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An Aharonov-Bohom interferometer for determining Bloch band topology

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The geometric structure of an energy band in a solid is fundamental for a wide range of many-body phenomena in condensed matter and is uniquely characterized by the distribution of Berry curvature over the Brillouin zone. In analogy to an Aharonov-Bohm interferometer that measures the magnetic flux penetrating a given area in real space, we realize an atomic interferometer to measure Berry flux in momentum space. We demonstrate the interferometer for a graphene-type hexagonal lattice, where it has allowed us to directly detect the singular π-Berry flux localized at each Dirac point. This interferometer enabled us to determine the distribution of Berry curvature with high momentum resolution. In addition, I will present results on extending these ideas to two-band models, where Berry phases generalize to Wilson loops and give rise to even richer geometric structures. This work can form the basis for a general framework to fully characterize topological band structures and can also facilitate holonomic quantum computing through controlled exploitation of the geometry of Hilbert space.