two faces, the imaginary one, of a more general structure called the Quantum Geometric Tensor. The other size, the real part, usually called the quantum metric, has been receiving a lot of attention lately as it has been shown to play a crucial role in the superconductivity of flat bands materials [1] , linear and non-linear response theory and a large compendium of other effects [2]. Moreover, it has been proven that the quantum metric is a key quantity in the Modern Theory of insulators [3], as it is directly related to the real-space localization of the ground state. In this work we make two huge developments on this new quantity: first, we show a numerically efficient way of computing it via linear-size scaling algorithmics based on the Kernel polynomial method. This allows us to study huge inhomogeneous systems and secondly, using this method, we have studied the Quantum metric (and the Chern number) in the presence of disorder showing its properties where more realistic conditions are present.

[1] S. Peotta et al.: Nat. Commun. 6, 1 (2015)
[2] P. Törmä: Phys. Rev. Lett. 131, 240001 (2023)
[3] R. Resta: Riv. Nuovo Cimento 41, 463 (2018)

Figures

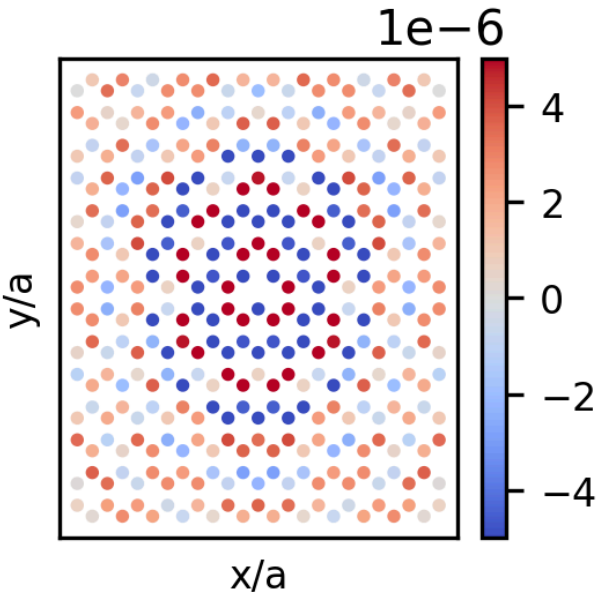

Figure 1: Space resolved integrated quantum metric around an impurity. It can be seen how there are localization-delocalization oscillations.