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Anomalously small superconducting gap in the strong spin-orbit coupled superconductor: $\beta-$Tungsten[1] PRASHANT CHAUHAN, Johns Hopkins University, RAMESH BUDHANI, Morgan State University, PETER ARMITAGE, Johns Hopkins University — Thin films of $\beta-$tungsten host superconductivity in the presence of strong spin-orbit coupling. This non-equilibrium crystalline phase of tungsten has attracted considerable attention in recent years due to its giant spin Hall effect and the potential promise of exotic superconductivity. However, more than 60 years after its discovery, superconductivity in this material is still not well understood. Using time-domain THz spectroscopy, we measure the frequency response of the complex optical conductivity of $\beta-$tungsten thin film with a T_c of 3.7 K in its superconducting state. At temperatures down to 1.6 K, we find that both the superconducting gap and the superfluid spectral weight are much smaller than that expected for a weakly coupled superconductor given the T_c. The conclusion of a small gap holds up even when accounting for possible inhomogeneities in the system, which could come from other crystalline forms of tungsten (that are not superconducting at these temperatures) or surface states on $\beta-$tungsten grains. Using detailed X-ray diffraction measurements, we preclude the possibility of a significant amount of other tungsten allotropes, strongly suggesting the topological surface states of $\beta-$tungsten play the role of inhomogeneity in th

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