1)

Generally Covariant Lorentz Force Law

Standard Model

The law is part of the transformation:

$$F'^{\mu\nu} = \frac{\partial x'^{\mu}}{\partial x^{\rho}} \frac{\partial x'^{\nu}}{\partial x^{\sigma}} F^{\rho\sigma} \qquad -(1)$$

of the field tensor. In matrix notation eq. (1) is:

$$F' = A F \tilde{A}. \qquad -(2)$$

In the standard model the Lorentz transformation is used from frame K to frame K' moving at $\underline{v}$ with respect to K. In SI units this gives:

$$\boxed{\underline{E}' = \gamma(\underline{E} + \underline{v} \times \underline{B})} - \frac{\gamma^2}{\gamma+1} \frac{\underline{v}}{c} \left(\frac{\underline{v}}{c} \cdot \underline{E} \right) \qquad -(3)$$

$$\underline{B}' = \gamma \left(\underline{B} - \frac{\underline{v}}{c^2} \times \underline{E} \right) - \frac{\gamma^2}{\gamma+1} \frac{\underline{v}}{c} \left(\frac{\underline{v}}{c} \cdot \underline{B} \right) \qquad -(4)$$

The Lorentz force law is part of eq. (3), i.e. for $\gamma^2 \ll \gamma$:

$$\boxed{\underline{F} = e\gamma(\underline{E} + \underline{v} \times \underline{B}) = e\underline{E}'} \qquad -(5)$$

Note that there are some internal inconsistencies

2)

in the standard model of electrodynamics, notably it is a theory of special relativity, one frame K′ can only translate with respect to another frame K at a velocity **v**. Secondly the field is different from the frame, and thirdly the spacetime is confined to flat or Minkowski spacetime, i.e the metric is:

$$\eta_{\mu\nu} = \eta^{\mu\nu} = \text{diag}(1, -1, -1, -1). \quad -(6)$$

This means that electrodynamics cannot be unified with gravitation in the standard model.

ECE Field Theory

The Lorentz force law is made generally covariant and unified with gravitation. This means that a frame K′ can move with respect to a frame K in any way. The electromagnetic part of the unified field is the Cartan torsion of spacetime, with the general metric $g_{\mu\nu}$. This is no longer equal to the inverse metric $g^{\mu\nu}$. With reference to paper 43: "General Covariance and Coordinate Transformation in Classical and Quantum Electrodynamics", the general tensor

3)

We follow eqns (16) ff of this paper. The generally covariant Lorentz force law is part[...] the transformation:

$$T^{a'}_{\mu'\nu'} = \Lambda^{a'}_{a} \frac{\partial x^{\mu}}{\partial x^{\mu'}} \frac{\partial x^{\nu}}{\partial x^{\nu'}} T^{a}_{\mu\nu} \quad -(7)$$

of the Cartan torsion tensor:

$$T^{a}_{\mu\nu} = \partial_\mu q^{a}_{\nu} - \partial_\nu q^{a}_{\mu} + \omega^{a}_{\mu b} q^{b}_{\nu} - \omega^{a}_{\nu b} q[...] \quad -(8)$$

The electromagnetic field is:

$$F^{a}_{\mu\nu} = A^{(0)} T^{a}_{\mu\nu} \quad -(9)$$

so the most general Lorentz force (cf. eq. (5)) is proportional to:

$$\boxed{F^{a'}_{\mu'\nu'} = A^{(0)} T^{a'}_{\mu'\nu'}} \quad -(10)$$

In general, gravitation influences $F^{a'}_{\mu'\nu'}$ [...]rough the spin connection. This is the rigorous [...]ervation of the law in ECE the [...]