Spin-asymmetric Josephson effect in ultracold Fermi gases

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In solid-state physics, the Josephson effect is of fundamental significance and has many practical applications. This effect can be realized as well with ultracold Fermi gases[1]. Here we predict a new many-body effect, namely that in the case of a spin-asymmetric driving (in which the two spin components of a Cooper pair are driven with fields of different detunings), the spin up and down components oscillate at the same frequency but with different amplitudes[2]. We propose two experimental implementations, by using four internal states of the atoms or two internal states and a two-well external potential. This effect cannot be realized in a straightforward way in solid-state systems, since it corresponds to to biasing a Josephson junction of two superconductors with different voltages for spin up and down electrons, respectively. Furthermore, our results reveal that the standard interpretation of the Josephson supercurrent in terms of coherent bosonic pair tunneling is insufficient. We provide an intuitive interpretation of the Josephson supercurrent as interference in Rabi oscillations of pairs and single particles, the latter causing the asymmetry.

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