Electronic correlations and superconducting response in the optical properties of FeTe\(_{0.55}\)Se\(_{0.45}\)\(^1\) C.C. HOMES, A. AKRAP, J.S. WEN, Z.J. XU, Z.W. LIN, Q. LI, G.D. GU, Condensed Matter Physics and Materials Science Dept., Brookhaven National Laboratory, Upton, New York — The in-plane complex optical properties of the iron-chalcogenide superconductor FeTe\(_{0.55}\)Se\(_{0.45}\) have been determined above and below \(T_c = 14\) K. At room temperature the conductivity is described by a weakly-interacting Fermi liquid with \(\omega_{p,D} \approx 7200\) cm\(^{-1}\) and \(1/\tau_D \approx 414\) cm\(^{-1}\). Below 100 K the conductivity is no longer described by the Drude model. Adopting the generalized Drude model reveals that \(1/\tau(\omega) \propto \omega\) in the terahertz region just above \(T_c\), signaling the increasingly correlated nature of this material.\(^2\) For \(T \ll T_c\) the superconducting plasma frequency \(\omega_{p,S} \approx 3000\) cm\(^{-1}\) (\(\lambda_{\text{eff}} \approx 5300\) Å); \(\omega_{p,S}^2/\omega_{p,D}^2 \ll 1\) indicating that this material is not in the clean limit. Allowing \(\sigma_{dc} \equiv \sigma_1(\omega \to 0)\), then \(\sigma_{dc}(T \approx T_c) \approx 3500 \pm 400\) Ω\(^{-1}\)cm\(^{-1}\) and the superfluid density \(\rho_{s0} \equiv \omega_{p,S}^2 \approx 9 \pm 1 \times 10^6\) cm\(^{-2}\) places material close to the scaling line \(\rho_{s0}/8 \approx 8.1\) \(\sigma_{dc} T_c\) for a BCS dirty-limit superconductor. Below \(T_c\) the optical conductivity reveals two energy scales for the superconductivity at \(\Delta_1(0) \approx 2.5\) meV and \(\Delta_2(0) \approx 5.1\) meV, consistent with the \(s^\pm\) model.

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