Quantum Mechanics 2, Autumn 2011 CMI

Problem set 6

Due by 3pm Saturday September 24, 2011

Non-degenerate stationary perturbation theory

Consider the anharmonic oscillator with hamiltonian $H = H_0 + gH_1$ where $g > 0$ and

$$H_0 = \frac{p^2}{2m} + \frac{1}{2}m\omega^2 x^2 \quad \text{and} \quad gH_1 = gx^4. \tag{1}$$

1. Use first order perturbation theory to estimate the ground state energy of the anharmonic oscillator. *Hint:* Express H_1 in terms of creation and annihilation operators.

2. Within the approximation of first order perturbation theory, find the projection of the ground state of the anharmonic oscillator H on the first excited state of the simple harmonic oscillator H_0.

3. Use symmetry arguments to explain why the projection is as obtained.