Mathematical Physics

Relativistic point dynamics and Einstein formula as a property of localized solutions of a nonlinear Klein-Gordon equation

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Einstein's relation E=Mc^2 between the energy E and the mass M is the cornerstone of the relativity theory. This relation is often derived in a context of the relativistic theory for closed systems which do not accelerate. By contrast, Newtonian approach to the mass is based on an accelerated motion. We study here a particular neoclassical field model of a particle governed by a nonlinear Klein-Gordon (KG) field equation. We prove that if a solution to the nonlinear KG equation and its energy density concentrate at a trajectory, then this trajectory and the energy must satisfy the relativistic version of Newton's law with the mass satisfying Einstein's relation. Therefore the internal energy of a localized wave affects its acceleration in an external field as the inertial mass does in Newtonian mechanics. We demonstrate that the "concentration" assumptions hold for a wide class of rectilinear accelerating motions.

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