# Bilayer Graphene / $WSe_2$ Josephson Junctions: Shapiro Steps and Supercurrent Revivals in In-plane Magnetic Fields


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For a long time, Josephson junctions have been subject to thorough investigation due to their versatile utility in infrared detection, ultrafast logic circuits, and the facilitation of precise magnetic flux and voltage measurements. Furthermore, over the past decade, Josephson junctions have emerged as fundamental components in the field of superconducting qubits. Introducing bilayer graphene as the weak link instead of a conventional normal conductor or insulator results in highly tunable Josephson junctions with transparent interfaces while the combination with the transition metal dichalcogenide $WSe_2$ leads to proximity induced spin-orbit interaction.

Recently, the magnetic field induced supercurrent modulation of such a bilayer graphene/$WSe_2$ Josephson has been investigated and indeed shows signatures of the expected helical edge modes [1]. However, Shapiro measurements to access the Josephson junctions dynamic response or the influence of in-plane magnetic fields [2] have not been investigated yet.

Here we present a detailed study of the response of a highly tunable bilayer graphene / $WSe_2$ Josephson junction as a function of microwave excitation, magnetic fields in different directions and temperature. First, we employ Shapiro measurements to probe the dynamic response of the Josephson junction. By tuning the charge carrier density and the out-of-plane magnetic field, we are able to tune the quality factor of the Josephson junction and thus probing the response for different damping regimes showing the transition from the under- to overdamped behavior. Furthermore, we apply an in-plane magnetic field while varying the in-plane angle. As the magnetic field increases, the critical current is anisotropically suppressed, but notably, at certain magnetic field directions the 2D Josephson junction shows multiple supercurrent revivals.

References


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[2] T. Dvir et al., Phys. Rev. B 103, 115401 (2021).