Massachusetts Institute of Technology
Department of Physics

Special Condensed Matter Seminar

10:30AM
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Room 4-331

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"Femtosecond Relativistic Dynamics of Photogenerated Electron-Hole Plasma in Graphene"

Graphene, a two-dimensional material with a unique relativistic energy-momentum dispersion has created intriguing opportunities for fundamental physics and applications. Besides novel demonstrations of the Klein Paradox and anomalous quantum Hall effects; we have seen applications of graphene in THz devices, broadband mid-infrared detectors and tunable ultrafast lasers.

In order to fully utilize its potential for photonic devices – particularly high-speed photonics, it is important to understand the ultrafast dynamics of photogenerated non-equilibrium electron-hole plasma in graphene's relativistic bandstructure; and how they maybe different from the dynamics in conventional materials.

In this talk, I will demonstrate the relativistic response of photogenerated non-equilibrium electron-hole plasma in graphene within 100 femtoseconds of photoexcitation, distinguishing it from the physics of non-relativistic materials. Using a counter-intuitive high-energy pump probe experiment, we isolated the Drude optical conductivity of the electron-hole plasma and showed that it scales as $\sqrt{N}$ of the plasma density, instead of the linear scaling in conventional materials. Our experimental results also indicated an unexpectedly rapid cooling of the carriers within the 100 femtosecond experimental resolution. We will discuss this cooling in the context of ultrafast, interactions with optical phonons and the unusual temperature dynamics resulting from graphene's relativistic bandstructure.