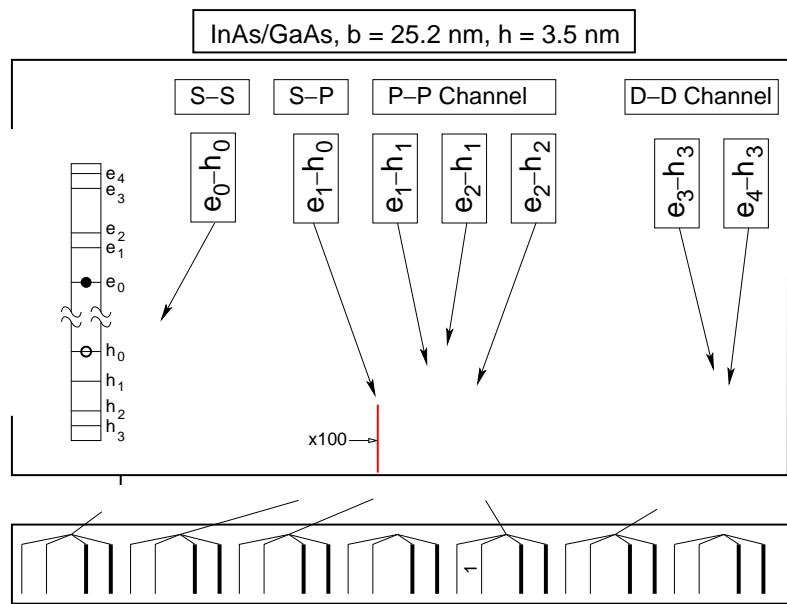
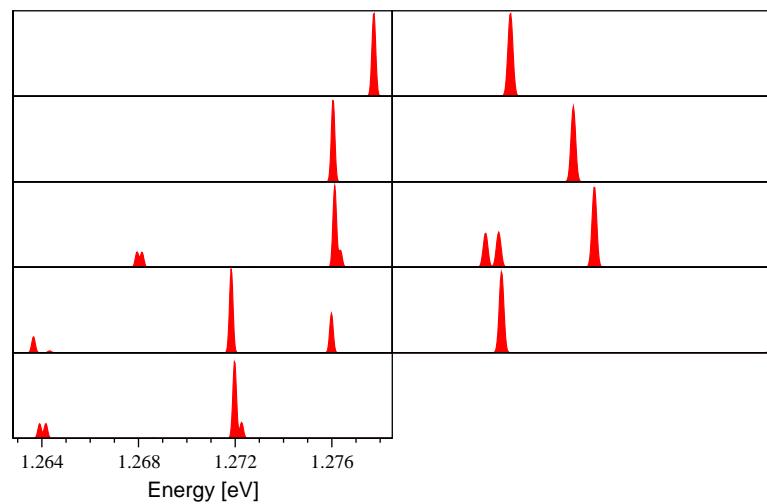


and featureless envelope functions $F_n(\cdot)$ cannot properly resolve the atomistic detail of the object being modeled. Thus, the theory is “hyperopic”, seeing the global shape but not the detailed symmetry. This was demonstrated recently in Ref. [12], where $k:p$ was shown to miss the correct symmetry of dots, leading to], where





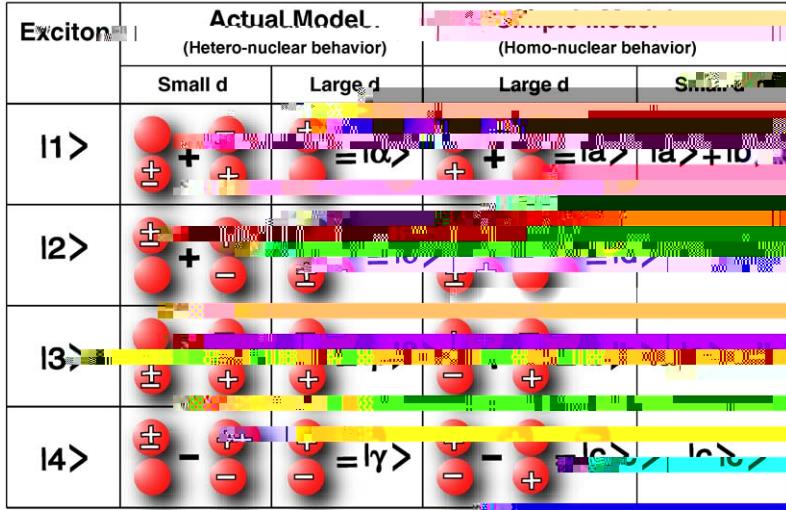


Fig. 5. Schematic representation of the excitonic wave functions obtained in our model (left), and in the simple model of Bayer et al. [38] (right). The symbols are: + (hole), – (electron) or \pm (exciton). The two spheres denote top and bottom dots.

The excitonic spectra we calculated for our dot molecules are shown in Fig. 4(d) and is very different from the simple model. Our dots are $12\text{ nm} \times 2\text{ nm}$ truncated-cone-shaped dots, with a linear composition gradient varying from $\text{In}_{0.5}\text{Ga}_{0.5}\text{As}$ at their bases to pure InAs at their tops. In Fig. 4(d) the oscillator strength of the first four excitons $|1\rangle$, $|2\rangle$, $|3\rangle$ and $|4\rangle$ is proportional to the size of the circles. We see (i) at large inter-dot separations only the first two excitons $|1\rangle$ and $|2\rangle$ are optically allowed, corresponding to excitons where the electron-hole pair is localized to the top and bottom dot, respectively. In contrast, the excitons $|1\rangle$ and $|3\rangle$ are optically allowed in the simple model. The dots are geometrically identical but due to random alloy fluctuations present in real dots, and taken into account in our calculations, the top dot is preferred by the exciton (see Fig. 5). The “dissociated states” $|3\rangle$ and $|4\rangle$, where the electron and the hole resides on different dots have no oscillator strength since there is no e-h overlap. (ii) At small inter-dot separation there are four states, all dipole-allowed. This is due to the interaction of the four excitons $|1\rangle$, $|2\rangle$, $|3\rangle$ and $|4\rangle$ which mix, like shown in Fig. 5. All four excitons are mixed excitonic-dissociated states with non-zero oscillator strength. (iii) At large inter-dot separation, the exciton states $|1\rangle$ and $|2\rangle$ and

the dissociated states $|3\rangle$ and $|4\rangle$ are separated by about 20 meV.

(iv) The lines collapse into one at a special separation of 8.5 nm. At this separation the entanglement (that can be calculated from our CI wave functions, following the definition of Von Neumann [39,40]) reaches a maximum of 80%. The degree of entanglement sharply drops for larger and shorter inter-dot separations (not shown).

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