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Broadband THz response of high-density excitons R. HUBER, R.A. KAINDL, B.A. SCHMID, D.S. CHEMLA, Dept. Physics, UC Berkeley and Lawrence Berkeley Lab, Berkeley, CA 94720 — Many-body interactions in electron-hole ($e-h$) gases determine their nature as a conductive unbound $e-h$ plasma or insulating exciton gas. THz spectroscopy, unlike bandgap luminescence or absorption, probes transitions between internal exciton states. In this way, exciton formation in a dilute, optically-generated $e-h$ gas was recently investigated in GaAs quantum wells (R. Kaindl, *et al.* Nature **423**, 734, 2003). Here, we report THz studies of a high-density exciton gas. For dilute, insulating excitons, the THz conductivity peaks around 7 meV due to 1s-2p transitions. With increasing density, the peak shows a striking red-shift and broadening, and finally evolves into a Drude shape. Quantitative analysis reveals a broadening that gradually exceeds the level spacing and is larger than expected for 1s excitons. This agrees with enhanced scattering from p-like states. In contrast to optical studies, which are limited due to counteracting bandgap renormalization and reduced $e-h$ attraction, THz radiation provides a direct way to measure the impact of phase-space filling and screening on exciton levels at high densities.

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