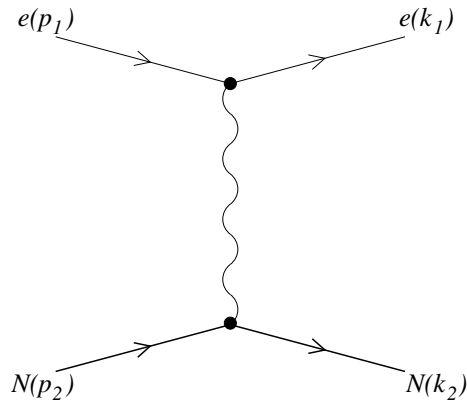


Physics 565 - Spring 2010, Assignment #6, Due March 31<sup>th</sup>

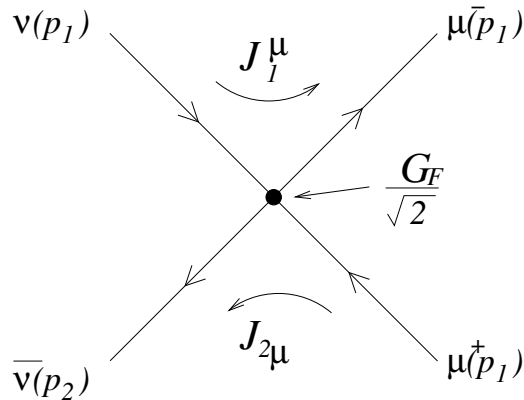
1. Calculate  $|\overline{\mathcal{M}}|^2$  for electrons scattering from spinless nuclei, described by the Feynman diagram:



expressing the result in terms of the Mandelstam variables and ignoring terms that are of order  $m_e^2$ .

2. Calculate  $|\overline{\mathcal{M}}|^2$  for electrons scattering from nuclei with spin 1/2, described by the same Feynman diagram, but with the nucleon current described by spinors. Again, express the result in terms of the Mandelstam variables and ignore terms that are of order  $m_e^2$ .

3. Calculate  $|\overline{\mathcal{M}}|^2$  for the hypothetical process in which muon neutrinos and muon anti-neutrinos scatter in the center of mass frame according to the Feynman diagram:



in which the charged currents are of the form

$$J_1^\mu = \bar{u}(k_1)\gamma^\mu(1 - \gamma^5)u(p_1)$$

$$J_{2\mu} = \bar{v}(k_1)\gamma_\mu(1 - \gamma^5)v(p_2).$$

Express the result in terms of the coupling constant,  $G_F$  and the Mandelstam variables. Show that this must eventually become unphysically large as  $s \rightarrow \infty$ .