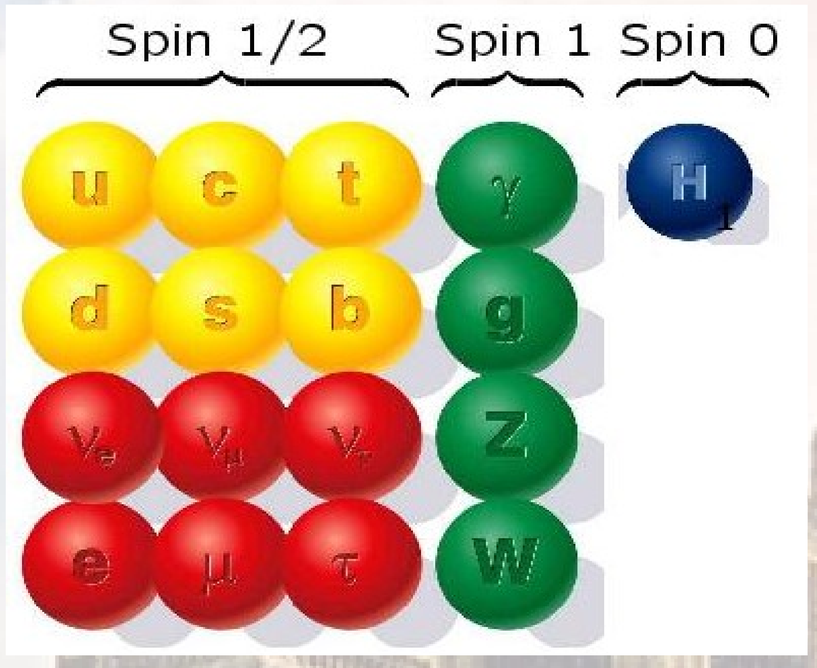
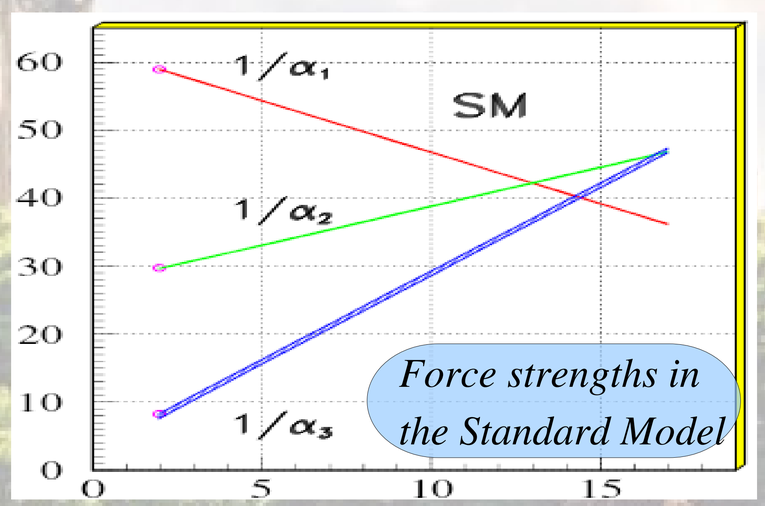
Durham University

SUPERSYMMETRY

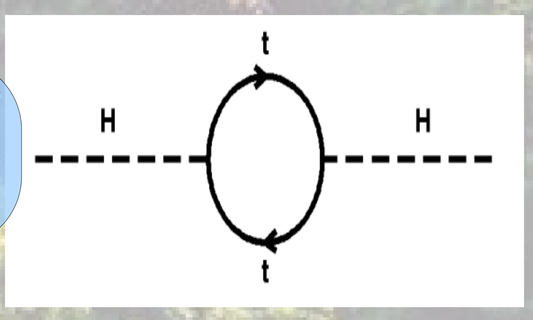


The Standard Model is a wonderfully precise model of the particles that make up our world, and the way they interact. There are two types of particle – fermions and bosons. All of the matter around us is made up of fermions. The bosons are responsible for carrying the three forces of the Standard Model: electromagnetism, the strong force and the weak force. Fermions are either attracted to or repelled from each other by exchanging bosons. When two magnets snap together, it is because they are exchanging a type of boson called a photon.

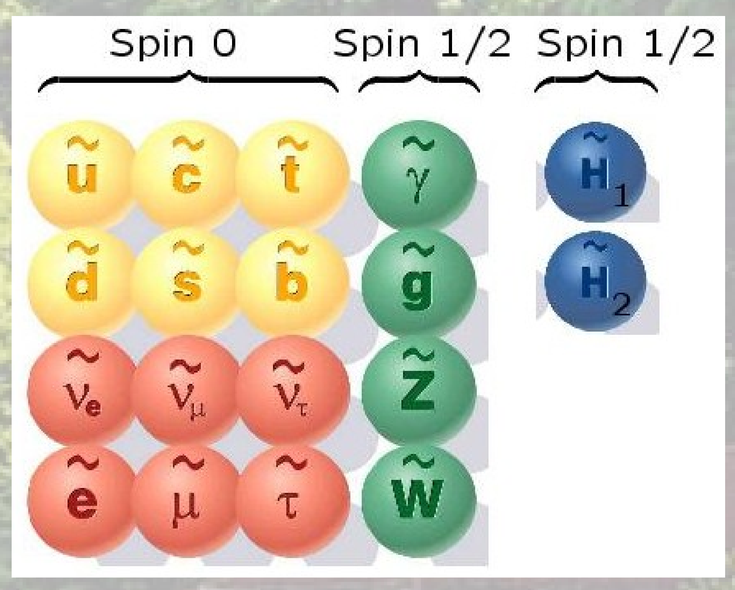
Despite its many triumphs, there are several problems with the Standard Model. One of these is called the Hierarchy problem. It seems unnatural that the mass of the Higgs boson is so much lighter than the fundamental mass scale (the Planck mass): a few 100GeV compared to 10^{19}GeV. Quantum contributions (via loop diagrams) inevitably make the mass of the Higgs enormous. Also, the forces in the standard model all have different strengths, and these strengths are dependent on energy. At very high energy, we think that these forces should unify. In the standard model, they come close, but they don't quite meet at the same point.



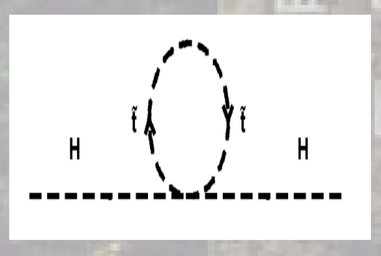
Force strengths in the Standard Model



Quantum contributions to the Higgs mass in the Standard Model

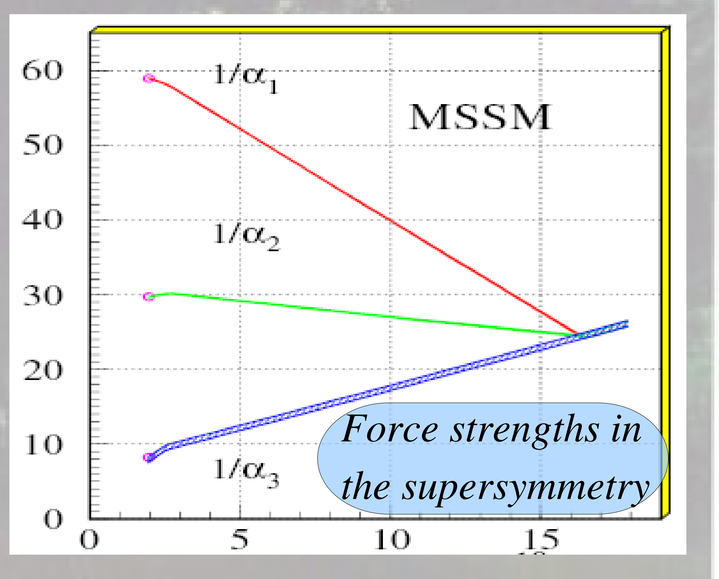


Supersymmetry is a way of directly relating fermions and bosons. The theory postulates that every particle in the standard model has a supersymmetric partner of the opposite type: for every Standard Model fermion, there is a corresponding supersymmetric boson, and for every boson there is a corresponding fermion.



Quantum contributions to the Higgs mass in supersymmetry

Not only is supersymmetry an extremely beautiful theory, but it also solves many of the problems of the Standard Model. In supersymmetry, there are several new types of quantum contributions to the Higgs mass. When you add the new (supersymmetric) and old (Standard Model) contributions together, they cancel one another out, resulting in a naturally low mass Higgs boson, thus solving the hierarchy problem. Also, the gradients of the force strengths are altered, and they all meet at a single point at approximately 10^{16}GeV.



Force strengths in the supersymmetry

The ILC will give us the chance to discover and study supersymmetry in depth, allowing very precise measurements of supersymmetric particles.

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