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Stueckelberg-Horwitz-Piron (SHP) classical mechanics with evolving local metric

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Stueckelberg-Horwitz-Piron (SHP) theory is a framework for posing classical and quantum relativistic physics in canonical form with an external parameter of evolution τ. SHP electrodynamics generalizes Maxwell theory by allowing the four-vector potential to depend on τ and introducing a scalar gauge potential $a_5(x,\tau)$ associated with this τ-dependence. As a result, current conservation, wave equations, and other scalar expressions suggest a formal 5D symmetry that breaks to tensor and scalar representations of O(3,1) in the presence of 4D matter. Following a similar approach, this electrodynamic theory has recently been extended to non-abelian gauge symmetries and to the classical and quantum many-body problem in curved 4D spacetime with local metric $g_{\mu\nu}(x)$, for $\mu,\nu = 0,1,2,3$.

In this talk we examine another extension of classical SHP mechanics by allowing the local metric to be τ-dependent and introducing new metric components associated with τ evolution. In order to obtain a reasonable prescription for this generalization, consistent with an extended equivalence principle, the breaking of formal 5D tensor symmetries must be treated in detail. This extension permits us to describe particle motion in geodesic form with respect to a dynamically evolving background metric. As an example, we consider the field produced by a τ-dependent mass $M(\tau)$, first as a perturbation in the Newtonian approximation and then for a Schwarzschild-like metric. As expected, the extended Einstein equations imply a non-zero energy-momentum tensor, representing the flow of mass energy corresponding to the changing source mass. Moreover, the Hamiltonian (the scalar system mass) is driven by terms proportional to $dM/d\tau$ and is not conserved. In τ-equilibrium, this system becomes a generalized Schwarzschild solution for which the extended Ricci tensor and mass-energy-momentum tensor vanish.

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