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Josephson Diode effect and Bilinear Magnetoelectric resistance in Bismuth nanowires

We have measured the field dependence of the critical current of a
bismuth nanowires under superconducting proximity effect for different field orientations. This field dependence exhibits a large asymmetry in magnetic field depending on the sign of the current (so called Josephson Diode effect). The shift in the Josephson interference pattern of critical current can be interpreted in terms of an effective magnetic field superimposed to the applied one.

In order to investigate the influence on this effect of the large spin orbit coupling present in the material, we also, performed magneto-electric experiments on the same nanowires in the normal state. This was does by measuring the linear field dependence of the second harmonic response in V(I) with an ac current excitation. This quantity is directly related to the bilinear magnetoresistance expected in large SO non-centro symmetric materials giving rise to current spin polarization (Edelstein effect) and can be interpreted as the existence of an effective field acting on the spins and proportional to the current like in the S state.

We analyze this effective magnetic field for different orientations of the applied magnetic field. These experiments reveal a similar behavior in the N state compared to the S state whereas the amplitude of this effective magnetic field is different for both experiments.

The combination of these experiments in the suggest that Bismuth nanowires present an Edelstein effect both in the normal state and the superconducting state.

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