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Nodal versus nodeless order parameters in LiFeP and LiFeAs superconductors T. SHIBAUCHI, K. HASHIMOTO, S. KASAHARA, R. KATSUMATA, Y. MIZUKAMI, M. YAMASHITA, H. IKEDA, T. TERASHIMA, Y. MATSUDA, Kyoto University, A. CARRINGTON, University of Bristol — There is growing evidence that the superconducting gap structure is not universal in the iron-based superconductors. It is essential to determine experimentally what causes nodal and nodeless states. The 111 materials, LiFeAs and LiFeP provide a unique route to study this problem as both materials are superconducting, nonmagnetic, and importantly very clean, with long electronic mean-free paths. Here we report on high-precision measurements of magnetic penetration depth λ in clean single crystals of LiFeAs and LiFeP superconductors, which reveal contrasting low-energy excitations of quasiparticles. In LiFeAs the low-temperature $\lambda(T)$ shows a flat dependence indicative of a fully gapped state, which is consistent with previous studies. In contrast, LiFeP exhibits a T-linear dependence of superfluid density $\propto \lambda^{-2}$, indicating a nodal superconducting order parameter. A systematic comparison of quasiparticle excitations in the 1111, 122, and 111 families of iron-pnictide superconductors implies that the nodal state is induced when the pnictogen height from the iron plane decreases below a threshold value of $\sim 1.33\,\text{Å}$.

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