

Signatures of 4π periodicity in the dynamics of HgTe Josephson junctions**R.S. Deacon¹, J. Wiedenmann², E. Bocquillon², T. Klapwijk³, S. Tarucha^{1,4},
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Two dimensional topological insulators coupled to superconductors are a candidate system for the realization of Majorana Fermions, exotic quasi-particle excitations which promise new physics with non-Abelian exchange statistics and application for topological quantum computation. We study Josephson junctions with weak links of the HgTe Quantum spin hall insulator. The signatures of a 4π -periodic current phase relation due to the topologically protected gapless Majorana modes of the junction are revealed in measurements of the ac-Josephson effect. We present two methods of detecting these modes [1-3]. First the Shapiro steps are measured in the presence of an rf-drive[1-2]. We observe a doubling of the Shapiro step voltage indicating a fractional ac Josephson effect. In the second method we detect the Josephson emission from a voltage biased junction and detect a peak in the emission power at half the Josephson frequency of the junction again indicating the gapless mode[3]. Both features are most prominent when the device is gated toward the quantum spin hall insulator regime providing evidence for the induced topological superconductivity in the quantum spin hall edge states.

[1] J. Wiedenmann, E. Bocquillon, R.S. Deacon *et al.*, Nature Comms., 7,10303 (2015).

[2] E. Bocquillon, R.S. Deacon, J. Wiedenmann *et al.*, Nature Nano. DOI:10.1038/NNANO.2016.159

[3] R.S. Deacon, J. Wiedenmann, E. Bocquillon *et al.*, arXiv:1603.09611.