Half-integer Shapiro Steps in Highly Transmissive InSb Nanoflag Josephson Junctions

Andrea Iorio[1], Alessandro Crippa[1], Bianca Turini[1], Sedighe Salimian[1], Matteo Carrega[2], Luca Chirolli[1], Valentina Zannier[1], Lucia Sorba[1], Elia Strambini[1], Francesco Giazotto[1] and Stefan Heun[1]

[1] NEST, Istituto Nanoscienze-CNR and Scuola Normale Superiore, Piazza San Silvestro 12, 56127 Pisa, Italy
[2] CNR-SPIN, Via Dodecaneso 33, 16146 Genoa, Italy

High-quality III-V narrow bandgap semiconductor materials with strong spin-orbit coupling and large Landé g-factor provide a promising platform for next-generation applications in the field of high-speed electronics, spintronics, and quantum computing. InSb stands out due to its narrow bandgap, high carrier mobility, and small effective mass, making it very appealing in this context. In fact, this material has attracted tremendous attention in recent years for the implementation of topological superconducting states. An attractive pathway to obtain two-dimensional InSb layers is the growth of freestanding single-crystalline InSb nanoflags [1].

We demonstrated fabrication of ballistic Josephson-junction devices based on these InSb nanoflags with Ti/Nb contacts that show gate-tunable proximity-induced supercurrent and sizable excess current [2]. The devices show clear signatures of subharmonic gap structures, indicating phase-coherent transport in the junction and a high transparency of the interfaces.

Our data demonstrate that these devices can work as Josephson diodes, with dissipation-less current flowing in only one direction [3]. Furthermore, under microwave irradiation, we have observed half-integer Shapiro steps that are robust to temperature, suggesting their possible nonequilibrium origin [4]. Our results demonstrate the potential of ballistic InSb nanoflag Josephson junctions as a valuable platform for understanding the physics of hybrid devices and investigating their nonequilibrium dynamics.

References

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