

§ Energy mass equation

1. Relativistic energy

$$E=mc^2, m=\gamma m_0, \gamma=\frac{1}{\sqrt{1-\frac{v^2}{c^2}}}, m_0 \text{ is the rest mass}$$

$$E_0 = m_0 c^2$$

2. Relativistic momentum

$$p = mv = \gamma m_0 v = \frac{m_0 v}{\sqrt{1-\frac{v^2}{c^2}}}$$

$$E = \gamma m_0 c^2 \Rightarrow E^2 = \gamma^2 m_0^2 c^4 = \frac{m_0^2 c^4}{1-\frac{v^2}{c^2}} \dots (1)$$

$$p = \gamma m_0 v \Rightarrow p^2 = \gamma^2 m_0^2 v^2 = \frac{m_0^2 v^2}{1-\frac{v^2}{c^2}}$$

$$p^2 c^2 = \frac{m_0^2 v^2 c^2}{1-\frac{v^2}{c^2}} \dots (2)$$

$$E^2 - p^2 c^2 = \frac{m_0^2 c^4 - m_0^2 v^2 c^2}{1-\frac{v^2}{c^2}} = \frac{m_0^2 c^2 (c^2 - v^2)}{\frac{c^2 - v^2}{c^2}} = m_0^2 c^4$$

$$E^2 = m_0^2 c^4 + c^2 p^2$$

1. 普適性：式子中不含速度。
2. 包含了 E , m , p
3. 靜止時， $E = m_0 c^2$ 表示物質的質能互換。
4. $m_0 = 0$ 時， $E=pc$ 表明光子的性質