The photo-electric effect

The photoelectric effect is a phenomenon that occurs when electromagnetic radiation illuminates a metal surface. Upon exposing a metallic plate, which is incorporated into an electrical circuit, to light, an observable voltage is generated across the circuit. This electrical response is instigated when electrons in the metallic plate absorb energy from the incoming photons—the quantum units of electromagnetic radiation—and as a result are ejected from the surface of the metal, surmounting the potential barrier and creating an electric current.

Contrary to historical assumptions that the intensity of electromagnetic radiation is purely a function of the electric field amplitude, the photoelectric effect demonstrates that the induced voltage is actually influenced by the frequency of the incident light, not its amplitude. Remarkably, if the frequency of light falls below a certain threshold, no electrons are liberated, and consequently, no voltage is produced.

Albert Einstein provided a groundbreaking explanation for this counterintuitive behavior. He posited that electromagnetic radiation is quantized, composed of discrete particles called photons. Each photon interacts individually with an electron in the metal. While the intensity of light relates to the number of photons impinging on the surface per unit of time, the frequency determines the energy each photon carries. Higher frequencies mean each photon has enough energy to dislodge an electron from the metal.

For his theoretical description of the photoelectric effect and his contributions to the understanding of quantum phenomena, Einstein was awarded the Nobel Prize in Physics in 1921 (not 1905, which is the year he published his paper on the special theory of relativity). His insights into the photoelectric effect notably supported the quantum theory of light and laid the groundwork for quantum mechanics.