Determination of quantum dot parameters using quantum dot continuum transitions

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A successful design of semiconductor quantum dot (QD) devices depends on the accuracy of the information about their structural properties [1]. We show, that spatial information about the bound QD states can be obtained by pump probe experiments [2] of optical transitions between bound QD states and continuum states [3].
The developed scheme to determine the spatial extension of bound states is applicable to self organized QDs embedded in bulk material and with modification also for QD wetting layer systems. In Fig. 1(a) interband and intraband transitions of a QD are illustrated.

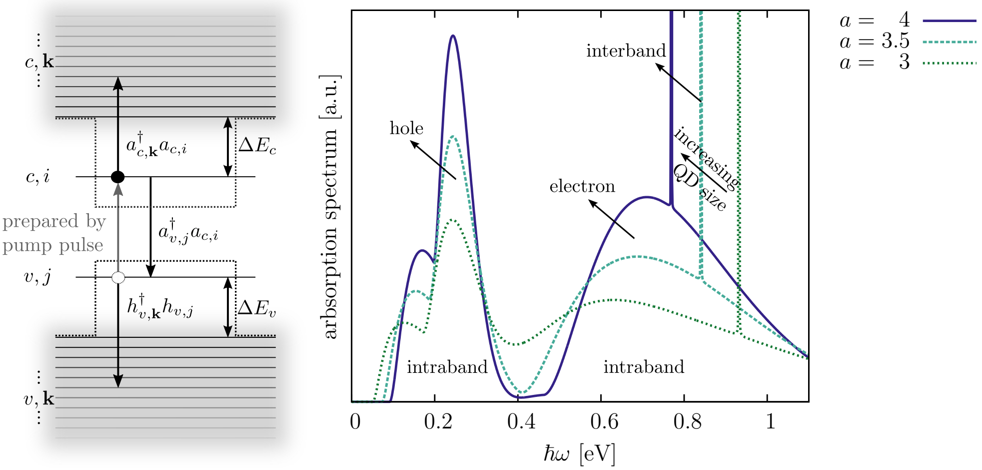

Figure 1: (a) Level scheme of the considered QD model. (b) Calculated absorption spectra for epitaxially grown InAs QD embedded in a GaAs bulk material and different QD sizes a for an excitation by the pump pulse of the ground exciton state.

We show theoretically that specific spectral information gained from pump probe experiments can be used to determine the spatial extension of bound states in QDs. Two steps are necessary: First, we separate the spectral contributions of electron, heavy hole and light hole intraband transitions of pump probe signals in frequency domain (Fig. 1(b)). Second, from the separated spectral contributions the absolute value of the corresponding intraband dipole moment can be obtained using analytical formulas. We show, that in first order approximation, the dipole moment is proportional to the derivative of the QD electron (hole) wave function in the wave number-space. This way, information about the spatial distribution of bound states can be obtained.

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