MAGNETO-PHOTOLUMINESCENCE OF TWO DIMENSIONAL ELECTRON GAS AT LOW FILLING FACTORS

B.M. Ashkinadze (Technion, Haifa, Israel); D. Smirnov, X. Wei (NHMFL); E. Cohen (Technion, Haifa, Israel); L.N. Pfeiffer (Lucent Technologies, NJ)

Introduction

The electronic and optical properties of a two dimensional electron gas (2DEG) in GaAs/AlGaAs heterostructures have been extensively studied, particularly in the quantum Hall effect regime. Recently, new effects that are caused by microwave irradiation of the 2DEG, were reported and attracted a great interest. These are optically detected cyclotron resonance (ODR) of composite fermions [1], resistance oscillations (see refs in [2]) and a set of sharp mw-absorption resonances attributed to a Wigner crystal [3]. The main objective of the present research is to study the nature of the mw-induced effects, particularly of the 2DEG optically detected resonances. These resonances appear as the photoluminescence (PL) changes induced by microwave irradiation at certain magnetic field values, *B*. The 2DEG PL spectrum exhibits many striking features under magnetic field [4 and refs. there], thus a first goal was to study the PL spectral evolution with increasing *B*.

Experimental

Photoluminescence experiments were performed in the NHMFL superconducting magnet (up to 18T) with a specially designed optical holder. Magnetic field was applied perpendicular to the 2DEG plane. The optical holder contains a single optical fiber for light excitation and PL collection from the sample. Two lenses are mounted on the end of fiber in order to effectively excite and collect PL from a small spot on the sample immersed in ^{3}He at temperature 0.3K. The PL spectra were measured with high spectral resolution by using a 0.75m spectrometer and a CCD detector.

Results and Discussion

PL evolution was studied for two single heterojunctions (HJs) having 2DEG densities of n_{2D}=0.7x10^{11} cm^{-2} and 1.6x10^{11} cm^{-2}, and for a 33nm-wide quantum well with n_{2D}= 0.2x10^{11} cm^{-2}. At integer and fractional filling factor ν, PL peak energy and intensity exhibits abrupt and strong discontinuities [4]. In high quality HJ, we observed, for the first time, several pronounced PL bands at ν~ 2/3 and 2/5. The PL spectra show a striking modification of the electron energy spectrum at ν<2/3 caused by electron-electron interaction.

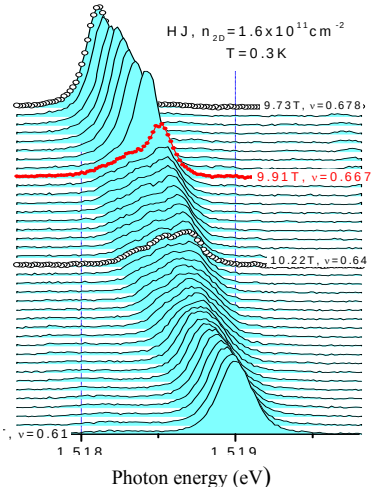

Figure: PL spectra of 2DEG-valence hole recombination at low filling factor.

Conclusions

A detailed PL study at low filling factors as a function of a 2DEG density and lattice temperature is needed. Then, microwave-modulated PL spectra will be investigated at magnetic field values corresponding to filling factors of 2, 1, 2/3, 1/2 and 1/3 .

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References

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