Arthur H. Compton (1892～1962), while at Washington University at St. Louis found that x-rays increase in wave length when scattered, which he explained in 1923 on the basis of the quantum theory of light.

(9) $P^2c^2 = (\hbar\omega - \hbar\omega')^2 + 2m_0c^2(\hbar\omega - \hbar\omega')$

(16) $P^2 = (\hbar K - \hbar K')^2 + 2m_0c(\hbar K - \hbar K')$

(15) $P^2 = (\hbar K')^2 + (\hbar K)^2 - 2(\hbar K')(\hbar K)\cos(\theta)$

(17) $-2(\hbar K')(\hbar K) + 2m_0c(\hbar K - \hbar K') = -2(\hbar K')(\hbar K)\cos(\theta)$

(18) $m_0c(\hbar K - \hbar K') = (\hbar K')(\hbar K)\{1 - \cos(\theta)\}$

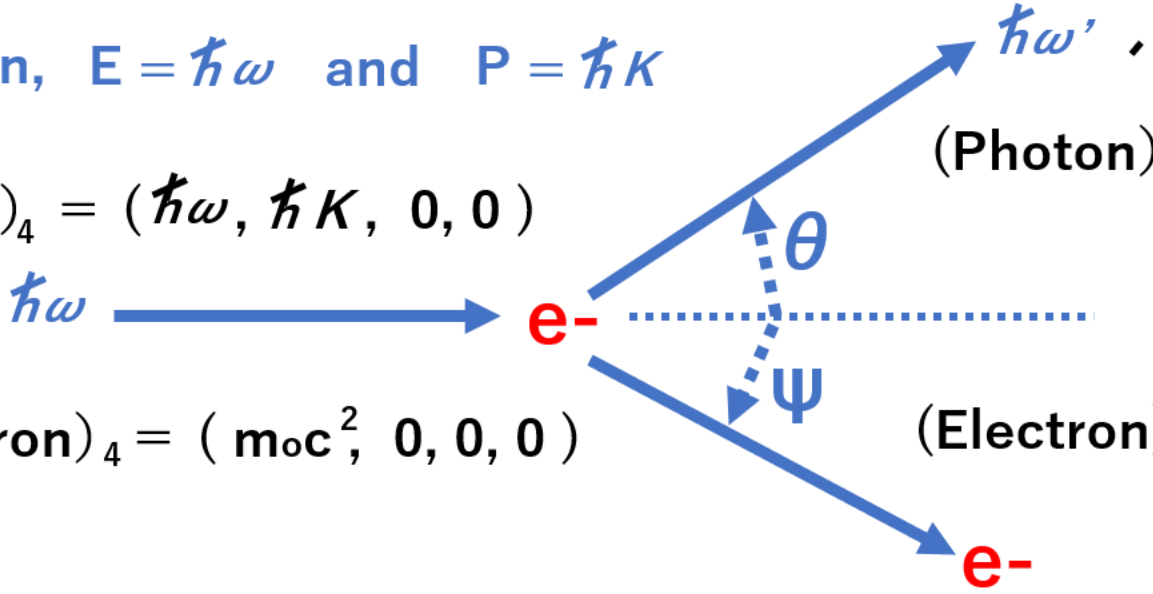
$$\lambda' - \lambda = \frac{h}{m_0c}\{1 - \cos(\theta)\}$$

(6) $\omega = cK = 2\pi c/\lambda$

For photon, $E = \hbar\omega$ and $P = \hbar K$

$(\text{Photon})_4 = (\hbar\omega, \hbar K, 0, 0)$

$(\text{Photon})'_4 = (\hbar\omega', \hbar K'\cos(\theta), \hbar K\sin(\theta), 0)$



$(\text{Electron})_4 = (m_0c^2, 0, 0, 0)$

$(\text{Electron})'_4 = (mc^2, P\cos(\psi), -P\sin(\psi), 0)$