Novel Josephson and Proximity Effect using Triplet Superconductors

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Josephson junctions with magnetic tunneling barriers provide an excellent opportunity to observe the interplay of ferromagnetism and superconductivity in a controlled setting. Using various approaches, we predict a universal 0-π transition (sign reversal) of the charge current as the orientation of the barrier magnetic moment is varied. Furthermore, in the theoretical study of Josephson junctions, it is usually assumed that the properties of the tunneling barrier are fixed. This assumption breaks down when considering tunneling between two triplet superconductors with misaligned d-vectors in a TFT-junction (triplet-ferromagnet-triplet). Such a situation breaks time-reversal symmetry, which radically alters the behavior of the junction. A further consequence of the d-vector misalignment is the appearance of a Josephson spin current. In particular, we study the interplay of spin and orbital degrees of freedom in a triplet superconductor-ferromagnet junction [3]. Depending on the number of helical modes, the capacity of carrying spin and charge currents is shown to be directly related to the amplitude and orientation of the ferromagnetic magnetization with respect to the superconducting d-vector.
Recent experimental progress allows fabricating interfaces with the triplet superconductor Sr2RuO4 and the ferromagnet SrRuO3 so that predictions for a long-range proximity effect could be verified. Since thin superconducting films, grown in a controlled way by MBE, of Sr2RuO4 are now available, heterostructures such as TFT-junctions or triplet SQUIDS are now in reach. We compare our theoretical results with existing data and contrast them with junctions based on singlet superconductors.

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