Recitation #4
Quantum 522

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1. Recall the Hamiltonian for the Ammonia molecule in the $|1\rangle, |2\rangle$ basis is

$$\left(\hat{H}\right)_{1,2} = \begin{pmatrix} E_0 + \mu\mathcal{E} & -A \\ -A & E_0 - \mu\mathcal{E} \end{pmatrix}$$

The exact solution is $E = E_0 \pm \sqrt{A^2 + (\mu\mathcal{E})^2}$. Assume $A << \mu\mathcal{E}$, and expand in a Taylor series keeping the leading term. Argue that the first order correction in perturbation theory should be zero. Show explicitly that the first order perturbation is zero. Find the second order correction and compare with the Taylor series expansion.

2. Use the variational principle to estimate the ground state energy of a particle subject to the 1 dimensional potential $V(x) = -aV_0\delta(x)$.