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244(5) Theory of the Photoelectric Effect

Consider the starting equation of note 244(4): for a photon colliding with a static electron:

$$\gamma m_1 c^2 + m_2 c^2 = \gamma' m_1 c^2 + \gamma'' m_2 c^2 \tag{1}$$

Now let:

$$\hbar\omega = \gamma m_1 c^2 \tag{2}$$

$$\hbar\omega'' = \gamma'' m_2 c^2 \tag{3}$$

and consider the case where the photon is stopped by the collision:

$$\hbar\omega + m_2 c^2 = m_1 c^2 + \hbar\omega'' \tag{4}$$

where $m_1 c^2$ is the rest energy of the photon. This concept does not exist in the standard model of physics. So

$$m_1 = m_2 / c^2 (\omega - \omega'') \tag{5}$$

If:

$$\omega = \omega'' \tag{6}$$

then

$$m_1 = m_2 \tag{7}$$

i.e. the mass of the photon and electron are the same and all the energy of the photon is transferred to the electron.

Now rate eq. (7) a new hypothesis of physics, the mass of the electron is the same as that of the photon.

If

$$\omega \neq \omega'' \tag{8}$$

then

$$\begin{aligned}\hbar(\omega-\omega'') &= \Phi+(m_1-m_2)c^2 \\ &= \Phi\end{aligned} \tag{9}$$

where Φ is the binding energy of the photoelectric effect. From eq. (9):

$$\hbar\omega + m_2c^2 = m_1c^2 + \hbar - \omega'' + \Phi \tag{10}$$

i.e.

$$\begin{aligned}\hbar\omega &= \hbar\omega'' + \Phi \\ &= E + \Phi\end{aligned} \tag{11}$$

or

$$E = \hbar\omega - \Phi \tag{12}$$

which is the usual photoelectric effect equation, QED.

Therefore it is assumed that the photon and the electron mass are the same. The photon does not disappear, and transfers its energy to the electron.