Filling a “Gap” in Iron-based Superconductor Research

Scientific Achievement
Found evidence for a full superconducting energy gap in a high-temperature (high-\(T_c\)) iron-based superconductor

Significance and Impact
Results help create a unified picture of how high-\(T_c\) iron-based superconductors work, a step toward determining how to use them in practical applications

Research Details
– The first iron-based material found to superconduct at temperatures above those of conventional superconductors is \(\text{LaFeAsO}_{1-x}\text{F}_x\), a compound of lanthanum, iron, arsenic, and oxygen, with \(x\) near 0.1 (10% of oxygen replaced with fluorine)
– Evidence of a full superconducting gap in a 300-nanometer \(\text{LaFeAsO}_{1-x}\text{F}_x\) thin film was revealed using two synchrotron infrared techniques, one transmission and the other pump-probe to sense the relaxation time of electron excitations
– Additional research needed to explore the structure of the gap and its role in superconductivity in \(\text{LaFeAsO}_{1-x}\text{F}_x\)

\(X\) \(X\) \(i\), \(Y\) \(M\) \(D\)ai, \(C\) \(C\) \(H\)omes, \(M\) Kidszun, \(S\) \(H\)aindl, GL Carr, Phys. Rev. B, 87, 180509(R) (2013)

Work was performed at Brookhaven National Laboratory

(a) Data taken from 3 to 30K showing the temperature dependence of infrared transmission through the \(\text{LaFeAsO}_{1-x}\text{F}_x\) thin film, normalized to the transmission at 33K
(b) Time-resolved infrared transmission data through the sample from about 2K to 15K. The slow (ns) relaxation time indicates the presence of a full superconducting gap.