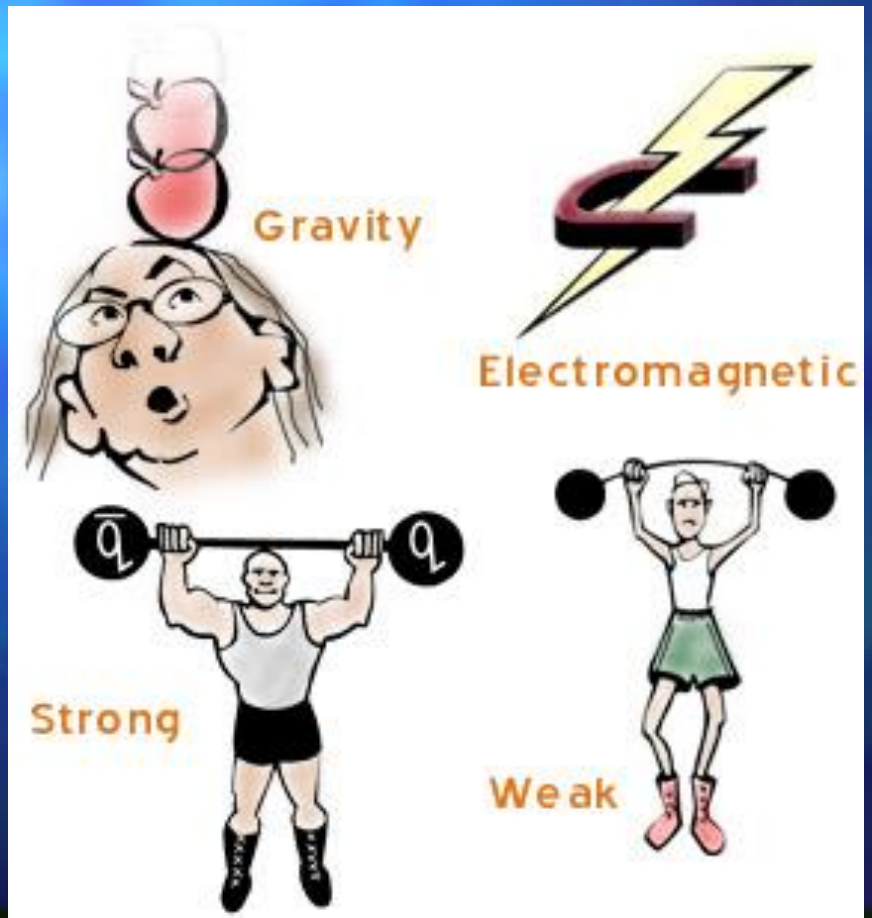
Four Interactions

There are four fundamental interactions between particles, and all forces in the world can be attributed to these four interactions!

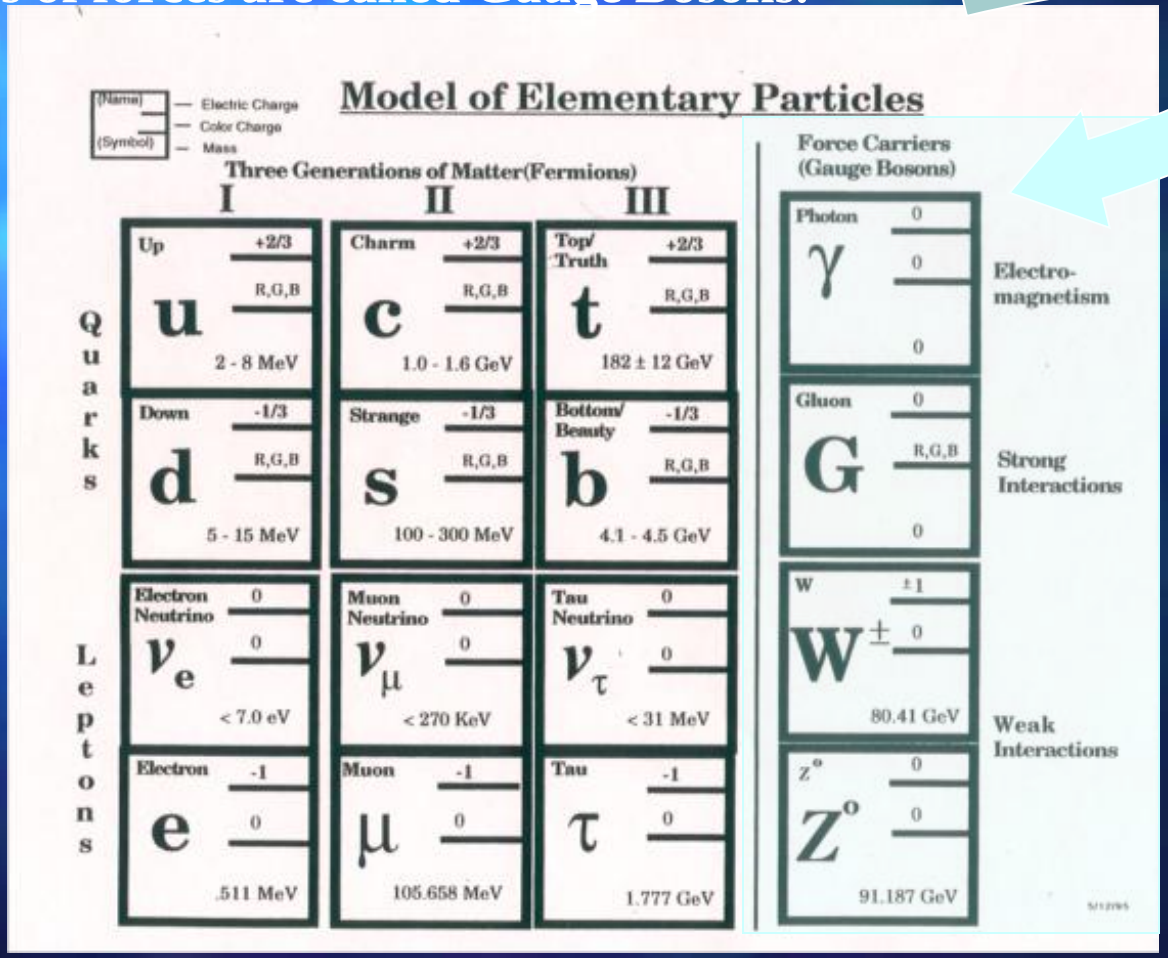


What's an Interaction?

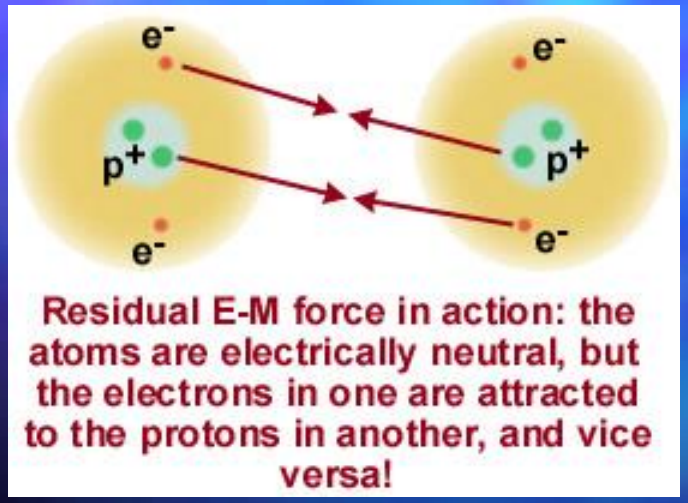
At a fundamental level, a force isn't just something that happens to particles. It is a thing which is passed between two particles.

Can We Find This On Our Standard Model Chart?

The carriers of forces are called Gauge Bosons.



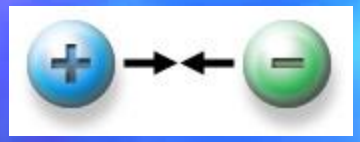
Electromagnetic Force

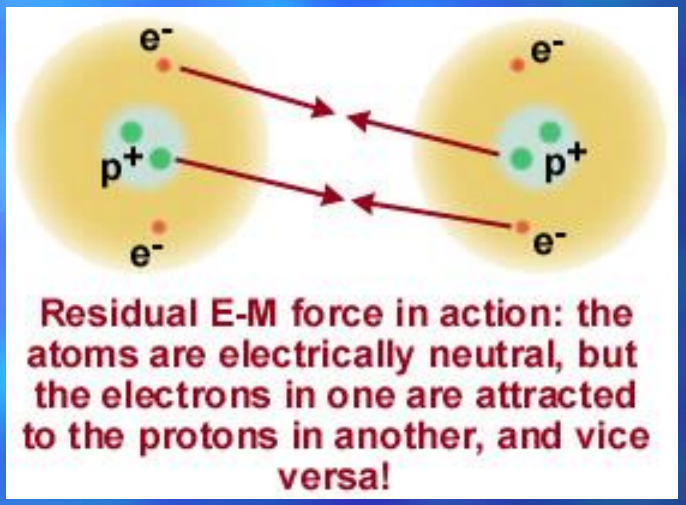


Residual E-M force in action: the atoms are electrically neutral, but the electrons in one are attracted to the protons in another, and vice versa!

The charged particles pass photons back and forth to remain connected and create the atoms that we have. The residual EM force will hold these overall neutral atoms together.

Electromagnetic Force





Residual E-M force in action: the atoms are electrically neutral, but the electrons in one are attracted to the protons in another, and vice versa!

The electromagnetic force is what allows atoms to bond and form molecules. Amazing, isn't it? All the structures of the world exist simply because protons and electrons have opposite charges!

Strong Force

The strong force holds quarks together, so its carrier particles are called gluons because they so tightly "glue" quarks together.

The residual strong force will hold the different baryons (aka protons and neutrons in the nucleus) together.

Color Charge

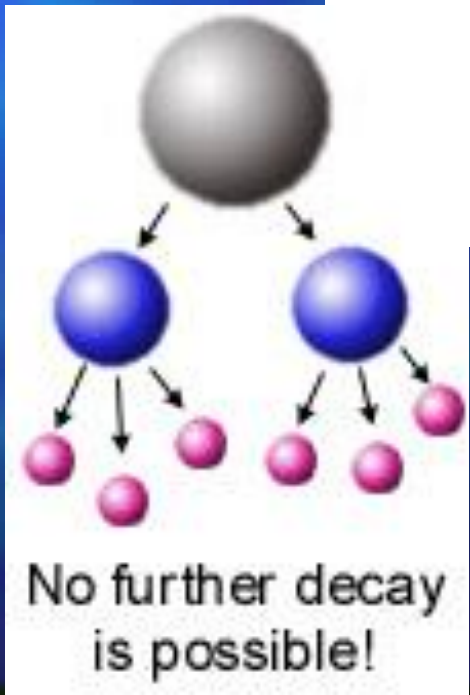
Quarks (and anti-quarks) are held together by the color charge which is "transmuted" by gluons of six colors. NOT visible color but easy way to think.

Any combination that makes "white light" makes it stable.

Because the gluon carries the color charge with it, it cannot be isolated

Weak Force

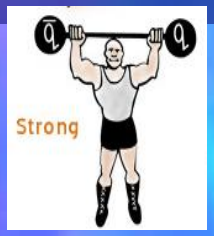
- Acts on Quarks and Leptons
- Causes Nuclear Decay
- (Note: The only stable matter around us is made out of the 1st Generation
- Has HEAVY carrier particles



Force Carriers

	Gravity	Weak (Electroweak)	Electromagnetic	Strong
Carried By	Graviton (not yet observed)	W^+ W^- Z^0	Photon	Gluon
Acts on	All	Quarks and Leptons	Quarks and Charged Leptons and W^+ W^-	Quarks and Gluons

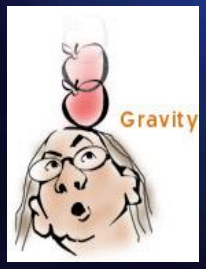
What Are The Relative Strengths?



Strength = 1

Relative to Strong = 1/100

Relative to Strong = 1/1,000,000,000



Relative to Strong =1/10,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000,000

Mini Check

Which interaction is responsible for…

- Friction? — Electromagnetic
- Nuclear Bonding? — Strong
- Planetary Orbits? — Gravity
- Which interaction acts on neutrinos? — Weak
- Which interaction has heavy carriers? — Weak
- Which force carriers cannot be isolated? — Gluons