Our world is made of elementary particles.

- Constituents of matter:
  - Leptons (electrons), quarks.
- Mediate fundamental forces:
  - Photons, gluons, W and Z bosons, gravitons.

Scattering process of elementary particles:

- Interaction of two or more particles.
- Fixed initial states, final states can vary.
- Fundamental laws reveal in these processes.

Mathematical description: scattering amplitude.

- Describes a probability that a given scattering process happens.
- It is a function of momenta and spins, $M(p, s)$.

Quantum field theory (QFT) is specified by a set of properties

- Particle content: each described by a field $\phi, \psi, A_p$.
- Symmetries of the theory.
- Interactions between fields given by Lagrangian $L$.
- The strength of the interaction: coupling constants $g$.

Perturbative expansion of scattering amplitudes

- Weak coupling: expansion around $g = 0$,
  \[ M = gM_1 + g^2M_2 + g^3M_3 + \ldots \]
- Each contribution $M_j$ can be calculated from the Lagrangian in perturbation theory.
- Graphical picture: Feynman diagrams.

In 2013 LHC discovered Higgs boson, last piece of the Standard Model.

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Perturbative expansion = loop expansion of Feynman diagrams.

- Diagrams with internal loops: higher powers of $g$.
- They are higher order terms in perturbation theory.
- They should be suppressed in ‘good’ theories.

Great universal approach to quantum field theory!

Problem: Huge cancellations between diagrams, some properties invisible.