

CCB 421/521: Homework 2

Due in class on Thursday, Feb. 10. (Note: these are problems from the book; I'm posting them here because the electronic/Kindle version of the text seems to have lots of typos. Let's hope I don't make typos myself!)

(3-34) Prove Eq. (3-85).

(3-43) Prove the commutation relation seen in Eq. (3-88).

(3-48) Assume that HCl and DCl ($H=^1H$, $D=^2H$, and $Cl=^{35}Cl$) can be treated as harmonic oscillators and that both have the same force constant ($4.8 \times 10^2 \text{ N m}^{-1}$). Calculate the fundamental vibrational frequency of each molecule.

(3-51) Show that if the constant a is properly chosen, then the function $\exp(-ar^2)$ is an eigenfunction of the operator $d^2/dx^2 - qx^2$. Use this result to compute the ground state energy of the harmonic oscillator. (*optional*): How could one continue to determine the excited state energies and wavefunctions as well?