Modern Physics PHYS 351 — “Summery of Relativity II”

July 29, 2017

Salwa Alsaleh, PhD
King Saud University

The relativistic linear momentum is given by the expression

$$\mathbf{p} = \frac{m\mathbf{u}}{\sqrt{1 - u^2/c^2}} = \gamma m\mathbf{u} \tag{1}$$

Where $\mathbf{u}$ is the velocity vector of the frame. That induces a notion of *relativistic mass*, given by

$$m' = \gamma m \tag{2}$$

Hence, as measured from the m frame m the mass of the moving frame m' is increased , $m > m'$. The relativistic Kinetic energy of the particle is given by:

$$T = \gamma mc^2 - mc^2 \tag{3}$$

We have, if $u = 0$ - the particle is at rest- the rest energy of the particle

$$E_{rest} = mc^2 \tag{4}$$

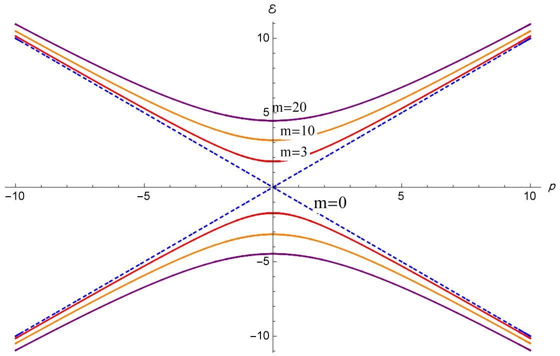
We treat energy and momentum the same way we treat time and space, therefore the relativistic expression for the ‘ total’ energy is related to the particle’s mass by the relation

$$\mathcal{E} = m'c^2 = \frac{m}{\sqrt{1 - v^2/c^2}} \tag{5}$$

Or to the particle’s momentum as

$$\mathcal{E}^2 = m^2c^4 + p^2c^2 \tag{6}$$

Hence, we obtain the relation for rest energy if we used the above equation and set the momentum $p = 0$.
The relation between mass, energy and momentum is given by the following graph, analogous to the spacetime graph The conservation of relativistic mass-energy states that the sum of the mass-energy of a system of particles before interaction must equal the sum of the massâĂŞ energy of the system after interaction. This can be applied to study the decay of nuclei and subnuclear particles. Nuclear fission of Uranium or Plutonium..etc.



Reference

Bondi, H. (1964). *Relativity and common sense: a new approach to Einstein*. Courier Corporation.

Einstein, A. (1954). Ideas and opinions, translated by sonja bargmann. *New York: Crown*.

Einstein, A. (1956). *Out of my later years*. Citadel Press.

French, A. P. (1968). *Special relativity*. CRC Press.

Gamow, G. (1946). *Mr. Tompkins in wonderland*. CUP Archive.

Resnick, R. (1968). Introduction to special relativity.

Wheeler, J. A. and Taylor, E. F. (1966). *Spacetime physics*. WH Freeman San Francisco, CA, USA:.