Fermions and bosons

FERMIONS

BOSONS

A **fermion** is any particle that has an odd half-integer (like 1/2, 3/2, and so forth) spin. Quarks and leptons, as well as most composite particles, like protons and neutrons, are fermions.

For reasons we do not fully understand, a consequence of the odd half-integer spin is that fermions obey the Pauli Exclusion Principle and therefore cannot co-exist in the same state at same location at the same time.

Bosons are those particles which have an integer spin (0, 1, 2...).

All the **force carrier particles** are bosons, as are those composite particles with an even number of fermion particles (like mesons).

Fermions				Bosons
Leptons and Quarks	Spin = $\frac{1}{2}$		Spin = 1*	Force Carrier Particles
Baryons (qqq)	Spin = $\frac{1}{2}$ $\frac{3}{2}, \frac{5}{2}$ ...		Spin = 0, 1, 2...	Mesons (q$\bar{q}$)

* The predicted graviton has a spin of 2.

The nucleus of an atom is a fermion or boson depending on whether the total number of its protons and neutrons is odd or even, respectively. Recently, physicists have discovered that this has caused some very strange behavior in certain atoms under unusual conditions, such as **very cold helium**.

Exhibit 2.