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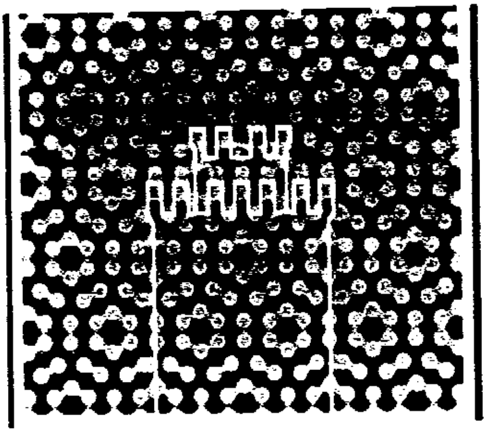

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HOT LUMINESCENCE IN MULTIQUANTUM WELLS INDUCED BY HIGH MAGNETIC FIELDS

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We have observed hot luminescence (HL) and studied its excitation spectroscopy in GaAs-AlAs multiquantum wells under magnetic fields. HL and excitation present more clear selection rules than the standard photoluminescence spectroscopy. From HL we can assign the different optical transitions and determine the Zeeman g-factors of excitons in multiquantum wells.

Absorption and emission of light by two dimensional exciton under magnetic fields has been studied with detail in the past years[1,2]. Through Photoluminescence (PL) and PL Excitation (PLE) the origin and the heavy vs. light character of the optical transitions in multiquantum wells (MQW) can be determined[3,4].

Hot luminescence has been observed in bulk semiconductors[5]. MQW systems under magnetic field are good candidates to observe HL emission of the higher energy magneto-excitons in addition to the fundamental heavy hole (hh) exciton luminescence. This is due in part to the intrinsic hh-lh splitting and also because the δ-like character of the density of states. We have studied the PL, HL and PLE spectra of a MQW consisting of 30 periods of GaAs (d_1= 100 Å) and AlAs (d_2= 100 Å) under magnetic field up to 12 Tesla at 2K. The light source was a LD-700 dye laser pumped by a Kr^+ laser. Four different polarization configurations ($\sigma^{\pm}\sigma^{\pm}$) were used by means of achromatic λ/4 plates. A Faraday configurations was used with the magnetic field perpendicular to the interfaces.

Typical PL spectra at 12 Tesla are shown in Fig. 1. Together with the band edge luminescence coming from the hh_o exciton (1569 meV), a hot luminescence band of the lh_o ground exciton appears around 1580 meV. There is only a small shift (0.5meV) between the hh_o peaks obtained in $\sigma^+\sigma^-$ and $\sigma^+\sigma^+$ configurations. At variance with the hh_o PL peak, the lh_o HL band shows a strong dependence on the polarization of the emitted light. The low (high) energy peak of the HL-lh_o emission, which is detected with $\sigma^+(\sigma^-)$ outgoing polarization, corresponds to the $e\uparrow$-$lh_o\downarrow$ ($e\downarrow$-$lh_o\uparrow$) lh_o ground-exciton according to the selection rules under magnetic fields[6] (See Fig.2). From Fig.1 one con see that the shift, at this field for outgoing polarizations σ^-,σ^+ has different sign for hh_o and lh_o excitons. The field dependence of PL and HL spectra is shown in Fig.3. The hh_o PL peak shows a diamagnetic shift with a very small $(\sigma^+\sigma^-)$, $(\sigma^-\sigma^+)$ splitting. However this splitting is very clear in the lh_o HL band. In fact the $(\sigma^-\sigma^+)$ peak does not shift with B because of the interactions with higher excitonic excited states[7]. However, for the $(\sigma^+\sigma^-)$ lh_o peak these effects are less important, resulting in a shift of 3.2 meV at 12 Tesla. The larger splitting of lh_o is responsible for the clearer selection rules [3]. From Fig.1 and 2 we have obtained g-factors for the light and heavy-hole excitons, g_{lh}=-4.3 and g_{hh}=0.6 respectively. The g factor for bulk GaAs (where the heavy- and light-hole bands are degenerate) is g = -1.97 [8].

The excitation spectra of the lh_o and hh_o luminescence at 12T are shown in Fig.4 and 5, respectively. Both sets of PLE are very similar except for the fact that the selection rules are much more pronounced for lh_o (Fig.4) than for hh_o (Fig.5). PLE spectra of the lh_o luminescence shows lh peaks (lh_o,lh_1) for polarized configuration ($\sigma^-\sigma^-$ and $\sigma^+\sigma^+$). However, the hh magneto-exciton appears more intense with respect to the lh ones in crossed polarization ($\sigma^-\sigma^+$)(See Fig.4). Actually, the selection rules are not completely fulfilled because lh (hh) magneto-exciton should only appear in polarized (depolarized) configuration (see Fig.2). The excitation spectra of the hh_o exciton (Fig.5) shows much less pronounced selection rules than those of the lh_o exciton. This is due to the smaller spin splitting of the hh_o exciton.

The study of the hot luminescence can help to assign electronic transitions in cases where standard PLE shows poor selection rules.

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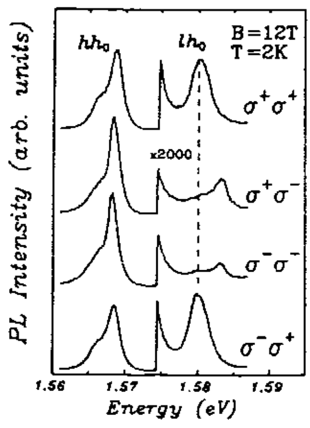

Figure 1. Luminescence and Hot Luminescence profiles of the hh_o and lh_o excitons respectively for different polarization configurations at 12 Tesla. Note that the HL is 2000 times weaker than hh_o luminescence peak.

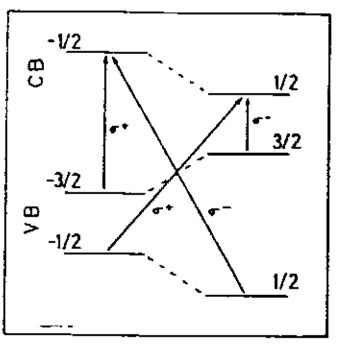

Figure 2. Optical transitions of hh and lh excitons for different light polarizations.

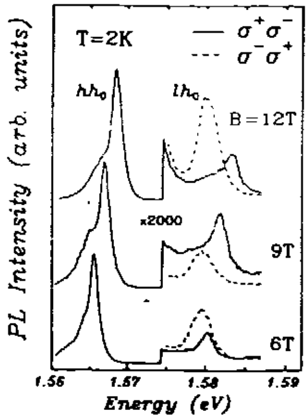

Figure 3. PL of the hh_o and lh_o excitons for different magnetic fields and polarization configurations.

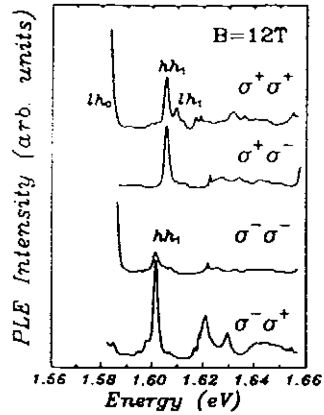

Figure 4. PLE profile of the lh_o exciton for different polarization configurations.

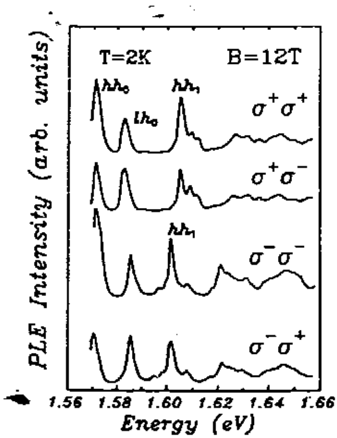

Figure 5. PLE profile of the hh_o exciton for different polarization configurations at 12 Tesla.