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Tunneling Spectroscopy of Andreev states in Graphene LANDRY BRETHEAU, Massachusetts Institute of Technology (MIT), USA, JOEL I-JAN WANG, Massachusetts Institute of Technology (MIT), USA / Harvard University (USA), RICCARDO PISONI, Massachusetts Institute of Technology (MIT), USA / Politecnico di Milano (Italy), KENJI WATANABE, TAKASHI TANIGUCHI, National Institute for Materials Science (NIMS), Japan, PABLO JARILLO-HERRERO, Massachusetts Institute of Technology (MIT), USA — Although not intrinsically superconducting, graphene (G) can inherit electronic properties of a superconductor (S) placed in good contact with it. This proximity effect originates from the formation in the graphene of entangled electron-hole states, the Andreev states. In an S-G-S geometry, the Andreev states energies depend on the difference between the order parameter phases of the two superconductors. Such a phenomenon is usually probed by measuring the dissipationless Josephson supercurrent carried by Andreev states. Here instead, we have performed a direct tunneling spectroscopy of graphene connected to two superconducting electrodes, in a SQUID geometry that enables us to vary the phase difference. The measured energy spectra are consistent with a continuum of Andreev bound states modulating with phase with energies smaller than the superconducting gap. Interestingly, out of gap modulation is also observed and can be interpreted as Andreev scattering states. Additionally, we discuss how these phenomena evolve as a function of graphene normal DOS, which is tuned by a back-gate electrode.

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