Terahertz absorption by magnetoplasma sound wave excitation in semiconductor heterostructures

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We report an interesting property in a magnetically quantized electronic system under EM radiation. By employing the exact time-dependent wavefunctions for an electron gas under a quantizing magnetic field and laser radiation [1], we study the dielectric properties of a system when the laser frequency equals to the cyclotron frequency, ($\omega = \omega_c$). It has long been recognized that the dielectric function of an electron gas under a quantizing magnetic field plays an important role in the understanding of optical and transport properties at low temperature, for example, the magnetoexciton effect and the quantum Hall effect. In a recent paper we have shown that in the case of non-resonance ($\omega \neq \omega_c$), the effect of the radiation field is to reduce the energy of collective excitation [2]. The situation at resonance is qualitatively different. Because the electron-photon side bands coincide with the Landau levels, the energy of resonant state has a finite dispersion in k_x and k_y. This resonant condition leads to a new magneto-photon-plasmon (magnetopolariton) mode. Unlike the ordinary magnetoplasmon which goes to zero as B and q goes to zero, the energy of the new mode increases rapidly with decreasing magnetic field in the low field regime. The plasma frequency also increases with the radiation intensity. In the large-q regime, the new mode behaves like a sound wave, with the speed of the plasma wave much higher than the Fermi velocity of the system at a moderate electric field.

References

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[2] C Zhang, Phys. Rev. B65, 153107 (2002).