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# Infrared probe of p-doped GaAs in the ferromagnetic semiconductor GaMnAs and non-magnetic system GaBeAs

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B. C. Chapler, University of California San Diego
S. Mack, University of California Santa Barbara
R. C. Myers, The Ohio State University
L. Ju, University of California Berkeley
B. W. Boudouris, University of California Berkeley
R. A. Segalman, University of California Berkeley
K. S. Burch, University of Toronto
N. Samarth, The Pennsylvania State University
F. Wang, University of California Berkeley
D. D. Awschalom, University of California Santa Barbara
D. N Basov, University of California San Diego

The III-Mn-V ferromagnetic semiconductor GaMnAs has emerged has an ideal test bed for prototype spintronic devices and effects, as it has the most ideal suite of properties for spintronics applications. Substitutional Mn in a GaAs host acts as a single acceptor, and additionally contributes a local magnetic moment, thus understanding the resultant the interplay between the electronic, magnetic, and optical properties of GaMnAs presents an enticing challenge in this unique material. Here we report on extensive studies exploring the electromagnetic response of GaMnAs at energy scales of several meV to the order of the fundamental band gap of the GaAs host (1.5 eV). In these studies, we use several techniques for tuning the hole concentration in our samples. These techniques include, tuning the chemical doping concentration, post-growth annealing to remove compensating Mn-interstitials, designing a spatial gradient of compensating As-antisite defects, as well as charge accumulation and depletion via electric field effect. We contrast these results with similar studies of the non-magnetic p-doped system GaBeAs, which is an ideal system to isolate affects attributable to the presence of magnetism in GaMnAs. Through these detailed studies and comparisons, we highlight the unconventional nature of the insulator-to-metal transition and conducting state of the enigmatic magnetic system, GaMnAs.

**Primary author:** CHAPLER, Brian (University of California San Diego)

**Presenter:** CHAPLER, Brian (University of California San Diego)

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