How to obtain slow roll inflation driven by non linear electrodynamics

- Do we need a scalar field for slow roll?
- Can we use gravity plus electromagnetism as a alternative mechanism to inflation?
- **We derive the general Lagrangian for NLED satisfying conditions for slow roll.**
- *With D. Malafarina and H. Chakrabarty arXiv:2503.19679. To appear on PRDL*

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- **Action:**

$$S = \int \left(16\pi R - \mathscr{L}(F)\right) \sqrt{-g}\, d^4x\,, \qquad F = F_{\mu\nu}F^{\mu\nu}$$

$$\mathscr{L} = -F/4\,, \quad F = 2(B^2 - E^2) \qquad \text{Maxwell limit}$$

- **Stress-energy tensor:**

$$T_{\alpha\beta} = -4(\partial_F \mathscr{L})F_{\rho\alpha}F^{\rho}_{\beta} + g_{\alpha\beta}\mathscr{L} = (\rho + p)u_\alpha u_\beta + p g_{\alpha\beta}$$

$$\rho = -4\partial_F \mathscr{L} E^2 - \mathscr{L} \qquad p = -4\partial_F \mathscr{L}\left(\frac{2B^2 - E^2}{3}\right) + \mathscr{L}$$

- **Magnetic Universe:** in the radiation dominated Universe the electromagnetic field interacts strongly with the plasma ⇒ the electric field is screened in the rest frame of the fluid ($E^2 = 0$).

- **Equation of state:** $\mathscr{A}(F) := \log \mathscr{L}(F)$

$$p = w\rho \;\Rightarrow\; w = -1 + \frac{8B_0^2}{3a^4}\partial_F \mathscr{A} = -1 + \frac{4}{3}F(\partial_F \mathscr{A})$$

- **Accelerated expansion:** $\ddot{a} > 0\,,\;\; \rho(1+3\omega) < 0 \;\Rightarrow\; \frac{4B_0^2}{a^4}\partial_F \mathscr{A} < 1$

- **Slow roll parameters:**

$$\epsilon \equiv -\frac{\dot{H}}{H^2} = \frac{3}{2}(1+w) = \frac{4B_0^2}{a^4}\partial_F \mathscr{A} \qquad \eta \equiv \frac{\dot{\epsilon}}{\epsilon H} = \frac{w_{,a}\, a}{1+w} = \frac{(\partial_F \mathscr{A})_{,a}}{\partial_F \mathscr{A}}a - 4$$

- **De Sitter initial state:** $(\epsilon, \eta) \to 0 \;\Rightarrow\; F(\partial_F \mathscr{A}) \to 0\,,\;\; \frac{F(\partial_{FF} \mathscr{A})}{\partial_F \mathscr{A}} \to -1$

- **Lagrangian NLED:** $\boxed{\mathscr{L} = -\alpha \log\left(1 + \beta F + h(F)\right)}$