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Universal Scaling of Quantum Geometric Tensor in Disordered Metals

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The geometrical structure of the Hilbert space continues to receive a lot of attention. The Fubini-Study metric tensor of the Hilbert space, also referred to as Fisher information metric, provides a natural measure of distance in the Hilbert space, related to quantum fidelity – a fundamental concept in quantum information science. Interestingly, the concepts of the Fubini-Study metric tensor and the Berry phase can be unified through the so-called quantum geometric tensor (QGT).

In the work to be presented [1], we demonstrate that the quantum geometric tensor offers deep insight into a long-standing problem in condensed matter physics, Anderson's disorder-driven metal insulator (MI) transition in small external magnetic fields. In particular, the structure of the QGT reflects the universality class of the Anderson transition. Elements of the QGT display universal finite size scaling close to the metal-insulator transition, and capture the flow between the orthogonal (B = 0) and unitary (B 6=.. 0) universality classes. At the transition, the elements of the QGT have universal distributions, characteristic of the underlying symmetry of the transition, but, surprisingly, independent of the direction of the external field. We predict that these universal fluctuations show up as universal and isotropic Hall conductance fluctuations at the metal-insulator transition.

[1] Miklós Antal Werner, Arne Brataas, Felix von Oppen, Gergely Zaránd, Phys. Rev. Lett. 122 (2019) 106601.

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