**Lorentz transformation rules:**

(active boost with velocity $\vec\beta = \frac{\vec v}{c}$)

$$\vec E' = \gamma E - \frac{\gamma^2}{\gamma+1}(\vec\beta\cdot\vec E)\vec\beta - \gamma\,\vec\beta\times\vec B$$

$$\vec B' = \gamma B - \frac{\gamma^2}{\gamma+1}(\vec\beta\cdot\vec B)\vec\beta + \gamma\,\vec\beta\times\vec E$$

in terms of $\vec E_\perp\cdot\vec p = 0$ and $\vec E_\parallel$,

$$\left\{\begin{array}{l} E_\parallel' = E_\parallel \\ \vec E_\perp' = \frac{E}{m}\vec E_\perp + \frac{1}{m}\vec p\times\vec B \\ B_\parallel' = B_\parallel \\ \vec B_\perp' = \frac{E}{m}\vec B_\perp' - \frac{1}{m}\vec p\times\vec E \end{array}\right.$$

(in terms of energy and momentum)
-good for boosting a particle of mass $m$.

$$\vec E' = \frac{E}{m}\vec E - \frac{1}{m}\left[\frac{1}{E+m}(\vec p\cdot\vec E)\vec p + (\vec p\times\vec B)\right]$$
$$= \vec E - \frac{1}{m}\left[\frac{\vec p\times(\vec p\times\vec E)}{E+m} + \vec p\times\vec B\right]$$

$$\vec B' = \frac{E}{m}\vec B - \frac{1}{m}\left[\frac{1}{E+m}(\vec p\cdot\vec B)\vec p - (\vec p\times\vec E)\right]$$
$$= \vec B - \frac{1}{m}\left[\frac{\vec p\times(\vec p\times\vec B)}{E+m} - (\vec p\times\vec E)\right]$$

$$\vec E_\perp' = \gamma\vec E_\perp + \gamma\vec\beta\times\vec B$$
$$\vec B_\perp' = \gamma\vec B_\perp - \gamma\vec\beta\times\vec E$$

**Discrete symmetry (C, P, T) transformation rules**

$A^\mu = (\phi, \vec A)$

$\phi$ = electrostatic (scalar) potential
$\vec A$ = electromagnetic vector potential

| | C | P | T | CP | CPT |
|---|---|---|---|---|---|
| $\phi$ | − | + | + | − | − |
| $\vec A$ | − | − | − | + | − |
| $\vec E$ | − | − | + | + | + |
| $\vec B$ | − | + | − | − | + |

consistent with:

$\vec\nabla\cdot\vec E = \rho$

$\vec\nabla\times\vec B = \vec J + \frac{\partial\vec E}{\partial t}$

$J^\mu = (\rho, \vec J)$

$\rho$ = charge density
$\vec J$ = current density

| | C | P | T | CP | CPT |
|---|---|---|---|---|---|
| $\rho$ | − | + | + | − | − |
| $\vec J$ | − | − | − | + | − |