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**Detecting Topological Superconductivity with $\varphi_0$ Josephson Junctions** CONSTANTIN SCHRADE, SILAS HOFFMAN, DANIEL LOSS, University of Basel — Topological superconductivity can emerge in conventional superconductors in the presence of spin-orbit interaction and magnetic fields. Remarkably, the recent experimental discovery of $\varphi_0$ Josephson junctions by Szombati et al., characterized by a finite phase offset in the supercurrent, require the same ingredients as topological superconductors, which suggests a profound connection between these two distinct phenomena. Here, we theoretically show that a quantum dot $\varphi_0$ Josephson junction can serve as a new qualitative indicator for topological superconductivity: Microscopically, we find that the phase shift in a junction of $s-$wave superconductors is due to the spin-orbit induced mixing of singly occupied states on the qantum dot, while for a topological superconductor junction it is due to singlet-triplet mixing. Because of this important difference, when the spin-orbit vector of the quantum dot and the external Zeeman field are orthogonal, the $s$-wave superconductors form a $\pi$ Josephson junction while the topological superconductors have a finite offset $\varphi_0$ by which topological superconductivity can be distinguished from conventional superconductivity. Our prediction can be immediately tested in nanowire

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