

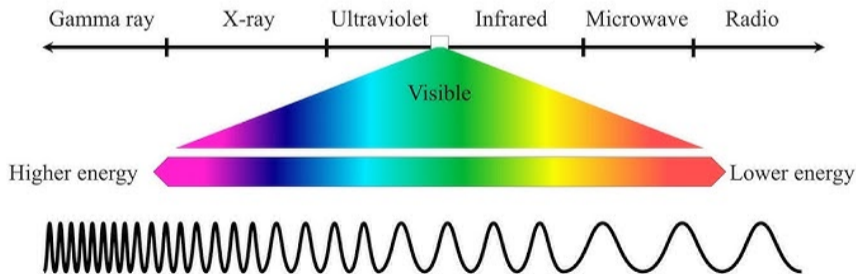
# Quantum Teleportation

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# Photons for Quantum Key Distribution

## Electromagnetic Spectrum

# Electromagnetic Spectrum



# Light Polarization

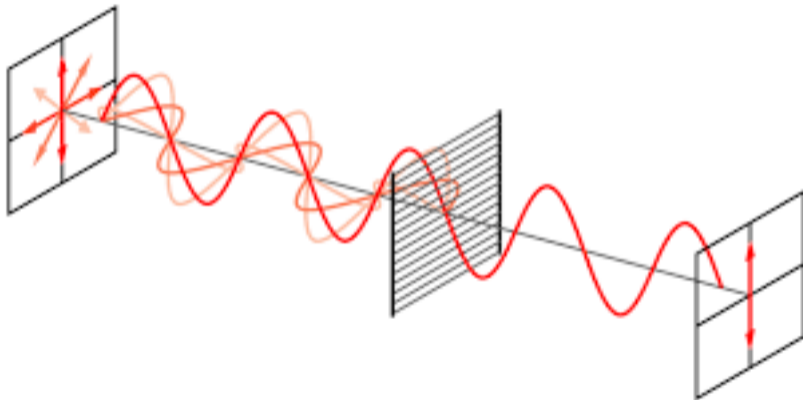


Figure 2: Electromagnetic Waves and Polarization

# Photons

- ▶ A photon is a single packet from an electromagnetic wave, they behave like a particle but have no mass
- ▶ Light has a wave-particle duality  $\longrightarrow$  has properties of both a wave and a particle
- ▶ The existence of photons proves that quantum mechanics is correct,



## Polarized Photos can be used as Qubits!

- ▶ Some quantum computers use photons as qubits
  - ▶ These are not the most common implementation of qubits (most are particles)

## Using Polarized Photons with Quantum Key Distribution

- ▶ Photons are easy to set into a given polarization and can be transported in that polarization
- ▶ Many example and current implementations of quantum key distribution use photons for transporting the message.
- ▶ But how could non-photons be used for quantum key distribution?



# Quantum Teleportation

## Quantum Entanglement: Spooky Action at a Distance

- ▶ We have been using entanglement this entire semester to perform computations, but there is no reason that entangled particles or photons need to be in similar locations
- ▶ Einstein referred to this as “spooky action at a distance”, the particles can affect each other even if they are not touching, even if they are not in the same location.

# What is Quantum Entanglement?

# Quantum Teleportation

- ▶ **This is not Star Trek teleportation**
- ▶ A particle or photon does not change its physical location but rather the particle or photon transfers its physical state to a particle or photon it is entangled with.
- ▶ Has been proven to occur with photons, believed to have been observed with electrons

# Alice and Bob Example: To Qiskit!