8.701

Introduction to Nuclear and Particle Physics

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1. Fermions, bosons, and fields

1.2 Feynman diagrams

Feynman diagrams

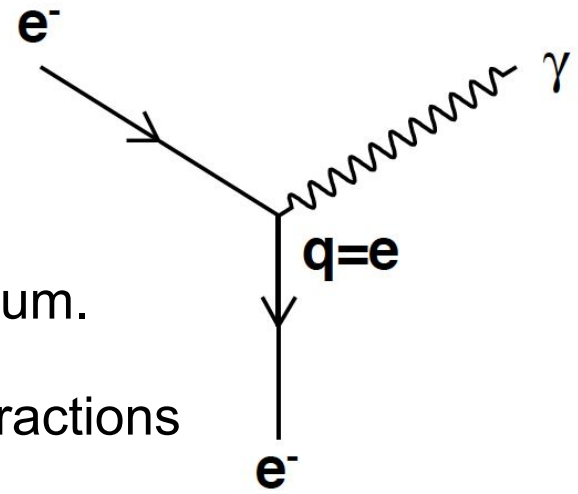
Arise from perturbative calculations of the amplitudes of reactions.

It turns out that the mathematical terms in the perturbation series can be represented as a diagram.

Each part of the diagram indicates a particular factor in the calculation.

Derivation of the associated rules is beyond this course.

Feynman diagram example



Lines represent particle with energy and momentum.

They can meet at points, vertices, where the interactions take place.

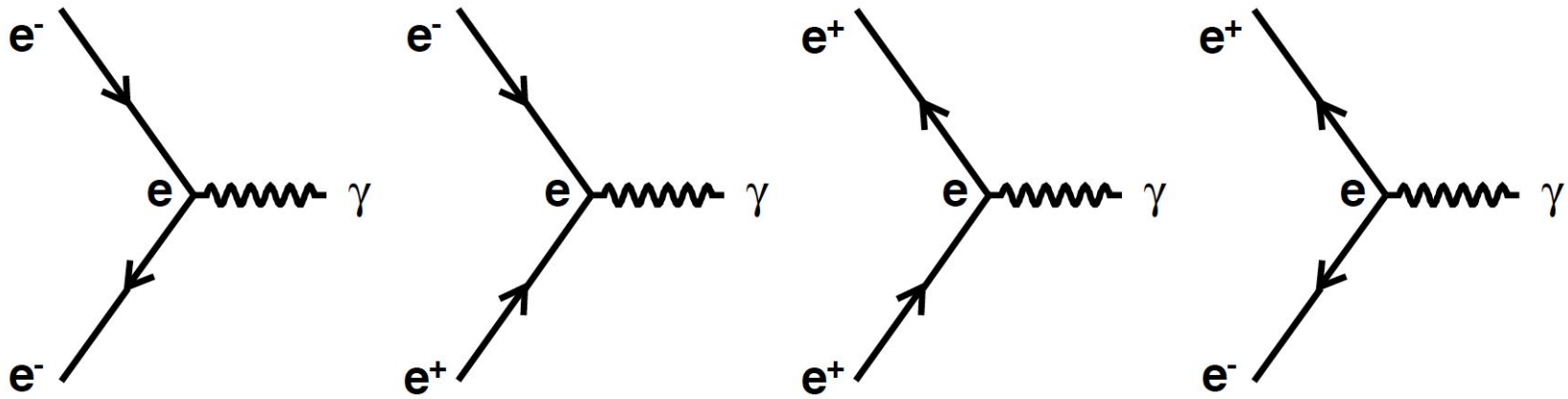
Amplitude for the interaction to happen is proportional to the charge. Diagrams with n vertices have a factor of e^n in the amplitude and e^{2n} in the probability.

For n vertices, there will be a factor α^n in the probability.

$$\alpha = \frac{e^2}{4\pi\epsilon_0\hbar c} \approx \frac{1}{137}$$

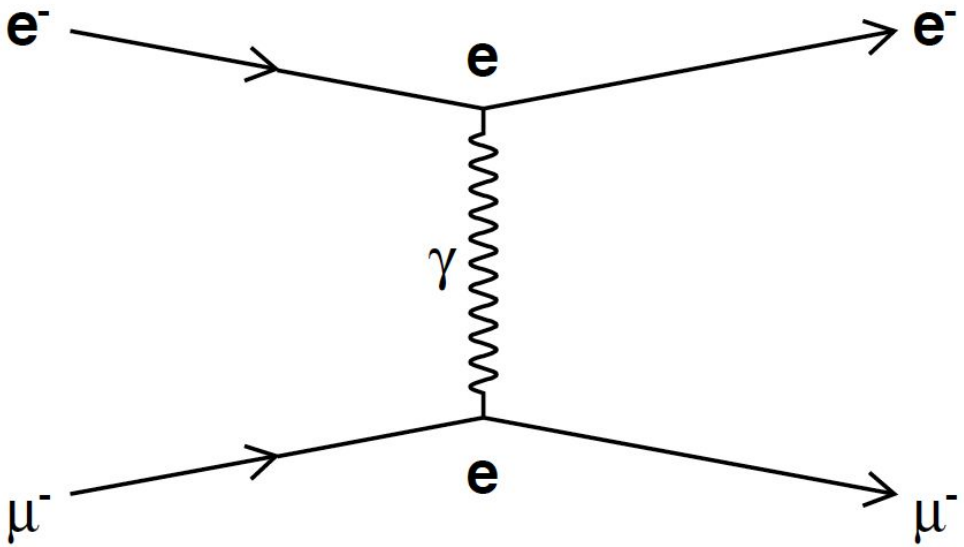
Antiparticles

The same vertex can represent various combination of electrons and/or positrons by reverting their directions and replacing them with antiparticles.



Reaction

More than one vertex needed for reactions



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