Simple Harmonic Oscillator

There is a special energy landscape that comes up all the time in physics, and is very important to understanding many systems. Believe it or not, it is a mass on a spring:

push mass - <u>wants</u> to move back toward center

pull mass - <u>wants</u> to move back toward center.

If ~~spr~~ mass <u>wants</u> to move somewhere else, what kind of energy does it have? What force is giving it this energy?

The mass is always "falling" toward the center.

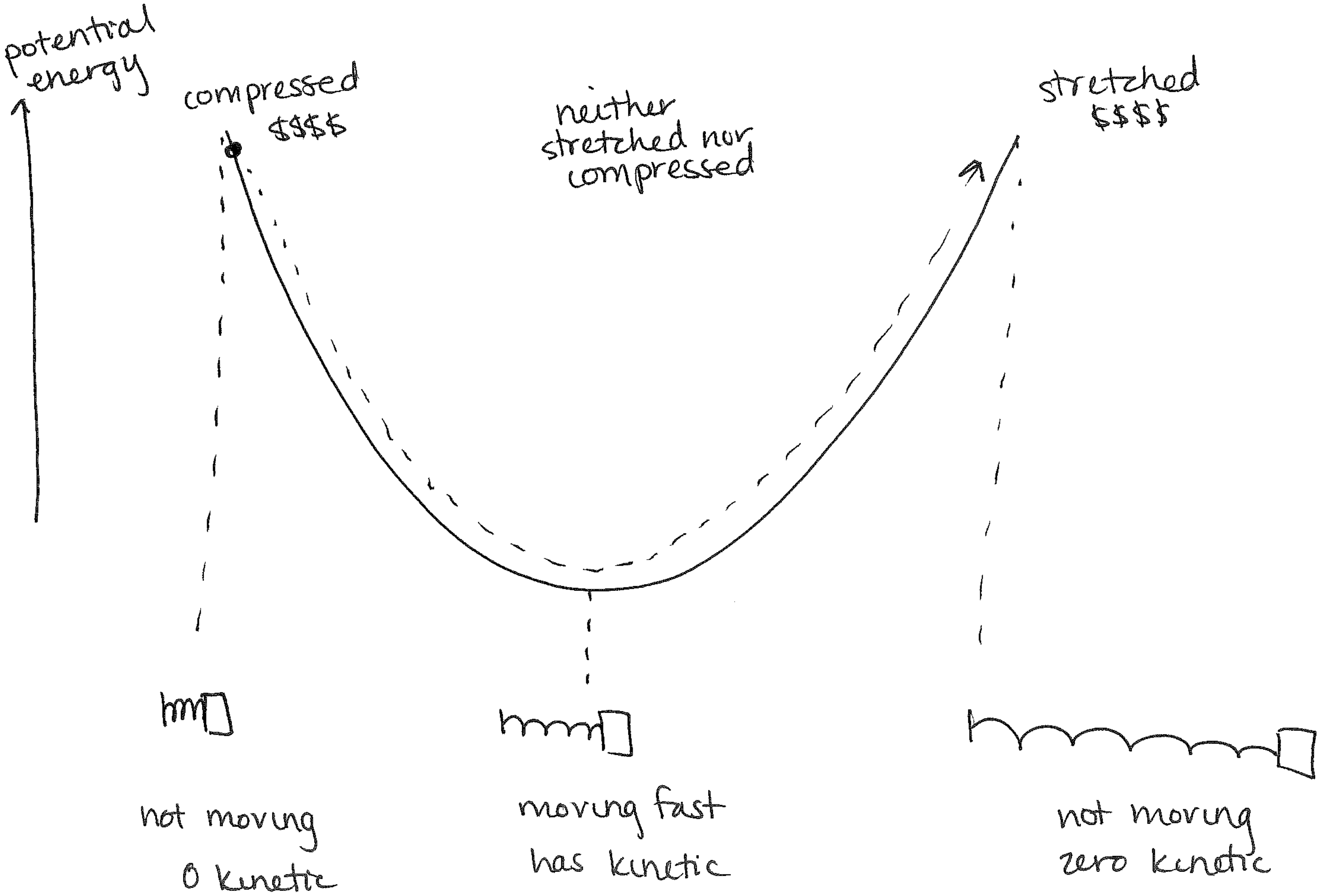
If we push/pull it and let go, it will vibrate, or oscillate, about the center point.

Take a minute and draw what the potential energy landscape looks like:

pushed -
not ~~kinetic~~ moving

at midpoint
moving very fast

extended
not moving



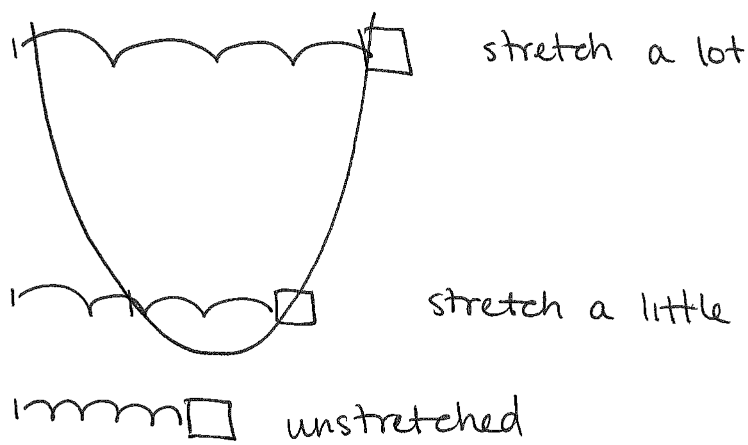
This looks like a hill again - another energy landscape. Only now the height of the hill corresponds only to spring potential energy. We are living in energy space.

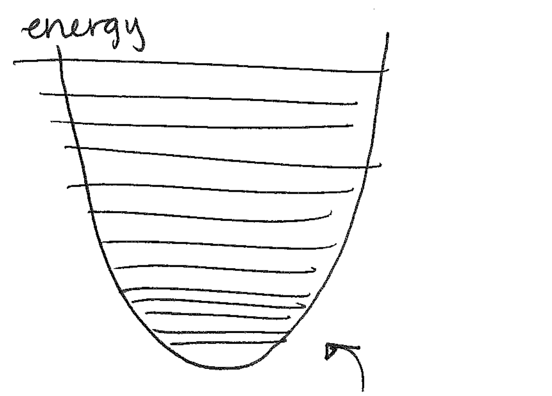
How much energy can we give spring (assuming we can't break it?)

→ any amount

→ the more we stretch the spring, the more potential energy we give it, the more kinetic energy it can buy

Simple harmonic oscillator

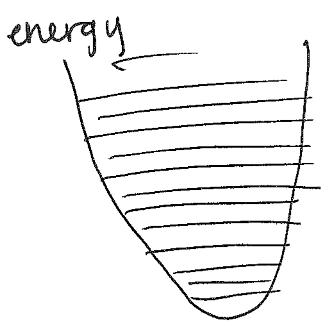




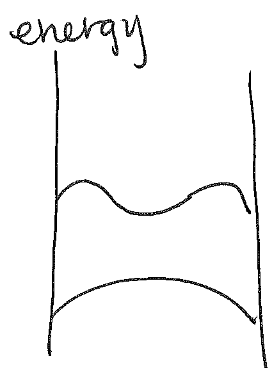
can start spring anywhere on this hill

can have any amount of energy (can ~~set~~ on any of these lines)

This is called a continuum of allowed energy states. The oscillator can have any energy. This is in contrast to the quantized states:



continuum - can have any energy



discrete - quantized can only have certain specific energies

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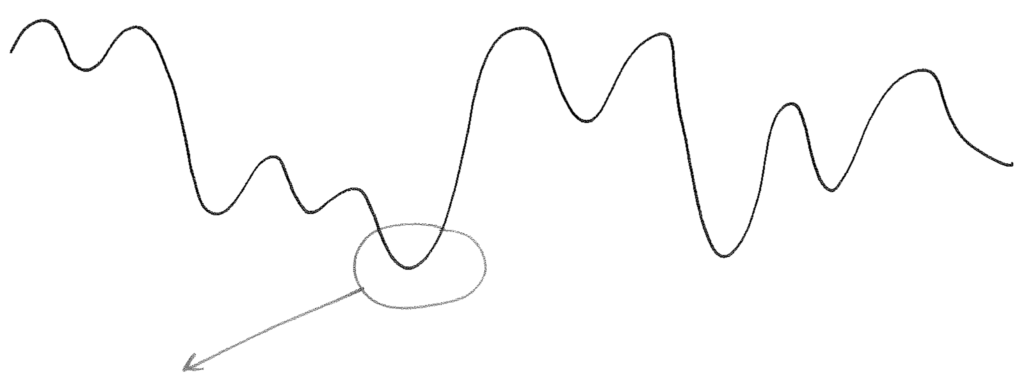
Why do we care about this system?

It turns out that the SHO energy landscape has a very specific shape → parabolic / quadratic

Now, if we have a very complicated energy landscape...



... if we ~~d~~ zoom in on one of the valleys, it looks quadratic. It looks like ~~the~~ energy landscape of the spring

The SHO is a good <u>approximation</u> for valleys of complicated energy landscapes, so understanding its behavior helps us understand complicated systems

Since systems want to minimize their potential energy (a ball wants ~~d~~ to roll <u>down</u> the hill), we often find systems sitting in these valleys w/ low potential energy - this is the region we want to describe, and the SHO helps us do that