The Relativistic Total Energy

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Abstract
We derive a universal nonlinear relation connecting the high (relativistic) and low (classical) energy scales. The relation extrapolates the expression for the total energy beyond both special and general relativity to regions of high potentials, and replaces the Schwarzschild singularity in the expression for energy by a continuous smooth function. It can be tested in atomic and nuclear physics, and applied in cosmology. We give a perturbation expansion of the total energy, which underlines the existence of a mixed energy generated from the kinetic and potential energies by the nonlinearity. The expression for the total energy obeys the correspondence principle in as far as classical mechanics, special relativity, and general relativity are concerned. As an application, we study the relativistic gravitational as well as relativistic electrostatic potentials, and evaluate the corrections to their classical expressions. The corrections become important at the Schwarzschild scale in the case of the gravitational potential, and at the scale of the classical charged particle radius in the case of the Coulomb potential.