Optically detected cyclotron resonance in a GaAs/GaAlAs heterostructure

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Optically detected magnetic resonance is an experimental technique combining simultaneous excitations with visible and THz radiation. In particular, it allows to detect low-energy transitions by studying a near - band luminescence. In the present experiment, this technique is used to observe an influence of a cyclotron resonance transition in a two-dimensional electron gas (2DEG) on a luminescence originating from recombination of a 2DEG electron with acceptor-bound photoexcited hole.

The sample under investigation was a GaAs/$Ga_{0.67}Al_{0.33}As$ heterostructure grown on a GaAs substrate. At the distance of 30 nm from the GaAlAs barrier, a δ layer of Be atoms in the GaAs channel was introduced with the concentration of 10^9 cm^{-2}. A 2DEG appears at the GaAs/GaAlAs interface due to doping of the GaAlAs barrier with Si donors. The structure was previous studied with luminescence experiments. The electron population on the first and second subbands under optical excitaion conditions was determined [1] as well as a dependence of the degree of polarization of luminescence on the electron concentration [2].

The experiment was carried out in an optical helium cryostat supplied with a split coil. The measurements were done at 1.6 K and magnetic field from 0.5 T to 1.2 T. A photoluminescence was excited with a Ar+ laser, with the power of excitation less than 0.1mWcm^{-2}. The spectra were detected with a spectrometer supplied with a CCD camera. At each magnetic field, two spectra were measured: one with and the other without illumination of the sample with a 336 GHz(1.37 meV) radiation which corresponds to a CR transition in GaAs at 0.84 T.

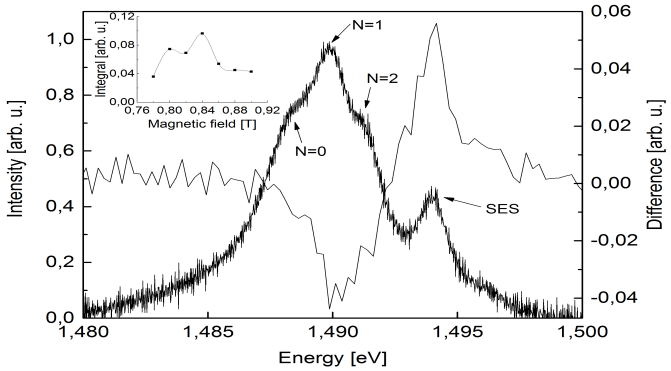

Fig.1: PL (THz off) and a difference spectrum at B = 0.84 T. Inset: integral of the modulus of the difference signal.

The spectra reflect a Landau quantization of the first electrical subband (FES) and a peak resulting from transitions from the second electrical subband (SES). A diffrence spectra (I_{on} - I_{off}; where I is a PL intensity) show a shift of the intensity from the FES to the SES. We note that occupation of all Landau levels on the FES is influenced by the THz radiation, even of these which are fully occupied at THz-off conditions. An integral of the modulus of difference spectra is shown in the inset as a function of the magnetic field and clearly exhibits a resonant character of the observed THz transition. The work opens the possiblity to optically detect low-energy resonances in a 2DEG and also carry out spectroscopy on the acceptor-bound hole.

[1] J. Łusakowski *et al.*, *Phys. Rev. B* **83**, 245313 (2011).
[2] J. Łusakowski *et al., J. Phys C* **19** 236205 (2007).
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