# Coupled Quantum Well Excitons and Polaritons in Electric and Magnetic Fields

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## Abstract

We present a rigorous and precise calculation of spatially-indirect exciton states in semiconductor coupled quantum wells (CQWs) and dipolariton states in microcavity-embedded CQWs in the presence of electric and magnetic fields applied perpendicular to the QW plane. Previous approaches[1-3] to solving the exciton Schrödinger equation in planar nanostructures in electric and magnetic fields are either limited in their accuracy or approximate the problem as strictly two-dimensional. The latter treatment is only applicable to narrow and deep QWs and cannot describe inter-well coupling.

Numerically-exact solutions[4,5] of the exciton Schrödinger equation in real space in three dimensions are found. We map the electric and magnetic field dependence of the exciton absorption spectrum (Fig. 1a) and, for the exciton ground state, evaluate the Bohr radius, optical lifetime, binding energy and dipole moment. A perturbative approach is used to calculate the exciton mass renormalization due to the magnetic field (Fig. 1b). We find a non-monotonous dependence of the effective mass on magnetic field. This is explained in terms of the ground state tending from an indirect to a direct exciton with increasing magnetic field.

Finally, we show how our numerical technique can be adapted to model polaritons in microcavity-embedded CQWs[6] in electric and magnetic fields.

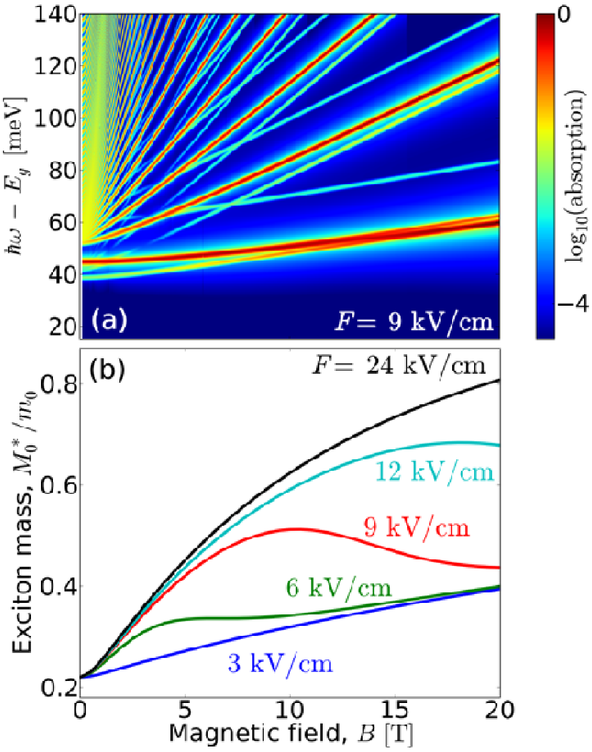


Fig. 1: Calculated magnetic field dependence of the exciton absorption spectrum (a) and ground state exciton effective mass (b) for an 8-4-8 nm $GaAs/Al_{0.33}Ga_{0.67}As$ CQW in a perpendicular electric field, *F*.

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