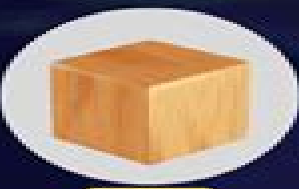


# FUNDAMENTAL PARTICLES



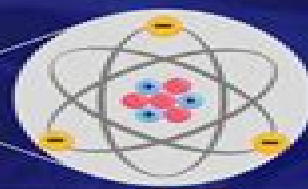
## Matter

(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**.



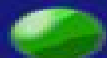
### Photons

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 Generations of Matter (Fermions)

Force Carriers (Bosons)

### Quarks

|           |              |             |
|-----------|--------------|-------------|
| up<br>u   | charm<br>c   | top<br>t    |
| down<br>d | strange<br>s | bottom<br>b |

### Leptons

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

### Gauge Bosons

|             |            |              |              |
|-------------|------------|--------------|--------------|
| photon<br>γ | gluon<br>g | Z Boson<br>Z | W Boson<br>W |
|-------------|------------|--------------|--------------|

### Scalar Bosons

|                  |
|------------------|
| Higgs Boson<br>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

- 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:



### Muon



### Electron



### Tau



### Electron Neutrino



### Muon Neutrino



### Tau Neutrino



### 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:



### Up



### Down



### Charm



### Strange



### Top



### Bottom

# The Particles Of The Universe

**Jeff Yee**



## **The Particles Of The Universe:**

**The Particles of the Universe** Jeff Yee, 2012-03-28 The universe is simply energy Everything around us including matter is energy A deep look into the mysteries of the subatomic world the particles that make up the atom provides answers to basic questions about how the universe works To solve the future of mankind s energy needs we need to understand the basic building blocks of the universe including the atom and its parts By exploring the subatomic world we ll find more answers to our questions about time forces like gravity and the matter that surrounds us More importantly we ll find new ways to tap into the energy that exists around us to power our growing needs In a new branch of particle physics where tiny particles are thought of as energy waves we find new answers that may help us in our quest to find alternative energy sources January 2018 Update This first book in The Particles of the Universe series serves as a call to action to renew support for the aether and it summarizes works from physicists working on the wave structure of matter The second book in the series is now available The Particles of the Universe 2 Disrupted proving elements of the original hypothesis of matter s wave properties The proof includes calculations of atomic orbital distances and photon energies for the first twenty atomic elements particle mass calculations derivations of fundamental physical constants and derivations of existing energy and force equations quantum and classical from one base equation Subscribe to the YouTube Channel for videos at <https://www.youtube.com/c/energywavetheory> Further details and downloads on the web site at <http://www.energywavetheory.com>

*Particles and the Universe* Stephan Narison, 2015-11-27 This book aims to present the history and developments of particle physics from the introduction of the notion of particles by the Ionian school until the discovery of the Higgs boson at LHC in 2012 Neutrino experiments and particle accelerators where different particles have been discovered are reviewed In particular details about the CERN accelerators are presented This book also discusses the future developments of the field and the work to popularize high energy physics A short presentation of some features of astrophysics and its connection to particle physics is also included At the end of the book some useful tools in the research of particle physics are given for the advanced readers

*The Particle Odyssey* Frank Close, Michael Marten, Christine Sutton, 2004-08-26 During the 20th century scientists discovered what the Universe is made of as the 21st century begins they are preparing experiments to find out how it came to be like this This great adventure which will involve a metaphorical journey back in time to within a billionth of a second of the Big Bang is the latest stage in the quest to understand the nature of the matter that makes our Universe and the forces that govern it The Particle Odyssey takes the reader on a spectacularly illustrated journey to the heart of matter In clear non technical language the authors describe the key experiments and fundamental discoveries which have led to our current understanding of the origins and nature of the material universe In this fascinating book you will find individual portraits of all the major subatomic particles from the electron to the top quark The authors describe the history of experimental particle physics its origins in the discovery of X rays in 1895 the dissection of the atom by Rutherford and

others the unexpected revelations of the cosmic rays the explosion of new particles in the 1950s and 60s the discovery of quarks and the rise of the standard model in the last part of the 20th century And they also look at the great challenges that face physicists today where did antimatter go what is dark matter can there be a theory of everything and the experiments they are devising to explore them The Particle Odyssey brings together and presents with style over 100 of the best images of particle events mysterious abstract beautiful pictures of the tracks of subatomic particles as they speed curve dance or explode through cloud and bubble chambers stacks of photographic emulsion and the giant multi element detectors of modern experiments Here are spiralling electrons the tell tale vees of strange particles matter and antimatter born from raw energy energetic jets of particles spraying out from the decay points of quarks and gluons A further 250 pictures many taken specially for this book illustrate the laboratories experiments and personalities of over a century of particle physics This superb book is a testament to the work of big science and one of the great detective stories of our age     *The Cosmos* Shouvik Sarkar,2023-10-20 The Cosmos is a scientific book explaining the various phenomena of the Cosmos It specifically empathizes on quantum physics to trying to explain the cosmos its creation and various phenomena of it including its end and intelligent beings This would be a good read to know about the reality of the Cosmos and dive deep into it s secrets     *What Is the World* Stoyan Kurtev,2013-08-23 What is the world is the deepest question one could ask Its answer requires an understanding of both matter and mind and also of the relationship between them This book offers a new approach to answering this question based on the concept of representation and resulting in an identity theory regarding the relationship between mind and matter In doing that it offers a new way of thinking about the notoriously counterintuitive quantum phenomena and also about the totality of everything what we call the universe That new understanding leads to a projection about the future of the universe for the next 10 million years and has practical implications about our present day way of life and worldviews     *Particles and the Universe* Kyle Kirkland,2007 Discusses the advances in physics since Newton s observations including nuclear physics particle physics quantum mechanics and cosmology     Elementary Particles and the Universe Murray Gell-Mann,1991-10-25 This book is a collection of research articles especially written by eminent scientists to celebrate the 60th birthday in September 1989 of the Nobel Laureate and inventor of quarks Professor Murray Gell Mann The main body of contributions are concerned with theoretical particle physics and its applications to cosmology     **The Particle Odyssey** Frank Close,Michael Marten,Christine Sutton,2004-11-11 1 The world of particle physics 2 Voyage into the atom 3 The structure of the atom 4 The extraterrestrials 5 The cosmic rain 6 The challenge of the big machines 7 The particle explosion 8 Colliders and image chambers 9 From charm to top 10 The whys of particle physics 11 Futureclash 12 Particles at work Table of particles Further reading acknowledgements Picture credits Index     *Geometry of Knowledge for Intelligent Systems* Germano Resconi,2012-07-27 The book is on the geometry of agent knowledge The important concept studied in this book is the Field and its Geometric Representation To develop a geometric image of the gravity Einstein used

Tensor Calculus but this is very different from the knowledge instruments used now as for instance techniques of data mining neural networks formal concept analysis quantum computer and other topics The aim of this book is to rebuild the tensor calculus in order to give a geometric representation of agent knowledge By using a new geometry of knowledge we can unify all the topics that have been studied in recent years to create a bridge between the geometric representation of the physical phenomena and the geometric representation of the individual and subjective knowledge of the agents

Particles in the Dark Universe Yann Mambrini, 2024-10-21 This second edition of Particles in the Dark Universe has been substantially enhanced with several new chapters that delve into crucial aspects of particle physics in the Universe These additions encompass the role of primordial black holes in the early universe tracing their formation to decay unification theories a comprehensive historical overview of cosmological models an extensive examination of the physics of the graviton and an educational exploration of gravitational phenomena such as Unruh type or Hawking radiation Additionally this edition incorporates 30 new exercises and provides a comprehensive presentation of inflationary models along with a pedagogical insight into the mechanism of baryogenesis Structured in a logical sequence this book offers a thorough and instructional exploration of particle physics within the early universe It initiates by elucidating the thermal history of the universe delving into pivotal concepts like Big Bang nucleosynthesis the cosmic microwave background CMB and inflation Subsequently it meticulously addresses both direct and indirect detection methods of dark matter followed by an in depth analysis of neutrino physics The book further scrutinizes potential candidates for dark matter and their interactions Designed for theoretical physicists engaged in particle physics within the universe dark matter detection astrophysical constraints and those interested in models of inflation or reheating this book also caters to astrophysicists involved in quantum field theory computations It encompasses all essential elements required for computing various physical processes providing mathematical tables necessary thermodynamic functions for the early universe and Feynman rules Consequently this book serves as an intersecting point between astrophysics particle physics and cosmology

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