Last time we considered the spontaneous symmetry breakdown for a matter field under an arbitrary Lie group $G$, and how there were Goldstone bosons for each direction in the coset space $\mathcal{G}/\mathcal{K}$, where $\mathcal{K}$ is the algebra of the unbroken symmetry. We also found that the remaining matter fields picked up real masses.

Then we looked into the magic that occurs when the symmetry group is a gauge group, so we would have massless vector particles in our Lagrangian. But when there is spontaneous symmetry breaking in the matter fields, the massless Goldstone bosons can get eaten by the corresponding massless gauge particles, making them fat (massive). This is the Higgs mechanism. We examined three possibilities, $U(1)$ with a complex scalar, $SU(2)$ with an isodoublet, and $SU(2)$ with a real isovector, but then I gave you a teaser of $SU(2) \times U(1)$ which will give us the Glashow-Salam-Weinberg electroweak theory.

Today

We will first work out the GSW theory, seeing how the $W^\pm$ and $Z^0$ develop their masses, what the Weinberg angle is, and what the Higgs really is.

Then we will add leptons and quarks to this theory, which are, of course, crucial to the physics. As this is a really important part of the standard model of high energy physics, we really should discuss this, but as this is all understood in terms of quantum field theory, some of what I say may not be totally clear to you. Nonetheless, it is a good for you to get some idea of what is involved.

Next Time

Next time we will make a complete change of topic, leaving more on gauge theory to a course in quantum field theory, and turn to the Poincaré group and then to supersymmetry.

Announcements

Normal classes next week.
No homework next week.