Anomalous Topological Pumps and Fractional Josephson Effects

FAN ZHANG, C.L. KANE, Department of Physics and Astronomy, University of Pennsylvania — We discover novel topological pumps in the Josephson effects for superconductors. The phase difference, which is odd under the chiral symmetry defined by the product of time-reversal and particle-hole symmetries, acts as an anomalous adiabatic parameter. These pumping cycles are different from those in the “periodic table,” and are characterized by $Z \times Z$ or $Z_2 \times Z_2$ strong invariants. We determine the general classifications in class AIII, and those in class DIII with a single anomalous parameter. For the $Z_2 \times Z_2$ topological pump in class DIII, one $Z_2$ invariant describes the coincidence of fermion parity and spin pumps whereas the other one reflects the non-Abelian statistics of Majorana Kramers pairs, leading to three distinct fractional Josephson effects. For the $Z \times Z$ topological pump in class DIII, Weyl or/and Dirac fermions appear in the Andreev spectrum. [arXiv:1310.5281]