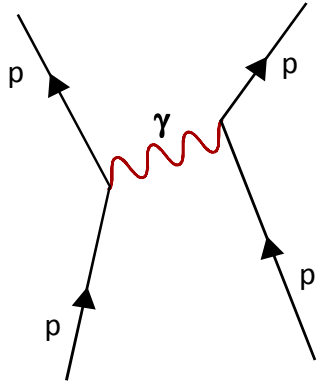
1.5 How Particles Interact

- Particles exert forces on each other, (we say they "interact"), by exchanging **virtual particles**. They were called "virtual" by physicist Richard Feynman because they cannot be detected directly.
- The **electromagnetic force** acts between charged particles through the exchange of **virtual photons**. These have zero rest mass and travel at the speed of light.

Feynman Diagrams

Particle interactions are represented by Feynman diagrams. Each one represents a way in which the interaction can happen. (They are **not** pictures and the lines do not represent the particle paths). In the version we use, time increases up the page.

Opposite is the Feynman diagram for the interaction of two protons (p). The diagram reads like this: the proton on the left emits a virtual photon (γ). The photon is absorbed by the proton on the right a short time later. The result is the two protons repel each other.



Weak Nuclear Force

- This is the force that causes a neutron in a nucleus to change into a proton, (beta minus decay), or a proton in a nucleus to change into a neutron, (beta plus decay).
- The exchange particle for weak interactions is the **W boson**, (W^+ or W^-). These have non-zero rest mass and a very short range, (about 10^{-18} m), so the weak nuclear force is a very short-range force.
- The negatively-charged W- boson decays into a β^- particle and an antineutrino ($\bar{\nu}$).
- The positively-charged W+ boson decays into a β^+ particle and a neutrino (ν).

See overleaf for the Feynman diagrams for these two decays.

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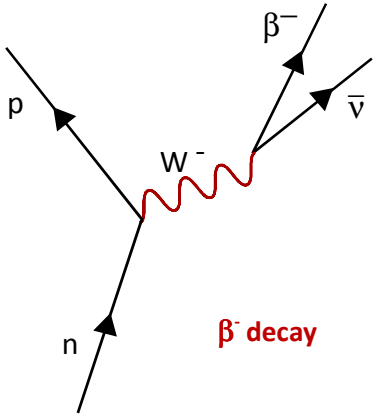
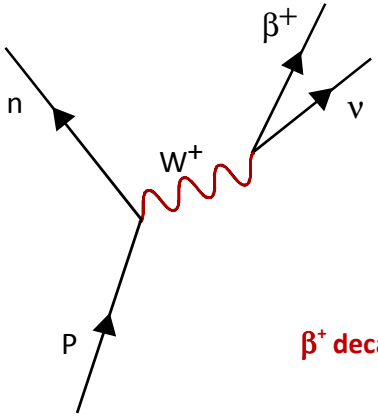


β⁻ decay

Read this diagram as: neutron decays by emitting a W^- boson and becomes a proton. W^- decays into a beta minus particle and an antineutrino.



β⁺ decay

Read this diagram as: proton decays by emitting a W+ boson and becomes a neutron. W+ decays into a beta plus particle, (a positron), and a neutrino.