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Geometric "charge" pumping with a Bose-Einstein condensate

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We realized a quantum "charge" pump for a Bose-Einstein condensate (BEC) in a novel bipartite magnetic lattice, whose bands are characterized by non-trivial topological invariants: the Zak phases. For each band, the Zak phase is determined by that band's integrated Berry curvature, a geometric quantity defined at each crystal momentum. We probed this Berry curvature in a charge pump experiment, by periodically and adiabatically driving the system. Unlike topological charge pumps in filled bands that yield quantized pumping, our BEC occupied just a single crystal momentum state allowing us to access its band's local geometry. Like topological charge pumps, for each pump cycle we observed an overall displacement (here, not quantized) and a temporal modulation of the atomic wavepacket's position in each unit cell, i.e., the polarization. Our magnetic lattice enabled us to observe this modulation by measuring the BEC's magnetization. While our periodic drive shifted the lattice potential by one unit cell per cycle, the displacement of the BEC, solely determined by the underlying Berry curvature, was always less than the lattice's displacement.