5/31/16 Lecture 18 outline / summary

• 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.

• Weak interactions at low-energies involve 4 Fermion interactions. Fermi's theory. But parity is violated. Wu (1957): $^{60}Co \to {}^{60}Ni^* + e^- + \overline{\nu_e}$, electrons are preferentially emitted in the direction opposite to $\vec{B}$, so not parity invariant. The 4-Fermi interaction involves $j^\mu_{V-A} \sim \bar{\psi} P_L \psi$, where recall $P_L = \frac{1}{2}(1-\gamma_5)$. The 4-Fermi theory predicted its own demise, since it breaks down for energies $\sim 100 GeV$. It is replaced with $SU(2)_W$ gauge fields, with $m_W = 80.358 \pm 0.015 GeV$. Also $m_Z = 91.1975 \pm 0.0021 GeV$.

• Again, recall the structure of the Standard Model.