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MASS, ENERGY AND RADIATION IN THREE SYSTEMS OF ELECTRODYNAMICS

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Abstract

Formulas for mass, energy and radiation are given in classical, relativistic and an alternative electrodynamics. The alternative electrodynamics gives a simple formula for radiation force, from which radiation power can be derived for a charged particle moving in an electric field.

Formulas for radiation reaction force and radiation power

The Table below gives expressions of mass, energy and radiation in classical, relativistic and an alternative electrodynamics for a particle of mass m (rest mass m_o) and charge q (rest charge q_o) moving at time t, in a straight line, with velocity $\boldsymbol{v}$ and acceleration $\boldsymbol{a} = (d\boldsymbol{v}/dt)$, in an electric field of intensity $\boldsymbol{E}$ (magnitude E), where c is the speed of light in a vacuum, E_m is the total energy of a mass, x is a constant and γ is the relativistic factor.

SN	Quantity	Classical Electrodynamics	Relativistic Electrodynamics	Alternative Electrodynamics
1	Electric charge q	$q = q_o$	$q = q_o$	$q = q_o$
2	Mass m	$m = m_o$	$m = \frac{m_o}{\sqrt{1-\frac{v^2}{c^2}}} = \gamma m_o$	$m = m_o$
3	Internal (mass) energy W	No consideration for internal energy	$W = m_o c^2$	$W = ½\, mc^2$
4	Kinetic energy K	$K = ½mv^2$	$K = mc^2 - m_o c^2$	$K = ½mv^2$
5	Total Energy $E_m = K + W$	No consideration for internal energy	$E_m = mc^2$	$E_m = ½m(c^2 + v^2)$
6	Radiation Reaction force **R**	$\mathbf{R} = xq^2(d\mathbf{a}/dt)$ *Abraham-Lorentz Formula*	No formula for radiation force in relativistic electrodynamics	$\mathbf{R} = qE\mathbf{v}/c$
7	Radiation Power P	$P = xq^2a^2$ *Larmor formula*	$P = xq^2a^2\gamma^4$ *Lienard formula*	$P = qEv^2/c$

Observations and Conclusion

There is no formula for radiation reaction force $\boldsymbol{R}$ in relativistic electrodynamics. In the alternative electrodynamics, radiation power P is simply obtained as the scalar product $-\boldsymbol{R} \cdot \boldsymbol{v}$ of two vectors, radiation reaction force $\boldsymbol{R}$ and velocity $\boldsymbol{v}$.

In classical electrodynamics, *Abraham-Lorentz formula* for radiation reaction force $\boldsymbol{R}$ and *Larmor formula* for radiation power P, one not derivable from the other, are questionable. Worse still is *Lienard formula* for radiation power, in relativistic electrodynamics, which contains the relativistic factor γ raised to the 4^{th} power.

In considerations of energy radiation the alternative electrodynamics is sufficient, with mass of a moving particle remaining constant.