Einstein and the Photoelectric Effect

Basics

- Hit any materials *hard enough* with some light and you will kick out some electrons. That phenomena is known as the *photoelectric effect*, and electrons emitted in this manner may be referred to as "photoelectrons".
  - The photoelectric effect was first observed by **Heinrich Hertz** in **1887**; the phenomenon was also known as the "**Hertz effect**" then.
  - The strange thing was that *"hard enough*" did not mean, as one would have expected, *plenty of light* or, more precisely, large amplitudes of the light waves. Instead it meant *high enough frequency*. No amount of light with a frequency just a little bit too small could produce any photoelectrons, while light with a frequency just above a critical values did - even at low intensities. It was just *how many* electrons were released per second that depended on the intensity but not *if* electrons were kicked out.
  - There is simply no way to understand this observation employing only "wave" optics. You need the photon concept.
- Much later (in **1921**) the **Compton effect** once more demonstrated that light with high frequencies (also called **X**-rays or γ radiation) shows distinct particle properties when encountering atoms.
  - The Hertz effect had to wait for **18** years before an explanation was found in **1905** by Albert**Einstein**. He solved the apparent paradox by introducing what we now call the "**photon**", a discrete quanta of light, somewhat particle-like, instead of a continuous wave.
  - Einstein based his approach on **Max Planck's** theory of black-body radiation. He postulated that the energy in each quantum of light was equal to the frequency multiplied by a constant, later called Planck's constant. A photon above a threshold frequency then has the required energy to eject a single electron, creating the observed effect