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Time Resolved Carrier Distributions in Graphene STEVE GILBERTSON, GEORGI DAKOVSKI, TOMASZ DU-RAKIEWICZ, JIAN-XIN ZHU, KESHAV DANI, ADITYA MOHITE, ANDREW DATTELBAUM, GEORGE RODRIGUEZ, Los Alamos National Laboratory — Graphene, a recently discovered two-dimensional form of carbon, is a strong candidate for many future electronic devices. A question of central importance in optoelectronics, particularly high-speed applications, is how photoexcited carriers behave on ultrashort time scales. Even though time-resolved studies have provided a wealth of information, fundamental questions concerning the quantum descriptions of the transient electron-hole plasma remain. On one hand, conflicting views on the relaxation dynamics go as far as precluding the possibility of observing some predicted phenomena, such as THz lasing or tunable lasers while the observation of phenomena such as ultrafast photoluminescence and carrier multiplication are already established. Here, by employing the technique of time-resolved photoemission, we directly obtain the evolving Fermi-Dirac distributions of the electrons and holes: on an ultrashort 500 fs time scale the electron and hole populations can be described by two separate Fermi-Dirac distributions, while on longer time scales the populations coalesce to form a single Fermi-Dirac distribution at an elevated temperature. This unusual behavior is a consequence of graphene's unique band structure and has important implications for possible applications.

> Steve Gilbertson Los Alamos National Laboratory

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