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Multi-terminal Josephson junctions as topological matter

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Topological materials and their unusual transport properties are now at the focus of modern experimental and theoretical research. Their topological properties arise from the bandstructure determined by the atomic composition of a material and as such are difficult to tune and naturally restricted to ≤ 3 dimensions. Here we demonstrate that n-terminal Josephson junctions with conventional superconductors may provide novel realizations of topology in $n-1$ dimensions, which have similarities, but also marked differences with existing 2D or 3D topological materials. For $n \geq 4$, the Andreev subgap spectrum of the junction can accommodate Weyl singularities in the space of the $n-1$ independent superconducting phases, which play the role of bandstructure quasimomenta. The presence of these Weyl singularities enables topological transitions that are manifested experimentally as changes of the quantized transconductance between two voltage-biased leads, the quantization unit being $4e^2/h$.

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