Gravitation F10

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1 Problem Set 1 Due Sep 29 2010

1.1 Consider vectors in two dimensional Minowski space: $u = (u_0, u_1)$ with $u \cdot u = u_0^2 - u_1^2$. Find the condition on a matrix so that its leaves the inner product unchanged: $(\Lambda u) \cdot (\Lambda u) = u \cdot u$. Solve this condition in terms of rapidity.

1.2 Solve the Lorentz force equation for a relativistic particle for the case of a constant electric field in the x_1-direction and also for the case of a magnetic field along the x^3- direction. In the second case, derive a formula for the synchrotron frequency.

$$\frac{du_\mu}{ds} = \frac{q}{m} F_{\mu\nu} u^\nu, \quad u^\mu = \frac{dx^\mu}{ds}.$$

1.3 Show that the Lorentz force equation follows from the variational principle

$$S = \frac{1}{2} m \int \eta_{\mu\nu} \frac{dx^\mu}{ds} \frac{dx^\nu}{ds} ds - \int q A_\mu(x) \frac{dx^\mu}{ds} ds$$