Observation of FQHE states in THz spectroscopy of CdTe-based quantum wells

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High quality quantum wells (QWs) based on CdTe allowed recently to observe a number of basic quantum phenomena, including the Integer and Fractional Quantum Hall Effects in magnetotransport measurements [1]. In the present study we show a possibility to observe FQHE states in CdTe-based QWs as features in spectra resulting from a THz spectroscopy experiment.

The experiments were performed on single 20 nm-wide CdTe or CdMnTe QWs doped with iodine donors in the CdMgTe barrier. Samples were kept in a variable temperature insert and the magnetic field (B) was produced by a 16 T superconducting coil. An optically pumped tunable molecular laser was used as a THz source. Transverse magnetoresistance was measured as a function of temperature in the interval from 1.8 K to 10 K. The sheet electron concentration n_s and the values of quantum scattering time τ_q were extracted.

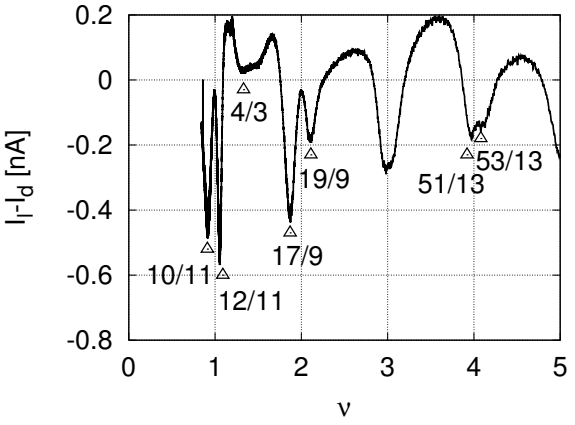

Figure 1: A typical photocurrent spectrum as a function of LL filling factor ν at the laser frequency $f = 2.52$ THz and $T = 1.8$ K. Electron sheet concentration is $n_s = 2.61\times10^{11}$ cm^{-2}. FQHE states differing by $\pm1/11$, $\pm1/9$ and $\pm1/13$ from $\nu = 1$, 2 and 4, respectively are marked with triangles.

A dependence of THz photocurrent on B was recorded at $T = 1.8$ K and laser frequencies of 2.52 THz and 3.11 THz. The spectra measured are dominated by optically induced Shubnikov - de Haas oscillations. The cyclotron effective mass $m^*_{cr} = (0.101 \pm 0.002)m_e$ and the electron relaxation time $\tau_c \sim 10^{-11}$ s were determined.

The spin spliting of Landau levels was observed both in *dc* magnetotransport and photocurrent data at the magnetic fields as low as 1 T. An feature corresponding to a FQHE state at $\nu = 4/3$ is clearly seen. Additionally, a symmetrical splitting at filling factors $\nu = 1, 2$ and 4 are present in photocurrent spectra shown in Fig. 1 both in CdTe/CdMgTe and CdTe/CdMnTe QWs. At the moment, we cannot propose a mechanism of this splitting, although a manifestation of FQHE states cannot be excluded.

In conclusion, THz spectroscopy experiment on CdTe-based QWs was shown to be a tool to investigate FQHE states. A ν=4/3 state was observed as well as spectral features of unknown origin at $\nu = 1$, 2 and 4.

[1] B.A. Piot, J. Kunc, M. Potemski, D. K. Maude, C. Betthausen, A. Vogl, D. Weiss, G. Karczewski, T. Wojtowicz, Phys. Rev. **B 82**, 081307 (2010).