**What we've learned so far about motion of quantum particles:**

The probability of finding a quantum particle at position x is given by $P(x=x_0) = |\Psi(x_0,t)|^2$

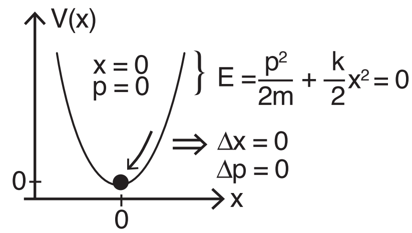
If we know the wavefunction at t=0, we can calculate it at future times using the Schrödinger equation $\hat{H}\Psi(x,t) = i\hbar\partial\Psi(x,t)/\partial t$, or on a computer use the SUR algorithm ('baby calculus" approximation like the Verlet algorithm).

Quantum particles are not fuzzy: $\Psi(x)$ can become spiky like a delta-function, but then of course its Fourier transform $\Psi(p)$ must become very wide.

## TODAY:

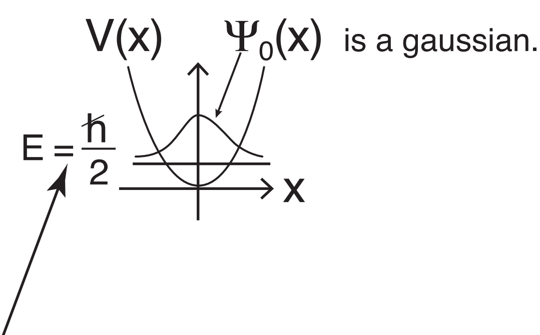
Stationary state: means the system is not changing in time, i.e. in steady-state or equilibrium.

In classical mechanics, there's only one stationary state, and friction will make the system fall down into it.




In quantum mechanics there can be infinitely many stationary states. This is the reason electrons don't fall onto the nucleus of a hydrogen atom. They get stuck at higher energies due to the Heisenberg principle.

But there is a lowest energy stationary state. Let's see what it is for a vibrating molecule.




Note: when m≠1 and k≠1, the same calculation gives

$$E = \frac{\hbar}{2}\omega$$

where $\omega=\sqrt{(k/m)}$ is the vibrational frequency of the spring