Universal Heat Conduction in the Iron-Arsenide Superconductor KFe$_2$As$_2$: Evidence of a $d$-wave State
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The thermal conductivity $\kappa$ of the iron-arsenide superconductor KFe$_2$As$_2$ was measured down to 50 mK for a heat current parallel and perpendicular to the tetragonal $c$ axis. A residual linear term at $T \to 0$, $\kappa_0/T$, is observed for both current directions, confirming the presence of nodes in the superconducting gap. Our value of $\kappa_0/T$ in the plane is equal to that reported by Dong et al. [Phys. Rev. Lett. 104, 087005 (2010)] for a sample whose residual resistivity $\rho_0$ was ten times larger. This independence of $\kappa_0/T$ on impurity scattering is the signature of universal heat transport, a property of superconducting states with symmetry-imposed line nodes. This argues against an $s$-wave state with accidental nodes. It favours instead a $d$-wave state, an assignment consistent with five additional properties: the magnitude of the critical scattering rate $\Gamma_c$ for suppressing $T_c$ to zero; the magnitude of $\kappa_0/T$, and its dependence on current direction and on magnetic field; the temperature dependence of $\kappa(T)$. 