

Truth is stranger than fiction, but it is because Fiction is obliged to stick to possibilities; Truth isn't.

– Mark Twain
Following the Equator: A Journey
Around the World

Why the caged bird sings

Free waves

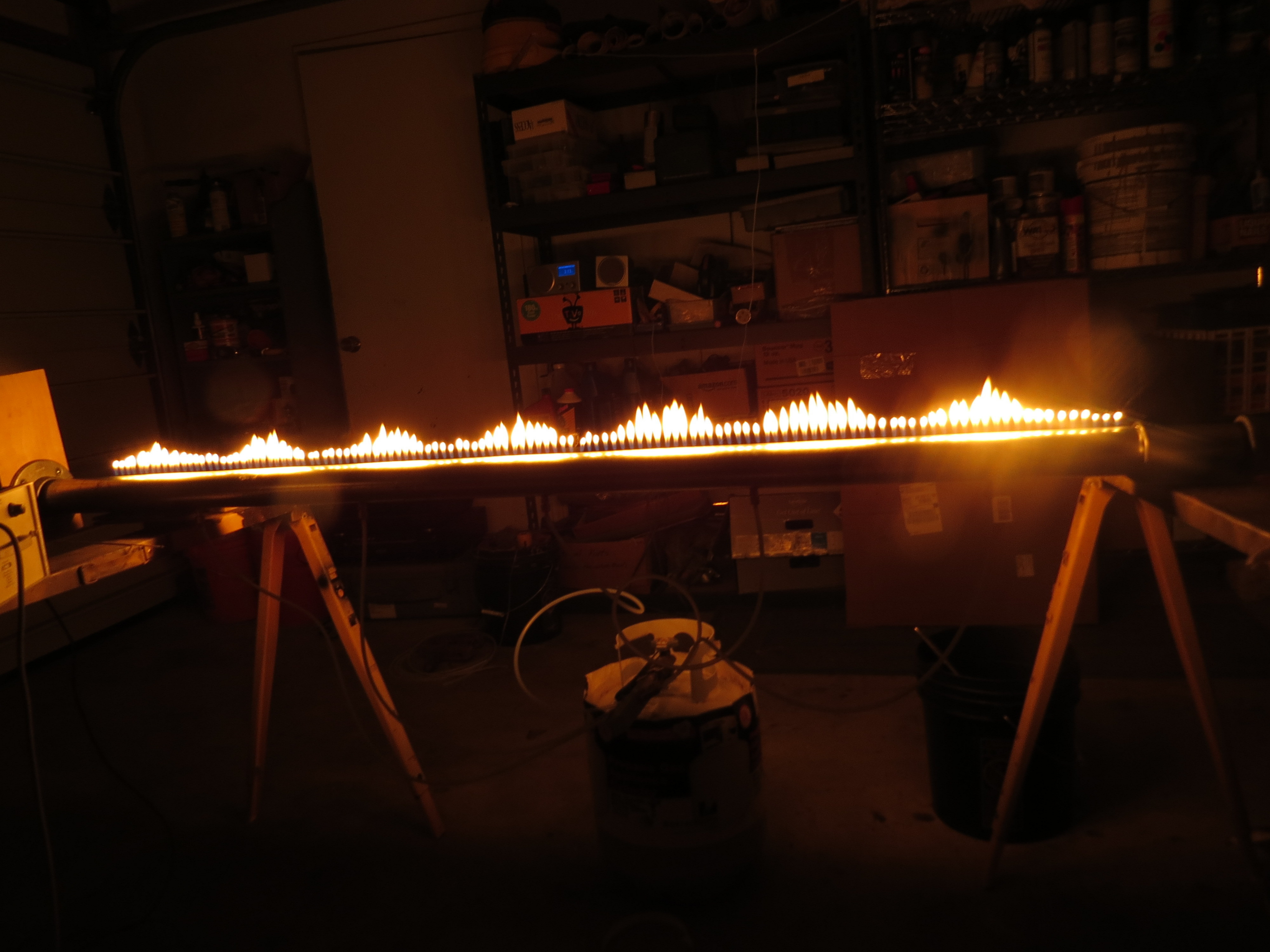
- Can have any primary wavelength (color, pitch)
- Move (always)
- Have a ripple length, and thus range of color
- Have a ripple width (very wide)

Trapped guitar strings



Result of color coating



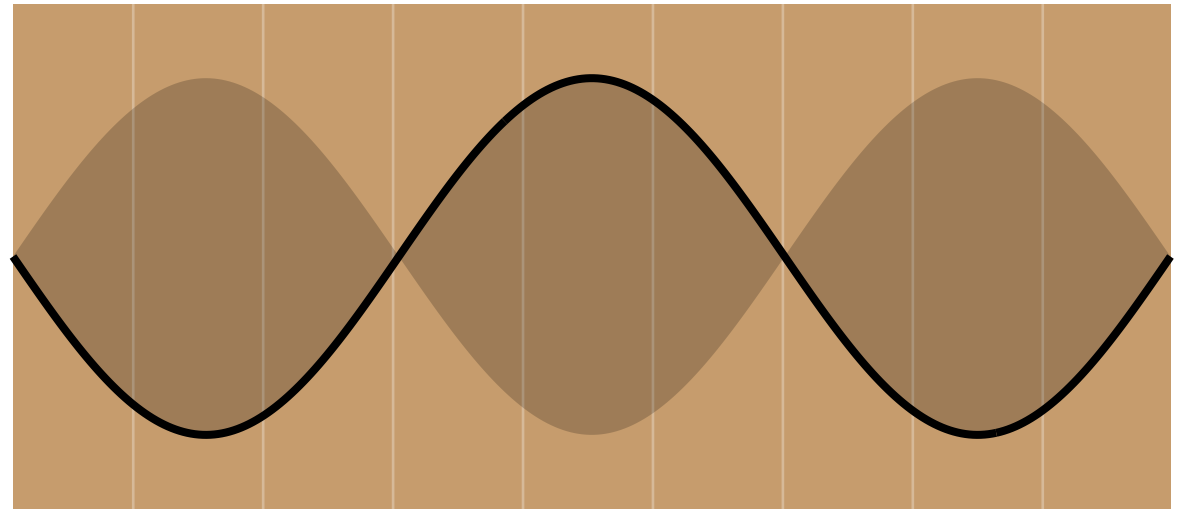
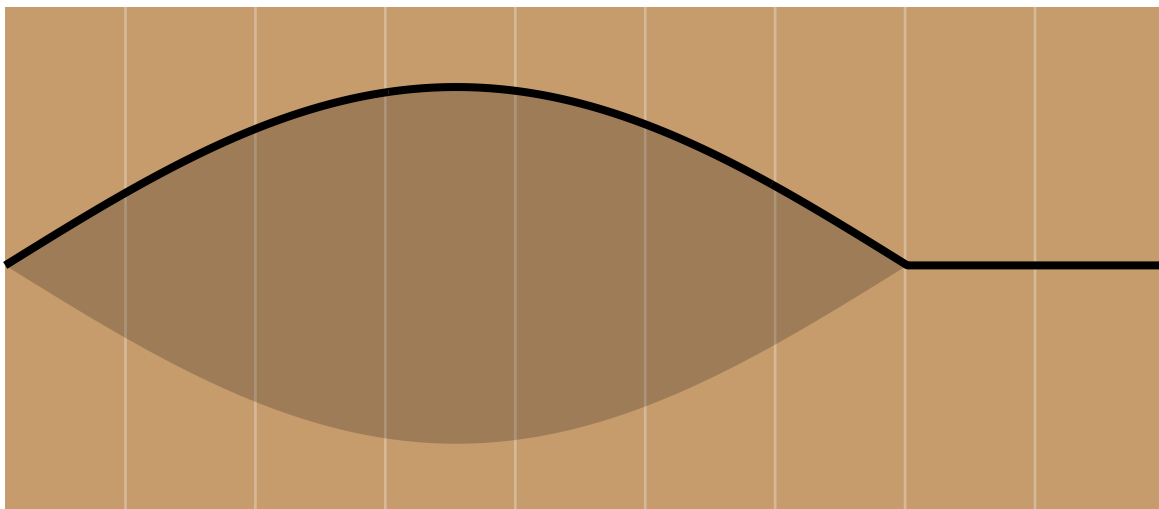
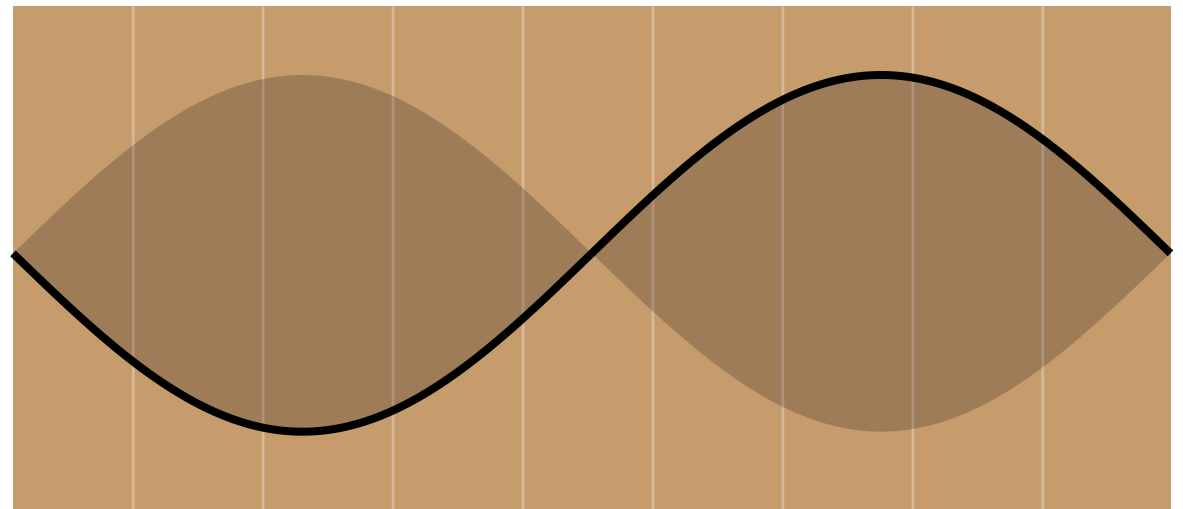
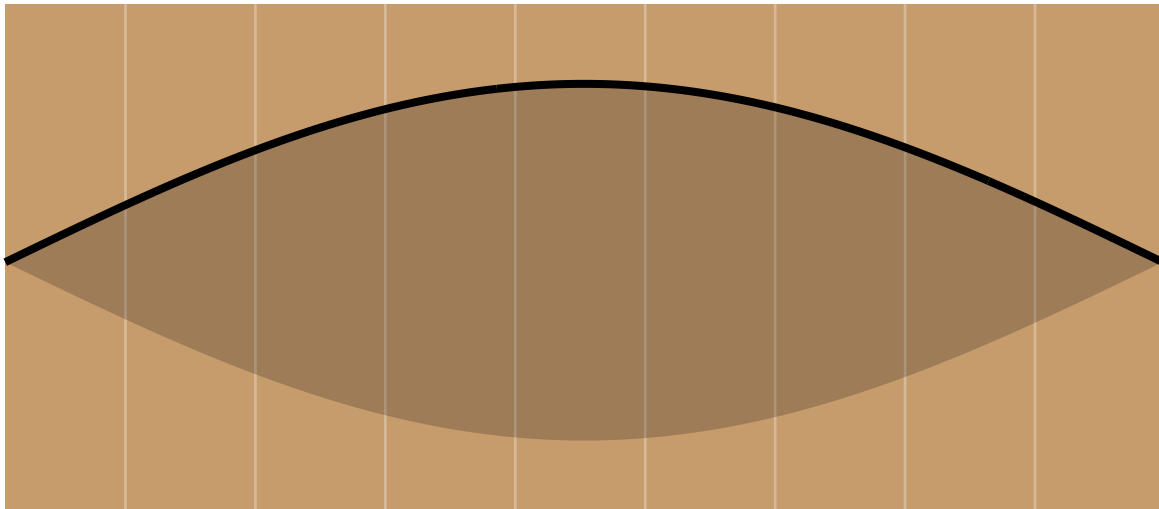


Sound in a pipe



Trapped Waves

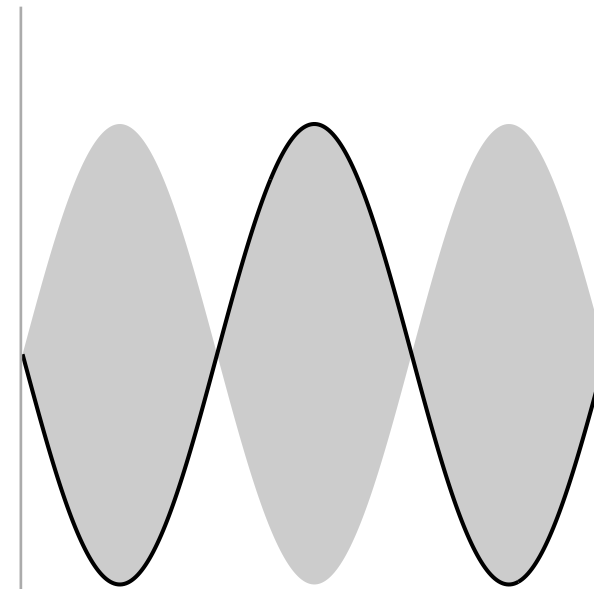
- Change length
- Nodes & anti-nodes



Guitar waves

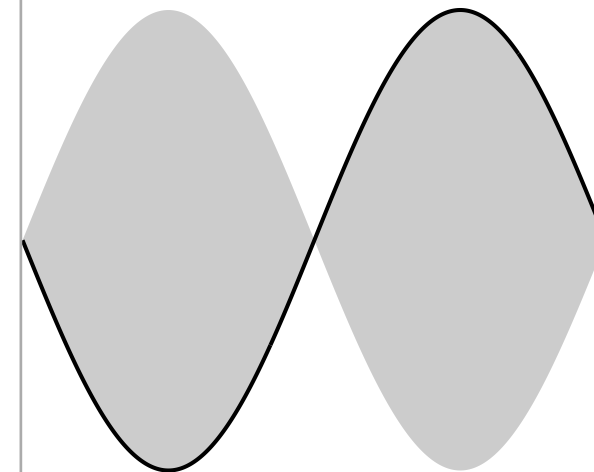
- Really any uniform trap of a line-like wave

3rd harmonic



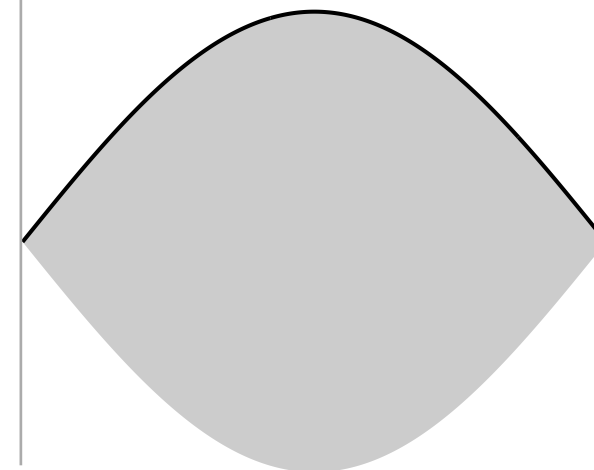
Next-next
lowest energy

2nd harmonic



Next lowest
energy

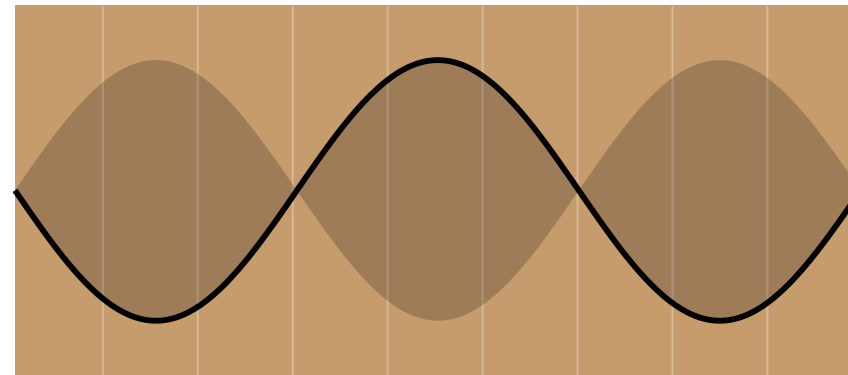
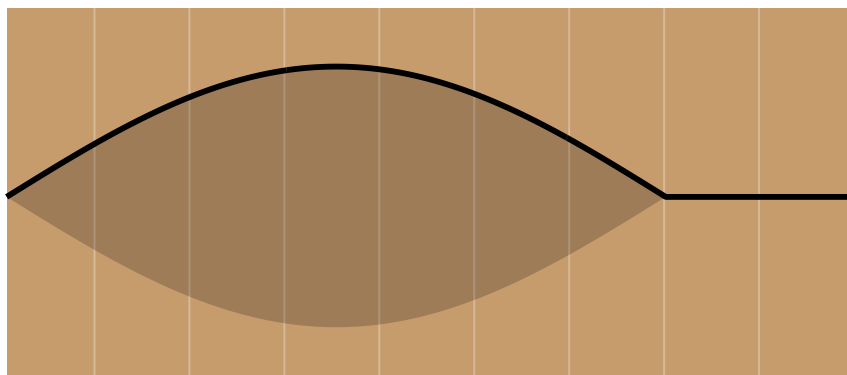
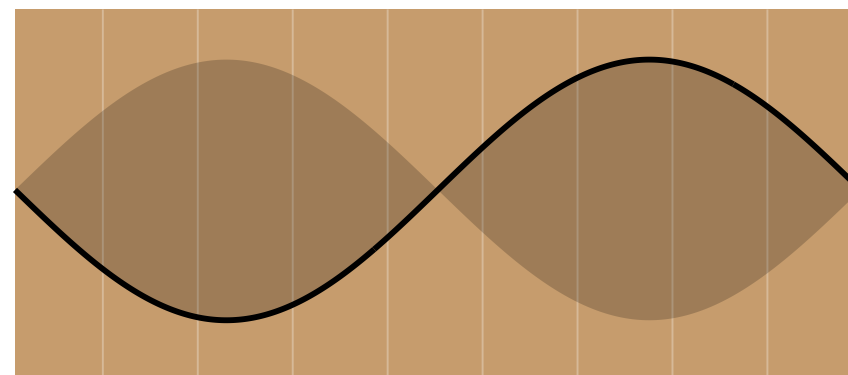
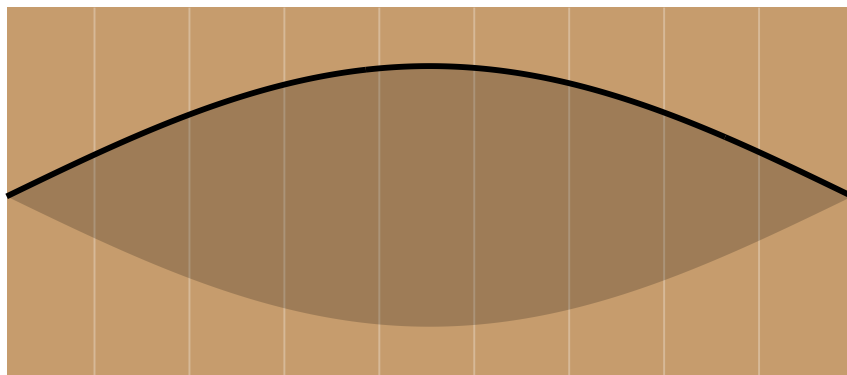
Fundamental



Lowest
energy

Trapped waves

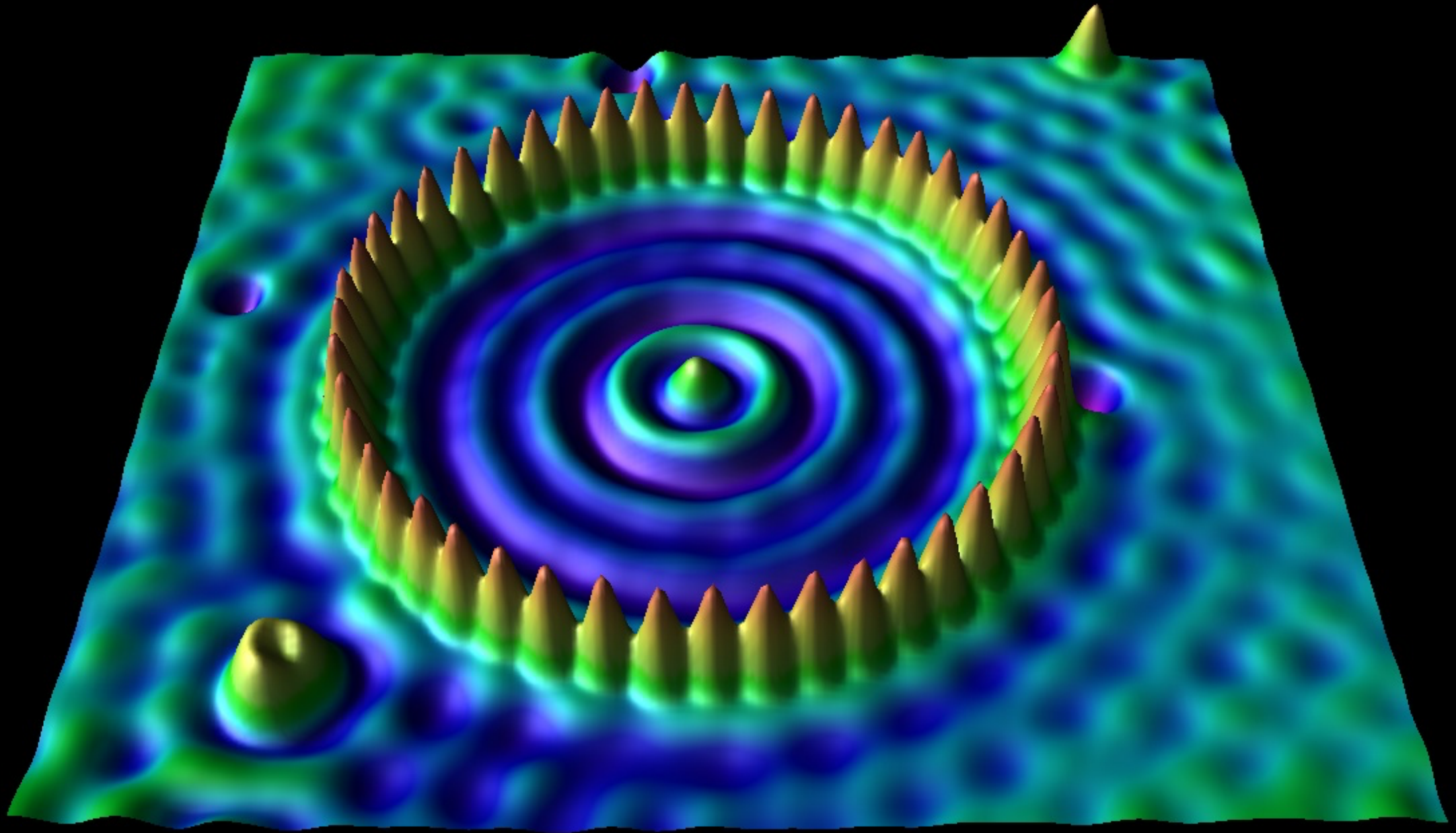
- Can only have wavelengths (colors, pitches) that fit in the trap. Colors are ***discrete***.
- Stay within the trap (~stationary)
- Have very narrow color ranges



Drums

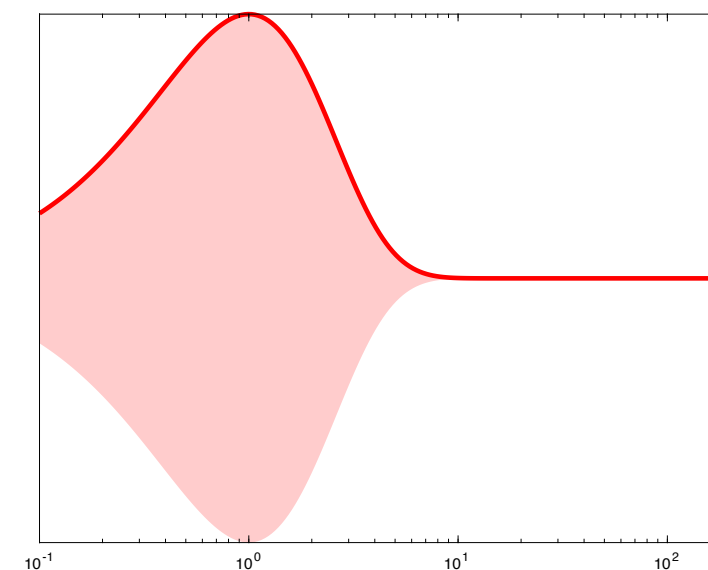
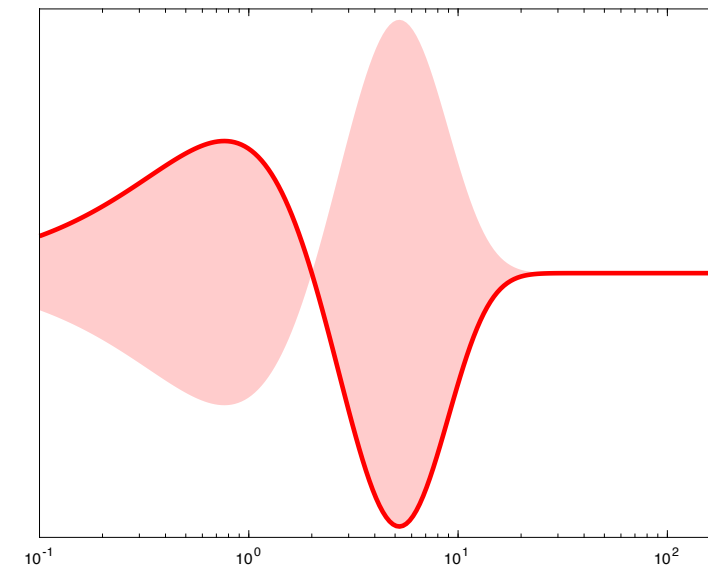
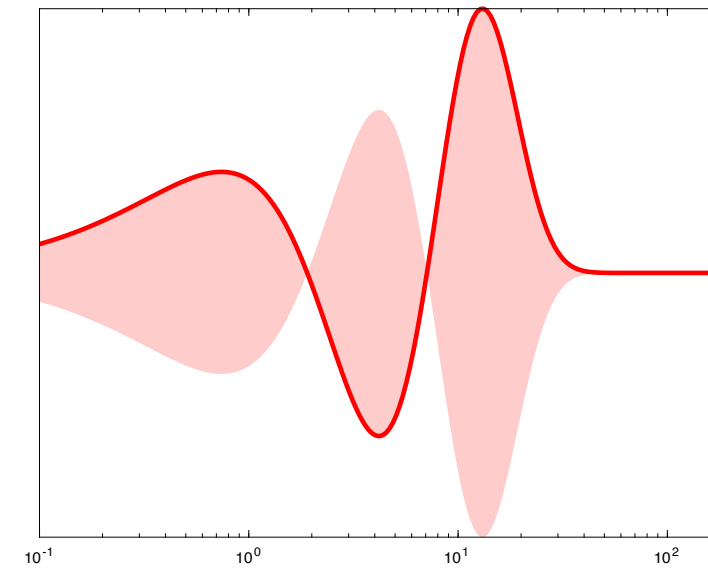


Quantum corral

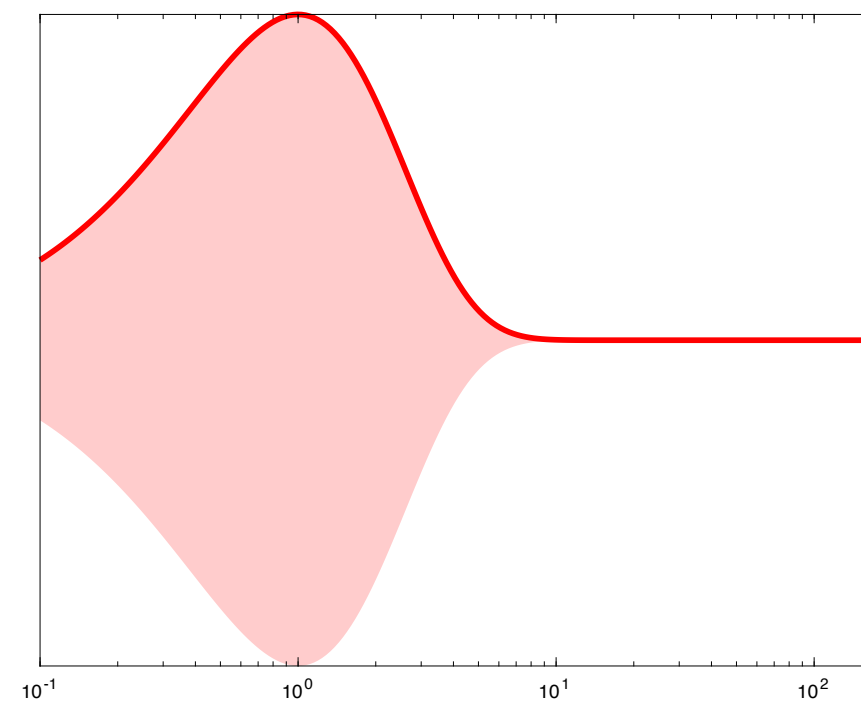
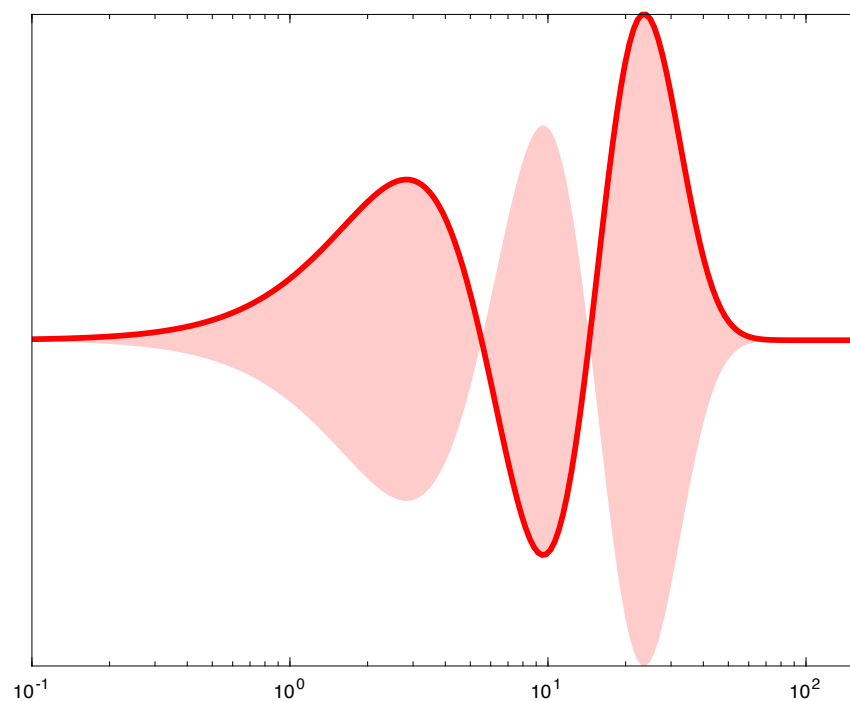
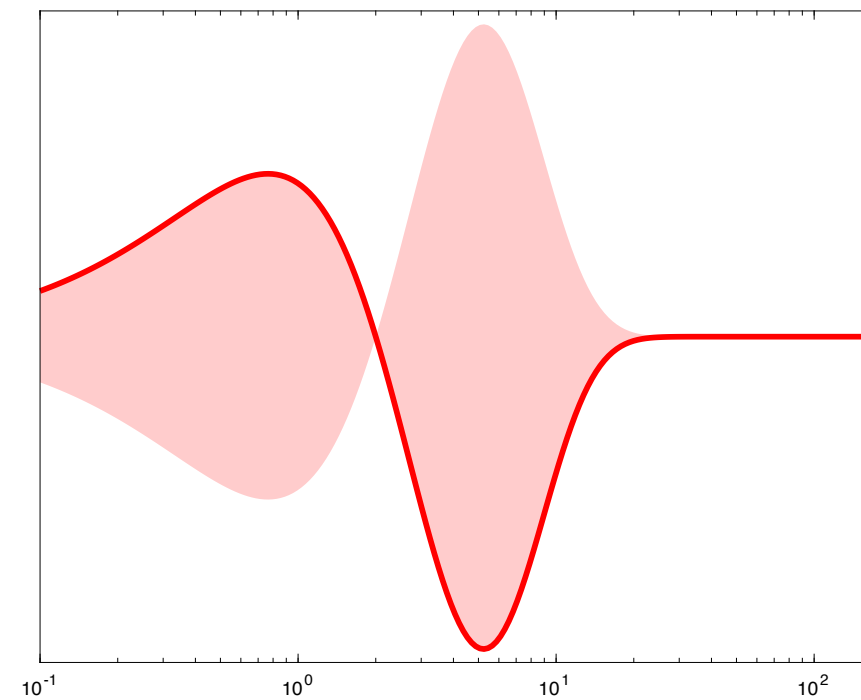
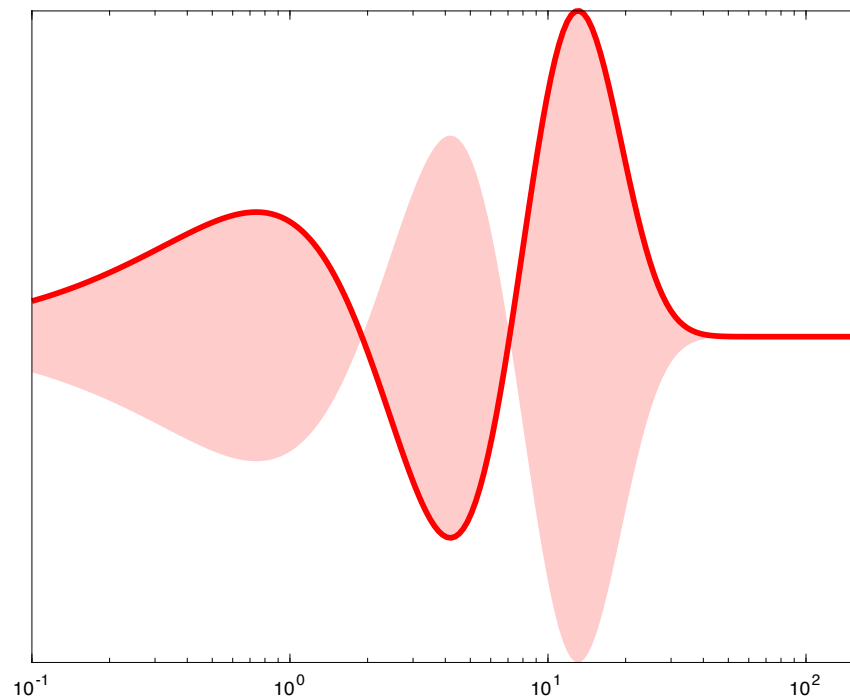


Atomic traps

- Electron moves like a wave
- Is trapped by the nucleus
- Funny trap 'shape': strong near nucleus weaker farther away
- Really 3D, only showing radial shape here



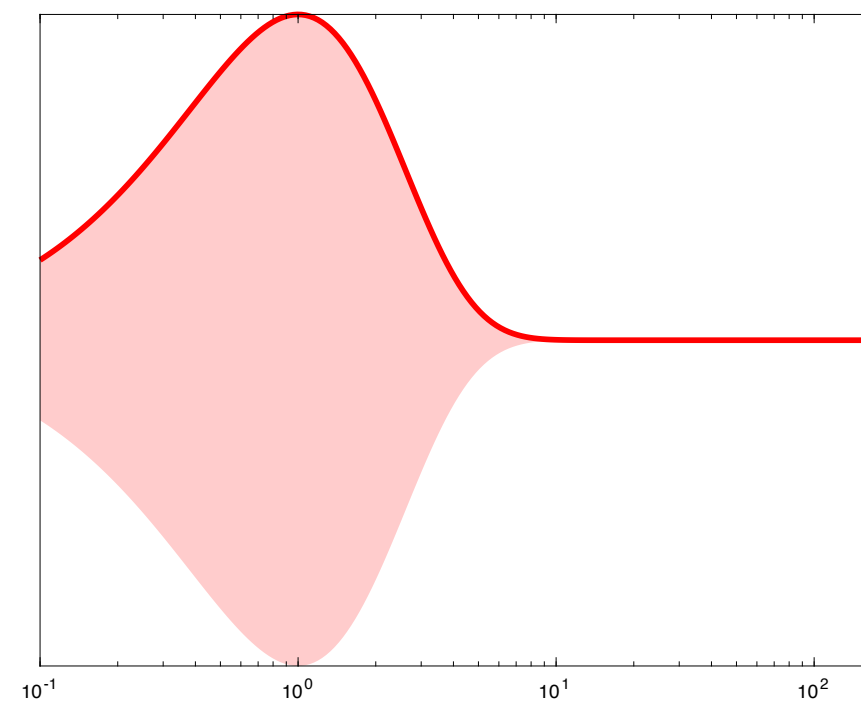
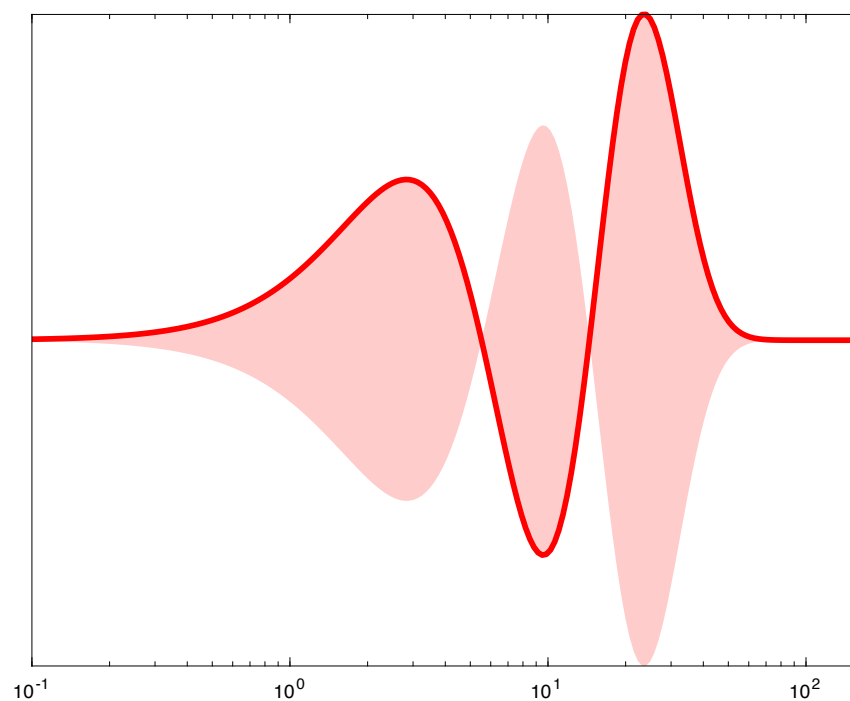
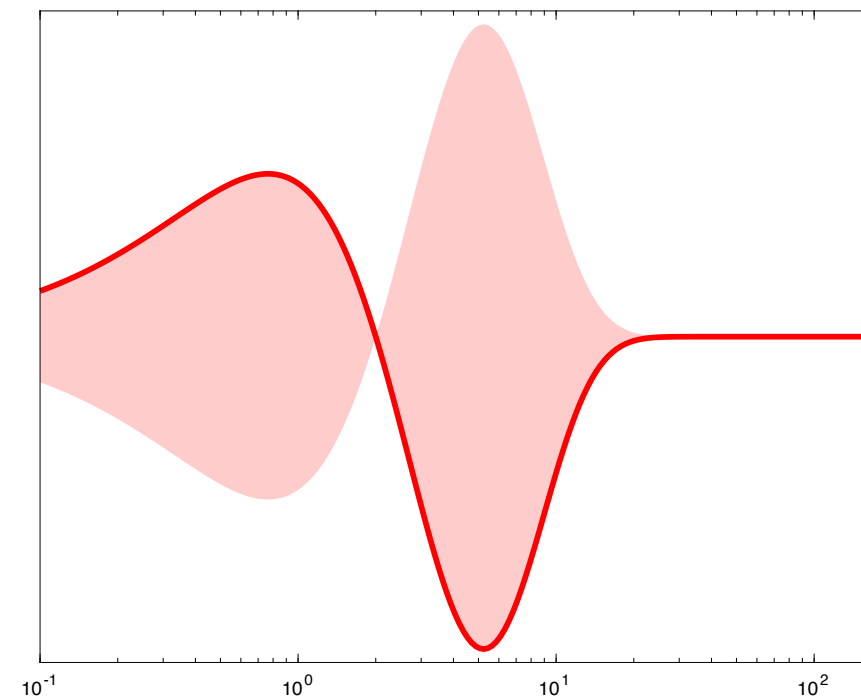
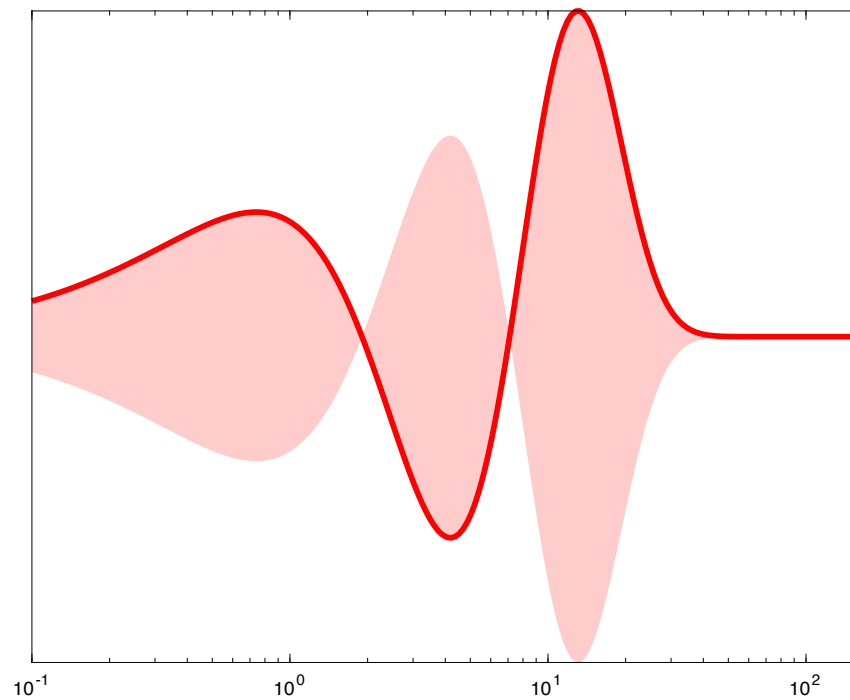
4 waves



Energy of an electron wave depends on:

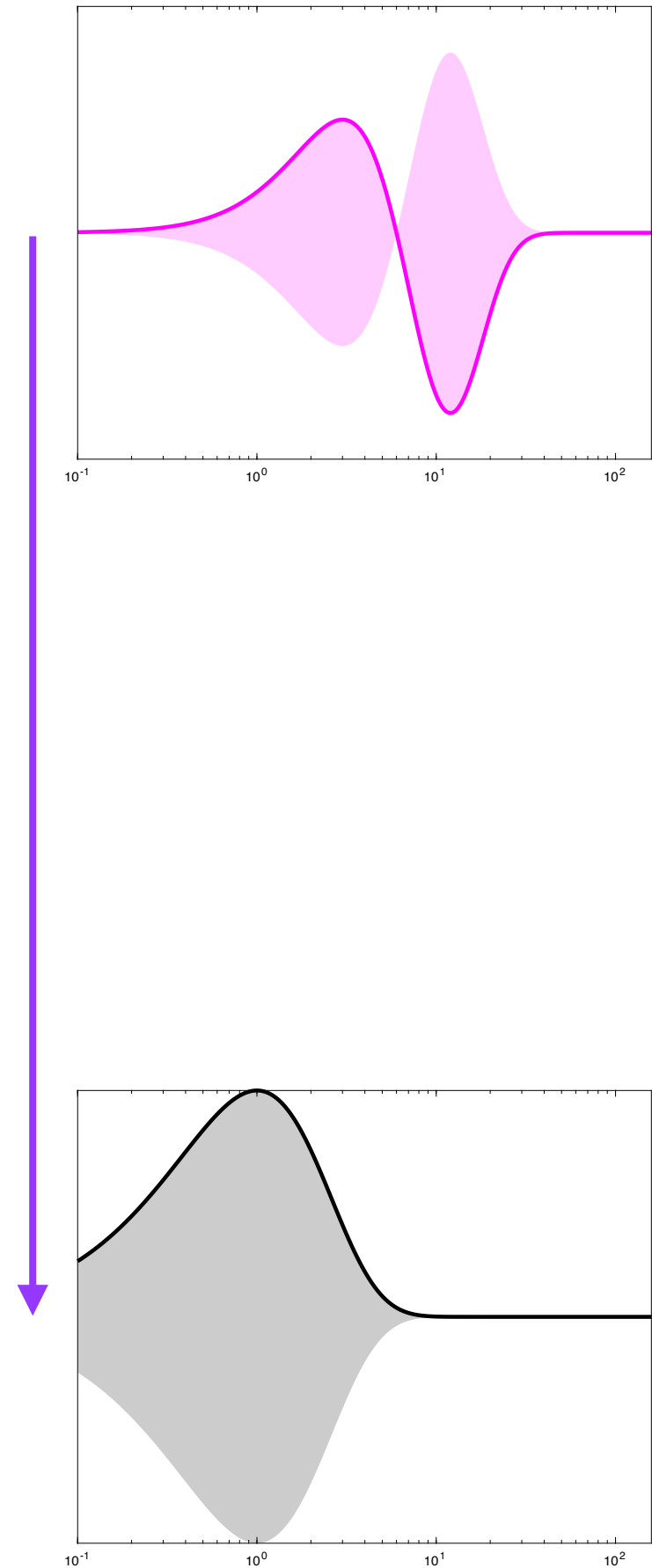
- How sharp the wave curvature is
- How far from the nucleus (how far right)

4 waves

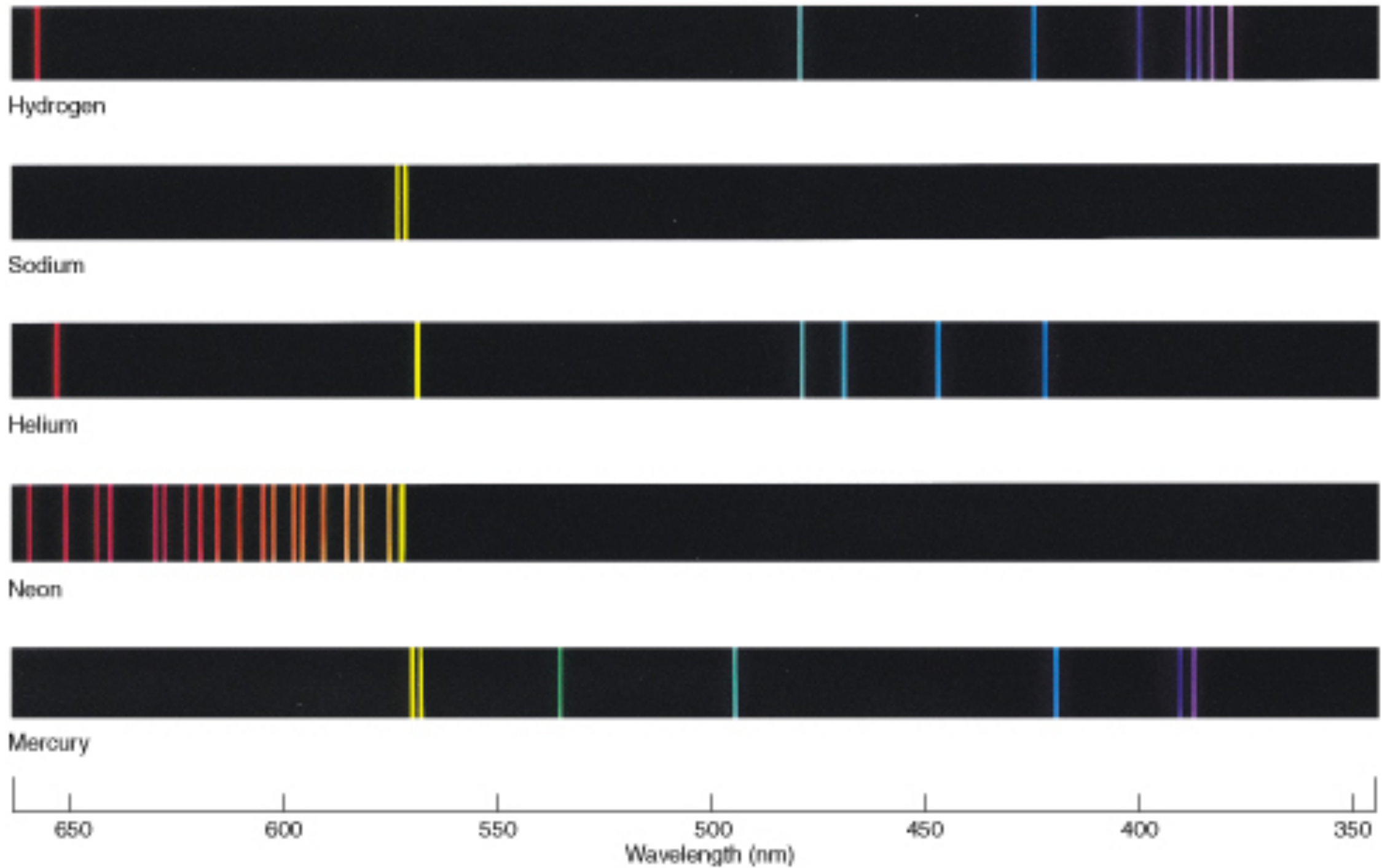


Making light

- We don't see the electron waves, or what energy they have
- When an electron jumps down from one wave to another, it creates a photon with the energy ***difference***.

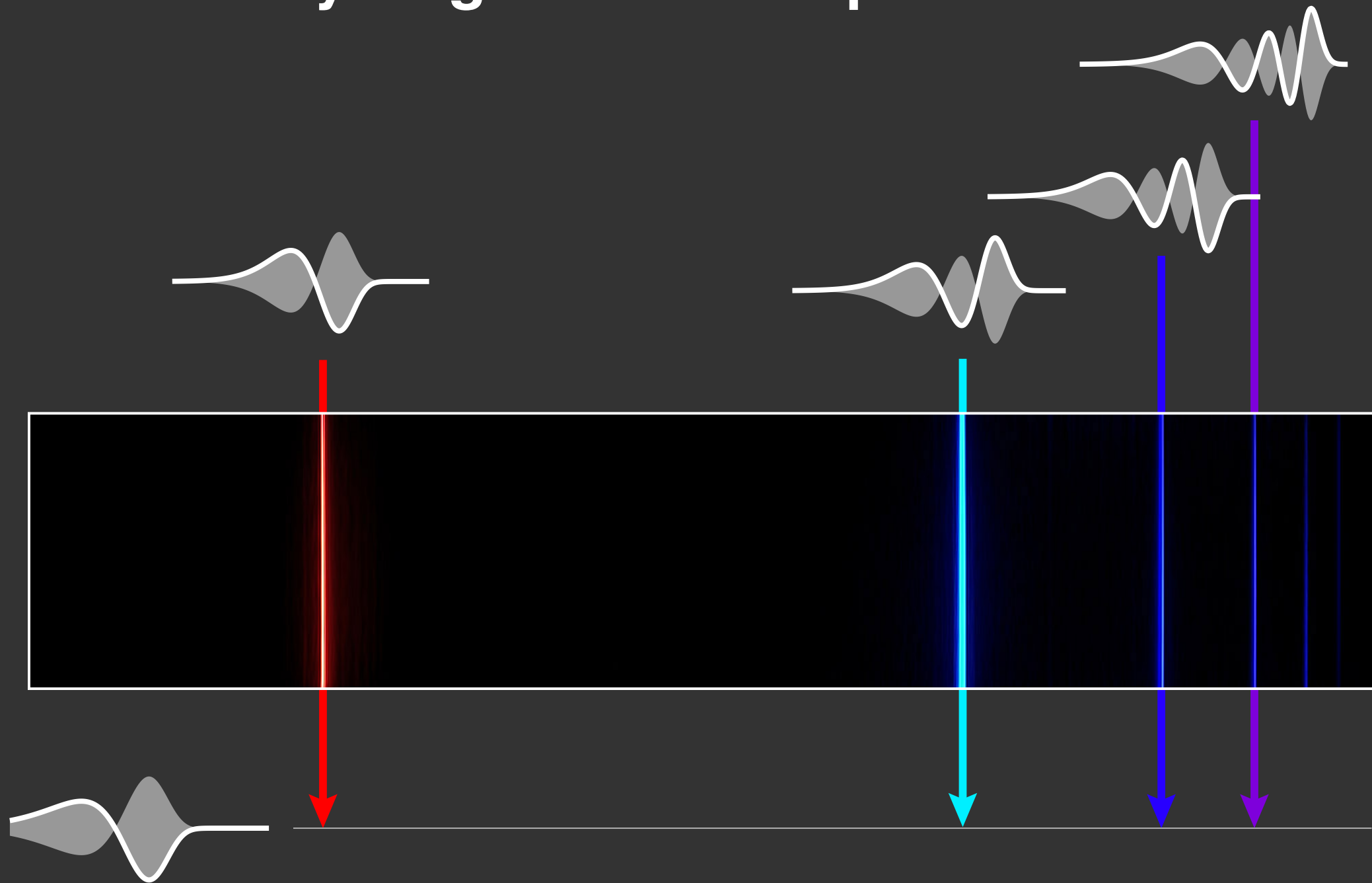


Spectra of elements



Hydrogen Spectrum

Hydrogen Balmer Spectrum



Spectra of elements

