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Nonlinear Electrodynamics

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Abstract: Personal notes on nonlinear electrodynamics.

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1 Nonlinear Electrodynamics

As is defined in the Pleban ´ski book [33], nonlinear elec- trodynamics are described by the following action prin- ciple

$$S_{\mathrm{E}}[g, A, P] = -\frac{1}{4\pi}\int \mathrm{d}^4x\sqrt{-g}\left(\frac{1}{2}F_{\mu\nu}P^{\mu\nu} - \mathscr{H}(\mathscr{P}, \mathscr{Q})\right) \tag{1.1}$$

which depends on the metric g , the gauge potential A and the antisymmetric tensor P . Here the struc- tural function H describes the precise nonlinear electro- dynamics and depends, in general, on the two Lorentz scalars that can be constructed with P [5]; see the first equality of Eq. (9b). As usual, the field strength is re- lated to the gauge potential as F = dA, ensuring the Faraday equations

$$\mathrm{d}F = 0 \tag{1.2}$$

On the other hand, the variation of action (1) with re- spect to the gauge potential leads to the Maxwell equa- tions

$$\mathrm{d} \star P = 0 \tag{1.3}$$

where ⋆ stands for the Hodge dual, whereas varying (1) with respect to the antisymmetric tensor P yields the constitutive relations

References