MAGNETO-PLASMONIC PHOTOLUMINESCENCE IN STRONG MAGNETIC FIELDS: EVIDENCE FOR STIMULATED EMISSION PROCESSES

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Introduction

Investigations of the interactions of strong laser fields with semiconductor systems in strong magnetic fields are now possible owing to the availability of ultrafast laser sources available at the NHMFL. Here, we report on the observation of anomalous photoluminescence from inter-Landau level transitions in dense magneto-plasmas [1]. Previous studies on electron-hole magneto-plasmas have been limited to relatively low ac electric fields and/or low magnetic fields [2,3]. Our experiments encompass an unexplored regime in which intense short pulse laser fields and strong magnetic fields are simultaneously employed to create extremely high carrier densities in quantum well heterostructures and observe their emission processes.

Experimental

Using a 150 fs, 775 nm Ti:sapphire chirped pulse amplifier and optical parametric amplifier, we study magneto-photoluminescence (MPL) at 4.2 K on the heavy hole (HH) exciton in $In_{0.2}Ga_{0.8}As$ as a function of laser power up to 25 GW/cm^2 (corresponding to a carrier density ~ 2.4x10^{12} cm^{-2}) and magnetic field up to 25 T using a 50 mm bore resistive magnet.

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Results and Discussion

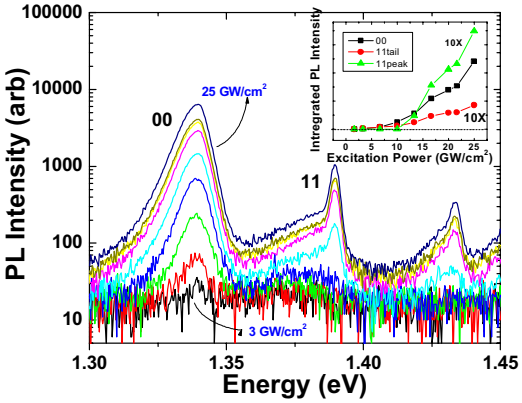

Fig. 1, we plot the MPL as a function of excitation intensity for a pump wavelength of 1.3 μm. Each peak is assigned, from the low energy side, to the (00), (11), and (22) HH transitions, respectively. Above a critical threshold of 10 GW/cm^2, the (11) and higher peaks have a significantly different character than the (00) peak. At low excitation, broad and weak (11) and (22) peaks appear above the (00) peak. Above a threshold intensity, narrow peaks appear on the high-energy side of these peaks, and become dominant at high excitation power. A threshold magnetic field of > 13 T is also necessary to observe the high energy sharp features. To determine how the MPL peak scales with pump power, we plot the integrated peak intensity of (00), (11) low energy tail, and (11) high-energy peak (shown in the inset). The high energy peak shows no emission until the threshold pump intensity and then increases super-linearly. Both the intensity dependence and the magnetic field dependence of the MPL, particularly the evidence of a threshold in both carrier density and field, strongly suggest that the emission process has a coherent character, either arising from purely inter-LL stimulated emission or from a more exotic emission such as superradiance [4]. More systematic studies including time-resolved spectroscopy are currently underway to determine the exact nature of the emission process.

Acknowledgements

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References

[1] Y. D. Jho, et al., International Journal of Modern Physics B, to appear.
[2] L. V. Butov et al., Phys. Rev. B **46**, 12765 (1992).
[3] G.E.W. Bauer, Phys. Rev. Lett. **64**, 60 (1990).
[4] A.A. Belyanin et al., Quantum Semiclass. Opt. **9**, 73683 (1997)