6/5/17 Lecture 17 outline / summary

• Recall: $\mathcal{L} \supset \bar{\psi}(i\not{D} - m)\psi$, with $D_\mu = \partial_\mu + iqA_\mu + igT^a A^a_\mu$. $F_{\mu\nu} = [D_\mu, D_\nu]/(-ig) = \partial_\mu A_\nu - \partial_\nu A_\mu - ig[A_\mu, A_\nu]$, in the adjoint representation of the gauge group. $\mathcal{L} \supset -\frac{1}{4}TrF_{\mu\nu}F^{\mu\nu} \supset -gf^{abc}\partial_\mu A^a_\nu F^{\mu b}A^{\nu c} - (g^2/4)f^{abc}f^{ade}A^b_\mu A^c_\nu A^{\mu d}A^{\nu e}$.

• Continue with QCD Feynman rules, examples of color factors.

• Running couplings in QED vs QCD. Asymptotic freedom. Confinement. Motivate grand unification.

• On to the weak force! Two differences from other forces: it is chiral (hence parity violating), and the force carriers (Ws and Zs) are massive, which is why it is weak. "How can a force carrier be massive?" given that forces are related to gauge symmetries, and gauge invariance forbids mass terms (e.g. for the photon). Answer: the gauge invariance is *spontaneously broken* by the Higgs field. This is roughly similar to the Bose condensate in a superconductor.