Canadian Association of Physicists

Association canadienne des physiciens et physiciennes

Contribution ID: **3559** Type: **Oral Competition (Graduate Student) / Compétition orale (Étudiant(e) du 2e ou 3e cycle)**

(G*) Tunnelling between a Weyl semimetal and a metallic band

Tuesday, June 20, 2023 12:15 PM (15 minutes)

Weyl semimetals (WSMs) are materials whose low-energy excitations are Weyl fermions. Since its first observation in 2015, much work has gone into understanding the various properties of the WSM, most notably the Fermi arc – a surface projection of the Berry flux connecting the WSM's zero-energy points. Here, we study the effects of tunnelling on the band structure and Fermi arc of a time-reversal broken WSM. When coupled to a simple non-magnetic parabolic band, the WSM's chiral arc state lowers in energy and forms, together with a previously extended state, a noticeable spin-dependent asymmetry in the interface spectrum in the vicinity of the Weyl nodes reminiscent of tunnelling in a Dirac cone. We study these effects with a lattice model which we solve numerically on a finite sample and analytically using an ansatz on an infinite sample, with both continuum and lattice frameworks. Our model agrees very well with the numerical simulation as it accurately describes the behaviour of the chiral state, from its energy asymmetry to the spin canting at the interface. We also find that the tunnelling effectively increases the Fermi arc length, allowing for the presence of interface states beyond the bare Weyl nodes in agreement with previous work. These additional states may also carry current along the interface and we propose methods to detect them experimentally.

Keyword-1

Weyl semimetal

Keyword-2

Surface tunnelling

Keyword-3

Lattice model

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Session Classification: (DCMMP) T2-7 Quantum Materials Symposium | Symposium sur les matériaux quantiques (DPMCM)

Track Classification: Symposia Day (Tues. June 20) / Journée de symposiums (mardi, le 20 juin): Symposia Day (DCMMP - DPMCM) - Quantum Materials | Matériaux quantiques