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MAGNETO-OPTICAL STUDIES OF SEMICONDUCTORS WITH AN OPTICALLY PUMPED FAR INFRARED LASER

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We first describe the optically pumped Far Infrared laser we developed. We present a list of a number of experimental works done with the laser. We then describe in more details an original experiment : E.P.R. studies under High Magnetic Fields.

I THE FAR INFRARED LASER (F.I.R) Fig. 1

We used a PL4 Edinburgh CW CO₂ laser. The pump radiation is chopped at typically 40 to 80 Hz and then focused into the waveguide cavity made of a 1.5 m long, 17 mm inner diameter Pyrex tube placed between two mirrors. The F.I.R. output stability was greatly improved using the passive isolator described by Mansfield et al. (1). With such a device the pump radiation is circularly polarized, no attempt was made to check the polarization of the emitted radiation. Depending upon the region of interest we used two waveguide cavities. In the short wavelength region 30-70 μm , in order to obtain a good stability of the optical FIR resonator the cavity was designed with one flat and one concave mirror (2). The fixed mirror was a flat gold plated brass mirror with a 1.5 mm central hole, the movable mirror was an aluminized glass mirror with a 3m radius of curvature. In this region we used the in/out coupling system described by Sigg et al (3). Above 100 μm we obtained higher FIR output power using the same fixed mirror and for the FIR output a movable mirror made of a flat aluminized glass mirror with a 4mm central hole. In the intermediate region we used either one of the two waveguide cavities.

FIG. 1 FAR INFRARED LASER

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II MAGNETO-OPTICAL STUDIES

We performed magneto-optical studies of a narrow gap semiconductor n-In Sb under hydrostatic pressure. Our research work is now mainly focused on two-dimensional systems : resonant polaron effect in Ga In As based heterostructures, effect of magnetic field reversal on far infrared resonances, determination of the donor profile in selectively doped GaAs - GaAlAs multiple quantum wells, study of GaAs - AlAs superlattices (in collaboration with R. Planel, F. Mollet, G. Danan L2M Bagneux).

III ELECTRON PARAMAGNETIC RESONANCE AT HIGH MAGNETIC FIELDS (EPR)

We developed a magnetic field modulation technique for far infrared transmission in the wavelength range 0,5 - 2mm in order to perform EPR spectroscopy at high magnetic fields (0 - 20 T).

In order to determine the sensitivity and resolution of the experimental set up we used n-type Phosphorus doped Silicon. On Fig 2 a is the modulated spectrum for a P concentration of $2.10^{18} \text{ cm}^{-3}$. The complexity of the spectrum is due to interactions between impurities. This spectrum shows that we can observe lines of a width of 5 gauss around 10 T. On fig. 2b is the spectrum for a P concentration of 10^{16} cm^{-3} which is the lower limit in concentration we can detect.

(a)

(b)

Fig 2 MODULATED SPECTRA OF P doped Si (see text)

In conclusion the EPR under high magnetic fields has a resolution of $5 \cdot 10^{-4}$ comparable with EPR at 9 Ghz. We need relatively high concentration samples. The advantages are to observe both ED and MD transitions and to work in a wide range of magnetic fields this enables us to study relaxation processes versus field.

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