Quantum Confinement in Thick Epitaxial Layers. Interference of Polariton Waves or Quantization of the Carrier Motion?

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Optical spectra of thin semiconductor layers display spectral features (oscillations) running apart with increasing energy, whose nature remains so far obscure. In the layers up to 50 nm thick this effect is explained by the quantization of the electron and hole motion. It is commonly accepted that in thicker (of the order of fractions or units of microns) epitaxial layers and thin crystals, these oscillations are related to quantization of the exciton center-of-mass motion rather than that of the carriers [1]. One more source of the spectral oscillations may be related to the interference of the polariton waves [2]. These effects are similar in their phenomenological characteristics and can hardly be distinguished experimentally.

In this paper, we present the results of studies of quasi-periodic oscillations in the reflectivity spectra of a wide highly-detailed series of GaAs/AlGaAs heterostructures with quantum wells 50 – 1000 nm thick. The reflectivity spectra were detected in the range 1500 – 1600 meV at 10 K. It was found that variation of the angle of incidence in a wide range does not change the shape of the oscillations. This allowed us to rule out the effects related to the interference of the polariton waves. It was established that the energy shift of the oscillation minima relative to the first excitonic peak, in all the samples, depends quadratically on their number. The experimental values of the proportionality factors of this quadratic dependence are compared with the results of calculations performed in the framework of the model of independent quantization of the carrier motion and quantization of the exciton center-of-mass motion. It is found that none of the above models completely agrees with the experimental data. The reasons of this discrepancy are discussed.

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References

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