1. Consider a quantum well of width $w$ made of $\text{Al}_x\text{Ga}_{1-x}\text{As-GaAS-Al}_x\text{Ga}_{1-x}\text{As}$ hetero-structure, where $w$ is such that the low lying bound electron states in the well are negligibly small compared with the height of the well $V_0$ (the conduction band offset $= \Delta E_c$). Derive the expression for $D_2(E)$ the 2D-DOS (Density Of States) in the well, and compare it with $D_3(E)$ the 3D-DOS. Also obtain the expression for $n_{2D}$ the 2D-density of electrons in such a case assuming electron chemical potential to be small compared with the well height.

2. From a $\text{Al}_x\text{Ga}_{1-x}\text{As-GaAS-Al}_x\text{Ga}_{1-x}\text{As}$ hetero-structure, a quantum wire of square cross section $L \times L$ is obtained by etching. Using similar approximation as in the previous problem, derive expressions for the density of states $D_1(E)$ and $n_{1D}$ the 1D-density of electrons in the wire.

3. From a $\text{Al}_x\text{Ga}_{1-x}\text{As-GaAS-Al}_x\text{Ga}_{1-x}\text{As}$ hetero-structure, a cubic quantum dot of side $L$ obtained by etching. Using similar approximation as in the first problem, obtain the energy eigenvalues and their degeneracies for electrons in the dot.

References:

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