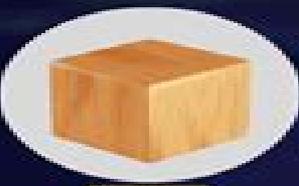


# FUNDAMENTAL PARTICLES



## Matter

(All things are composed of atoms)



## Molecule

(Matter is composed of molecules, which are groups of two or more atoms bonded together)



## Atom

(Electrons orbit the positively charged nucleus of an atom)



## Nucleus

Fundamental particles are classified into "Bosons" and "Fermions" based on their spin.

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## BOSONS



Particles with **whole number spins** (0, 1, 2, etc.). They are energy and **force carriers** throughout the universe. They include **photons** (light), **gluons** (particles that act as force carriers in the nucleus), the **Higgs boson**, and the **W and Z bosons**.



### Photons

Photons are massless, **charge-less** particles of light that travel at the speed of light.



### Gluons

**Gluons** are **charge-less** particles that mediate the **strong nuclear force**, holding quarks together in protons and neutrons. They have color charges (red, green, blue) and are studied in high-energy environments like the **Relativistic Heavy Ion Collider (RHIC)**.



### Higgs Boson

The Higgs boson, linked to the Higgs field, **gives mass to particles like electrons and quarks**. Mass determines a particle's resistance to force. **Photons**, which carry the electromagnetic force, **have no mass**.



### W and Z Bosons

**W and Z bosons** are elementary particles with **spin 0 or 1**, discovered in 1983. They mediate the weak force, which is weaker than the strong force. There are two W bosons (W+ and its antiparticle W-), while Z bosons are their own antiparticles.

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Three Components of Matter (Fermions)



Force Carriers (Bosons)

### Quarks

up u	charm c	top t
down d	strange s	bottom b

### Leptons

electron e	muon μ	tau τ
electron neutrino ν <sub>e</sub>	muon neutrino ν <sub>μ</sub>	tau neutrino ν <sub>τ</sub>

### Gauge Bosons

photon γ	gluon g	Z Boson Z	W Boson W
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### Scalar Bosons

Higgs Boson H
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## FERMIONS



Particles with **half-number spins** (1/2, 3/2, etc.). They include protons, neutrons, electrons, neutrinos, and quarks.



- **Leptons** are fundamental particles that do not feel the strong nuclear force.
- **Electrons**, commonly found in atoms, are the most well-known leptons.
- There are six types of leptons:



### Neutrinos

- **Neutrinos** are tiny, neutral particles with nearly undetectable mass.
- They are the **most abundant massive particles in the universe**.
- Produced during nuclear reactions in stars, reactors, and particle accelerators.
- **Bananas** emit neutrinos due to their natural radioactivity.



### Gluon

### Quarks



Neutron  
Proton

- **Quarks** are the building blocks of protons and neutrons. They combine to form protons and neutrons.
- **Protons** and **neutrons** are **not** fundamental particles because they are composed of smaller particles called **quarks**.
- There are six types (flavors) of quarks:



# Fundamental Problems In Elementary Particle Physics

**Werner Heisenberg**



## **Fundamental Problems In Elementary Particle Physics:**

The Top Books of the Year Fundamental Problems In Elementary Particle Physics The year 2023 has witnessed a remarkable surge in literary brilliance, with numerous captivating novels captivating the hearts of readers worldwide. Lets delve into the realm of top-selling books, exploring the captivating narratives that have captivated audiences this year. Fundamental Problems In Elementary Particle Physics : Colleen Hoover's "It Ends with Us" This heartfelt tale of love, loss, and resilience has gripped readers with its raw and emotional exploration of domestic abuse. Hoover expertly weaves a story of hope and healing, reminding us that even in the darkest of times, the human spirit can triumph. Fundamental Problems In Elementary Particle Physics : Taylor Jenkins Reids "The Seven Husbands of Evelyn Hugo" This spellbinding historical fiction novel unravels the life of Evelyn Hugo, a Hollywood icon who defies expectations and societal norms to pursue her dreams. Reids compelling storytelling and compelling characters transport readers to a bygone era, immersing them in a world of glamour, ambition, and self-discovery. Discover the Magic : Delia Owens "Where the Crawdads Sing" This mesmerizing coming-of-age story follows Kya Clark, a young woman who grows up alone in the marshes of North Carolina. Owens weaves a tale of resilience, survival, and the transformative power of nature, captivating readers with its evocative prose and mesmerizing setting. These popular novels represent just a fraction of the literary treasures that have emerged in 2023. Whether you seek tales of romance, adventure, or personal growth, the world of literature offers an abundance of engaging stories waiting to be discovered. The novel begins with Richard Papen, a bright but troubled young man, arriving at Hampden College. Richard is immediately drawn to the group of students who call themselves the Classics Club. The club is led by Henry Winter, a brilliant and charismatic young man. Henry is obsessed with Greek mythology and philosophy, and he quickly draws Richard into his world. The other members of the Classics Club are equally as fascinating. Bunny Corcoran is a wealthy and spoiled young man who is always looking for a good time. Charles Tavis is a quiet and reserved young man who is deeply in love with Henry. Camilla Macaulay is a beautiful and intelligent young woman who is drawn to the power and danger of the Classics Club. The students are all deeply in love with Morrow, and they are willing to do anything to please him. Morrow is a complex and mysterious figure, and he seems to be manipulating the students for his own purposes. As the students become more involved with Morrow, they begin to commit increasingly dangerous acts. The Secret History is a masterful and gripping novel that will keep you speculating until the very end. The novel is a warning tale about the dangers of obsession and the power of evil.

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