Quantized phase-coherent heat transport of counterpropagating Majorana modes

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We demonstrate that phase-coherent heat transport constitutes a powerful tool to probe Majorana physics in topological Josephson junctions. We predict that the thermal conductance transverse to the direction of the superconducting phase bias is universally quantized by half the thermal conductance quantum at phase difference $\varphi = \pi$. This is a direct consequence of the parity-protected counterpropagating Majorana modes which are hosted at the superconducting interfaces. Away from $\varphi = \pi$, we find a strong suppression of the thermal conductance due to the opening of a gap in the Andreev spectrum. This behavior is very robust with respect to the presence of magnetic fields. It is in direct contrast to the thermal conductance of a trivial Josephson junction which is suppressed at any phase difference φ. Thus, thermal transport can provide strong evidence for the existence of Majorana modes in topological Josephson junctions.

[1] A. G. Bauer, B. Scharf, L. W. Molenkamp, E. M. Hankiewicz, B. Sothmann, Phys. Rev. B 104, L201410 (2021).