Introduction to Physics of Nanoparticles and Nano structures

Part II: Physics of Nanostructures **Questions on Module 2**

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1. Consider a quantum well of width w made of $Al_xGa_{1-x}As$-GaAS-$Al_xGa_{1-x}As$ 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_o (the conduction band offset = ΔE_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 $Al_xGa_{1-x}As$-GaAS-$Al_xGa_{1-x}As$ 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 $Al_xGa_{1-x}As$-GaAS-$Al_xGa_{1-x}As$ 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:
1. Physics of semiconductor devices, Jean-Pierre Colinge and Cynthia Colinge, SI (Springer International) Edition, 2007.
2. Transport in Nanostructures, David K. Ferry and Stephen M. Goodnick, (Cambridge University Press, Cambridge, New York, Melbourne, Madrid, Cape Town, Singapore, Sao Paulo, 1997, paperback edition 1999, reprinted 2001).

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