

# Lagrangiana de Yang-Mills

- A ação do eletromagnetismo, com fontes, é baseada na seguinte lagrangeana:

$$\mathcal{L} = \mathcal{L}_{\text{field}} + \mathcal{L}_{\text{int}} = -\frac{1}{4\mu_0} F^{\alpha\beta} F_{\alpha\beta} - A_\alpha J^\alpha$$

- Acima,  $F_{\alpha\beta} = \partial_\alpha A_\beta - \partial_\beta A_\alpha$ . E as equações de Maxwell são dadas por  $\partial_\alpha F^{\alpha\beta} = J^\beta$ .

- A ação de Yang-Mills é baseada na seguinte lagrangeana:

$$\mathcal{L}_{\text{gf}} = -\frac{1}{2} \text{Tr}(F^2) = -\frac{1}{4} F^{a\mu\nu} F_{\mu\nu}^a$$

- Acima,  $F_{\mu\nu} = \partial_\mu A_\nu - \partial_\nu A_\mu - ig[A_\mu, A_\nu]$ ,  $A_\mu = \sum_{a=1}^3 A_\mu^a T^a$  e  $[T^a, T^b] = i \sum_{c=1}^3 f^{abc} T^c$

# Standard Model of Elementary Particles

	three generations of matter (fermions)			interactions / force carriers (bosons)	
	I	II	III		
mass	$\approx 2.2 \text{ MeV}/c^2$	$\approx 1.28 \text{ GeV}/c^2$	$\approx 173.1 \text{ GeV}/c^2$	0	$\approx 124.97 \text{ GeV}/c^2$
charge	$\frac{2}{3}$	$\frac{2}{3}$	$\frac{2}{3}$	0	0
spin	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	1	0
QUARKS	<b>u</b> up	<b>c</b> charm	<b>t</b> top	<b>g</b> gluon	<b>H</b> higgs
	$\approx 4.7 \text{ MeV}/c^2$ $-\frac{1}{3}$ $\frac{1}{2}$ <b>d</b> down	$\approx 96 \text{ MeV}/c^2$ $-\frac{1}{3}$ $\frac{1}{2}$ <b>s</b> strange	$\approx 4.18 \text{ GeV}/c^2$ $-\frac{1}{3}$ $\frac{1}{2}$ <b>b</b> bottom	0 0 1 <b>γ</b> photon	
LEPTONS	$\approx 0.511 \text{ MeV}/c^2$ -1 $\frac{1}{2}$ <b>e</b> electron	$\approx 105.66 \text{ MeV}/c^2$ -1 $\frac{1}{2}$ <b>μ</b> muon	$\approx 1.7768 \text{ GeV}/c^2$ -1 $\frac{1}{2}$ <b>τ</b> tau	$\approx 91.19 \text{ GeV}/c^2$ 0 1 <b>Z</b> Z boson	
	$< 1.0 \text{ eV}/c^2$ 0 $\frac{1}{2}$ <b>ν<sub>e</sub></b> electron neutrino	$< 0.17 \text{ MeV}/c^2$ 0 $\frac{1}{2}$ <b>ν<sub>μ</sub></b> muon neutrino	$< 18.2 \text{ MeV}/c^2$ 0 $\frac{1}{2}$ <b>ν<sub>τ</sub></b> tau neutrino	$\approx 80.39 \text{ GeV}/c^2$ $\pm 1$ 1 <b>W</b> W boson	

GAUGE BOSONS  
VECTOR BOSONS

SCALAR BOSONS