

Abstract Submitted  
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**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]

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