Stationary states of the harmonic oscillator

\[ \psi_n(x) \]

\[ |\psi_n(x)|^2 \]

\[ \psi_3(x) \quad E_3 = \frac{7\hbar\omega}{2} \]

\[ \psi_2(x) \quad E_2 = \frac{5\hbar\omega}{2} \]

\[ \psi_1(x) \quad E_1 = \frac{3\hbar\omega}{2} \]

\[ \psi_0(x) \quad E_0 = \frac{\hbar\omega}{2} \]
Stationary states of the harmonic oscillator

Wave functions

Probability distributions

source: 230nsc1.phy-astr.gsu.edu/hbase/quantum/hosc7.html
Stationary states of the harmonic oscillator

**peculiar features**

- The probability of finding the particle outside the classically allowed range is non-zero.
- The quantum position distribution is unlike the classical distribution.

Quantum oscillator in the ground state most likely found at center whereas classical oscillator with same energy spends least time at center where its velocity is largest.
Stationary states of the harmonic oscillator

successively higher excited states
“approach” the classical probability distribution

for successively higher states...

1) less extension into classically forbidden region

2) if you smooth over the bumps, the quantum probability looks more and more like the classical probability