6.4: Weak Nuclear Force

The weak nuclear force manifests itself through nuclear β decay,

$$n \rightarrow p + e^{-} + \bar{\nu}_e.$$

The standard coupling for this theory is called the Fermi coupling, G_F, after its discoverer. After the theory was introduced it was discovered that there were physical particles that mediate the weak force, the $W^{\pm}$ and the Z^0 bosons. These are very heavy particles (their mass is about 80 times the proton mass!), which is why they have such a small range – fluctuations where I need to create that much mass are rare. The $W^{\pm}$ bosons are charged, and the Z^0 boson is neutral. The typical β decay referred to above is mediated by a W^{-} boson as can be seen in the Feynman diagram in Figure 6.4.1. The reason for this choice is that it conserves charge at each point (the charge of a proton and a W^{-} is zero, the charge of an electron and a neutrino is -1, the same as that of a W^{-}).

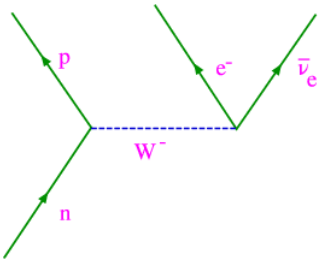

Figure 6.4.1: The Feynman diagram for the weak decay of a neutron.