Physics 4410
Quantum Mechanics 2

Lecture 6

Harmonic oscillator: series solution

September 4, 2020

1. What is the position space time-independent Schrödinger equation for the harmonic oscillator?

2. What is the asymptotic behavior of $\psi(x)$ as $|x| \to \infty$?

3. Look for a series solution.

4. For general E, the solution is not normalizable.

5. For what E do normalizable states exist?

Activity. Consider a highly excited state ψ_n, with $n \gg 1$.

(a) At large x, we've found the scaling

$$\psi_n(x) \sim \left(\sqrt{\frac{m\omega}{\hbar}}x\right)^{\ell} \mathrm{e}^{-x^2 m\omega/2\hbar}.$$

What is ℓ? Estimate the value of $|x|$ above which $\psi_n(x)$ begins to rapidly decay. Express the answer in terms of E_n.

(b) Compare your answer to the behavior of a classical oscillator.