5c) **Short Range Repulsion**

Short range repulsion is due to the exchange of neutral vector bosons. They are like massive photons. Because the nucleons are charged with respect to these photons, the interaction is repulsive $m_V = 790 \text{ MeV}$. The interaction is short range.

This short range interaction also gives rise to the spin-orbit force. For the Coulomb interaction, it is given by

$$\frac{1}{r} \frac{dV}{dr} = \frac{Ze}{r^2}$$

For the short range repulsion, we then find the spin-orbit interaction

$$\frac{1}{r} \frac{dV}{dr} \left( \frac{\mathbf{r}_1 \times \mathbf{r}_2}{r^2} \right) \cdot \mathbf{r}_1 \times \mathbf{r}_2$$

5d) **The Nuclear Potential**

We can interchange more than one pion. This results in intermediate range attraction.

\[ \text{Vector exchange} \]

\[ \text{pion exchange, like meson exchange} \]

\[ \text{One pion exchange} \]