

First, Some Basic Stuff

- Forces of Nature
- Our friend, the Universe 😊... up close and far away

All Interactions in Nature Seem to be the Result of Just 4 Fundamental Forces

- **Gravity** – acts between objects which have the property we call MASS
- **Electromagnetism** – acts between objects which have the property we call CHARGE
- **The Strong Nuclear Force** – acts between certain nuclei: Baryons (protons, neutrons, and many others which are unstable and short-lived)
- **The Weak Nuclear Force** – causes some kinds of “radioactive” decay.

The Four Fundamental Forces of Nature

Electro-
magnetism



Weak
Interaction



Strong
Interaction



Gravitation



The Strengths of these forces are VERY different

- **Gravity:** 10^{-39} the strength of the Strong Force
- **Weak Force:** 10^{-13} of the Strong Force
- **Electromagnetism:** $\sim 1/137$ of the Strong Force
- Yes, **the Strong Force**.... Is the Strongest!
- This is oversimplified, as these forces (interactions, really) differ in more fundamental ways than just strength, as we'll see, and their strength vs. distance are not identical either

For Now, Just Remember that there's only 4 Forces and they account for ALL Processes (except maybe for Dark Energy?)

- We'll talk about each of these in more detail as needed, in explaining the workings of the stars, galaxies and the Universe

A cool Java movie...

- Zooming in from The Universe.... to the deep innards of the Proton by magnifying a power of 10 in size for each frame
- Click on the link to get started...

Key Points to This Intro

- 4 interactions (forces) describe all that we have observed.
- Gravity is the weakest, but it is always attractive and it is a long-range force, so comes to dominate in big things, like much of Astronomy
- The nuclear forces are far stronger than gravity, but only act over tiny distances, like a 10 trillionth of a centimeter