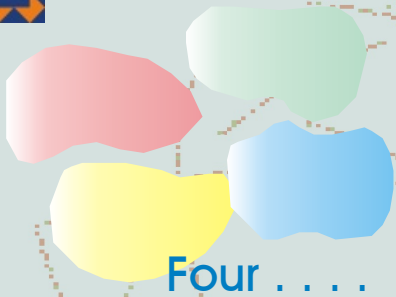


The Forces



Four

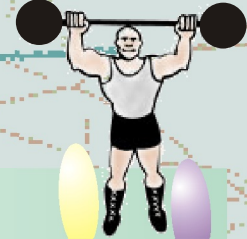


. . . . or one ?

The forces of nature between matter particles (quarks and leptons) arise from the exchange of other 'force carrying' particles called bosons. If a boson is emitted by one quark or lepton and is absorbed by another, then there is a force between the two.

Force	Boson	Source	Relative strength*	Range
gravity	graviton	mass	10^{-39}	infinite
weak	W^+ , W^- , Z	weak charge	10^{-5}	10^{-18} m
electromagnetism	photon	charge	10^{-2}	infinite
strong	gluons	colour	1	10^{-15} m

* in the nucleus



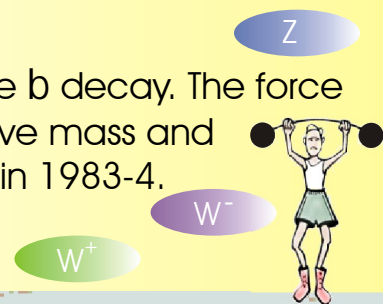
Gravity

The weakest force, but responsible for the attraction between astronomical objects. The graviton has not been observed. Felt by all particles.



Weak

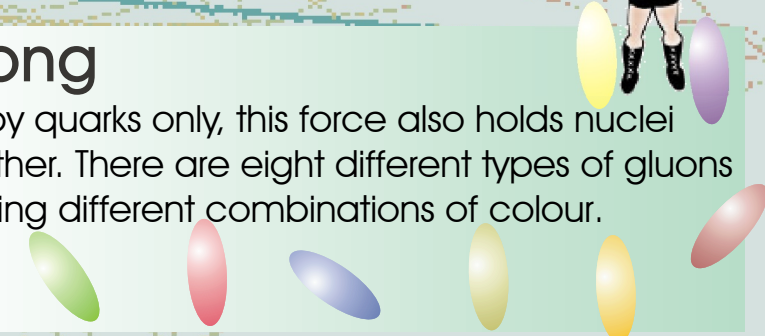
Responsible for radioactive beta decay. The force carriers (W^+ , W^- , Z bosons) have mass and were discovered at CERN in 1983-4. Felt by all matter particles.



The weak force and electromagnetism are different manifestations of the electroweak force. The mathematical theory of this force predicts the existence of the Higgs boson, responsible for the mass of all objects.

Strong

Felt by quarks only, this force also holds nuclei together. There are eight different types of gluons carrying different combinations of colour.



Electromagnetism

Holds atoms together and plays a major role in everyday life. The force carrier is the familiar photon. Electricity and magnetism are simply different manifestations of this force. Felt by all particles except neutrinos, which are uncharged.



Can all four forces be described as different aspects of a more general theory ?