

$$p^2 = m^2 v^2 = \gamma^2 m_o^2 v^2$$

$$\Rightarrow p^2 \cdot c^2 + m_o^2 c^4$$

$$= \frac{m_o^2 v^2 c^2}{1 - \frac{v^2}{c^2}} + m_o^2 c^4$$

$$= m_o^2 c^2 \left(\frac{v^2}{1 - \frac{v^2}{c^2}} + c^2 \right)$$

$$= m_o^2 c^2 \left(\frac{v^2}{1 - \frac{v^2}{c^2}} + c^2 \cdot \frac{1 - \frac{v^2}{c^2}}{1 - \frac{v^2}{c^2}} \right)$$

$$= m_o^2 c^2 \left(\frac{v^2}{1 - \frac{v^2}{c^2}} + \frac{c^2 - v^2}{1 - \frac{v^2}{c^2}} \right)$$

$$= m_o^2 c^4 \left(\frac{1}{1 - \frac{v^2}{c^2}} \right) = \gamma^2 m_o^2 c^4 = E^2$$

Thank you

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