

1 COMPONENTES COVARIANTES

$$\begin{aligned}\partial_\mu &= \frac{\partial}{\partial x^\mu} = \left(\frac{\partial}{\partial t}, \frac{\partial}{\partial x^i} \right)^T = \left(\frac{\partial}{\partial t}, \frac{\partial}{\partial X_i} \right)^T \\ \partial^\mu &= \frac{\partial}{\partial x_\mu} = \left(\frac{\partial}{\partial t}, \frac{\partial}{\partial x_i} \right)^T = \left(\frac{\partial}{\partial t}, -\frac{\partial}{\partial X_i} \right)^T\end{aligned}$$

2 EQUAÇÕES DE EULER-LAGRANGE

$$\frac{\partial}{\partial x^\mu} \left(\frac{\mathcal{L}}{\partial \phi^r_{,\mu}} \right) - \frac{\mathcal{L}}{\partial \phi^r} = 0$$

$$\mathcal{H} = \pi_r \dot{\phi}^r - \mathcal{L}$$