

Standard Model of FUNDAMENTAL PARTICLES AND INTERACTIONS

The Standard Model is a quantum theory that summarizes our current knowledge of the physics of fundamental particles and fundamental interactions (interactions are manifested by forces and by decay rates of unstable particles).

FERMIONS

matter constituents
spin = 1/2, 3/2, 5/2, ...

BOSONS

force carriers
spin = 0, 1, 2, ...

Leptons spin = 1/2			Quarks spin = 1/2		
Flavor	Mass GeV/c ²	Electric charge	Flavor	Approx. Mass GeV/c ²	Electric charge
ν_L lightest neutrino*	(0-0.13) $\times 10^{-9}$	0	u up	0.002	2/3
e electron	0.000511	-1	d down	0.005	-1/3
ν_M middle neutrino*	(0.009-0.13) $\times 10^{-9}$	0	c charm	1.3	2/3
μ muon	0.106	-1	s strange	0.1	-1/3
ν_H heaviest neutrino*	(0.04-0.14) $\times 10^{-9}$	0	t top	173	2/3
τ tau	1.777	-1	b bottom	4.2	-1/3

*See the neutrino paragraph below.

Spin is the intrinsic angular momentum of particles. Spin is given in units of \hbar , which is the quantum unit of angular momentum where $\hbar = h/2\pi = 6.58 \times 10^{-25}$ GeV s = 1.05×10^{-34} J s.

Electric charges are given in units of the proton's charge. In SI units the electric charge of the proton is 1.60×10^{-19} coulombs.

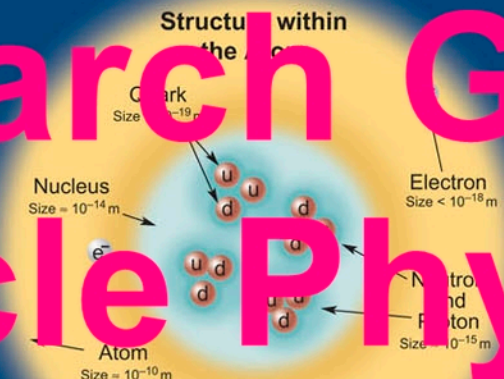
The **energy** unit of particle physics is the electronvolt (eV), the energy gained by one electron in crossing a potential difference of one volt. **Masses** are given in GeV/c² (remember $E = mc^2$ where $1 \text{ GeV} = 10^9 \text{ eV} = 1.60 \times 10^{-10}$ joule. The mass of the proton is $0.938 \text{ GeV}/c^2 = 1.67 \times 10^{-27}$ kg.

Neutrinos

Neutrinos are produced in the sun, supernovae, reactors, accelerator collisions, and many other processes. Any produced neutrino can be described as one of three neutrino flavor states ν_e , ν_μ , or ν_τ , labelled by the type of charged lepton associated with its production. Each is a defined quantum mixture of the three definite mass neutrinos ν_L , ν_M , and ν_H for which currently allowed mass ranges are shown in the table. Further exploration of the properties of neutrinos may yield powerful clues to the puzzle about matter and antimatter and the evolution of stars and galaxy structures.

Matter and Antimatter

For every particle type there is a corresponding antiparticle type, denoted by a bar over the particle symbol (unless + or - charge is shown). Particle and antiparticle have identical mass and spin but opposite charges. Electrically neutral bosons (e.g., Z^0 , γ , and $\eta_c = c\bar{c}$ but not $K^0 = d\bar{s}$) are their own antiparticles.



If the proton and neutrons in this picture were the size of a grape, then the quarks and electrons would be smaller than 0.1 mm in size and the entire atom would be about 1 cm across.

Unified Electroweak spin = 1		
Name	Mass GeV/c ²	Electric charge
γ photon	0	0
W^-	80.39	-1
W^+	80.39	+1
Z^0	91.1876	0
τ lepton	1.777	-1
ν_τ neutrino	0	0

Strong (color) spin = 1		
Name	Mass GeV/c ²	Electric charge
g gluon	0	0

Color Charge
Only quarks and gluons carry "strong charge" (also called "color charge") and can have strong interactions. Each quark carries three types of color charge. These charges have nothing to do with the colors of visible light. Just as electrically-charged particles interact by exchanging photons, in strong interactions, color-charged particles interact by exchanging gluons.

Quarks Combined into Hadrons
Quarks and gluons cannot be isolated – they are confined in color-neutral particles called **hadrons**. This confinement (binding) results from multiple exchanges of gluons among the color-charged constituents. As color-charged particles (quarks and gluons) move apart, the energy in the color-force field between them increases. This energy eventually is converted into additional quark-antiquark pairs. The quarks and antiquarks then combine into hadrons; these are the particles seen to emerge.

Two types of hadrons have been observed in nature **mesons** $q\bar{q}$ and **baryons** qqq . Among the many types of baryons observed are the proton (uud), antiproton ($\bar{u}\bar{u}\bar{d}$), neutron (udd), lambda Λ (uds), and omega Ω^- (sss). Quark charges add in such a way as to make the proton have charge 1 and the neutron charge 0. Among the many types of mesons are the pion π^+ (u \bar{d}), kaon K^- (s \bar{u}), B^0 (d \bar{b}), and η_c (c \bar{c}). Their charges are +1, -1, 0, 0 respectively.

Properties of the Interactions

The strengths of the interactions (forces) are shown relative to the strength of the electromagnetic force for two u quarks separated by the specified distances.

Property	Gravitational Interaction	Weak Interaction (Electroweak)	Electromagnetic Interaction	Strong Interaction
Acts on:	Mass – Energy	Flavor	Electric Charge	Color Charge
Is experimentally verified:	All	Yes, Leptons	Electric Charge	Gluons
Particles mediated:	(no mediator observed)	W^+ , W^-	Photon	Gluons
Range:	$> 10^{26}$ m	$\sim 10^{-16}$ m	$> 10^{26}$ m	$\sim 10^{-15}$ m
Strength:	10^{-41}	10^{-4}	1	60

Visit the award-winning feature *The Particle Adventure* at ParticleAdventure.org

This chart has been made possible by the generous support of:
 U.S. Department of Energy
 U.S. National Science Foundation
 Lawrence Berkeley National Laboratory

©2006 Contemporary Physics Education Project. CPEP is a non-profit organization of teachers, physicists, and educators. For more information see CPEPweb.org

Particle Processes

These diagrams are an artist's conception. Blue shaded areas represent the cloud of virtual particles that mediate the interaction.

A free neutron (udd) decays to a proton (uud), an electron, and an antineutrino via a virtual (mediating) W boson. This is neutron β (beta) decay.

An electron and positron (antielectron) colliding at high energy can annihilate to produce B^0 and B^0 mesons via a virtual Z boson or a virtual photon.

Unsolved Mysteries

Driven by new puzzles in our understanding of the physical world, particle physicists are following paths to new wonders and startling discoveries. Experiments may even find extra dimensions of space, mini black holes, and/or evidence of string theory.

Universe Accelerating?

The expansion of the universe appears to be accelerating. Is this due to Einstein's Cosmological Constant? If not, will experiments reveal a new force of nature or even extra (hidden) dimensions of space?

Why No Antimatter?

Matter and antimatter were created in the Big Bang. Why do we now see only matter except for the tiny amounts of antimatter that we make in the lab and observe in cosmic rays?

Origin of Mass?

In the Standard Model, for fundamental particles to have masses, there must exist a particle called the Higgs boson. Will it be discovered soon? Is supersymmetry theory correct in predicting more than one type of Higgs?

(Dr. Rupak Nath)

Research Book

Dark Energy

73%

God Particle Physics

By

Dr. Rupnathji

(Dr. Rupak Nath)

Atoms 4%

Cold Dark Matter 23%





Guide Book

A-Z Astro Physics

By

Dr. Rupnathji

(Dr. Rupak Nath)



Guide Book

**A-Z Numerical
Astro Physics**

By

**Dr.Rupnathji
(Dr.Rupak Nath)**



The background of the image is a deep space scene. It features a bright green nebula or star-forming region in the upper left, with a bright green star at its center. To the right, there are two large, dark planets or moons. The foreground planet is blue and white, resembling Earth, while the one behind it is dark and featureless. The overall color palette is dominated by dark blues, greens, and blacks, with bright highlights from the star and nebula.

Text Book

**A-Z Numerical
Astro Physics
Encyclopedia**

By

**Dr.Rupnathji
(Dr.Rupak Nath)**



Text Book

A-Z Mathematical

Astro Physics

Encyclopedia

By

Dr.Rupnathji

(Dr.Rupak Nath)

Text Book

**A-Z Modern
Astro Physics
Encyclopedia**

By

**Dr.Rupnathji
(Dr.Rupak Nath)**

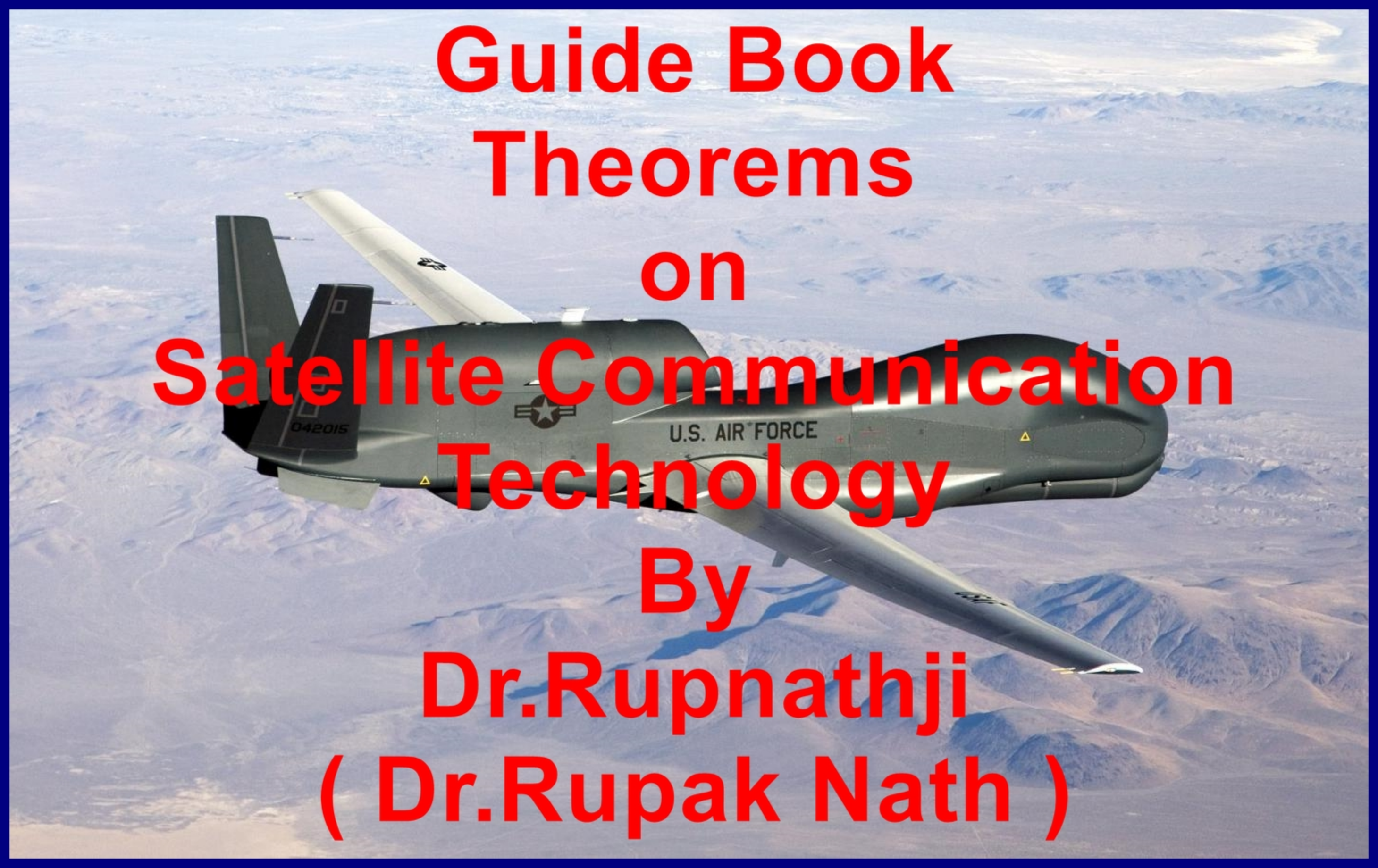
A photograph of the Space Shuttle Discovery on the Mobile Launcher Platform being mated to the External Tank and Solid Rocket Boosters on the Vehicle Assembly Building at night. The shuttle is white with orange and black markings. The background shows the launch complex illuminated by lights.

Text Book

**A-Z Modern
Space Technology
Encyclopedia**

By

**Dr. Rupnathji
(Dr. Rupak Nath)**



**Guide Book
Theorems
on
Satellite Communication
Technology
By
Dr. Rupnathji
(Dr. Rupak Nath)**

Text Book

Theorems
On
University College
Physics Encyclopedia
By
Dr.Rupnathji
(Dr.Rupak Nath)



$$T = 2\pi \sqrt{\frac{a^3}{\mu}}$$

$$\mu = 6 \times M(\text{sun})$$

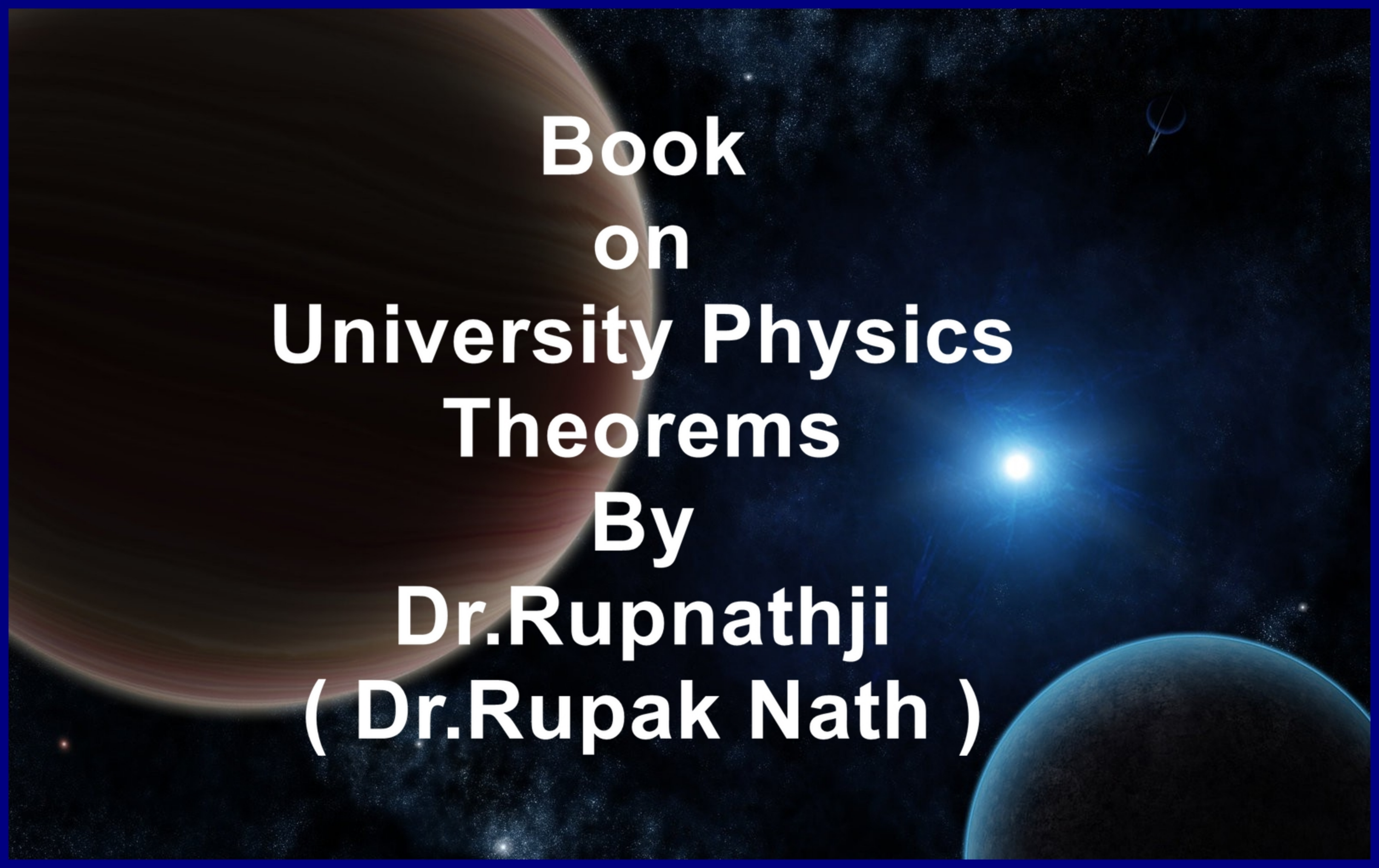
$$T = 2\pi \sqrt{\frac{149,597,887.5^3 \text{ km}^3}{132,712,440,018 \text{ km}^3 \text{ s}^{-2}}}$$

$$T = 2\pi(5022643.737) \text{ s}$$

$$T = 31558201.33 \text{ seconds}$$

$$31558201.33 \text{ s} \times \frac{1 \text{ minute}}{60 \text{ seconds}} = 525,970 \text{ minutes}$$

$$525,970 \times \frac{1 \text{ hour}}{60 \text{ minutes}} \times \frac{1 \text{ day}}{24 \text{ hours}} \approx \underline{\underline{365.25}}$$

The background is a deep space scene. On the left, a large, reddish-brown planet with prominent rings is partially visible. In the center-right, a bright blue star or nebula glows. At the bottom right, the dark, curved horizon of a blue planet is visible. The sky is filled with numerous small, distant stars.

**Book
on
University Physics
Theorems
By
Dr.Rupnathji
(Dr.Rupak Nath)**

ESTRUTURA ELEMENTAR DA MATÉRIA

Text Book

Of

Quantum Physics

By

Dr. Rupnathji

(Dr. Rupak Nath)

PARTÍCULAS MEDIADORAS

Interação Eletromagnética
FÓTON

Interação Fraca
W⁺ Z⁰ W⁻

Interação Forte
GLÚON

Interação Gravitacional
GRÁVITON

QUARKS

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

LÉPTONS

ν_e neutrino e	ν_μ neutrino μ	ν_τ neutrino τ
e elétron	μ múon	τ tau

Léptons

Léptons são partículas que interagem por meio das interações eletromagnética e fraca. Há três famílias de léptons, cada uma composta por um lépton carregado, que interage eletromagneticamente e fracamente, e por um neutrino, que interage apenas fracamente.

Os **elétrons** (e) são estáveis e compõem a eletrosfera que envolve o núcleo dos átomos, sendo os responsáveis pelas ligações químicas entre os elementos. Em movimento, produzem corrente elétrica e geram campos magnéticos. Os léptons **múon** (μ) e **tau** (τ) possuem características similares às do elétron, mas são muito mais pesados e instáveis, decaindo rapidamente em partículas mais leves.

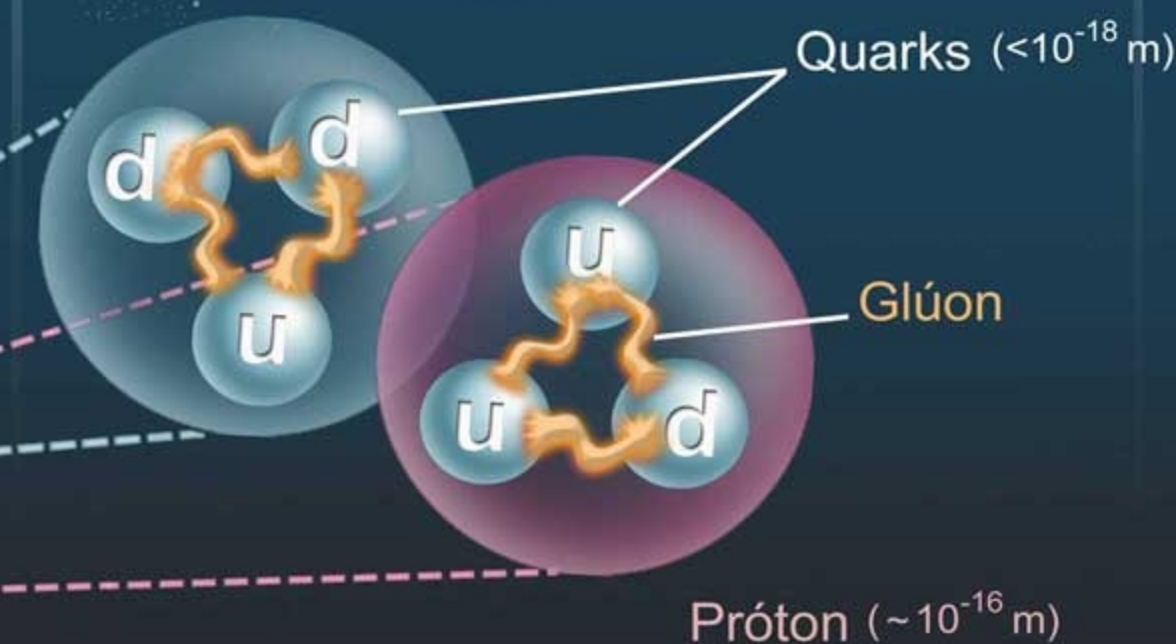
Os **neutrinos** (ν) são extremamente leves, não possuem carga elétrica e interagem muito fracamente, ponto de vista de atravessar toda a Terra sem sofrer qualquer alteração em sua partícula. São produzidos em reações nucleares e nas explosões nucleares que ocorrem no Sol e são responsáveis pelo seu brilho.

Quarks

Quarks são partículas que interagem por meio das interações eletromagnética, fraca e forte, e possuem carga elétrica fracionária (+2/3 e -1/3), além das "cargas de cor" relativas à interação forte. Eles formam os hádrons (três quarks ou um quark e um antiquark) e permanecem confinados dentro deles, não sendo observados em estado livre.

Os quarks da primeira família, **up** (u) e **down** (d), formam os prótons (uud) e nêutrons (udd) e, portanto, toda a matéria usual, além de diversos mésons, como o pión π⁺ (u d̄) e o káon K⁰ (d s̄).

As outras duas famílias de quarks, compostas pelo **strange** (s) e **charm** (c), e pelo **bottom** (b) e **top** (t), não formam a matéria usual, sendo apenas produzidas como resultado de colisões entre outras partículas.



Interação Eletromagnética (γ)

O fóton (γ) é o quantum do campo eletromagnético. Toda radiação **eletromagnética**, desde as ondas de rádio e televisão, passando pela luz visível, até os raios ultravioleta e gama, é formada por fótons. Partículas sem massa ou carga, os fótons são responsáveis pela transmissão da interação entre as partículas eletricamente carregadas.

Interação Gravitacional (G)

A interação gravitacional atua sobre todas as partículas e é intermediada pelo gráviton. No entanto, no mundo microscópico, ela tem nenhuma influência, já que ela é uma centena de milhão de milhão de milhão de milhão de milhão (10⁻³⁸) de vezes mais fraca que as outras três interações.

Interação Fraca (W e Z)

A **interação fraca** é intermediada pelos bósons carregados **W⁺** e **W⁻** e pelo bóson neutro **Z⁰**. A interação fraca é de curtíssimo alcance, agindo em distâncias muitas vezes menores que o núcleo atômico, sendo 10.000 mais fraca que a interação eletromagnética. A interação fraca afeta também leptões como elétrons e é responsável pelo decaimento beta, quando um nêutron se transforma em um próton, emitindo um elétron e seu antineutrino. Ela também desempenha importante papel na geração da energia das estrelas como o Sol.

Interação Forte (g)

O glúon (g) desempenha para a **interação forte** papel semelhante ao dos fótons para a interação eletromagnética. Eles são trocados entre partículas que possuem "cargas de cor", como os quarks e os três "cores" de "carga forte" equivalentes das partículas compostas de elétrons positivos e negativos. A interação forte é 100 vezes mais intensa que a interação eletromagnética e seu alcance não vai além do núcleo atômico. Ela é responsável por manter os quarks ligados, formando prótons e nêutrons, e seu efeito residual de longa distância mantém prótons e nêutrons unidos, formando o núcleo atômico.

Antipartículas

Toda partícula possui sua antipartícula, com mesma massa e spin, mas com carga oposta para contrariar as partículas. As antipartículas possuem a mesma massa e spin das partículas, mas com carga oposta. A matéria formada por antipartículas é chamada de antimatéria.

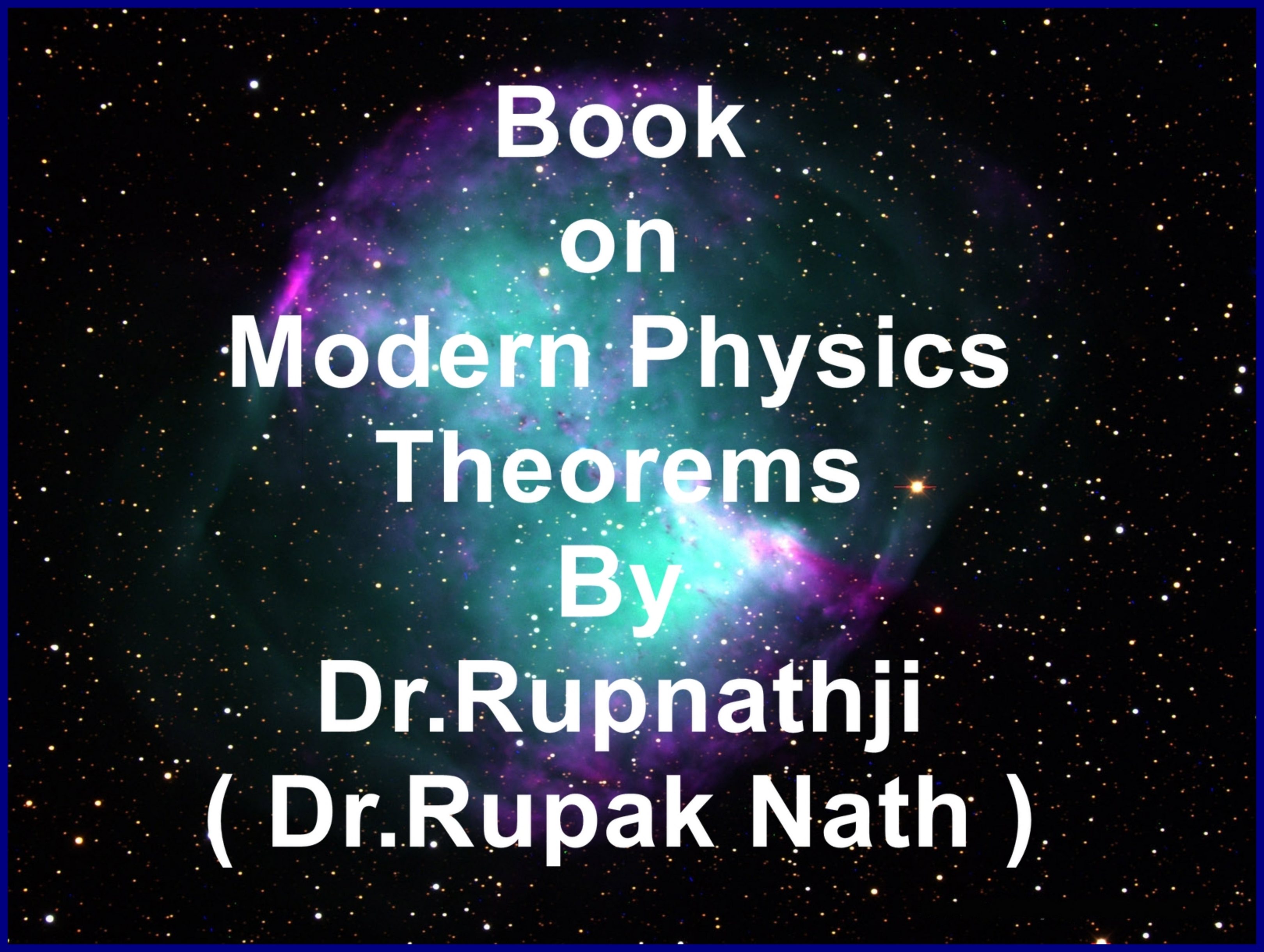
Para obter mais informações sobre os conceitos apresentados neste cartaz, acesse o site:

<http://www.sprace.org.br/eem/>

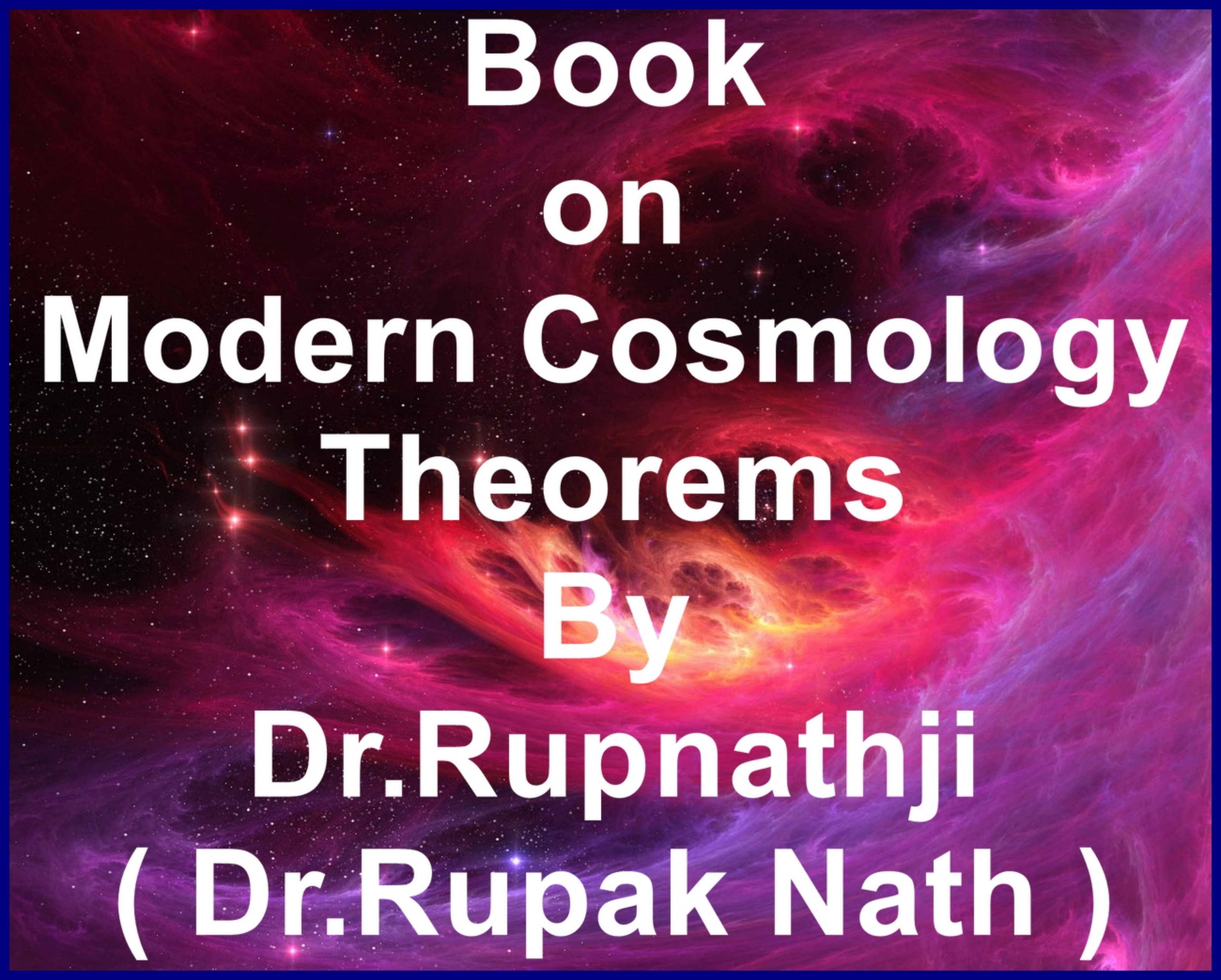
Se você quiser fazer perguntas sobre o tema para especialistas na área ou discutir com seus colegas, acesse o Fórum de Discussão no site:

<http://www.sprace.org.br/forum/>

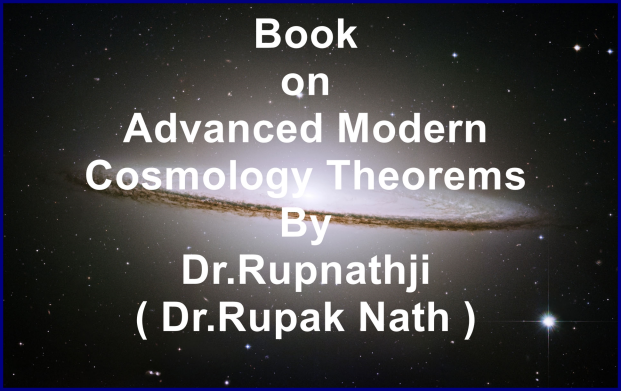




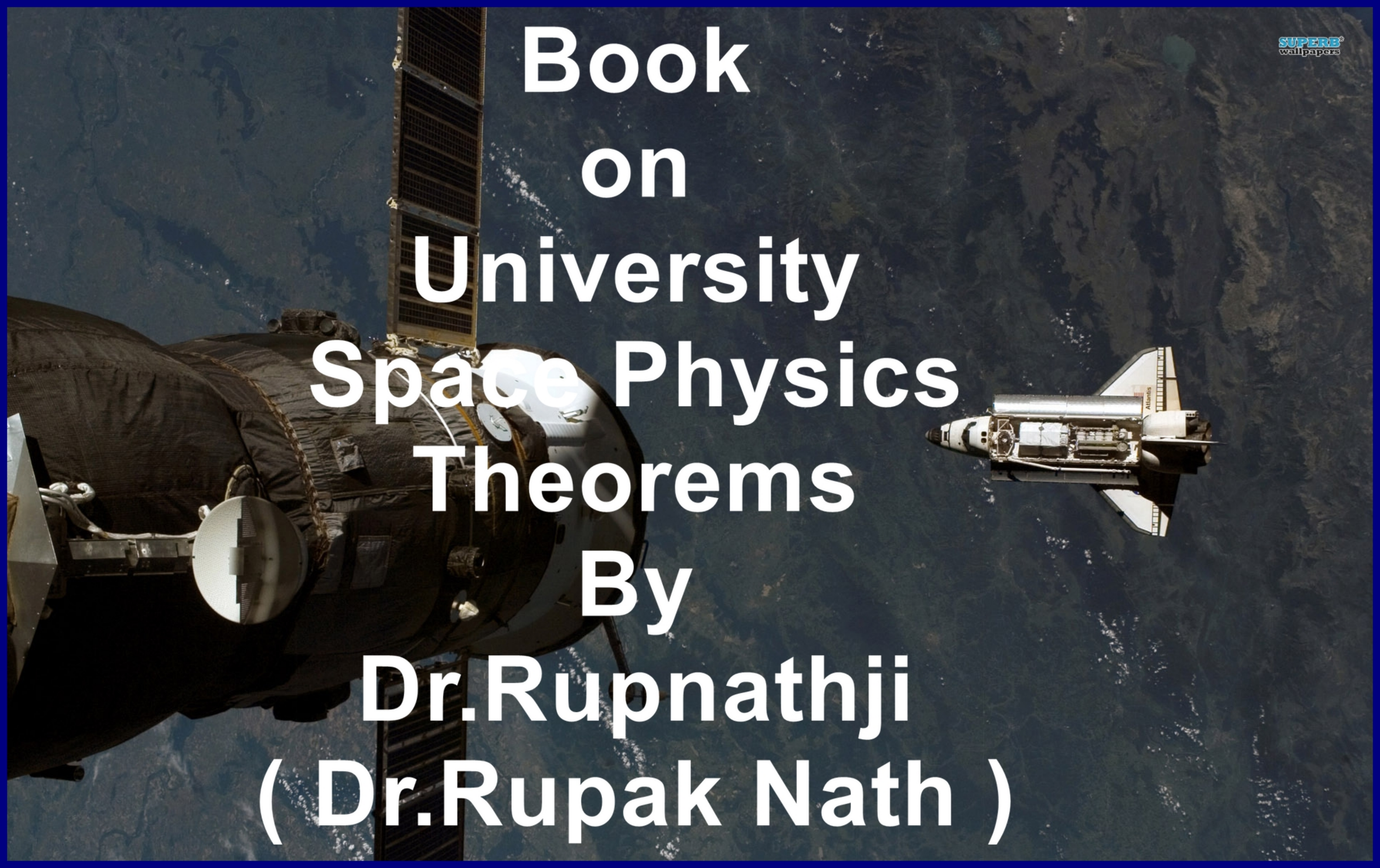
**Book
on
Modern Physics
Theorems
By
Dr.Rupnathji
(Dr.Rupak Nath)**



**Book
on
Modern Cosmology
Theorems
By
Dr. Rupnathji
(Dr. Rupak Nath)**



**Book
on
Advanced Modern
Cosmology Theorems
By
Dr.Rupnathji
(Dr.Rupak Nath)**

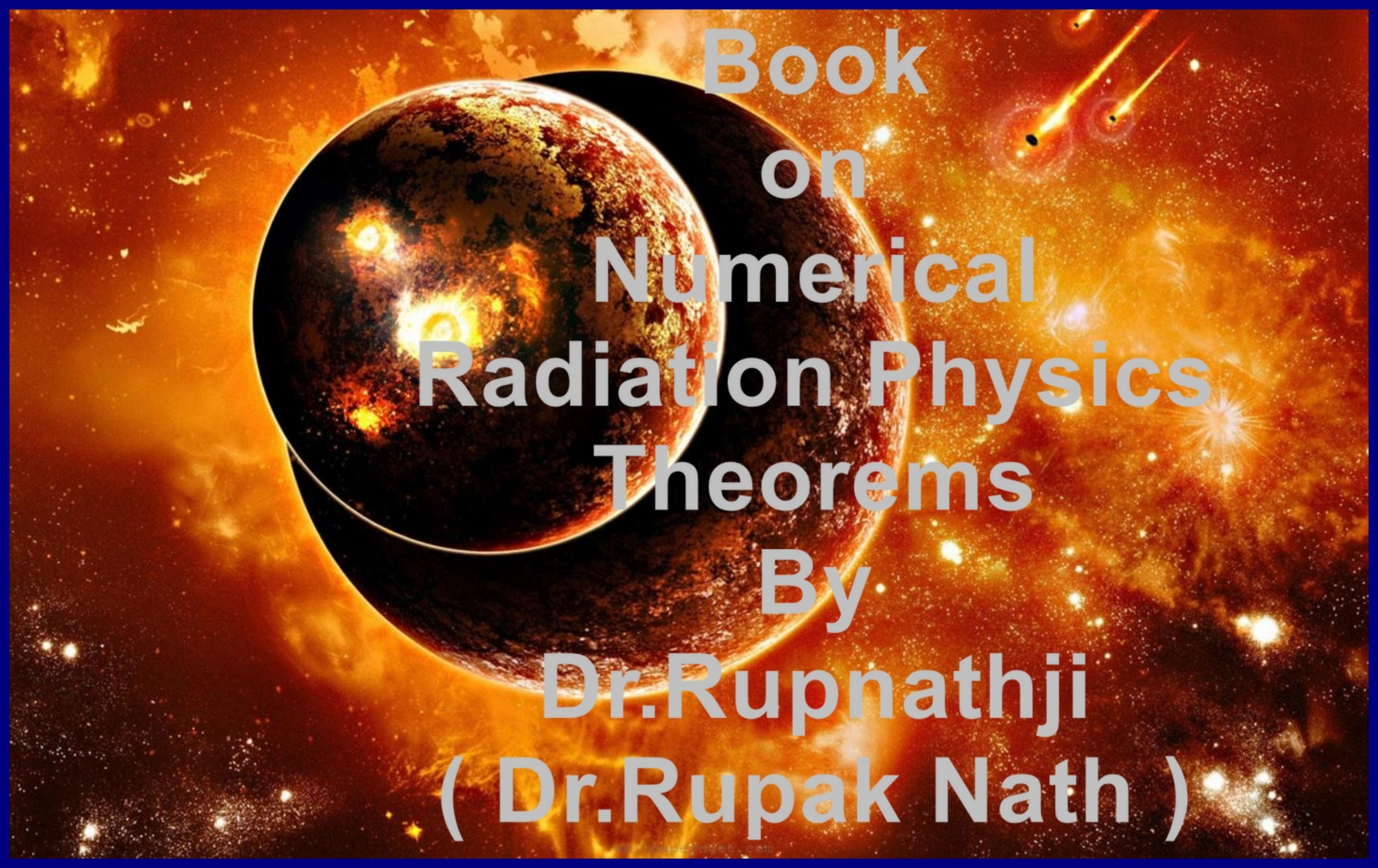
A photograph of the Space Shuttle Atlantis in orbit above Earth. The shuttle is on the right, with the name 'Atlantis' visible on its side. To the left, a large satellite or payload is visible, featuring a prominent white parabolic dish antenna. The background is the blue and white surface of the Earth from space.

**Book
on
University
Space Physics
Theorems
By
Dr. Rupnathji
(Dr. Rupak Nath)**

The background of the image is a photograph of the International Space Station (ISS) in orbit above Earth. The station's complex structure, including its truss, solar panel arrays, and various modules, is clearly visible against the bright blue of the planet's atmosphere and the blackness of space. The text is overlaid on this image in a bold, red font.

Guide Book

**Theorems
Of
University
Space Physics
By
Dr.Rupnathji
(Dr.Rupak Nath)**



**Book
on
Numerical
Radiation Physics
Theorems
By
Dr. Rupnathji
(Dr. Rupak Nath)**

**Book
on
A-Z University Cosmology
Encyclopedia
By
Dr.Rupnathji
(Dr.Rupak Nath)**



Guide Book

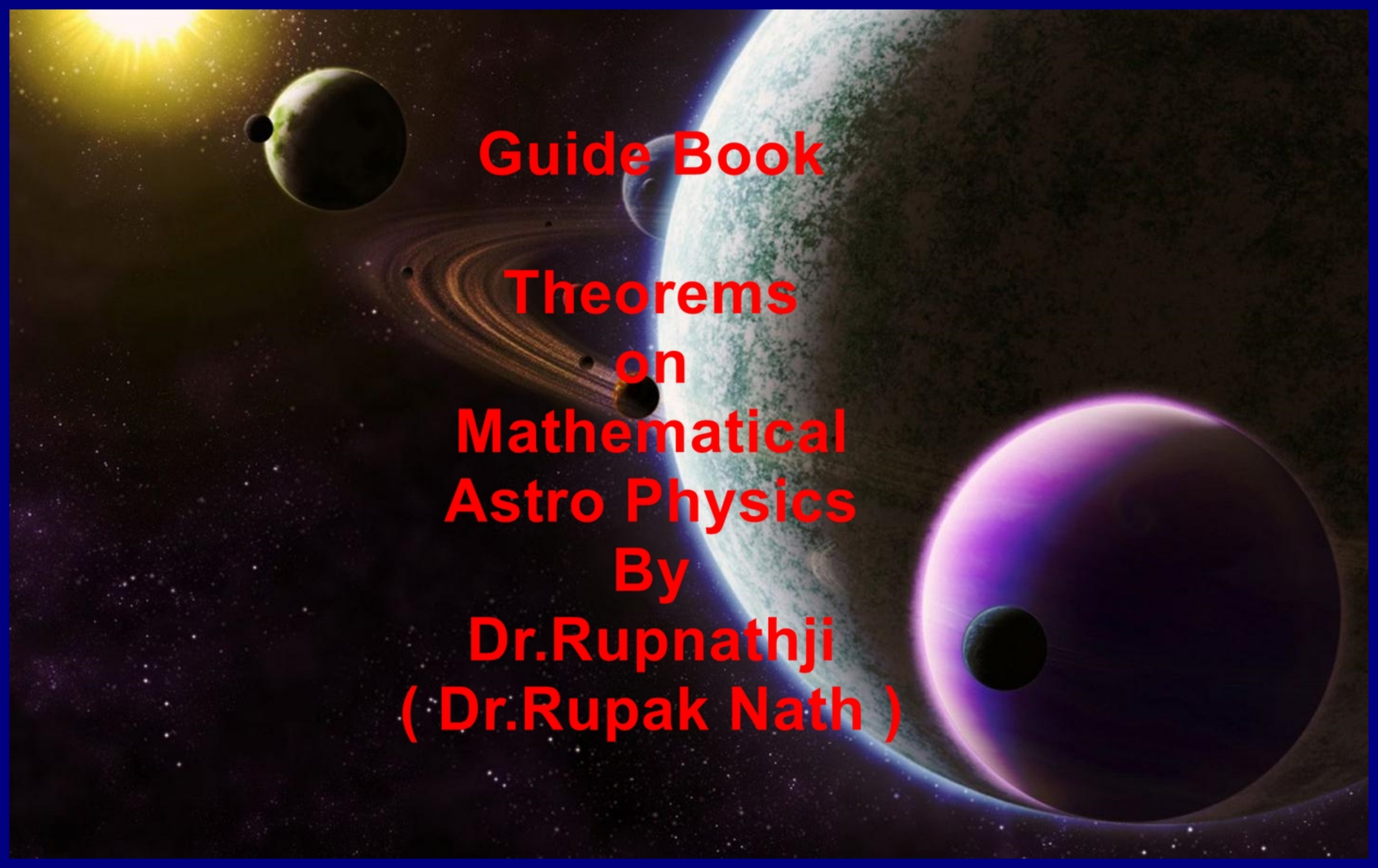
**Theorems
on**

Numerical Cosmology

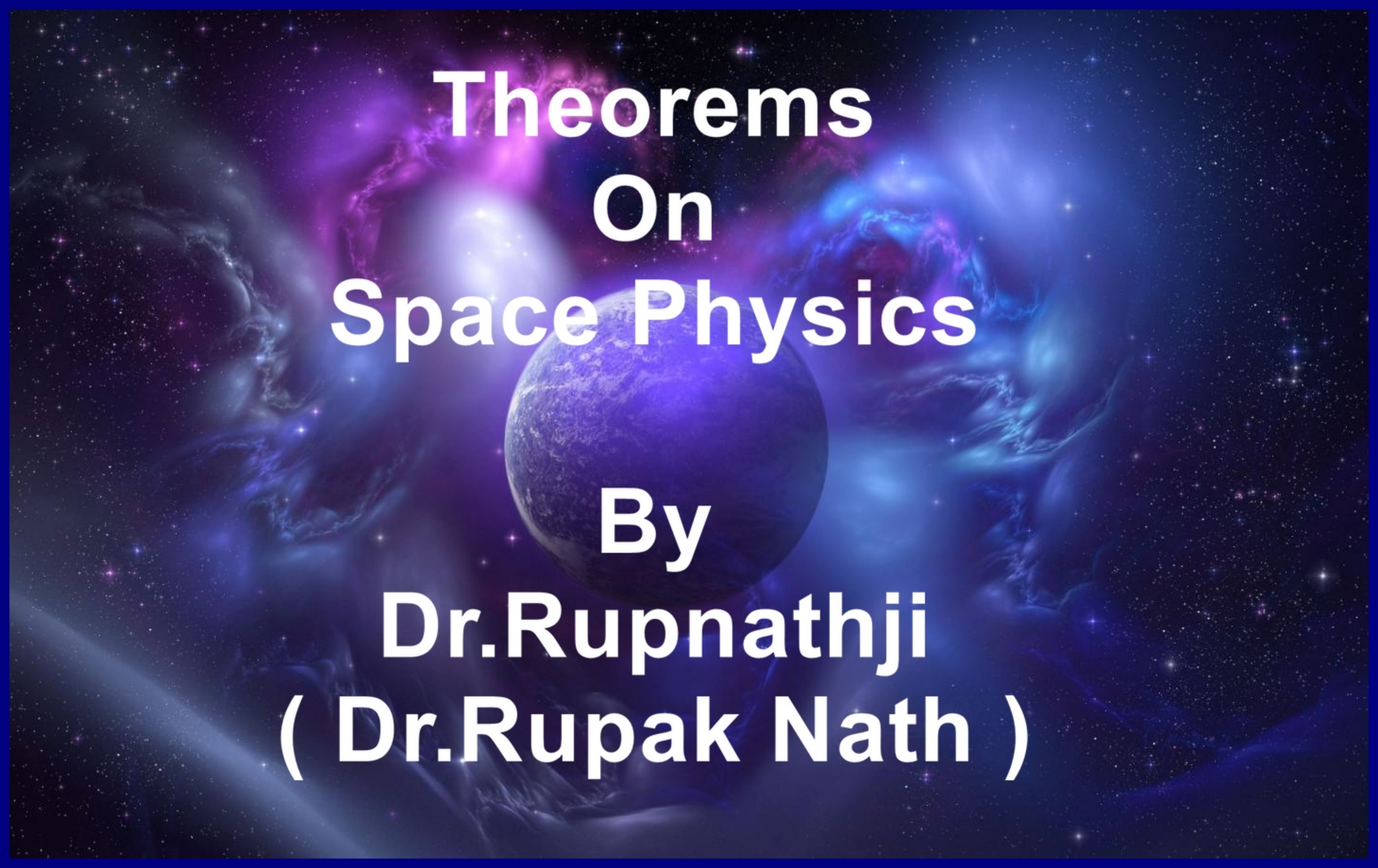
By

Dr.Rupnathji

(Dr.Rupak Nath)



Guide Book
Theorems
on
Mathematical
Astro Physics
By
Dr.Rupnathji
(Dr.Rupak Nath)



**Theorems
On
Space Physics**

**By
Dr.Rupnathji
(Dr.Rupak Nath)**

Where is the Higgs Hiding?

Collider
Detector at
Fermilab

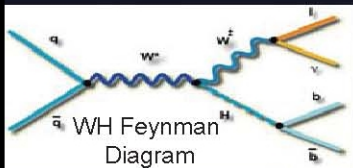


Tevatron Accelerating protons and antiprotons to approximately 2 TeV

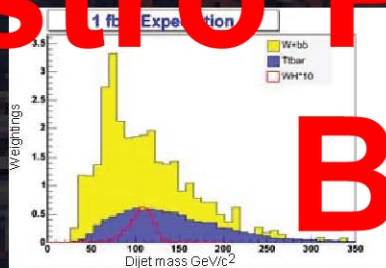
By: Dr. Rupak Nathji with Dr. John Campbell, Dr. Richard Hughes, E. Gordon Phillips and Ron Sluiter. Ohio State Department of Physics

Research Guide Book

Where is WH?



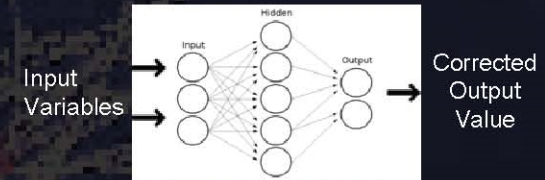
- Higgs is the only undiscovered particle in the Standard Model
- One Mechanism for Higgs Production at Tevatron



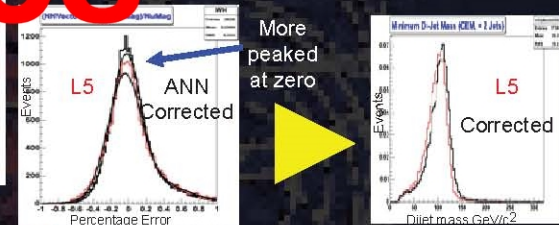
Tools and Results

Artificial Neural Network

- Advanced analysis technique
- Ease of the human brain's ability to recognize patterns
- Varies weights in a series of tests called training to improve the E_t



Improving the MET measurement
Correct the jet measurement



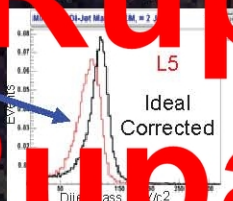
Problems

- Large Background
- Small Cross-section

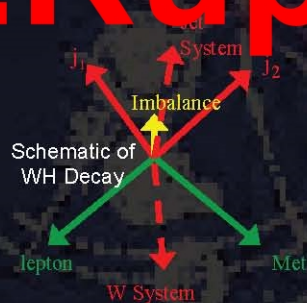
How to make Improvements?

$$\text{Resolution} = \frac{\sigma}{\mu}$$

Want to sharpen this peak by improving the measurement of the neutrino

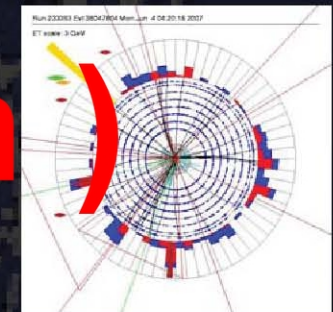


- Every one percent improvement in resolution leads to a 10% increase in sensitivity
- This analysis aims for an improvement of at least a 2-3%.
- This analysis may require improvement in the measurement of the missing energy from the neutrino

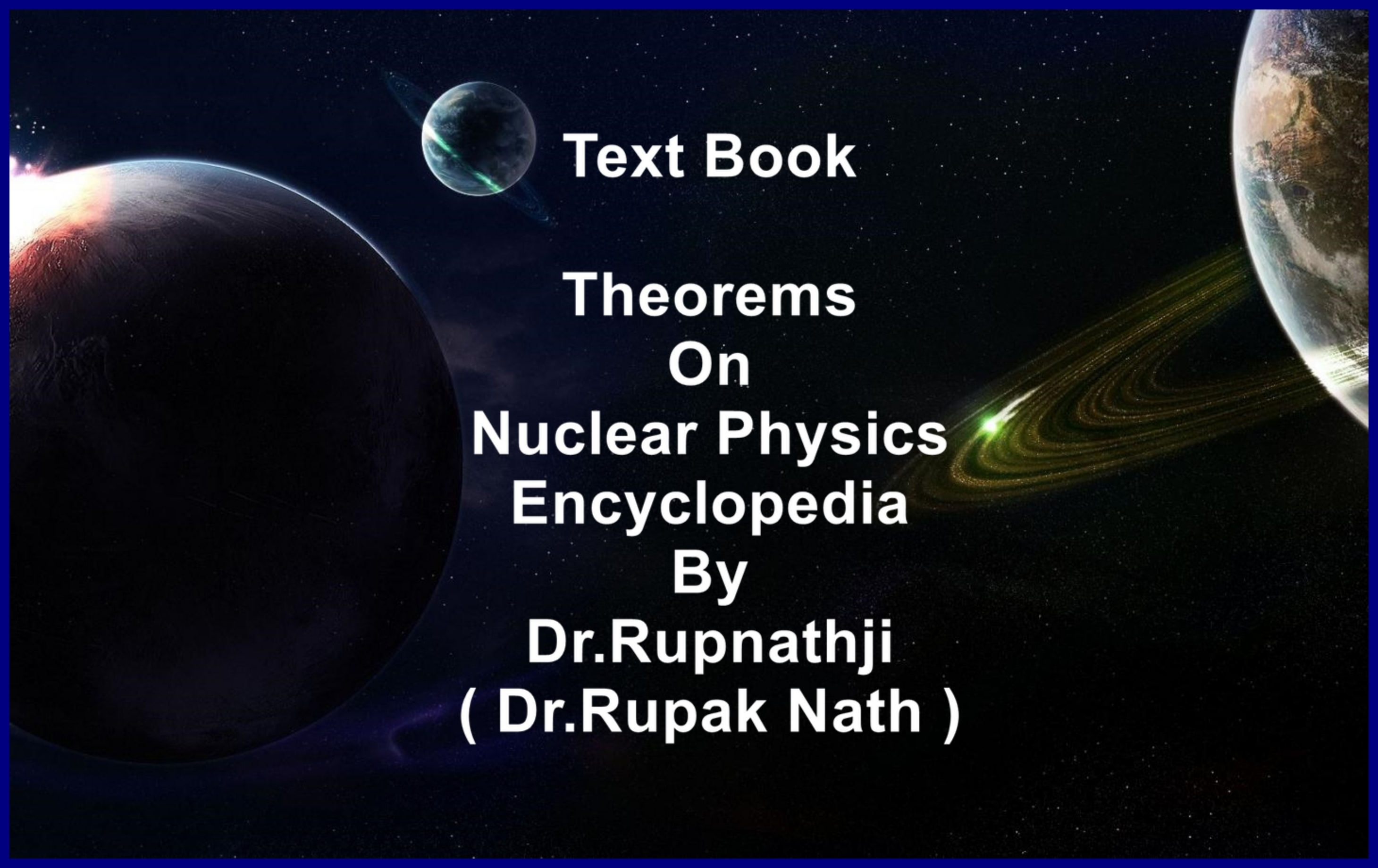


Future?

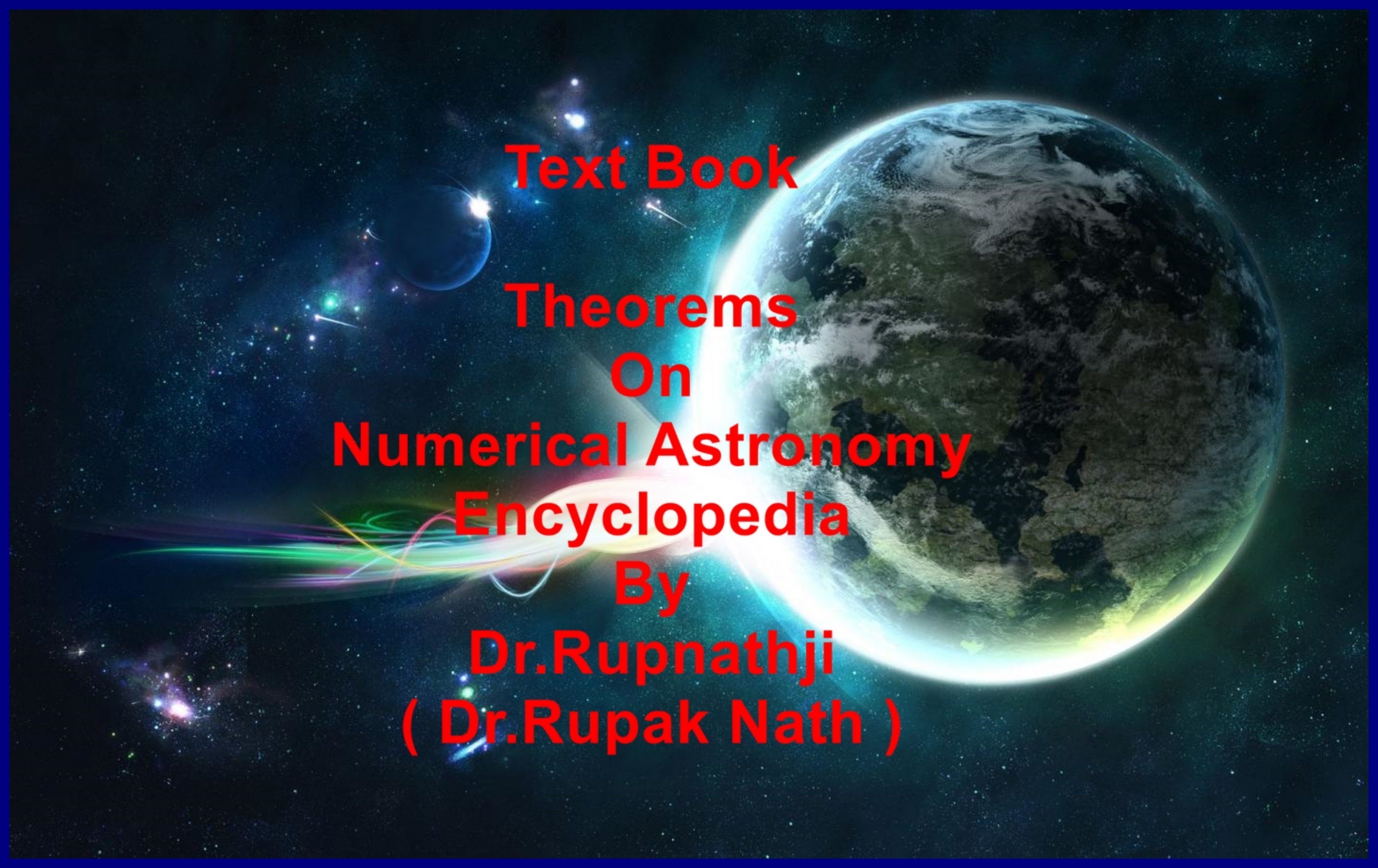
- Use track met variables to try to eliminate some fake MET from events
- Develop cuts to eliminate events with poorly measured MET
- Examine these cuts on previously eliminated signal regions




Track and cone definition for jets

The background is a deep space scene. On the left, a large, dark, reddish-brown planet is partially visible. In the upper center, a smaller planet with a blue and white atmosphere and a thin ring system is shown. On the right, a large portion of Earth is visible, showing continents and oceans. In the lower right, the rings of Saturn are depicted with a bright green light source illuminating them. The text is centered in white, bold font.

Text Book
Theorems
On
Nuclear Physics
Encyclopedia
By
Dr.Rupnathji
(Dr.Rupak Nath)



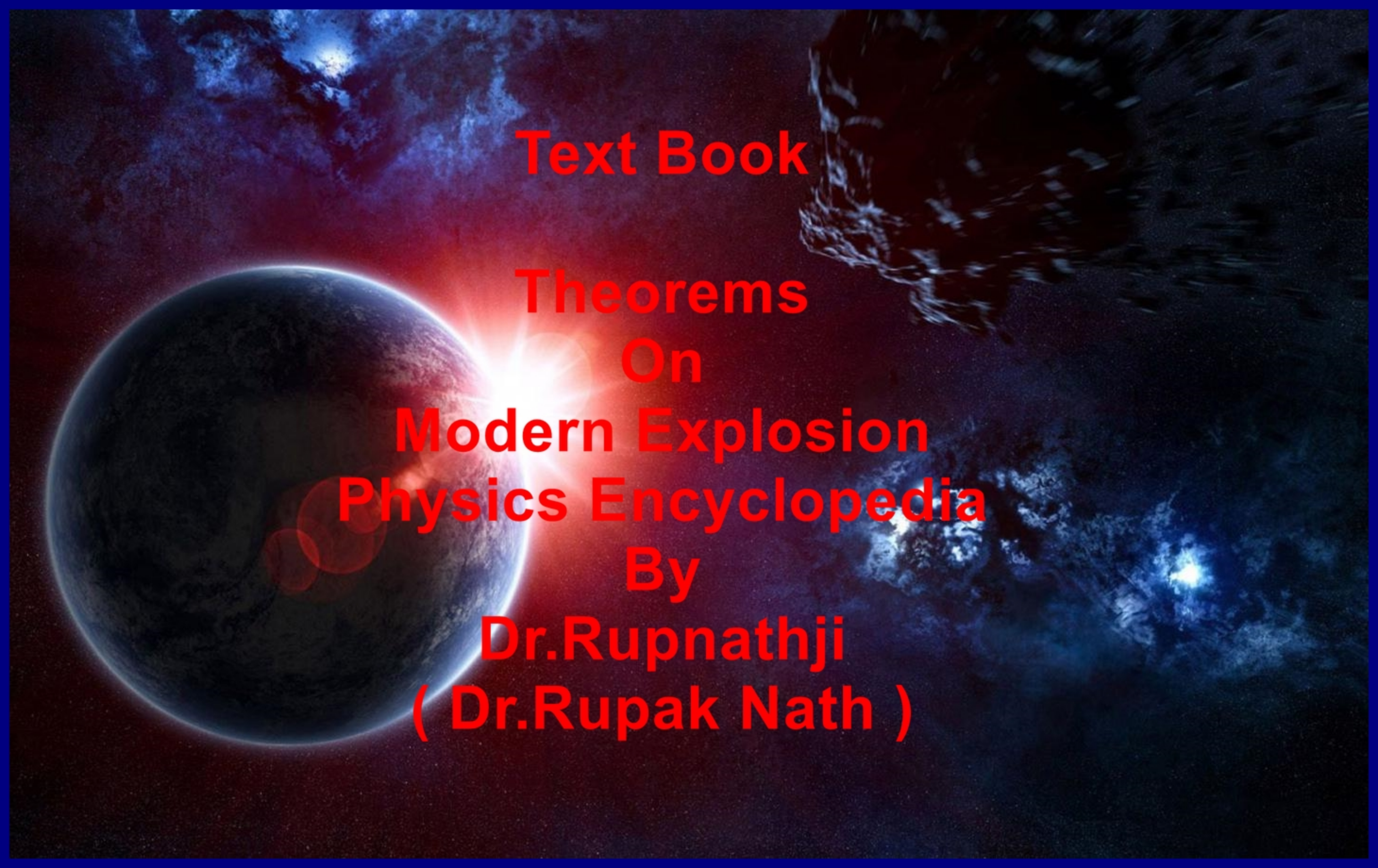
**Text Book
Theorems
On
Numerical Astronomy
Encyclopedia
By
Dr.Rupnathji
(Dr.Rupak Nath)**



**Text Book
Theorems
On
Nuclear Explosion**



**By
Dr. Rupnathji
(Dr. Rupak Nath)**



Text Book
Theorems
On
Modern Explosion
Physics Encyclopedia
By
Dr.Rupnathji
(Dr.Rupak Nath)

Guide

**A-Z Mathematical
Physics**

By

**Dr.Rupnathji
(Dr.Rupak Nath)**

A black dog's head is shown in profile, facing left, against a background of a starry night sky. A prominent red nebula is visible behind the dog's head. The text is overlaid on the image in white, bold, sans-serif font.

Guide Book

**Theorems
on**

Big Bang

By

Dr.Rupnathji

(Dr.Rupak Nath)

A futuristic space scene featuring a vibrant purple and blue galaxy in the background. In the foreground, the curved horizon of Earth is visible, with a bright blue and white atmosphere. Several advanced spacecraft are scattered throughout the scene, including a large, dark, rectangular vessel with glowing lights and a smaller, sleeker craft. The overall atmosphere is one of deep space exploration and advanced technology.

Guide Book

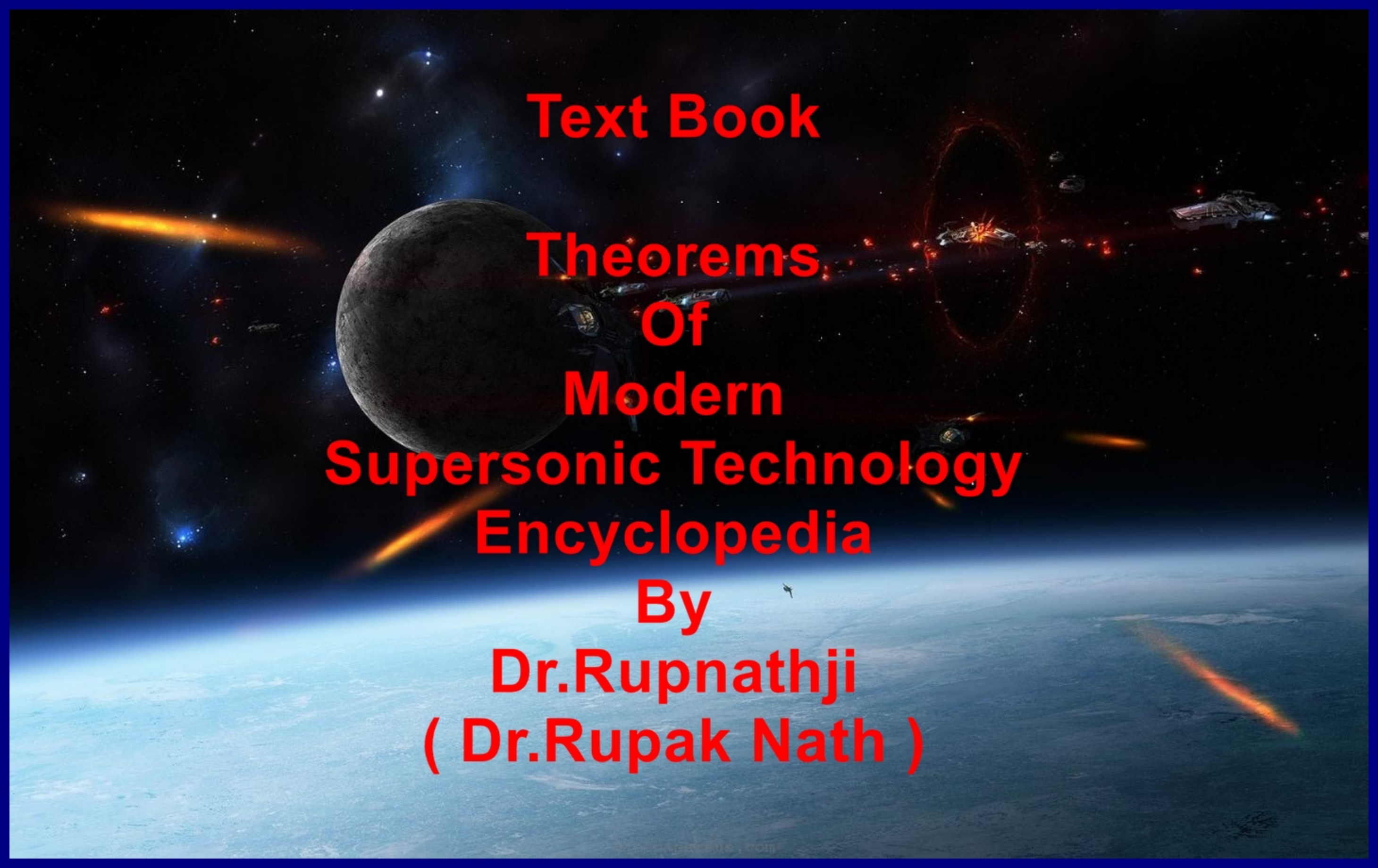
**Theorems
on
Great Explosions
By
Dr. Rupnathji
(Dr. Rupak Nath)**

A blue and white fighter jet, possibly an F-16, is shown in flight against a backdrop of a blue sky with scattered white clouds. The jet is angled upwards and to the right. It features a skull and crossbones emblem on the tail fin, the number '301' on the nose, and the word 'UNSPACY' on the side of the fuselage. The text 'Guide Book' is overlaid in large red letters at the top of the image.

Guide Book

**Theorems
on
Supersonic Technology
By**

**Dr. Rupnathji
(Dr. Rupak Nath)**

The background of the image is a vibrant space scene. On the left, a large, dark, cratered moon is partially visible. Below it, the blue and white horizon of a planet is seen from space. The right side of the image is filled with various futuristic spacecraft, some with glowing orange and red lights, and a large, glowing orange ring-like structure. The overall color palette is dominated by blues, oranges, and reds against a black starry background.

Text Book
Theorems
Of
Modern
Supersonic Technology
Encyclopedia
By
Dr.Rupnathji
(Dr.Rupak Nath)



Guide Book

**Features & variety
of
Geostationary Satellites**

By

**Dr.Rupnathji
(Dr.Rupak Nath)**

STANDARDMODELLEN ELEMENTÆRPARTIKLER OG VEKSELVIRKNINGER

Standardmodellen er summen av vår kunnskap om de fundamentale partikler og krefter som styrer universet. Den inkluderer kvantefeltteori, relativitetsteori og svak kjernekraft beskrevet i kvanteelektrosvak teori og fargekraft beskrevet i kvantekromodynamikk (QCD). Gravitasjon, som en relativitetsteori, er ikke inkludert i dag av standardmodellen.

Baryoner (utvalg av ca 120 typer) spinn = 1/2, 3/2

Partikkel	Kvark Innhold	S	C	B	Spinn	Masse MeV/c ²	El. Ladn	Henfall	
								tid (s)	til
p Proton	uud	0	0	0	1/2	938,3	+1	>3•10 ⁴⁴	Not
p̄ antiproton	ūūd	0	0	0	1/2	938,3	-1	?	observed
n Nøytron	udd	0	0	0	1/2	939,6	0	885,7	p, e ⁻ , ν _e
Δ ⁺⁺ Delta	uuu	0	0	0	3/2	1232	+2	6•10 ⁻²⁴	π ⁺ , p
Δ ⁺ Delta	uud	0	0	0	3/2	1232	+1	6•10 ⁻²⁴	π ⁺ , n / π ⁰ , p
Δ ⁰ Delta	udd	0	0	0	3/2	1232	0	6•10 ⁻²⁴	π ⁰ , n / π ⁻¹ , p
Δ ⁻ Delta	ddd	0	0	0	3/2	1232	-1	6•10 ⁻²⁴	π ⁻¹ , n
Λ Lambda	uds	-1	0	0	1/2	1115,7	0	2,6•10 ⁻¹⁰	π ⁻¹ , p / π ⁰ , n
Ξ ⁰ Bøtt. Xi	dsb	-1	0	1	1/2	5792	-1	1,4•10 ⁻¹²	Ξ ⁻¹ , J/Ψ
Ω Omega	sss	-3	0	0	3/2	1672	-1	8,2•10 ⁻¹¹	Λ ⁰ , K ⁻ / Ξ ⁰ , p

Energien oppgis i elektronvolt (eV) som er energien for å flytte en elementær ladning (e) gjennom et potensiale på 1 V 1 eV = 1,60•10⁻¹⁹ J. Total bevart energi er sum av mekanisk kinetisk energi, fotonenergi osv.

Masse oppgis i atommasseenheter u eller i eV delt på c² (etter E= mc²) 1 MeV/c² = 1,782•10⁻³⁰ kg 1 u = 1,66•10⁻²⁷ kg = 938 MeV/c² og 1 eV/c² = 1,782•10⁻³⁶ kg

Elektrisk Ladning er multipler av elementærladningen e = 1,60•10⁻¹⁹ C

Spinn er dreiemoment som oppgis i multipler av Plancks konstant ħ = h/2π = 1,054•10⁻³⁴ J s

Leptoner spinn = 1/2

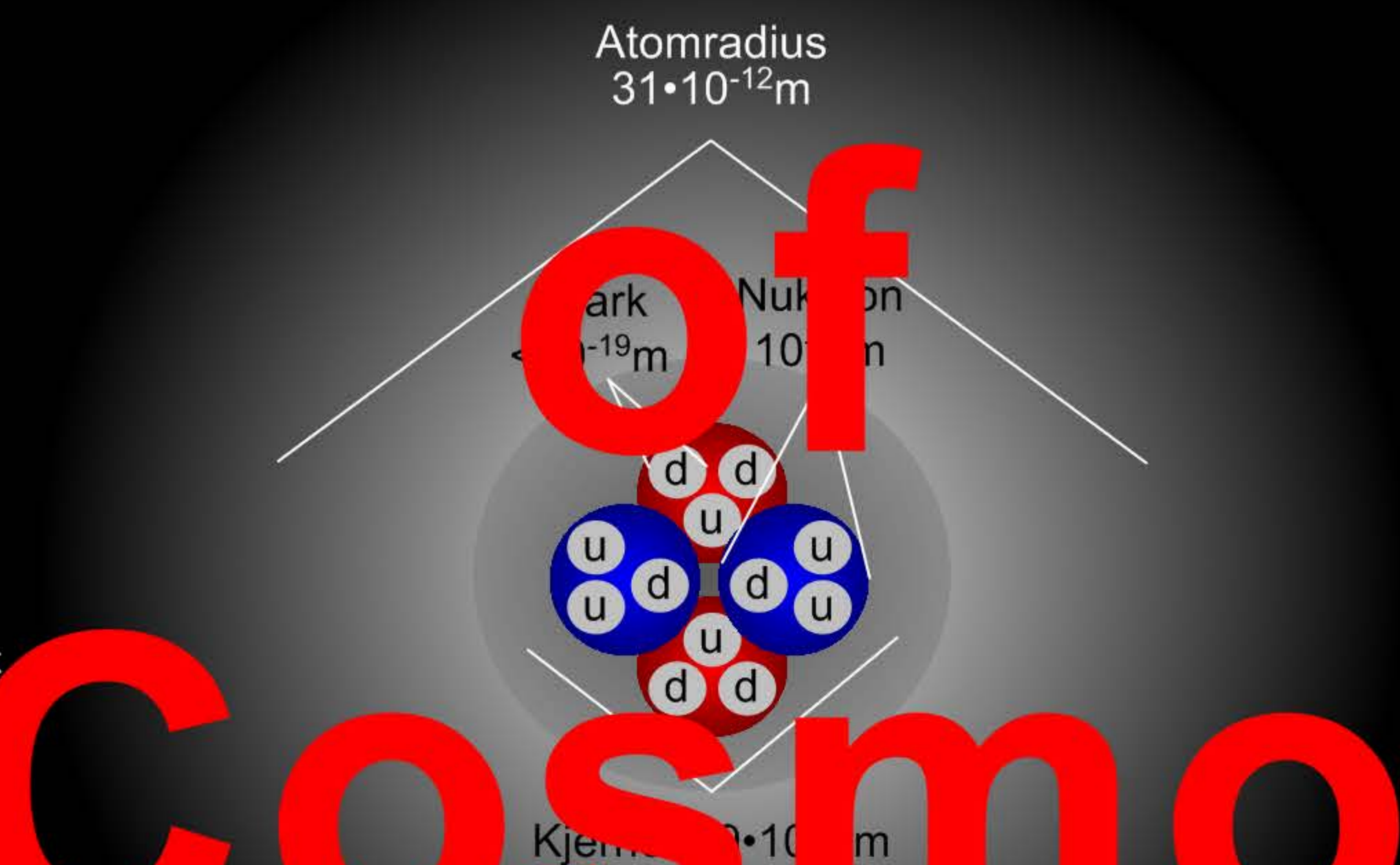
Smak	Masse MeV/c ²	Elektrisk Ladning
ν _e Elektron Nøytrino	< 1•10 ⁻⁵	0
e Elektron	0,511	-1
ν _μ Muon Nøytrino	< 0,2	0
μ Muon	106	-1
ν _τ Tau Nøytrino	< 20	0
τ Tau	1777,1	-1

Kvarker spinn = 1/2

Smak	Masse MeV/c ²	Elektrisk Ladning
u Opp	3	+2/3
d Ned	6	-1/3
c Sjarm	1300	+2/3
s Sær	100	-1/3
t Topp	175000	+2/3
b Bunn	4300	-1/3

Vekselvirkning beskrives med et Feynman diagram. Normalt er tiden høyre mot venstre. Pilene viser partikler ► og antipartikler ◄. Retter er elektroner, og bølgelinjer er vekselvirkningsbosoner. Nedenfor er β⁻ her med svak kjernekraft som skjer spontant når et fritt nøytron over til et proton, et elektron og en antielektron nøytrino. β⁺ krever energi, f.eks. fra et foton og oppretter et proton til et nøytron, et positron (antielektron) og et nøytrino.

Partikler og antipartikler kan bli skapt eller ødelagt i høy energi kollisjoner. Hvis en partikkel og en antipartikkel møtes, kan de annihileres og gi energi som kan bli brukt til å skape nye partikler. Tilsvarende kan en partikkel og en antipartikkel bli skapt fra energi som blir brukt til å skape nye partikler. Dette er et viktig aspekt ved forståelse av partikkelproduksjon og -annihilasjon.



Elementærpartikler har en radius på høyst 10⁻¹⁸m og regnes som punktførmede. Skyggeleggingen illustrerer at partiklens posisjon er sannsynlighetsfordelt, de to elektronene i 1s orbitalet befinner seg her innen et kuleformet område. Figurens målestokk er komprimert: I virkeligheten kan kjernen sammenlignes med et fotballstadium (100m) i midten av et fotballstadion (200m).

Baryoner og mesoner som består av sammensetning av kvarker men der kvantetall (f.eks. spinn og ladning) er forskjellige gitt opphav til partikler med forskjellige egenskaper, som f.eks. Bøtter og p⁺ eller Mesoner π⁺ og ρ⁺

For hver partikkel eksisterer en antipartikkel. Den markeres enten med strek over tegnet eller ved spesifisert ladning (e⁻ = p⁺). Antipartikkelen har eksakt samme masse og spinn, elektrisk ladning har motsatt fortegn. Baryon, Særhet (S), Sjarm (C) og Bunn(B) kvantetalletene endrer også fortegn. Ytterligere effekter opptrer i supersymmetri, og strengteori

Mesoner (utvalg av ca 140 typer) spinn = 0, 1

Partikkel	Kvark Innhold	S	C	B	Spinn	Masse MeV/c ²	El. Ladn	Henfall	
								tid (s)	til
π ⁺ Pion	u \bar{d}	0	0	0	0	139,6	+1	2,6•10 ⁻⁸	μ ⁺ , ν _μ
π ⁻ Pion(π ⁻)	ūd	0	0	0	0	139,6	-1	2,6•10 ⁻⁸	μ ⁻ , ν _μ
π ⁰ Pion	(uū-dđ)/√2	0	0	0	0	135,0	0	8,4•10 ⁻¹⁵	2γ
K ⁺ Kaon	u \bar{s}	1	0	0	0	493,7	+1	1,24•10 ⁻⁸	μ ⁺ , ν _μ / π ⁺ , π ⁰
K ⁰ Kaon	d \bar{s}	1	0	0	0	497,7	0	(svak)	-
ρ ⁺ Rho	u \bar{d}	0	0	0	1	776	+1	4,0•10 ⁻²⁴	-
φ Phi	s \bar{s}	0	0	0	1	1020	0	1,6•10 ⁻²²	-
B ⁰ B-null	d \bar{b}	0	0	1	0	5279	0	1,5•10 ⁻¹²	-
η _c eta-c	c \bar{c}	0	0	0	0	2980	0	-	-
Υ Upsilon	b \bar{b}	0	0	0	1	9460	0	2,6•10 ⁻⁸	e ⁺ , e ⁻ / μ ⁺ , μ ⁻

Fargekraft formidles av gluoner: Kvarker bærer tre typer fargeladning som gir opphav til 8 ulike typer fargeladning. Gluonene danner "fluksrør" der kraften avtar under 10⁻¹⁸ m og over er konstant 104 N på lang avstand. Det fører til at kvarkene inneholder farge-energi som oppbeholdes i tre (Baryoner) og to (Mesoner). Forsøk på å separere kvarker gir rasende energi (E=F•l) som danner kvarkepar som forblir sammen seg selv de opprinnelige til tilsvarende gruppe.

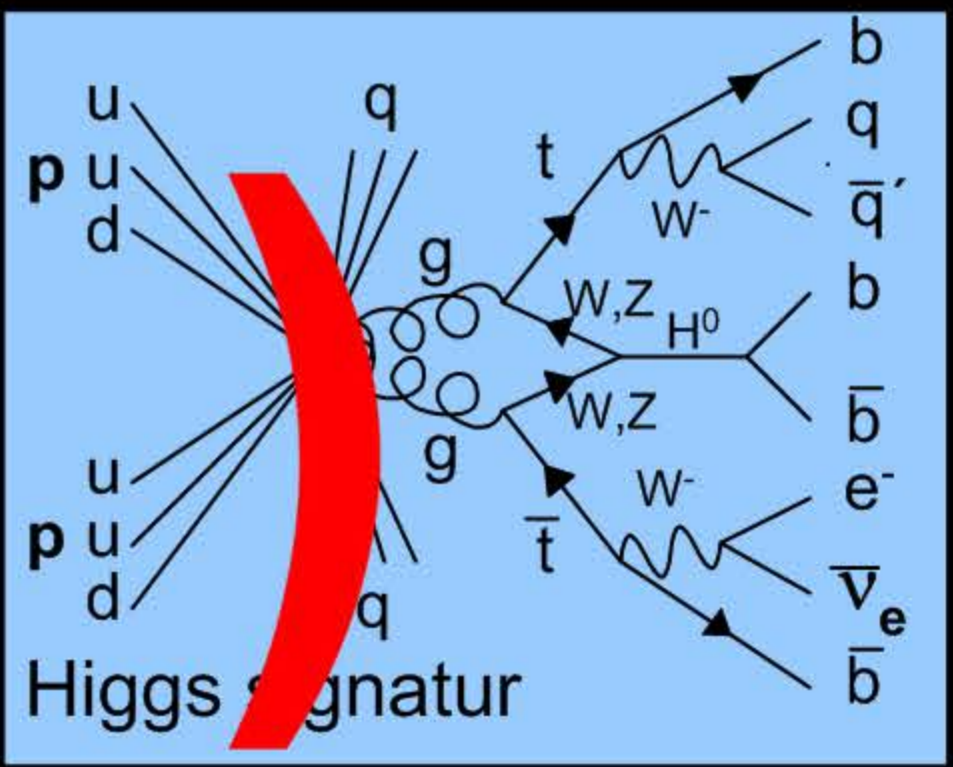
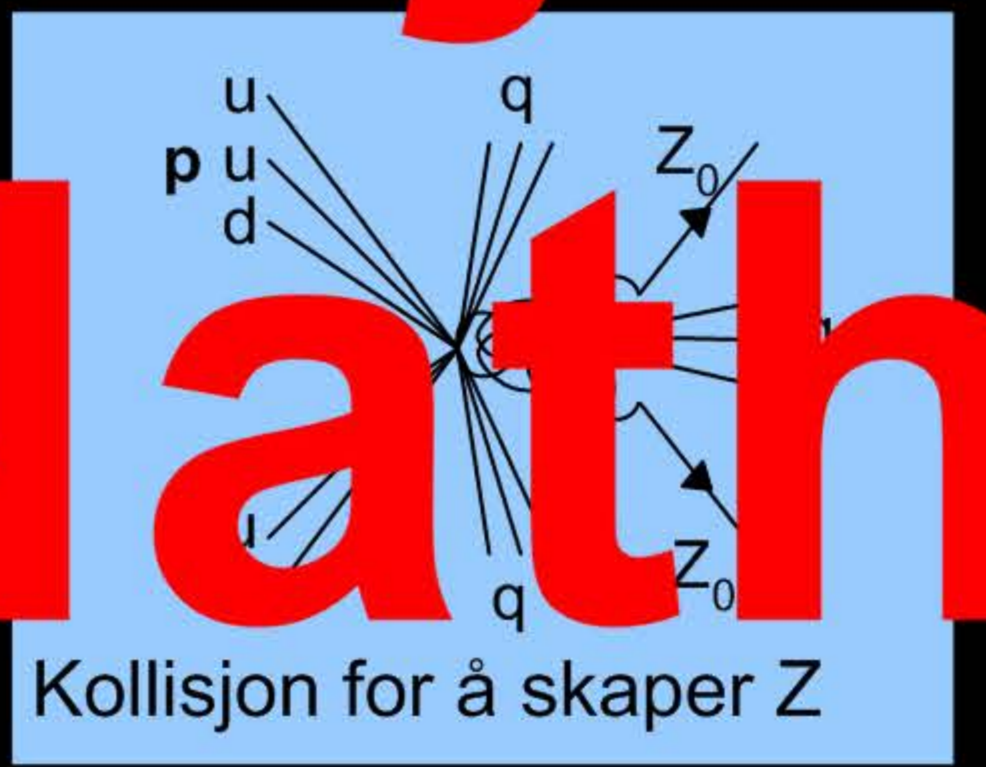
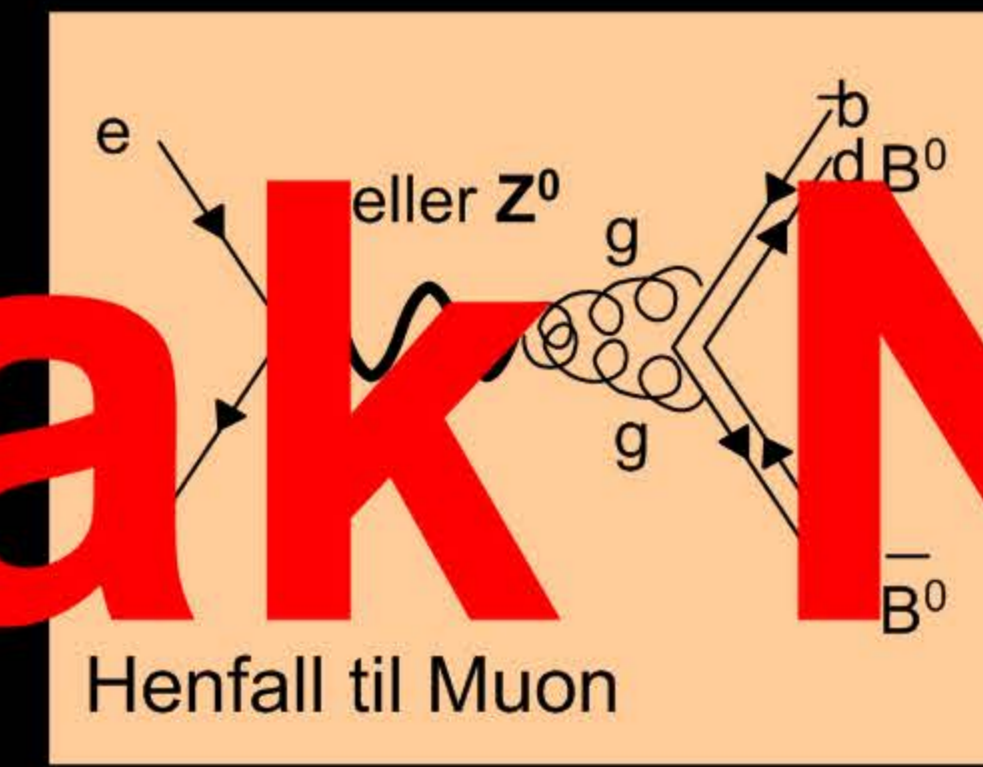
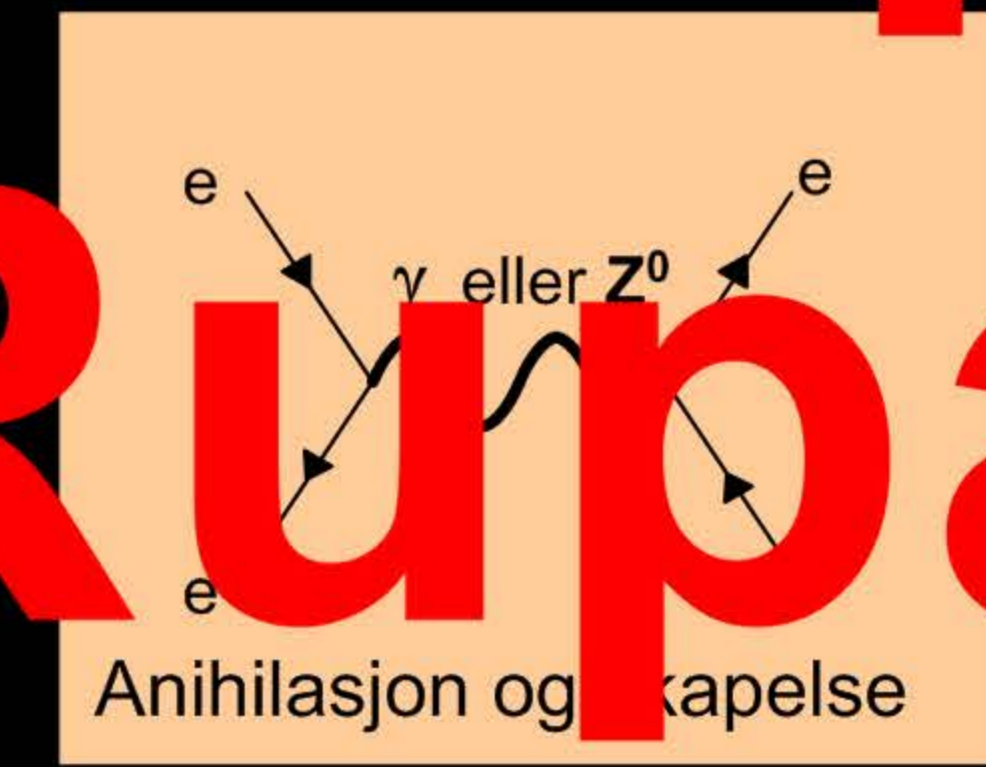
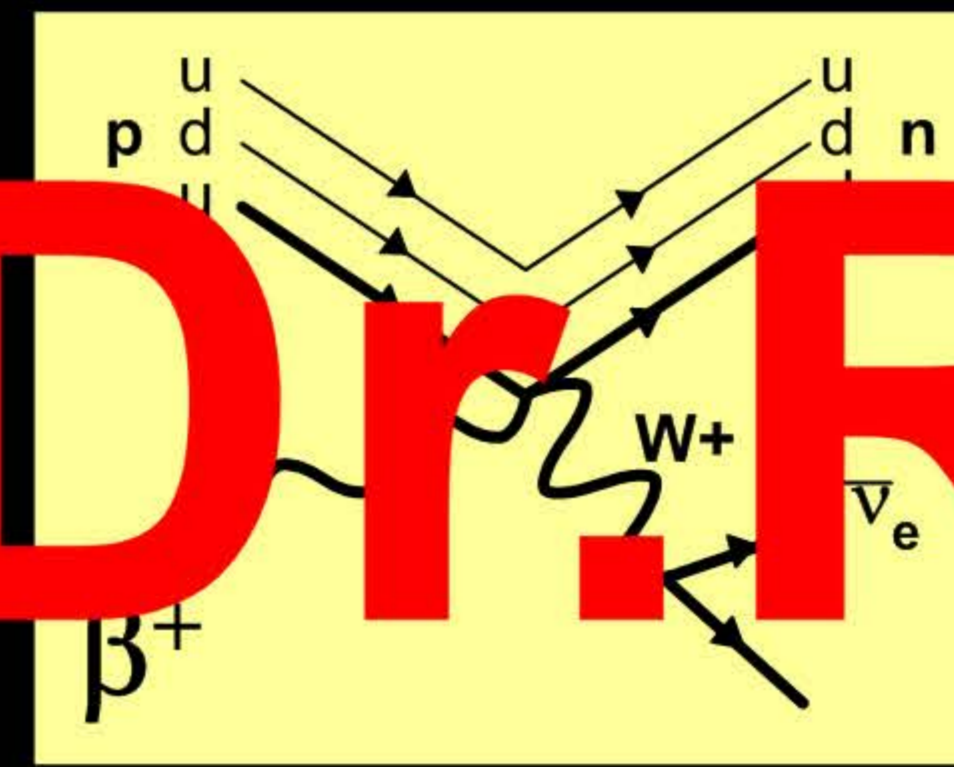
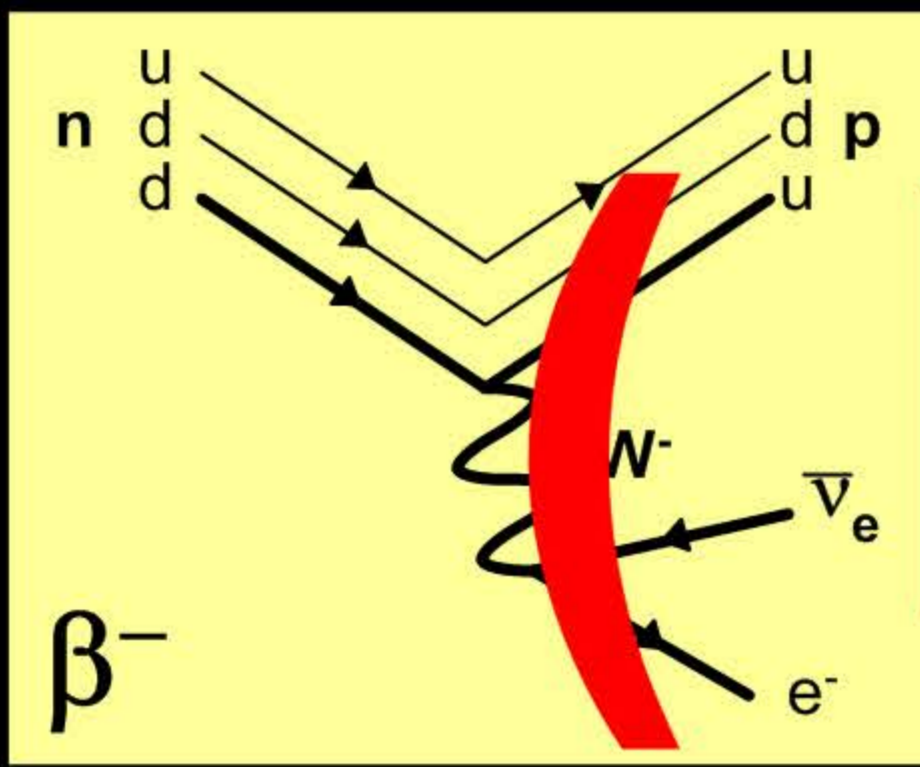
En fargeoplyst gruppe vil dekke opp tre energiladning i fargekraften som som resulterer i sterk kjernekraft mellom hadroner. Denne formidles av mesoner.

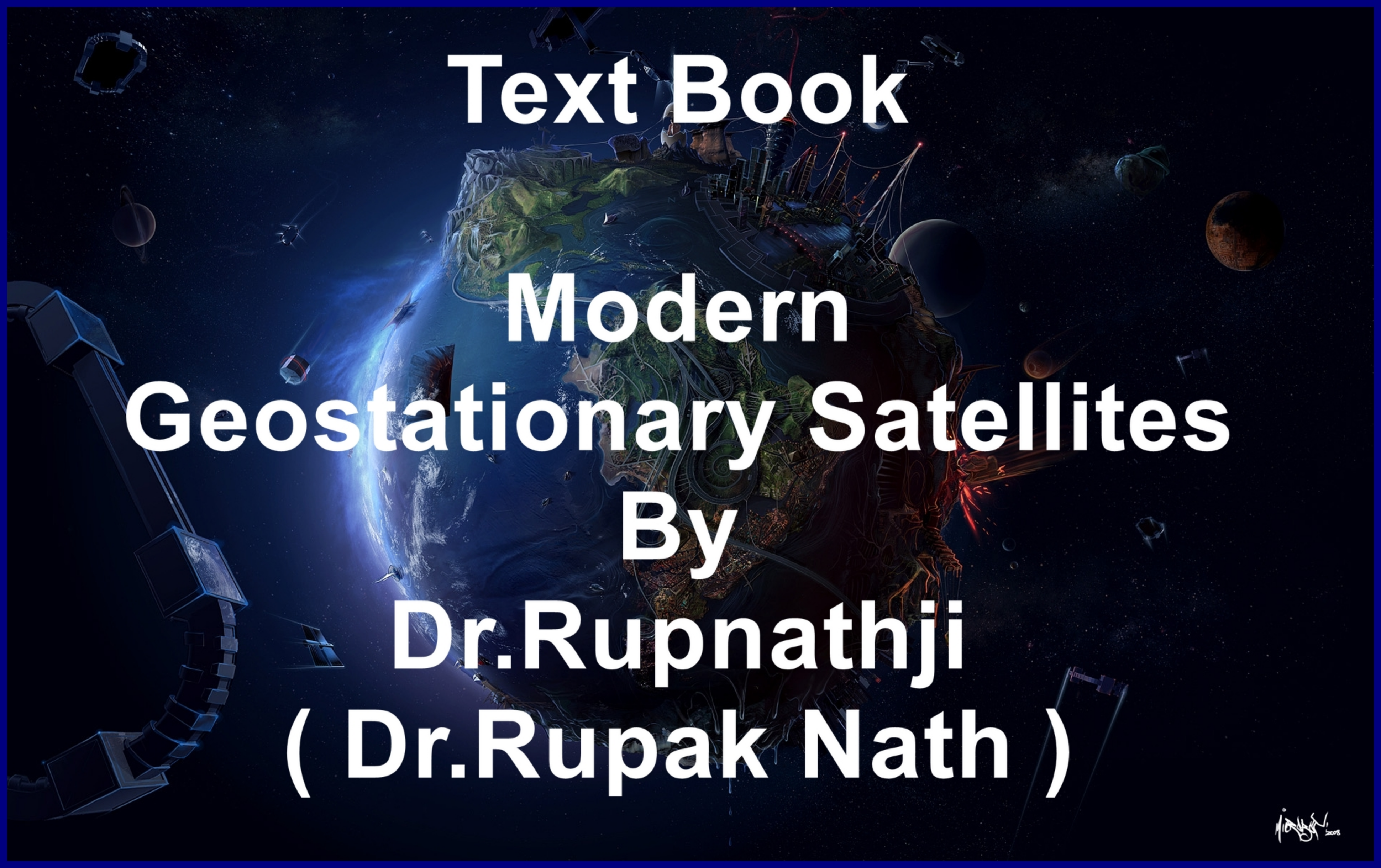
Vekselvirkningsbosoner spinn = 1 (2)

Vekselvirkning	Navn	Masse MeV/c ²	Elektrisk Ladning	Relativ styrke mellom		
				10 ⁻¹⁸ m	u kvarker	protoner
Elektromagnetisme	γ Foton	0	0	1	1	1
Elektrosvak	W ⁻ Massive	80398	-1	0,8	10 ⁻⁴	10 ⁻⁷
	W ⁺ Gauge	80398	+1			
	Z ⁰ Bosoner	91188	0			
Fargekraft	g Gluon	0	0	25	60	Ikke hadroner
	Sterk kjernekraft	Meson	140-9400	+/-1, 0	Ikke kvarker	Ikke kvarker 20
Masse	h Higgs	> 114400	0	Ikke verifisert, formidler masse til partikler og elektrosvakt symmetribrudd		
Gravitasjon	g Graviton	Hypotetisk, masse 0, ladning 0, spinn 2		10 ⁻⁴¹	10 ⁻⁴¹	10 ⁻³⁶

Partikler med høy energi kan ved kollisjon produseres i forskjellige partikler eller virtuelle, og kan bryte deres her sprøder. I kollisjoner to protoner og oppretter fåtal bosoner sammen med en rekke andre hadroner

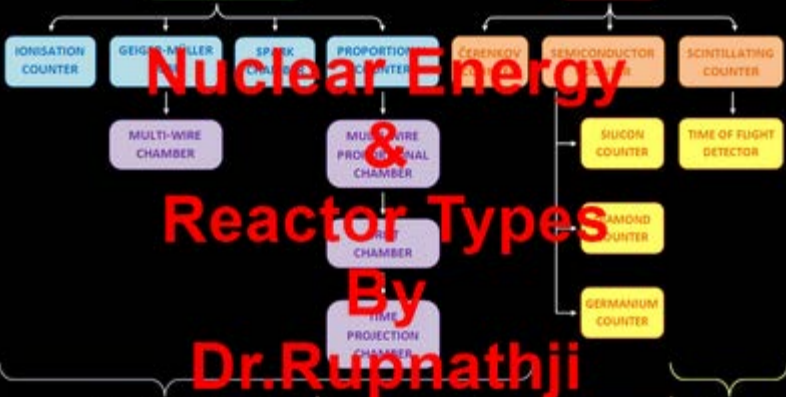
Large Hadron Collider (LHC) som er under bygging ved CERN kolliderer protoner med høy energi og gir forskjellige hadroner og gluoner. ATLAS eksperimentet vil kunne se henfall av Higgs bosonet som en unik kombinasjon av partikler.





Text Book
Modern
Geostationary Satellites
By
Dr. Rupnathji
(Dr. Rupak Nath)

Guide Book

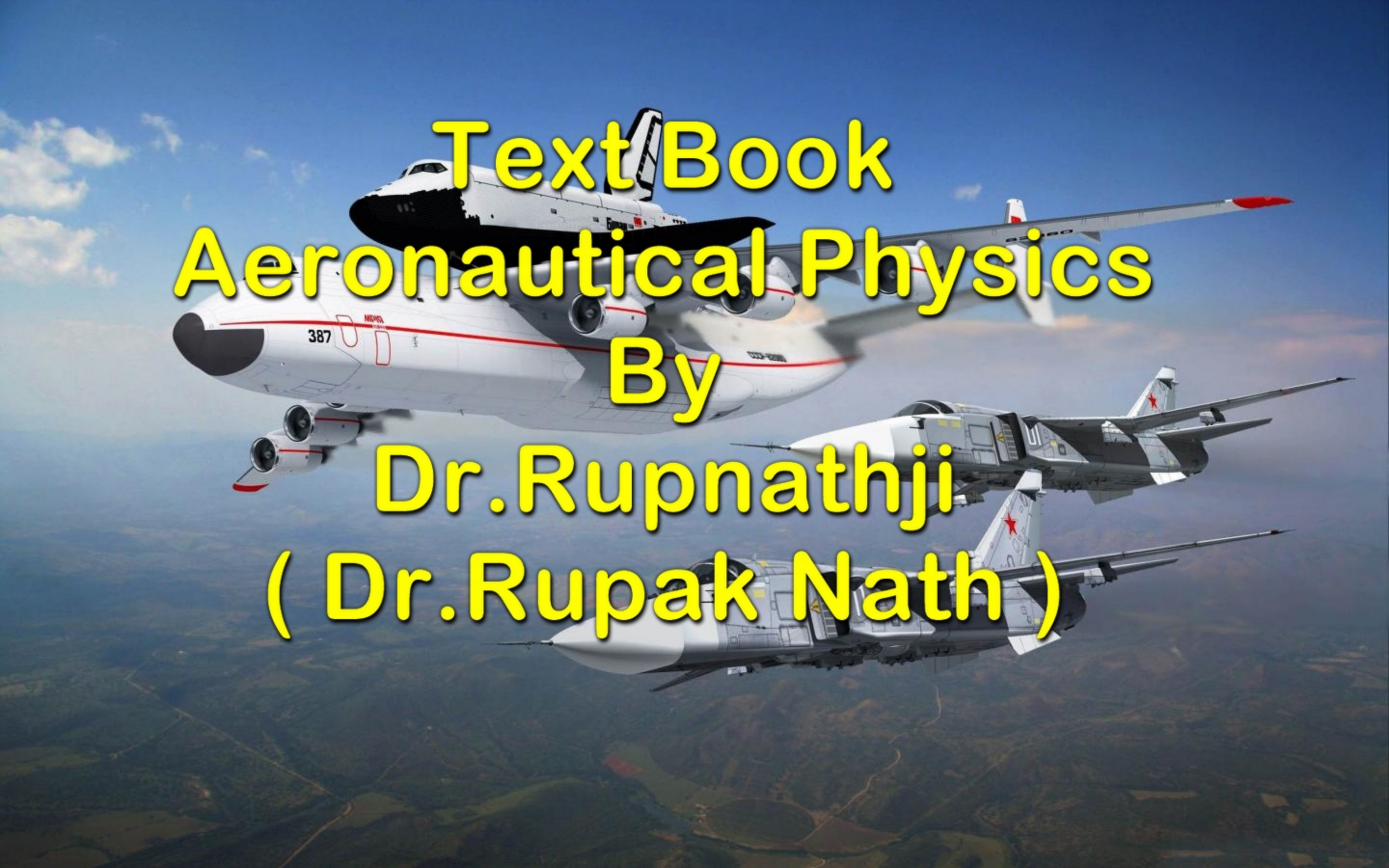


TRACKING DETECTORS

CALORIMETERS

TRIGGERS

Dr. Rupnathji
(Dr. Rupak Nath)



Text Book Aeronautical Physics

By

Dr. Rupnathji
(Dr. Rupak Nath)

Standard Model of FUNDAMENTAL PARTICLES AND INTERACTIONS

Text Book

FERMIONS

matter constituents
spin = 1/2, 3/2, 5/2,...

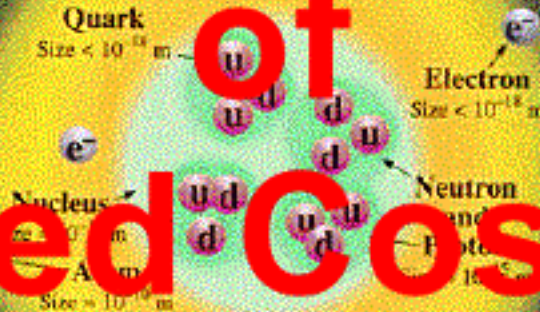
Leptons spin = 1/2			Quarks spin = 1/2		
Flavor	Mass GeV/c ²	Electric charge	Flavor	Approx. Mass GeV/c ²	Electric charge
ν_e electron neutrino	$< 7 \times 10^{-9}$	0	u up	0.005	2/3
e^- electron	0.000511	-1	d down	0.01	-1/3
ν_μ muon neutrino	< 0.0003	0	c charm	1.5	2/3
μ^- muon	0.106	-1	s strange	0.2	-1/3
ν_τ tau neutrino	< 0.0018	0	t top	173	2/3
τ^- tau	1.7771	-1	b bottom	4.7	-1/3

Spin is the fermionic angular momentum of particles. Spin is given in units of \hbar , which is the quantum unit of angular momentum, where $\hbar = h/2\pi = 6.58 \times 10^{-16}$ GeV s = 1.05×10^{-34} J s.

Electric charges are given in units of the proton's charge. It is 1/3 units the electric charge of the proton is 1.6×10^{-19} coulombs.

The energy unit of particle physics is the electron volt (eV), the energy gained by one electron in crossing a potential difference of one volt. Masses are given in GeV/c² (abbreviated E = mc²), where 1 GeV = 10^9 eV = 1.6×10^{-10} joule. The mass of the proton is 0.938 GeV/c² = 1.67×10^{-27} kg.

Structure within the Atom



If the protons and neutrons in this picture were 10 cm across, then the quarks and electrons would be less than 0.1 mm in size and the atom would be about 10 km across.

BOSONS

force carriers
spin = 0, 1, 2,...

Unified Electroweak spin = 1	Mass GeV/c ²	Electric charge	Strong or color spin = 1	Mass GeV/c ²	Electric charge
γ photon	0	0	g gluon	0	0
W^-	80.22	-1			
W^+	80.22	+1			
Z^0	91.187	0			

Color Charge

Each quark carries one of three types of "strong charges," also called "color charges." These charges have nothing to do with the colors of visible light. There are eight possible types of color charge but only three types of strong interactions color charge. The strong force is a strong interaction color charge. The strong force is a strong interaction color charge. The strong force is a strong interaction color charge.

Confinement

As color-charged particles (quarks and gluons) are separated, the energy between them approaches a constant value and the energy in the color force field increases. This energy eventually is converted into additional quark-antiquark pairs (see the figures below). The objects that finally emerge are color-neutral combinations called hadrons (mesons and baryons).

Residual Strong Interactions

The strong binding of the color-neutral protons and neutrons to form nuclei is due to residual strong interactions between their color-charged constituents. It is similar to the residual electrical interaction which binds electrically neutral atoms to form molecules. It can be viewed as the exchange of mesons between the hadrons.

PROPERTIES OF THE INTERACTIONS

Sample Fermionic Hadrons

Baryons qqq and Antibaryons $\bar{q}\bar{q}\bar{q}$

Symbol	Name	Quark content	Electric charge	Mass GeV/c ²	Spin
p	proton	uud	1	0.938	1/2
\bar{p}	anti-proton	$\bar{u}\bar{u}\bar{d}$	-1	0.938	1/2
n	neutron	udd	0	0.940	1/2
Λ	lambda	uds	0	1.116	1/2
Ω^-	omega	sss	-1	1.672	3/2

Property	Gravitational	Weak	Electromagnetic	Strong
Particles experiencing:	All	Quark, Lepton	Electrically charged	Quarks, Gluons
Particles mediating:	Graviton (not yet observed)	W^+ W^- Z^0	γ	Gluons, Mesons
Relative strength (for two particles at a distance of 10^{-16} m)	10^{-41}	0.8	1	25
Relative strength (for two particles in a nucleus)	10^{-36}	0	1	100

Sample Bosonic Hadrons

Mesons $q\bar{q}$

Symbol	Name	Quark content	Electric charge	Mass GeV/c ²	Spin
π^+	pion	u\bar{d}	+1	0.140	0
K^+	kaon	u\bar{s}	+1	0.494	0
ρ^+	rho	u\bar{d}	+1	0.770	1
D^+	D	c\bar{d}	+1	1.869	0
ψ_c	charmed-c	c\bar{c}	0	2.979	0

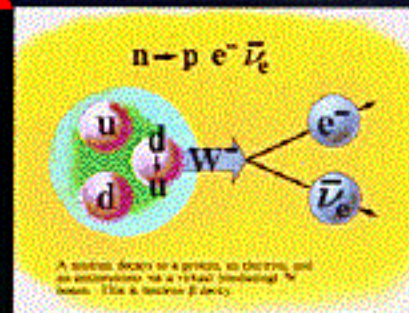
Matter and Antimatter

For every particle type there is a corresponding antiparticle type, denoted by a bar over the particle symbol. Particle and antiparticle have identical mass and spin but opposite charges. Some electrically neutral bosons (i.e., Z^0 , γ and η) are their own antiparticles.

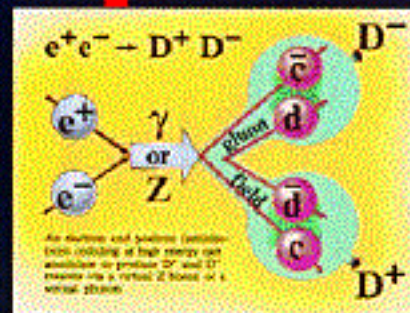
Figures

These diagrams are an artistic conception of physical processes. They do not show and have not yet revealed to us. Lines (solid and dashed) represent the tracks of particles in a detector, and the quark paths, and track lines the paths of leptons.

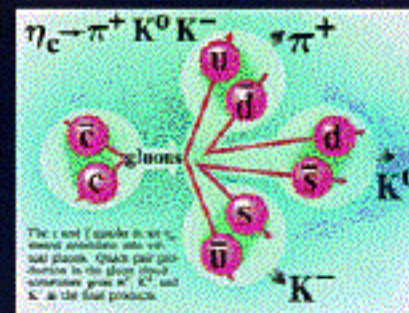
Copyright © 1999 Fermilab



A neutron decays to a proton, an electron, and an antineutrino via a virtual W^- boson. This is beta minus decay.



An electron and positron (particle-antiparticle) pair colliding at high energy can annihilate to produce D^+ and D^- mesons via a virtual Z boson or a virtual photon.



The η_c and ψ quarkonium mesons consist of a charm quark and anti-charm quark. They can decay into various quark-antiquark pairs ($u\bar{u}$, $d\bar{d}$, $s\bar{s}$) and mesons (π^+ , π^- , K^+ , K^-) in the final products.

Contemporary Physics Education Project (CPEP)

CPEP is a non-profit organization of teachers, physicists, and others. For information on the chart, software, book, and/or other materials, contact the chart authors, look on WWW at <http://pdg.lbl.gov/cpep/>, send e-mail to pdg@LBL.gov, or write: CPEP, MS 50, 805, Lawrence Berkeley Laboratory, Berkeley, CA 94720. Corporate and private educators, as well as national laboratory funding have been and remain crucial to the success of this project.

U.S. Department of Energy
Lawrence Berkeley Laboratory
Standard Energy Accelerator Center
American Assoc. of Physics Teachers
DURABLE Edition Tables

Exclusive Worldwide Distribution By:
Science Kit & Boreal Laboratories

Explore

Particle

New Concept

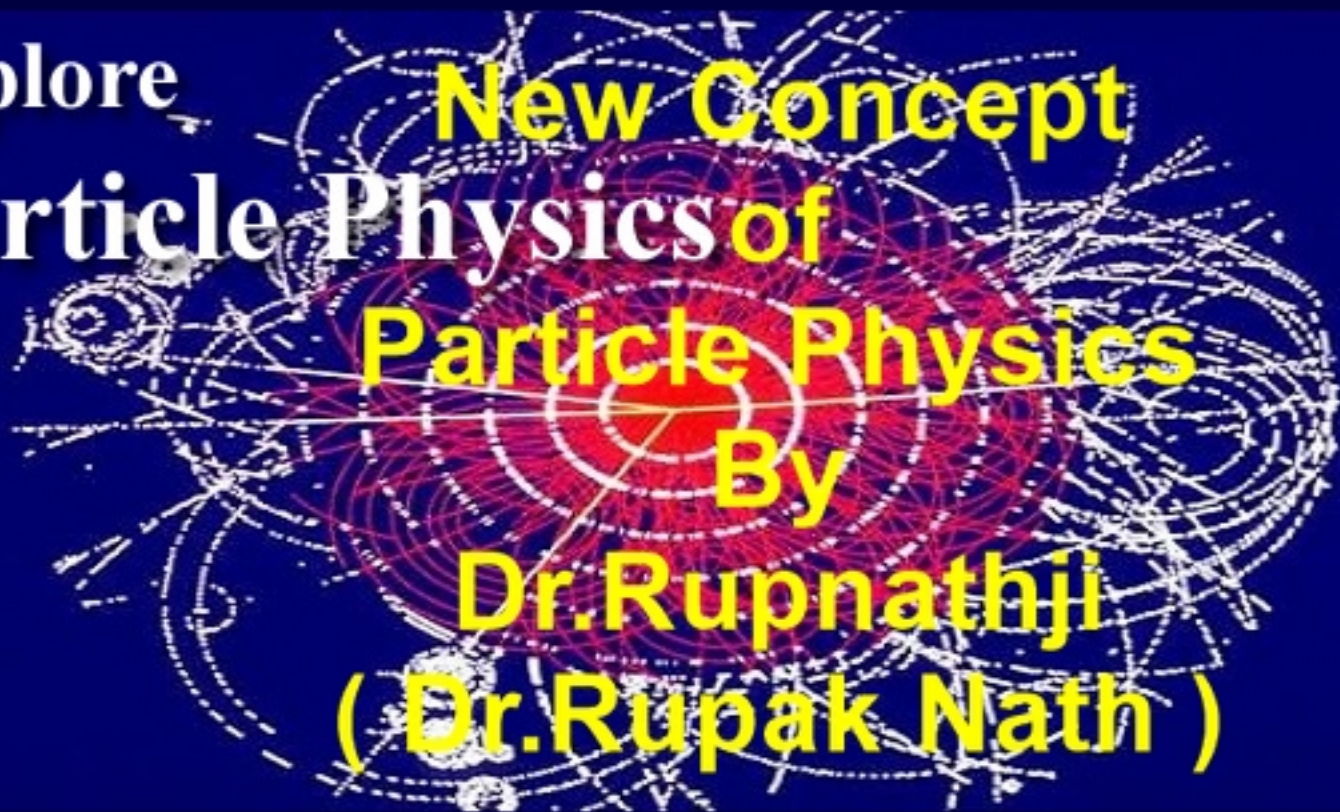
Physics of

Particle Physics

By

Dr. Rupnathji

(Dr. Rupak Nath)



[WHY THE HIGGS?]

BREAKING SYMMETRY

A central question of the Standard Model is why the electroweak forces are asymmetrical: electromagnetism is long-ranged, whereas the weak nuclear force is short-ranged. Physicists think the two forces are actually symmetrical, but their symmetry is hidden, or "broken."

MAGNETIC SPATIAL SYMMETRY

A simple analogy is an infinite grid of magnetic filings. The symmetry in this case is the equivalence of all directions in space.

The symmetry is evident at high temperatures. Heat jostles the filings every which way.



Symmetry

When the temperature drops, the filings lock one another in place. Although their alignment may seem more orderly, it is less symmetrical because it singles out one randomly chosen direction over the others.



Broken symmetry

ELECTROWEAK SYMMETRY

This symmetry is more abstract. It means the freedom to decide which leptons are electrons and which are neutrinos, or how to label up and down quarks.

In the symmetrical case, the lepton naming convention (represented by an arrow) is set independently at each point in space. What one person calls an electron, another might call some mixture of electron and neutrino, and it would make no difference to their predictions.



In the broken symmetry, the convention is fixed everywhere. What one person calls an electron, all do. The Higgs field brings about this symmetry breaking.

Electroweak symmetry makes all the electroweak force particles massless.



Broken symmetry gives masses to the W and Z bosons, thereby restricting their range.



Hydrogen Wave Function

Probability density plots.

$$\psi_{nlm}(r, \theta, \varphi) = \sqrt{\left(\frac{2}{na_0}\right)^3 \frac{(n-l-1)!}{2n[(n+l)!]}} e^{-\rho/2} \rho^l L_{n-l-1}^{2l+1}(\rho) \cdot Y_{lm}(\theta, \varphi)$$

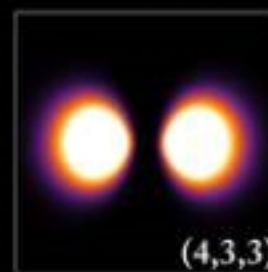
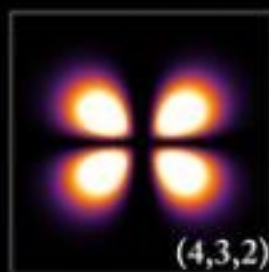
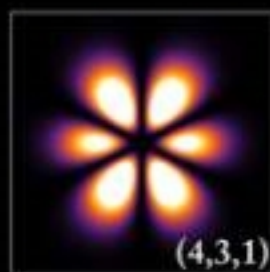
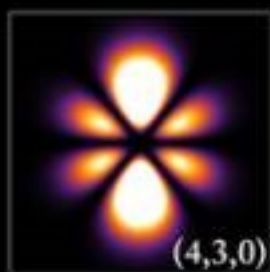
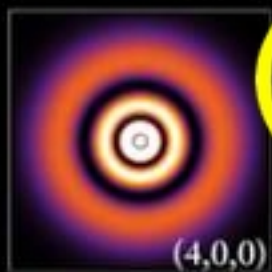
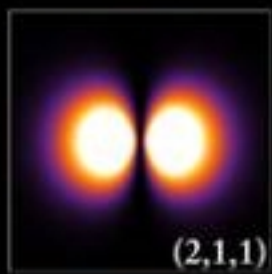
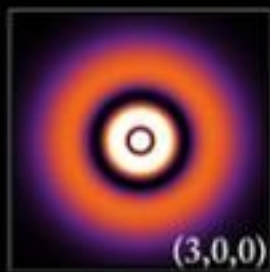
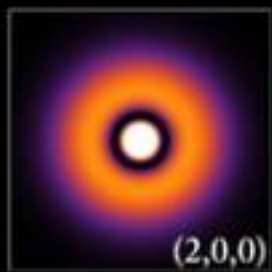
Text Book

Quantum Super Position



By Dr. Rupnathji

(Dr. Rupak Nath)

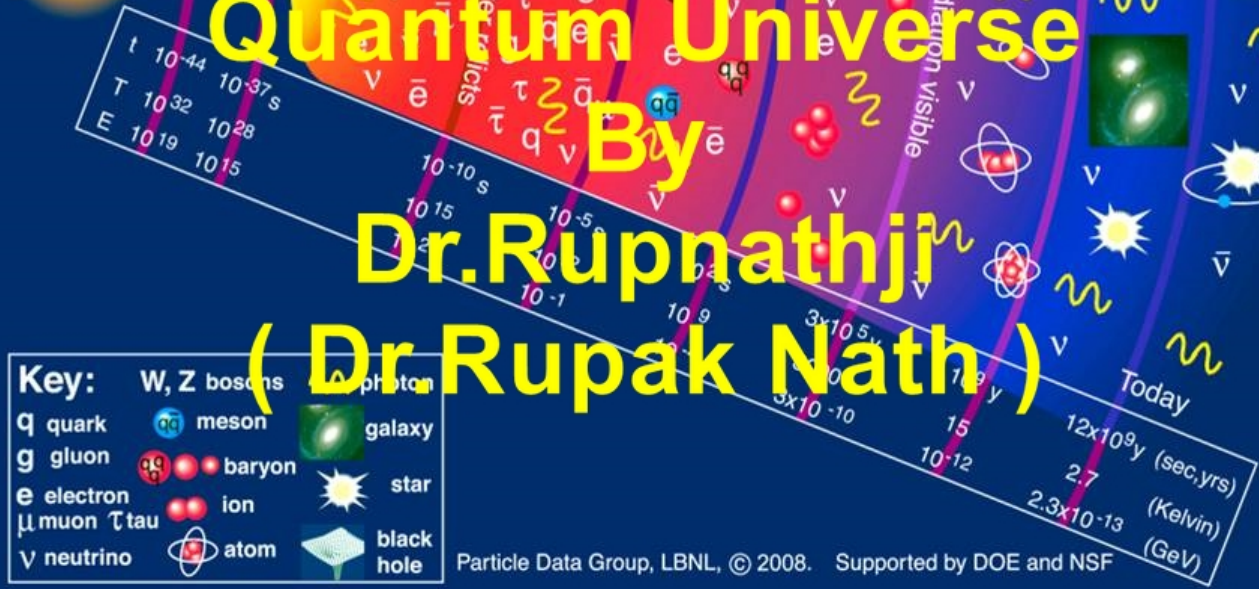


History of the Universe

Research Guide Book

Dark Energy & Quantum Universe

By
Dr. Rupnathji
 (Dr. Rupak Nath)



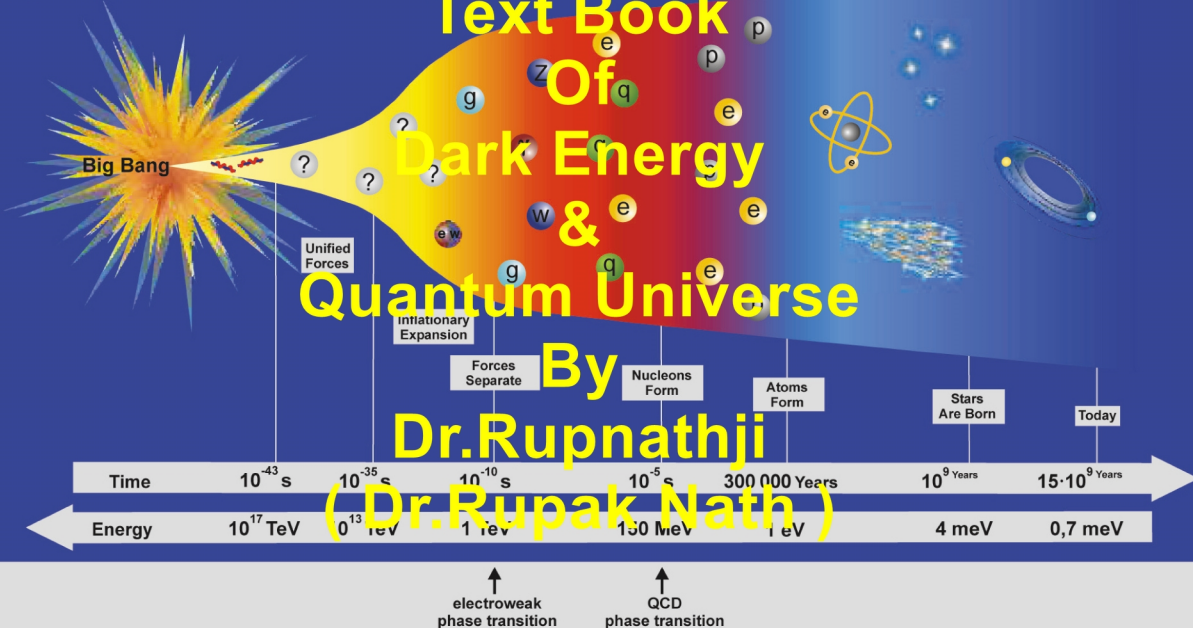
Key:

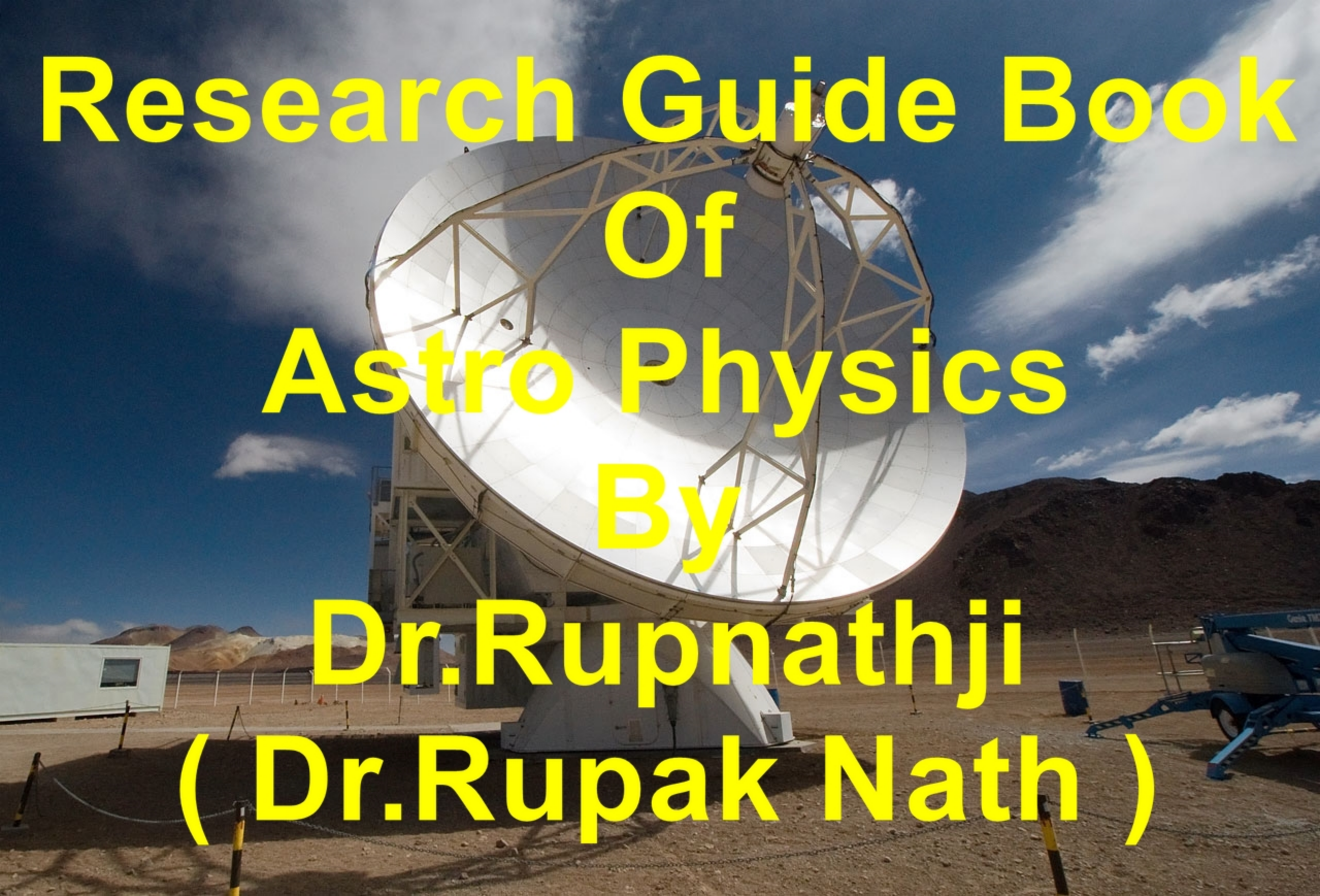
W, Z bosons	photon
q quark	meson
g gluon	baryon
e electron	ion
μ muon τ tau	atom
ν neutrino	black hole
	galaxy
	star

Evolution of the Universe

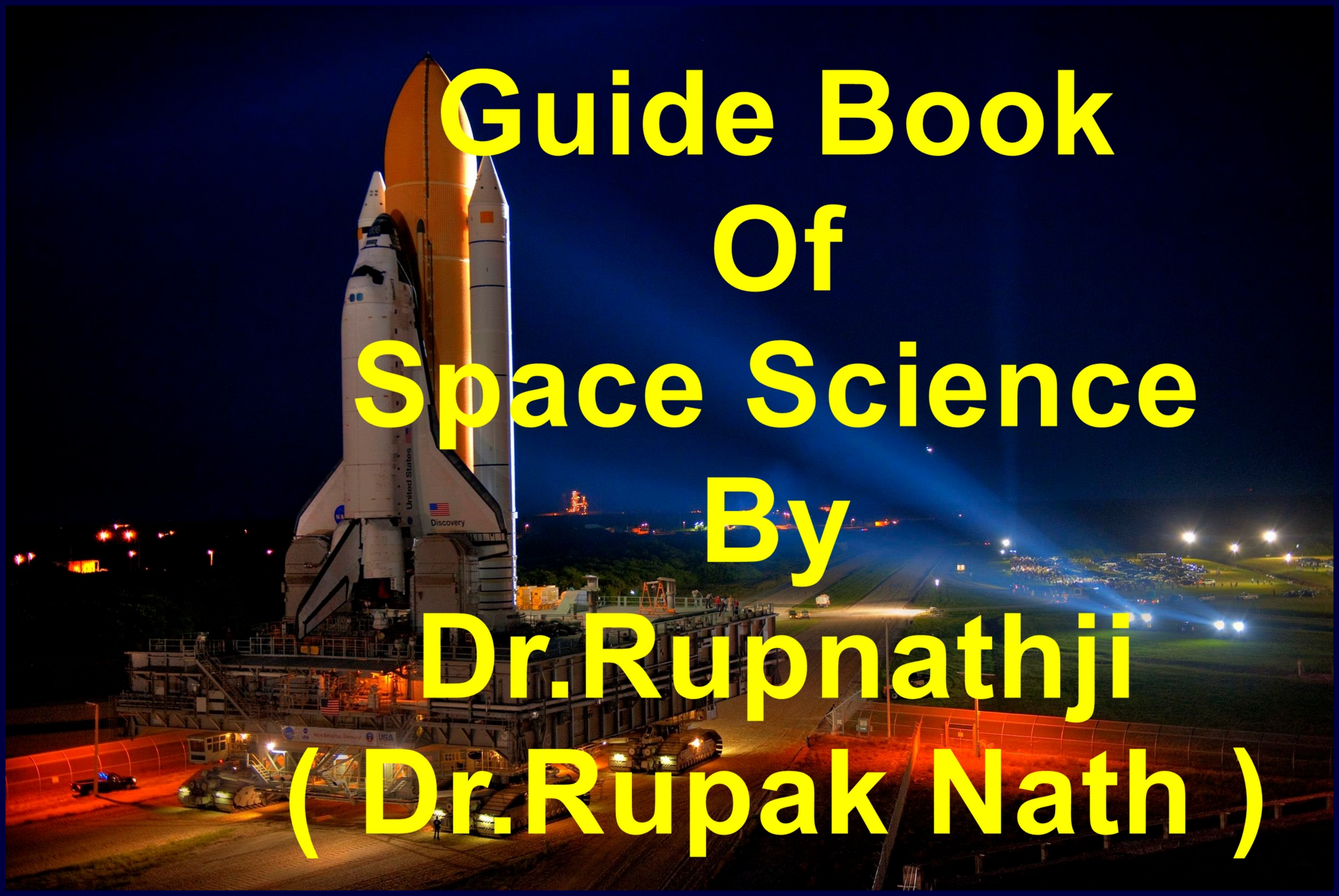
Text Book Of Dark Energy & Quantum Universe

By
Dr. Rupnathji
(Dr. Rupak Nath)

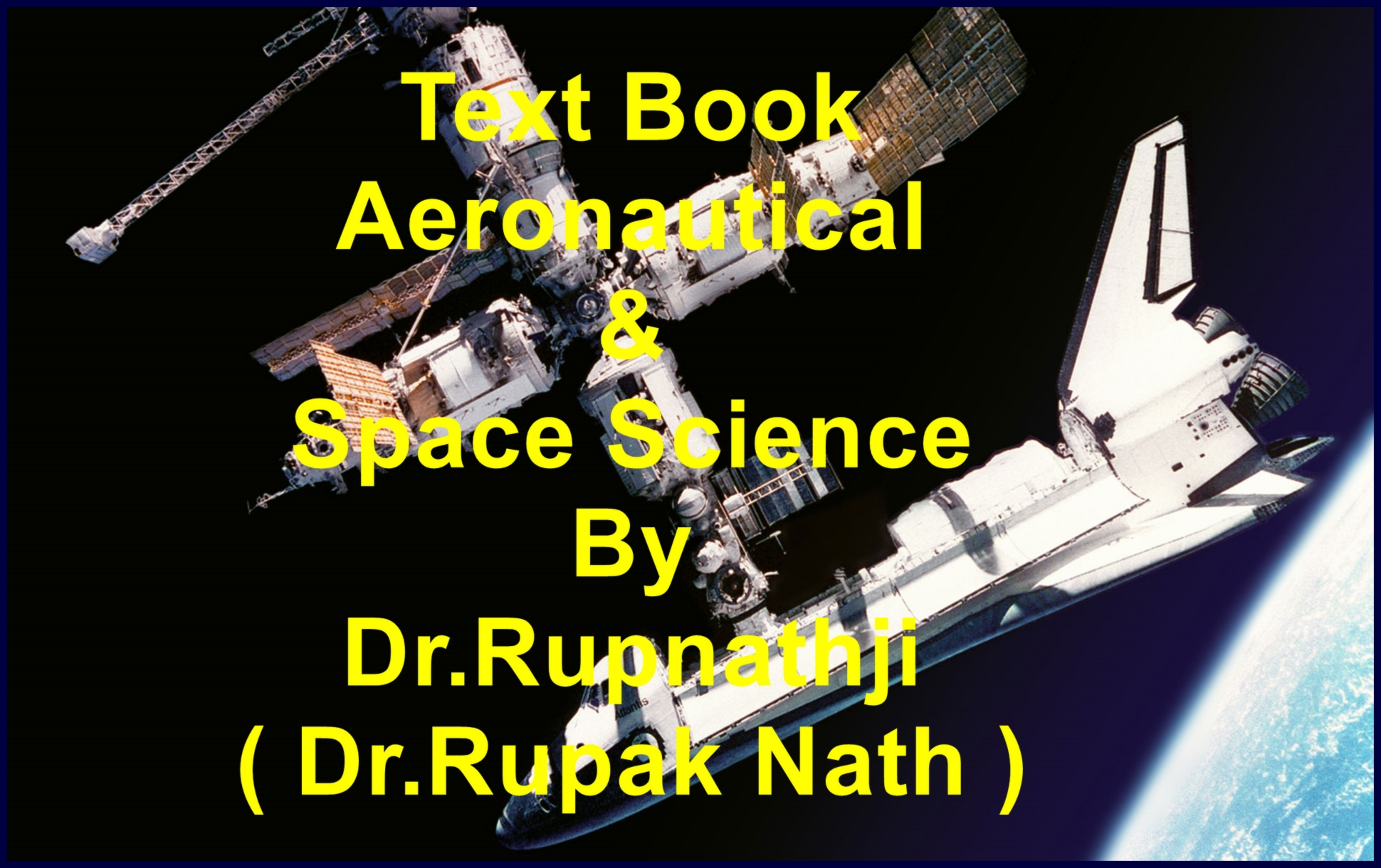




**Research Guide Book
Of
Astro Physics
By
Dr. Rupnathji
(Dr. Rupak Nath)**

A night-time photograph of the Space Shuttle Discovery on the Mobile Launcher Platform (MLP) being transported by a crawler-transporter. The MLP is illuminated by bright lights, and the shuttle is clearly visible with its name and NASA logo. The crawler-transporter is moving along a gravel path, and the background shows a large field with many lights, suggesting a launch complex or airfield.

**Guide Book
Of
Space Science
By
Dr. Rupnathji
(Dr. Rupak Nath)**

A photograph of the Space Shuttle Columbia in orbit above Earth. The shuttle is oriented vertically, with its nose pointing towards the top left. The Earth's blue and white atmosphere is visible in the bottom right corner. The shuttle's external tank and solid rocket boosters are clearly visible.

**Text Book
Aeronautical
&
Space Science
By
Dr.Rupnathji
(Dr.Rupak Nath)**

A composite image showing the International Space Station (ISS) in orbit above the Earth, with the Space Shuttle Columbia flying below it. The Earth's blue oceans and white clouds are visible in the background.

Text Book
New Concept
of
Space Science
By
Dr. Rupnathji
(Dr. Rupak Nath)

Advanced Guide Book

The Elements

Chemistry-Biology

By

Dr. Rupnathji

(Dr. Rupak Nath)



☠ Radioactive elements

Photographs show samples of the pure or nearly pure element except as follows: At, Rn, Fr, Ac, Pa, and Np show radioactive elements containing visible traces of the element. Po, Pa, Th, Pu, Am, and Ar show artificial elements containing invisible amounts of the element. Technetium shows a Tc-99 bone scan. Hydrogen shows a bubble above. Telescope image of the Eagle Nebula is mostly hydrogen. 96-111 show the person or group which the element is named. 112-118 had not been named in 2006.

Poster and photography by Theodore W. Gray, American Chemical Society, Ltd.

All images Copyright © 2006 Theodore W. Gray except as noted above. All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording, or by any information storage and retrieval system, without the prior written permission of Theodore W. Gray.

Other sizes of this poster: www.theodoregray.com

Real samples like these: www.theodoregray.com

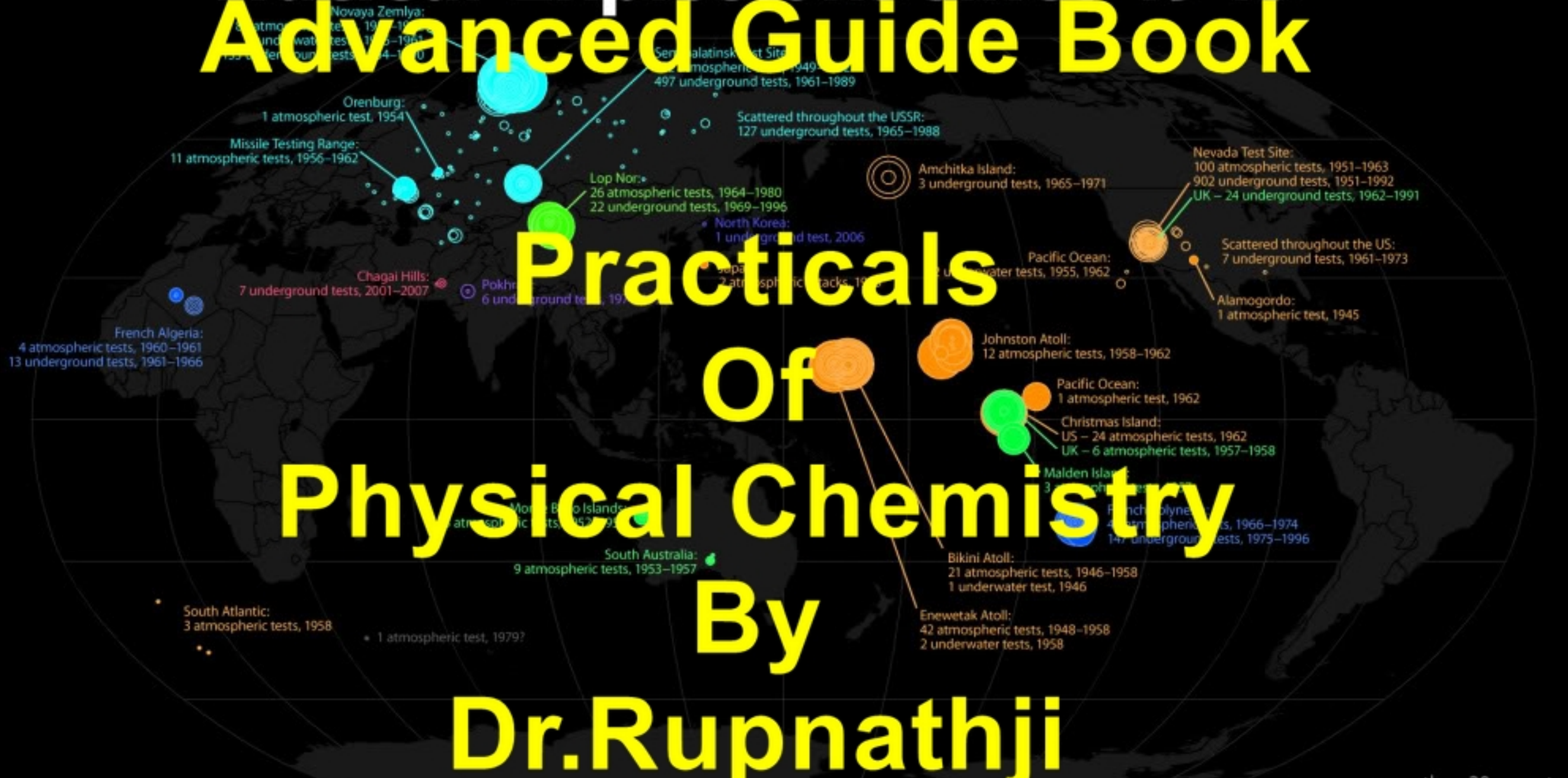
Nuclear Explosions since 1945

Advanced Guide Book

Practicals Of Physical Chemistry By

Dr. Rupnathji

(Dr. Rupak Nath)

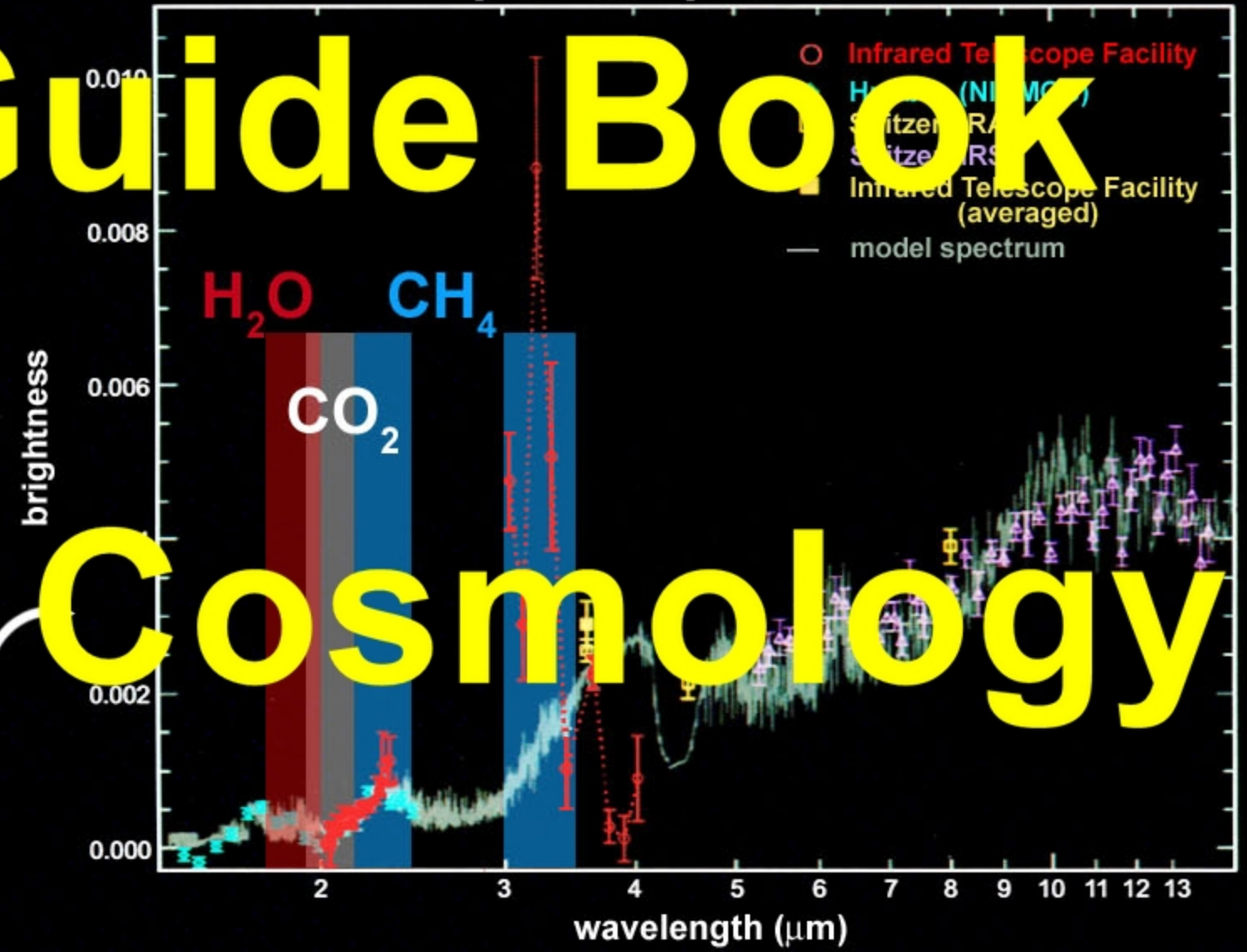


Country	Year of first detonation	Number of atmospheric detonations	Number of underground or underwater tests
United States	1945	9	30
USSR	1949	225	756
United Kingdom	1952	21	24

Advanced Guide Book

Practicals Of Cosmology

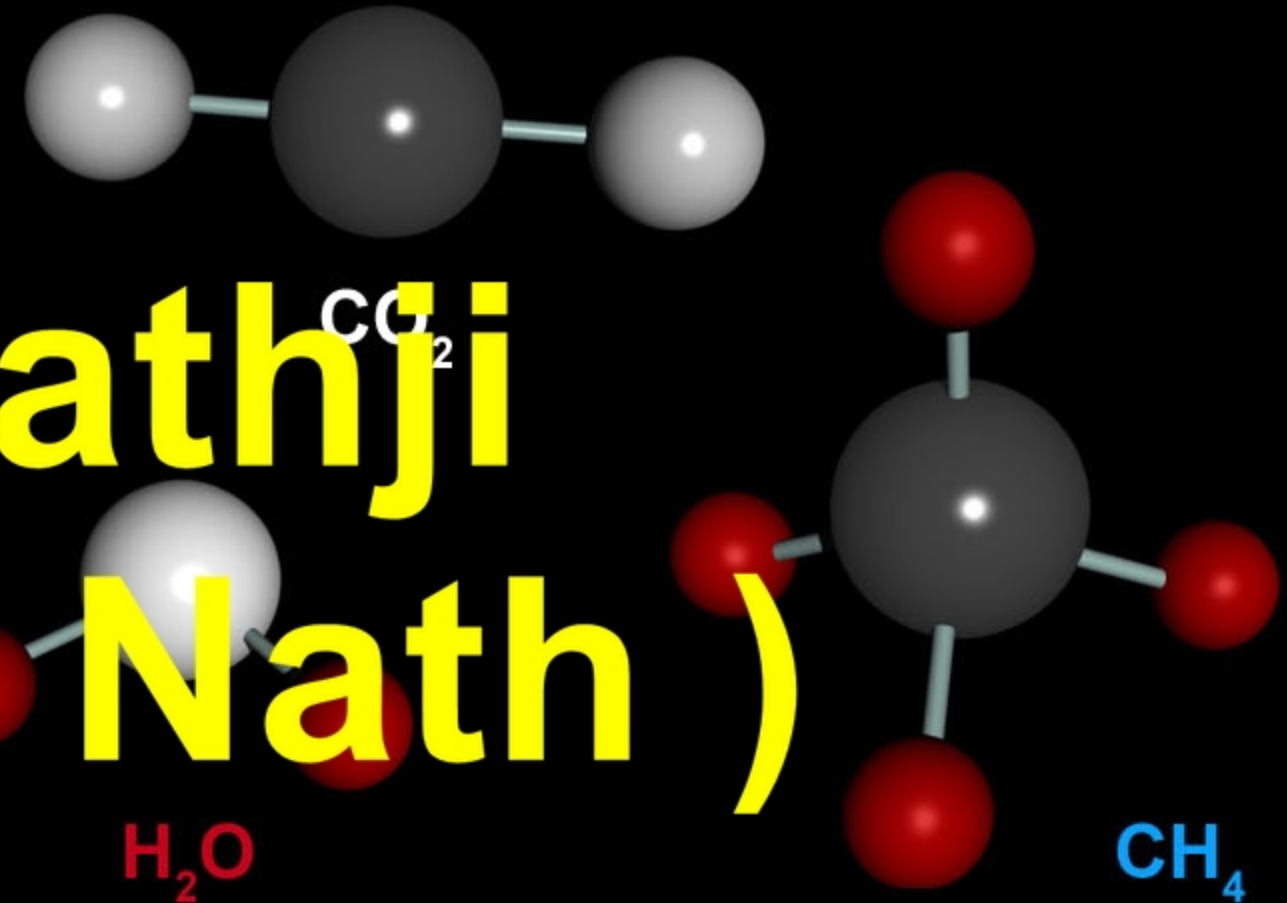
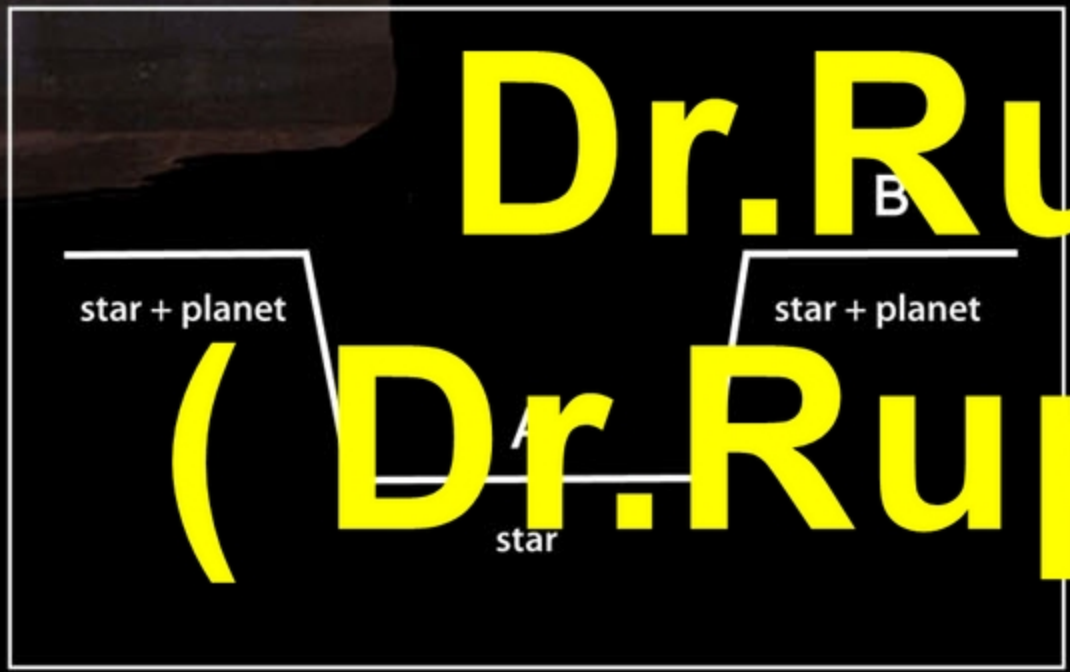
planet spectrum



B - A By

Dr. Rupnathji

(Dr. Rupak Nath)



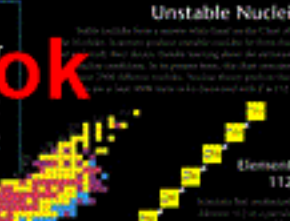
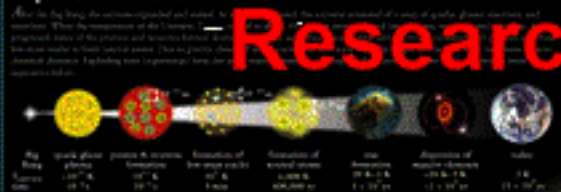
Nuclear Science

Nuclear Science is the study of the structure, properties, and interactions of the atomic nuclei. Nuclear reactions involve changes and rearrangements of the atomic nuclei. Nuclear science studies and analyzes the nuclear structure, mass, and decay of nuclei in rest and in motion. The key questions, such as "Why do nuclei stay together?", "What combinations of protons and neutrons are possible?", "What happens after nuclei are compressed or rapidly heated?", "What is the origin of the nuclei found on Earth?",

Legend

- Yellow: reference [1]
- Green: reference [2]
- Blue: reference [3]
- Red: reference [4]
- Purple: reference [5]
- Orange: reference [6]
- Light Blue: reference [7]
- Dark Blue: reference [8]
- Light Green: reference [9]
- Light Purple: reference [10]
- Light Orange: reference [11]
- Light Yellow: reference [12]
- Light Cyan: reference [13]
- Light Magenta: reference [14]
- Light Blue-Grey: reference [15]
- Light Green-Grey: reference [16]
- Light Purple-Grey: reference [17]
- Light Orange-Grey: reference [18]
- Light Yellow-Grey: reference [19]
- Light Cyan-Grey: reference [20]
- Light Magenta-Grey: reference [21]
- Light Blue-Grey: reference [22]
- Light Green-Grey: reference [23]
- Light Purple-Grey: reference [24]
- Light Orange-Grey: reference [25]
- Light Yellow-Grey: reference [26]
- Light Cyan-Grey: reference [27]
- Light Magenta-Grey: reference [28]
- Light Blue-Grey: reference [29]
- Light Green-Grey: reference [30]
- Light Purple-Grey: reference [31]
- Light Orange-Grey: reference [32]
- Light Yellow-Grey: reference [33]
- Light Cyan-Grey: reference [34]
- Light Magenta-Grey: reference [35]
- Light Blue-Grey: reference [36]
- Light Green-Grey: reference [37]
- Light Purple-Grey: reference [38]
- Light Orange-Grey: reference [39]
- Light Yellow-Grey: reference [40]
- Light Cyan-Grey: reference [41]
- Light Magenta-Grey: reference [42]
- Light Blue-Grey: reference [43]
- Light Green-Grey: reference [44]
- Light Purple-Grey: reference [45]
- Light Orange-Grey: reference [46]
- Light Yellow-Grey: reference [47]
- Light Cyan-Grey: reference [48]
- Light Magenta-Grey: reference [49]
- Light Blue-Grey: reference [50]
- Light Green-Grey: reference [51]
- Light Purple-Grey: reference [52]
- Light Orange-Grey: reference [53]
- Light Yellow-Grey: reference [54]
- Light Cyan-Grey: reference [55]
- Light Magenta-Grey: reference [56]
- Light Blue-Grey: reference [57]
- Light Green-Grey: reference [58]
- Light Purple-Grey: reference [59]
- Light Orange-Grey: reference [60]
- Light Yellow-Grey: reference [61]
- Light Cyan-Grey: reference [62]
- Light Magenta-Grey: reference [63]
- Light Blue-Grey: reference [64]
- Light Green-Grey: reference [65]
- Light Purple-Grey: reference [66]
- Light Orange-Grey: reference [67]
- Light Yellow-Grey: reference [68]
- Light Cyan-Grey: reference [69]
- Light Magenta-Grey: reference [70]
- Light Blue-Grey: reference [71]
- Light Green-Grey: reference [72]
- Light Purple-Grey: reference [73]
- Light Orange-Grey: reference [74]
- Light Yellow-Grey: reference [75]
- Light Cyan-Grey: reference [76]
- Light Magenta-Grey: reference [77]
- Light Blue-Grey: reference [78]
- Light Green-Grey: reference [79]
- Light Purple-Grey: reference [80]
- Light Orange-Grey: reference [81]
- Light Yellow-Grey: reference [82]
- Light Cyan-Grey: reference [83]
- Light Magenta-Grey: reference [84]
- Light Blue-Grey: reference [85]
- Light Green-Grey: reference [86]
- Light Purple-Grey: reference [87]
- Light Orange-Grey: reference [88]
- Light Yellow-Grey: reference [89]
- Light Cyan-Grey: reference [90]
- Light Magenta-Grey: reference [91]
- Light Blue-Grey: reference [92]
- Light Green-Grey: reference [93]
- Light Purple-Grey: reference [94]
- Light Orange-Grey: reference [95]
- Light Yellow-Grey: reference [96]
- Light Cyan-Grey: reference [97]
- Light Magenta-Grey: reference [98]
- Light Blue-Grey: reference [99]
- Light Green-Grey: reference [100]

Expansion of the Universe



Research Guide Book

Nuclear Physics

Radioactivity

Radioactivity is the process by which unstable atomic nuclei lose energy by emitting radiation. The three main types of radiation are:

- Alpha Decay:** Emission of an alpha particle (^4He).
- Beta Minus Decay:** Emission of an electron (e^-).
- Beta Plus Decay:** Emission of a positron (e^+).
- Gamma Decay:** Emission of a gamma ray (γ).

Radioactive decay is a stochastic process at the atomic level, and it is impossible to predict the exact time at which a particular nucleus will decay. However, the decay of a large number of nuclei can be predicted statistically.

The Nucleus

The nucleus is the central part of an atom, composed of protons and neutrons. It is held together by the strong nuclear force, which is mediated by the exchange of mesons. The strong force is the most powerful of the four fundamental forces, but it has a very short range.

Labels in the diagram:

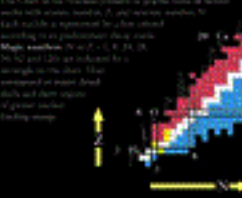
- neutron (10^{-16} m)
- proton (10^{-16} m)
- strong field
- quark (10^{-16} m)
- lepton (10^{-16} m)
- neutrino (10^{-16} m)
- electron (10^{-16} m)
- photon (10^{-16} m)

Nuclear Energy

Nuclear energy is the energy released during nuclear reactions. The two main types of nuclear reactions are:

- Fusion:** Two light nuclei combine to form a heavier nucleus, releasing energy.
- Fission:** A heavy nucleus splits into two lighter nuclei, releasing energy.

Chart of the Nuclides



By Dr. Rupnathji (Dr. Rupak Nath)

<http://pdg.lbl.gov/cpep.html>

Applications

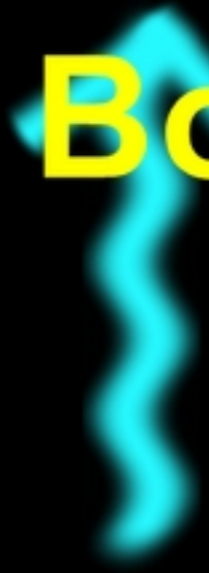
- Radiation Dosimetry:** Measurement of the dose of ionizing radiation.
- Space Exploration:** Use of nuclear power for space exploration.
- Nuclear Reactors:** Generation of electricity and production of isotopes.
- Medical Devices:** Use of nuclear medicine for diagnosis and treatment.
- Magnetic Resonance Imaging (MRI):** Use of nuclear magnetic resonance for medical imaging.

Advanced Guide Book

p



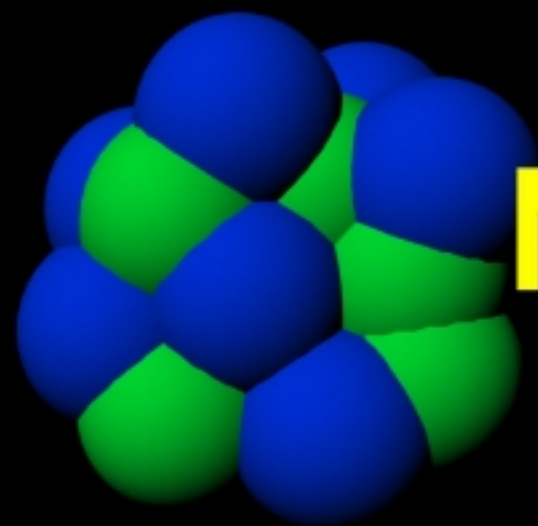
$n + e^+ + \gamma$
Practicals



γ

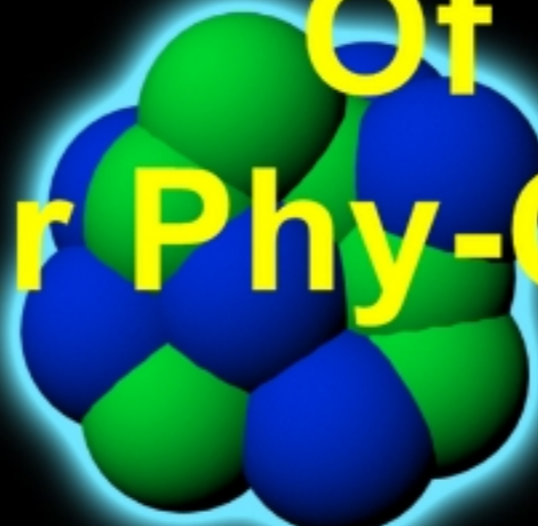
Of

Nuclear Phy-Chemistry



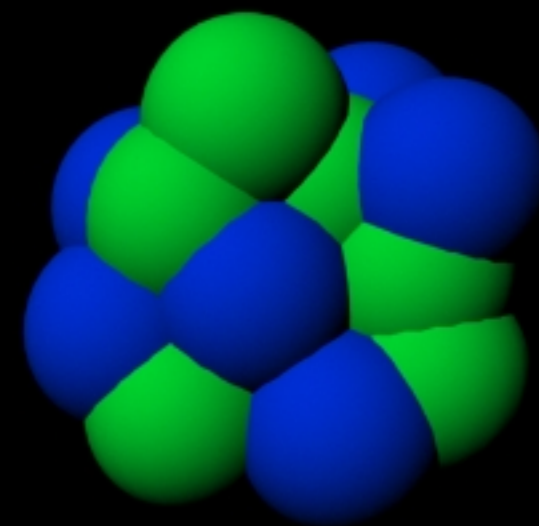
^{26}Al

13p + 13n



$^{26}\text{Mg}^*$

12p + 14n



^{26}Mg

12p + 14n

By

Dr. Rupnathji

(Dr. Rupak Nath)



Advanced Guide Book

Practicals Of Astro Physics

By

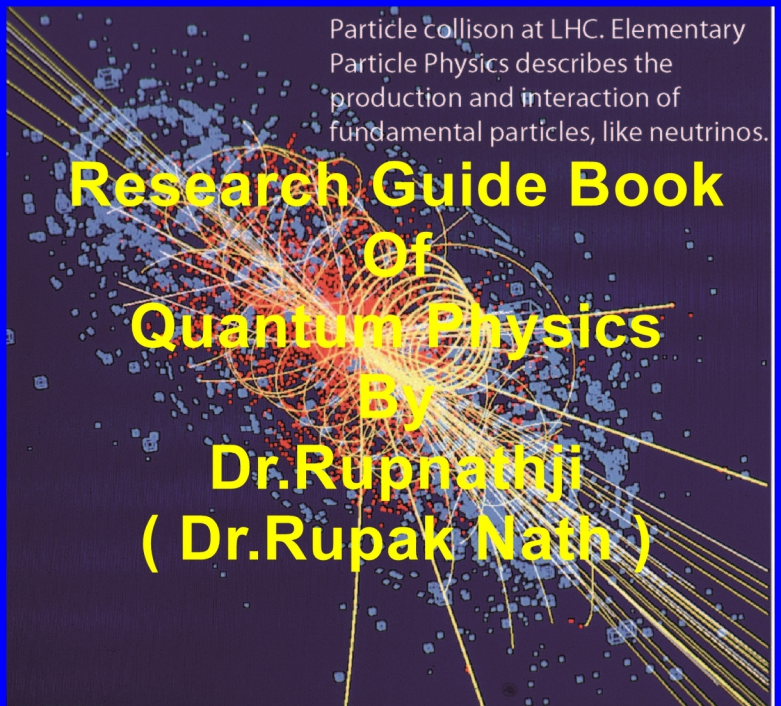
Dr.Rupnathji (Dr.Rupak Nath)

A photograph of a Space Shuttle orbiter mounted on a Mobile Launcher Platform (MLP) being moved by a crawler-transporter at night. The MLP is a large, complex structure with many lights and scaffolding. The shuttle is white with black and grey markings. The background is dark with some light flares.

Advanced Guide Book

New Concept of Rocket Technology

By
Dr. Rupnathji (Dr. Rupak Nath)

A visualization of a particle collision at the Large Hadron Collider (LHC). The background is dark blue with a complex pattern of glowing yellow and orange lines radiating from a central point, representing the paths of particles produced in the collision. Small blue and red squares are scattered throughout the scene, likely representing individual particles or data points.

Particle collision at LHC. Elementary Particle Physics describes the production and interaction of fundamental particles, like neutrinos.

**Research Guide Book
Of
Quantum Physics
By
Dr.Rupnathji
(Dr.Rupak Nath)**

Text Book

you have been watching
**GOD IS IN THE
NEURONS**



God Particle

By
Dr. Rupnathji

THE NEXT 1001
**THE GRAND SCHEME
OF THINGS**



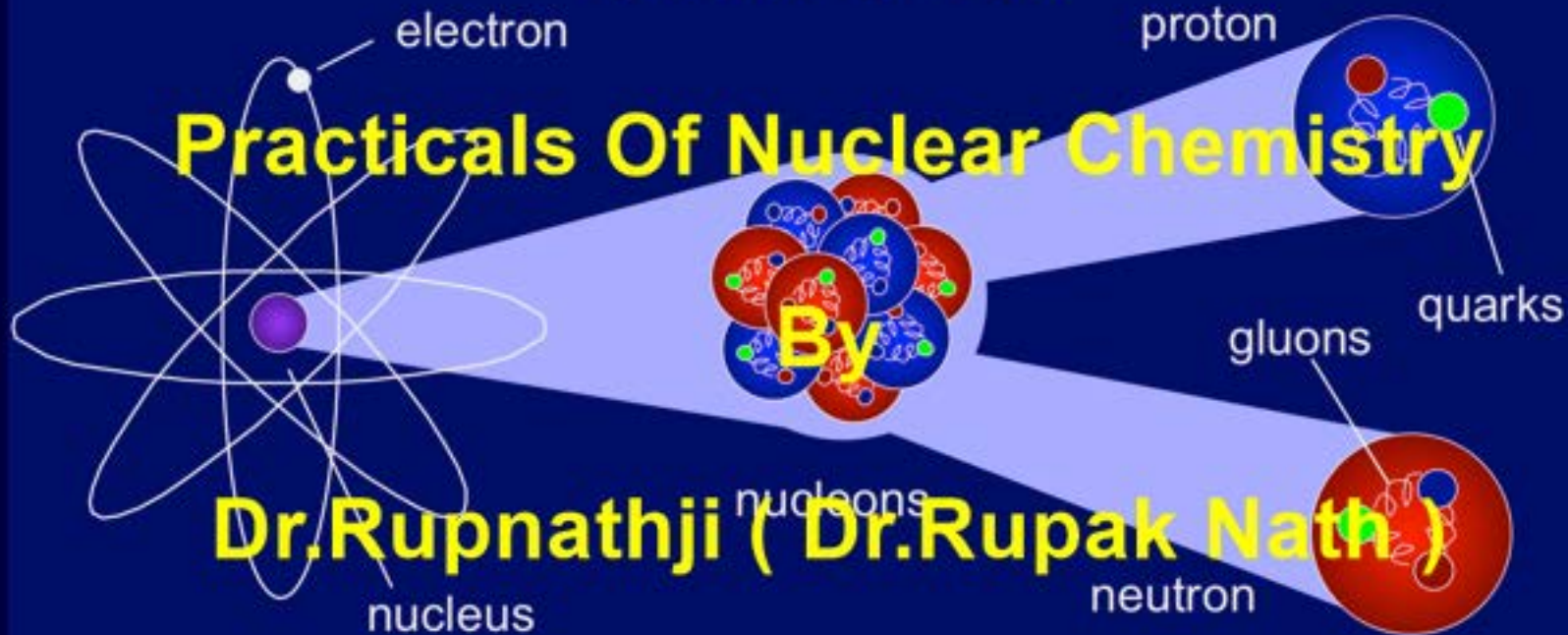
(**Dr. Rupak Nath**)

Guide Book

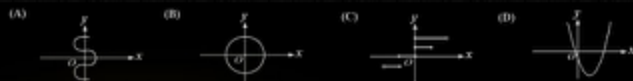
Practicals Of Nuclear Chemistry

By

Dr. Rupnathji (Dr. Rupak Nath)



- 10 PLUTO
- 9 NEPTUNE
- 8 URANUS
- 7 SATURN
- 6 JUPITER
- 5 MARS
- 4 EARTH
- 3 VENUS
- 2 MERCURY
- 1 SUN



Research Guide Book

The Sun

History

Until the middle ages it was assumed that the Sun orbited around the Earth. The first man to suggest that the Earth actually orbited the Sun was Nicolaus Copernicus in the early 16th century.

However his model of the Solar System was not accepted for many years, and many astronomers including Galileo were persecuted for endorsing his ideas.

The theory was widely accepted until Newton formulated his laws of motion, successfully modelling the dynamics of the Solar System.

The Sun is by far the largest object in the solar system. It contains more than 99.8% of the total mass of the Solar System (Jupiter contains most of the rest).

Radiation Physics

More Information

Like other gas giants in the Solar System, the gases that make up the Sun spin around its axis. This rotation is not constant, but happens at different speeds between the poles and the equator and at different depths beneath the Sun's surface. This differential rotation causes the Sun's magnetic field, which initially varies smoothly between the North and South poles to warp. Eventually the field becomes so complex that it collapses, causing the north and south poles to swap, and the process to begin again.

A complete Sun cycle takes 22 years, after which the original North pole is restored. Maximum Sunspot activity occurs during the period when the poles are switching. Such a change occurred in 2001.

The time it takes for light from the Sun to reach Earth is 8.3 minutes.

THE SUN

The Sun has been given many names over the course of history. The Greeks named it Helios, from which we obtain the adjective heliocentric. The Romans referred to the Sun as Sol.

By

Dr. Rupnathji

(Dr. Rupak Nath)

Solar Flares

Variations in the Sun's magnetic field often cause huge jets or loops of stellar material to shoot out into space. Often these emit clouds of charged particles, dense enough to affect communications on Earth.

$$f(x) = (x-1)^2$$

$$f'(x) = 2(x-1)$$

$$f''(x) = 2$$

$$f(x) = x^2 - 2x + 1$$

$$f'(x) = 2x - 2$$

$$f''(x) = 2$$

Facts and figures :-

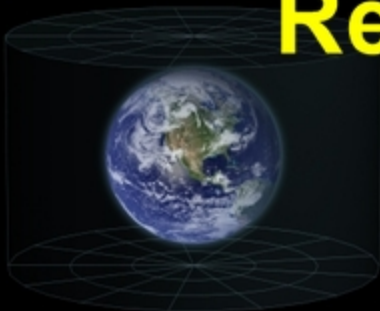
The Sun's energy output is estimated to be 386 billion billion megawatts. A figure so immense even Professor Stephen Hawking might have problems getting his head around it. Rephrased, it's estimated that in 15 minutes our Sun radiates as much energy as mankind consumes in all forms, during an entire year.

The Sun is by far the brightest object in the sky: so bright that its light renders virtually every other astronomical body invisible when it is visible. It is also so bright that it will damage eyesight when viewed with the naked eye.

The temperature at the surface reaches 5500°C. Yet even this is cool compared with temperature at the core: a sweltering 15.6 million °C.

SIZE - DIAMETER	1.39 MKM
MASS	1.989E30 KG
TYPE	G2 STAR
ATMOSPHERE	HYDROGEN/HELIUM
MOONS	THE NINE PLANETS
TEMPERATURE	5500 KELVIN
COLOR	YELLOW / ORANGE
CORE	HYDROGEN
ORBITAL PERIOD	-
FROM EARTH	149.6 MKM
LENGTH OF DAY	25H - 36 EARTH DAYS

Earth



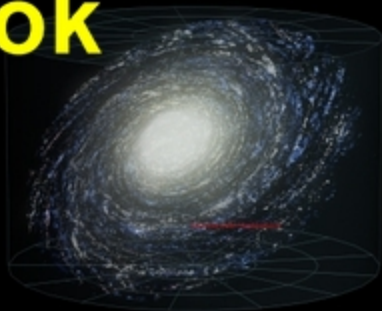
Solar System



Solar Interstellar Neighborhood



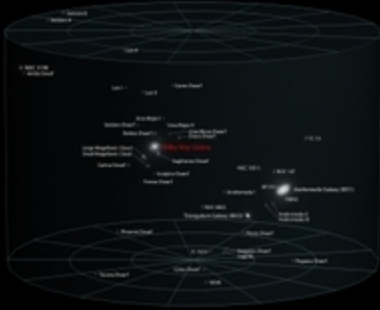
Milky Way Galaxy



Research Guide Book

Total Astronomy

Local Galactic Group



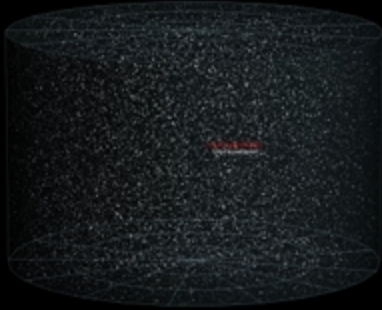
Virgo Supercluster



Local Superclusters



Observable Universe



By
Dr. Rupnathji
(**Dr. Rupak Nath**)

Text Book

Dark Energy
Accelerated Expansion

Afterglow Light
Pattern
380,000 yrs.

Dark Ages

Development of
Galaxies, Planets, etc.

Universal Physics

Inflation

Quantum
Fluctuations

WMAP

By

1st Stars

about 400 million yrs.

Dr. Rupnathji

Big Bang Expansion

(Dr. Rupak Nath)

13.7 billion years

Text Book

Laws Of Physics



$$F_G = \frac{Gm_1m_2}{R^2}$$



By

Dr.Rupnathji

(Dr.Rupak Nath)

We Have a Natural Attraction to One Another

- 1. SUN
- 2. MERCURY
- 3. VENUS
- 4. EARTH
- 5. MARS
- 6. JUPITER
- 7. SATURN
- 8. URANUS
- 9. NEPTUNE
- 10. PLUTO



Research Guide Book

Advanced Astronomy

Pluto & Charon

Charon is unusual in that it is the largest moon with respect to its primary planet in the Solar System (a distinction once held by Earth's Moon). Some prefer to think of Pluto/Charon as a double planet rather than a planet and a moon.

Scientists think there may be thousands of little icy planets like Pluto on the outer edge of our solar system.

It would take 500 Pluto's to equal the Earth's mass.

NASA is has plans to send a new flying robot explorer that will fly by Pluto in 2015. The project is called the Pluto-Kuiper Express and it will give us a really close up look!

WWW.PHOTOGRAPHY.COM



By
Dr. Rupnathji
(Dr. Rupak Nath)

Kuiper Belt

The Kuiper Belt is a disk-shaped region between Neptune & Pluto roughly 30 to 100 AU from the Sun containing many small icy objects. It is considered to be the source of short-period comets.

Pluto is probably a big chunk of rock and ice that is covered by a layer of frozen nitrogen and carbon monoxide. None of our flying robot explorers have gone by Pluto... So, there's a lot about Pluto that we just aren't sure of.

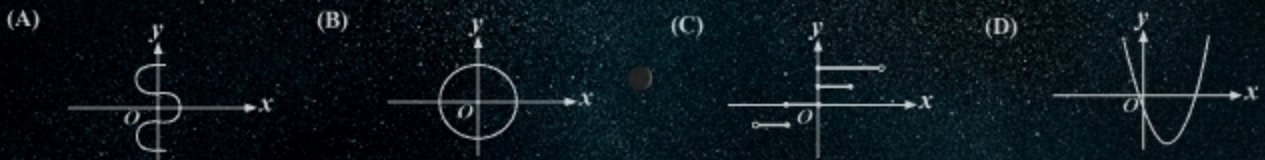
Pluto's only known moon, Charon, was discovered in 1978. The really cool thing is that Pluto and Charon rotate as Charon moves around Pluto, they each keep the same face towards each other all the time.

One of the coolest things about Pluto is that it rotates in the opposite direction of most of the other planets! If we look down on the planets from above we see that Pluto rotates clockwise (the way a clock's hand moves around the clock) and all the other planets (except Uranus and Venus) and all the moons spin counterclockwise (like if the clock's hands were moving backwards).

SIZE	DIAMETER 2300KM
MASS	1.32ND EARTH'S
FROM SUN	5945 MILLION KM
ATMOSPHERE	VERY THIN NITROGEN
MOONS	1 (CHARON)
TEMPERATURE	-220°C
COLOR	UNKNOWN
CORE	UNKNOWN
ORBITAL PERIOD	90.566 DAYS
FROM EARTH	4275 - 7625 M KM
LENGTH OF DAY	6.387 DAYS

"From Pluto, the sun is so far away that it looks little brighter than a bright star"

- 10 SUN
- 20 MERCURY
- 30 VENUS
- 40 EARTH
- 50 MARS
- 60 JUPITER
- 70 SATURN
- 80 URANUS
- 90 NEPTUNE
- 100 PLUTO



Neptune

Guide Book

Practicals Of Astronomy

* Neptune's most prominent feature "The Great Dark Spot" is a storm 7000 miles across, approximately the size of earth.

* The composition of Neptune's complete rings is as yet unknown.

By

Dr. Rupnathji (Dr. Rupak Nath)

Problem 12

Evaluate: $\int_{-1}^{2} \left(\frac{e^x}{x^2} + \frac{2}{x} \right) dx$

$u = \frac{1}{x} \Rightarrow 2x^{-2}$

Raining Diamonds
Scientists think that it is raining giant diamonds on Neptune!!! That's right - raining diamonds! A simulation of Neptune's atmosphere was recently done at University of California, Berkeley... and it produced diamond dust. So, they think with all the carbon in Neptune's atmosphere and the extreme pressure on that planet that it may be, literally, raining giant diamonds!

Neptune has been visited by only one spacecraft, Voyager 2 on Aug 25 1989. Much of we know about Neptune comes from this single encounter. But fortunately, recent ground-based and HST observations have added a great deal, too.

Neptune's blue color is largely the result of absorption of red light by methane in the atmosphere but there is some additional as-yet-unidentified chromophore which gives the clouds their rich blue tint.

Like a typical gas planet, Neptune has rapid winds confined to bands of latitude and large storms or vortices. Neptune's winds are the fastest in the solar system, reaching 2000 km/hour.

Like Jupiter and Saturn, Neptune has an internal heat source - it radiates more than twice as much energy as it receives from the Sun.

SIZE :	DIAMETER 49,532KM
MASS :	1.024X10 ²⁶ KG
FROM SUN :	4504 MILLION KM
ATMOSPHERE :	HYDROGEN
MOONS :	8
TEMPERATURE :	-220°C
COLOUR :	DEEP BLUE
CORE :	ROCKY/ICE CORE
ORBITAL PERIOD :	60,190.3 DAYS!
FROM EARTH :	4354 - 4564 MKM
LENGTH OF DAY :	16 HOURS 7 MINS

M101

NASA'S GREAT OBSERVATORIES

Guide Book

Practicals Of

Rocket Science

By

Dr. Rupnathji (Dr. Rupak Nath)

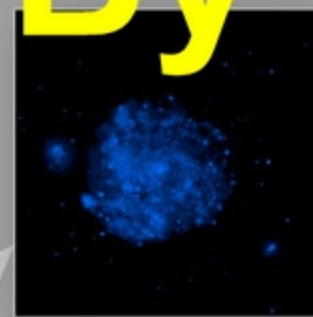
SPITZER
SPACE
TELESCOPE
INFRARED



HUBBLE
SPACE
TELESCOPE
VISIBLE



CHANDRA
X-RAY
OBSERVATORY
X-RAY



These represent the data from NASA's three Great Observatories in a single color-composition image. At the left are separate images from three different regions of infrared light from *Spitzer Space Telescope*, three images from different regions of visible light from *Hubble Space Telescope*, and three different regions of x-ray light from *Chandra X-ray Observatory*. The three images from each observatory are combined into a single black and white image representing the light from that part of the spectrum. Each of these images is assigned a color: red for infrared light, yellow for visible light, and blue for x-ray light. These three separate color images can blend together to see the light from a very broad range of light energy in one image.

Guide Book

**Practicals
Of**

**Aeronautical
&
Space Technology**

By

**Dr.Rupnathji
(Dr.Rupak Nath)**

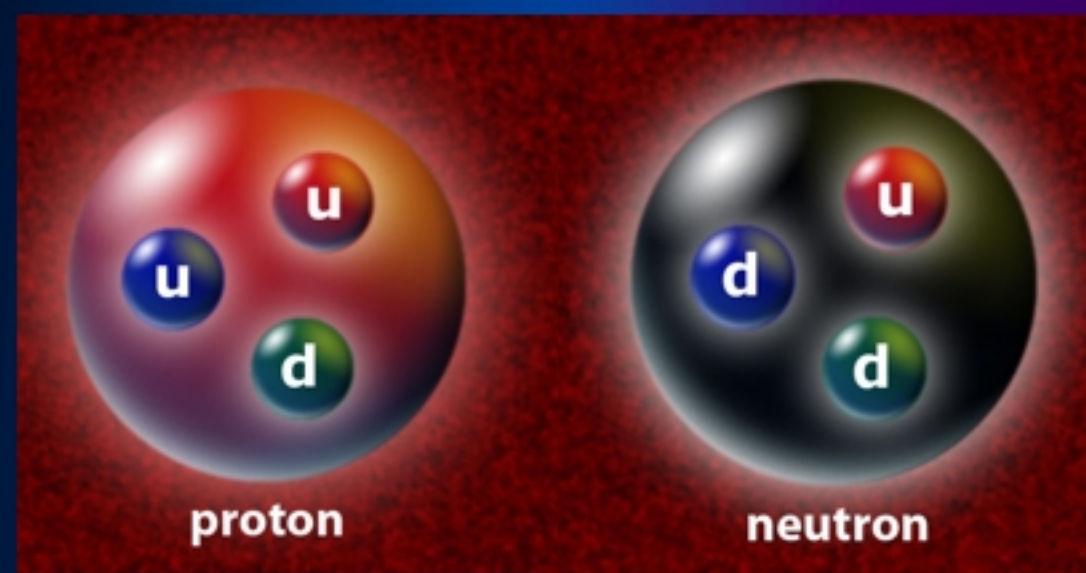
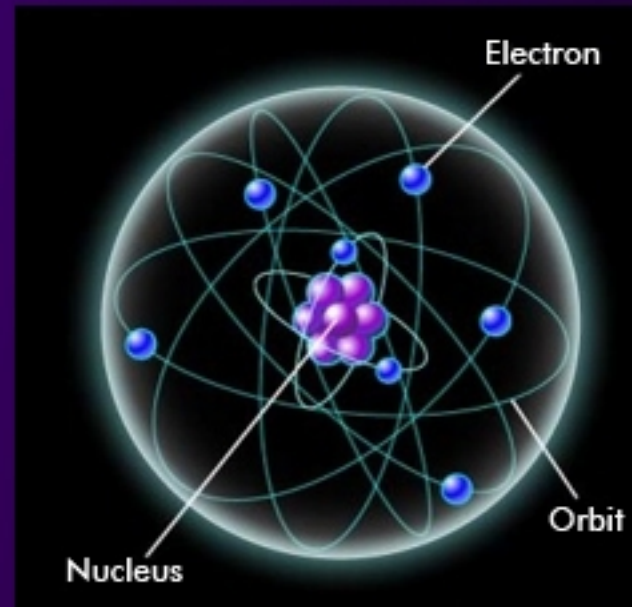


Advanced Guide Book



What is Fundamental-1: The Four Elements
 Many centuries ago, it was believed that all matter was made up of four elements: Fire, Earth, Air, and Water. People walked on Earth, breathed Air, drank the water and were fire for warmth. We now know that all of these things in fact are made up of many differently smaller elements, which themselves are made up of something more fundamental.

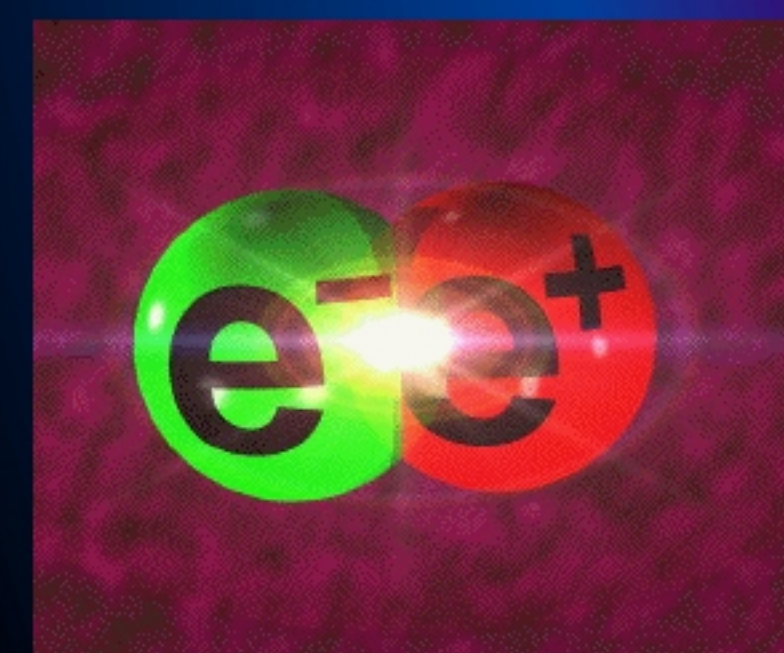
What is Fundamental-2: The Atom
 In 1911 Rutherford predicted that matter was made up of fundamental particles called 'atoms'. The atomic theory was later confirmed in the 1930s. Atoms were thought to be fundamental, but are in fact made up of a nucleus consisting of positively charged protons and uncharged neutrons. Orbiting the nucleus are the negatively charged electrons.



What is Fundamental-3: Quarks
 In the 1960s it was discovered that the proton and neutron are not fundamental particles, but are actually composed of smaller particles known as 'quarks'. Pictures here show the proton and neutron and contain three quarks.



The Six Quarks
 The image at right shows the six types of quarks, from top left: bottom, top, strange, charm, down, up. Solitary quarks are never seen, they are always found with another quark or antiquark. The top quark is the heaviest, and the up quark is the lightest.



Antimatter
 For every matter particle, there is a corresponding antimatter particle. Antimatter is identical to matter, except in charge and magnetic moment. To the left is an artist's conception of an electron and its antiparticle, the positron. When matter contacts antimatter, they annihilate into pure energy.



Hadrons
 There are two types of hadrons: baryons, which are composed of three quarks (i.e. the proton and the neutron); mesons, which are composed of a quark and an antiquark. To the right is an example of a meson, the pion, which consists of an up quark and a down antiquark. (Antimatter particles are generally denoted by a bar over the symbol).

Leptons	Quarks	
ν_e (electron neutrino)	u (up), c (charm), t (top)	
ν_μ (muon neutrino)	d (down), s (strange), b (bottom)	
ν_τ (tau neutrino)		
e (electron)		
μ (muon)		
τ (tau)		
I	II	III

The Generations of Matter

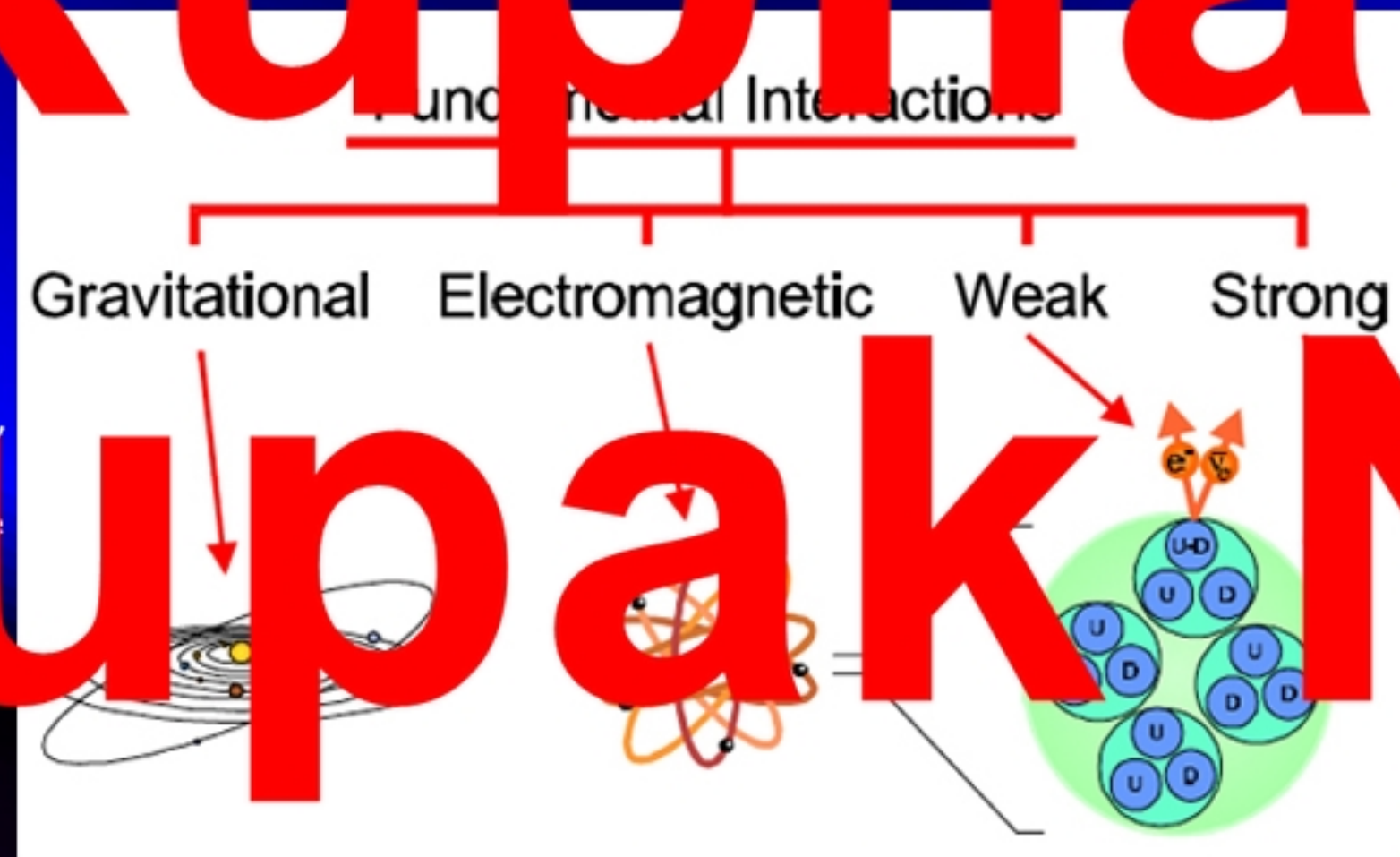
The Fundamental Particles
 The six quarks and the six leptons are what we call the fundamental particles. The leptons are the electron, muon, tau and their corresponding neutrinos. In this course we will study the properties of these particles as well as their antiparticles. The fundamental particles are organized into 3 generations, where the heaviest (generation III) decay into the lightest (generation I).

Humans have always wondered about their surroundings. For some, the path to understanding lies among the stars, for others it lies within the fundamental particles that we are all composed of. An atom is made up of many tiny particles that behave strangely compared to the macroscopic universe we are used to. For example, an atom is made up of mostly empty space, and yet anyone that runs into a wall may opt to argue with that. At subatomic levels, particles behave like waves and phenomena are explained through the mathematics of quantum mechanics.

Until scientists can fully understand the subatomic world, we rely on the "Standard Model of particle physics", which, for all other things, is a step in the direction of understanding.



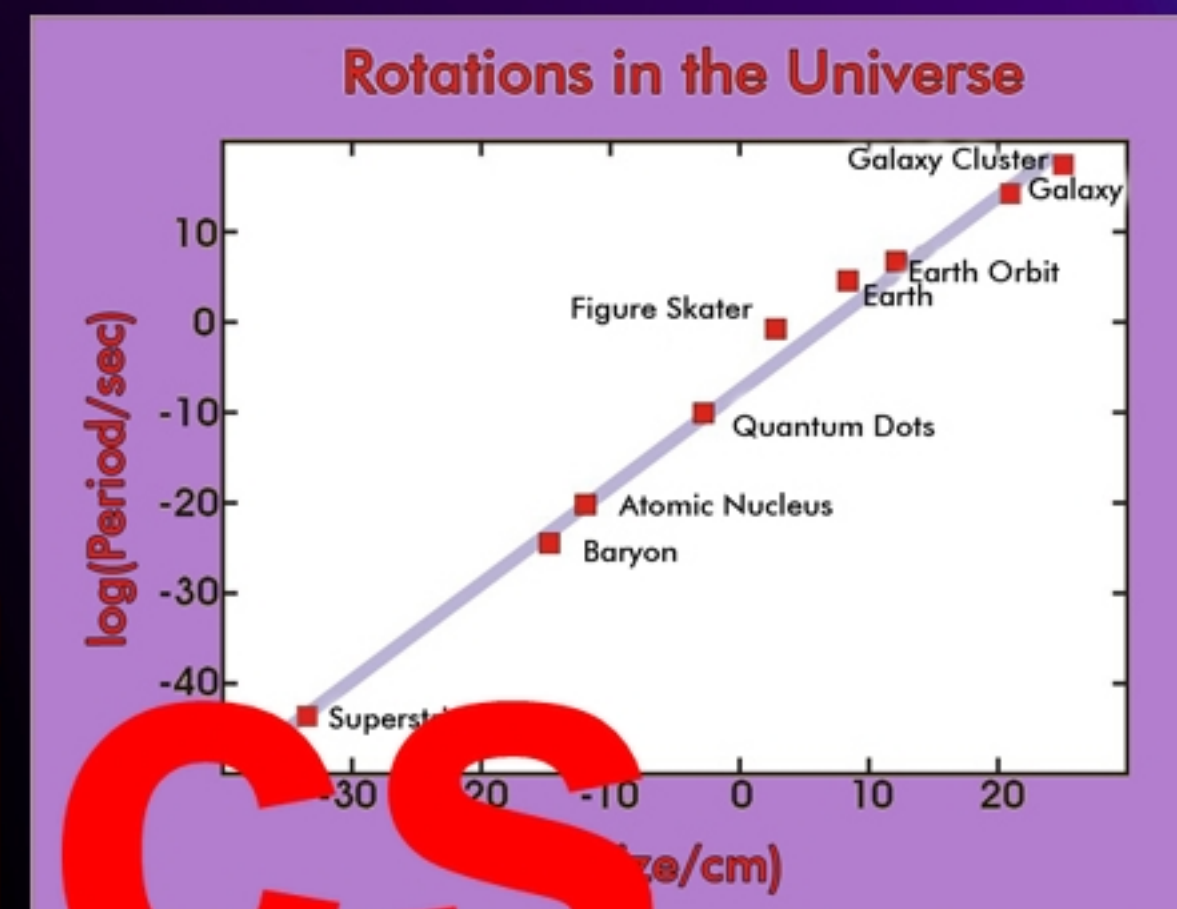
Size Matters
 The above image shows a distance scale (in metres, from right to the left). Starting with a computer simulation of a proton's shape, then a platinum atom, red blood cells, human, and Cape Breton.



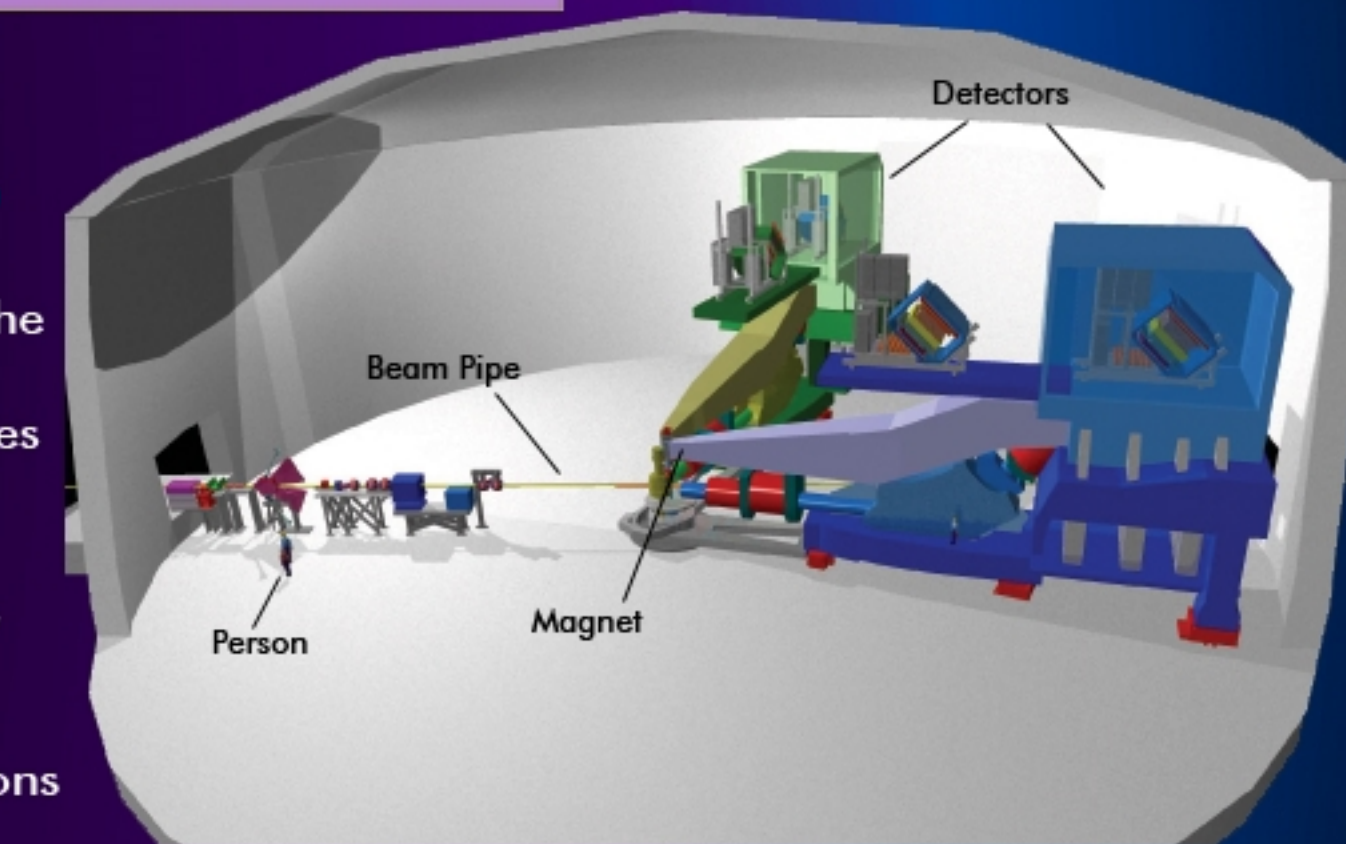
What Holds It Together? The Four Forces
 We have now the fundamental particles, but what governs their behaviour? There are four fundamental forces that work by exchanging particles called gauge bosons. These forces are Strong, Weak, Electromagnetic and Gravitational. Field theory connects these forces to quantum mechanics. Only quantum mechanics can explain what happens at the subatomic level. We will use quantum mechanics with the other sciences to search for a Theory of Everything to connect all four.



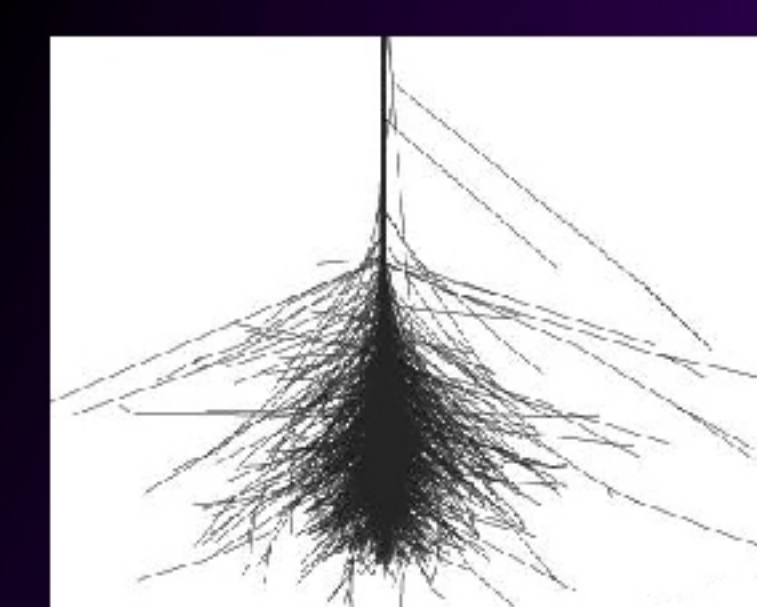
Canadian Research Facilities
 These are two facilities in Canada for nuclear physics research. Above: The TRIUMF facility in Vancouver, British Columbia. Right: The Sudbury Neutrino Observatory (SNO) in Sudbury, Ontario.



Rotations
 Nuclei with extra energy can rotate. Some rotating nuclei take on odd shapes; they can be squished like a tangerine or extended like a pecan. By studying gamma radiation from rotating nuclei, we can learn about these unusual shapes. To the left is a plot of many familiar rotational periods, which seem to follow a linear slope.



Jefferson Lab
 At right is a cartoon image of the equipment used to study proton structure in Hall A of Jefferson Laboratory. An electron beam enters the room in the "beam pipe" from the left, after having been accelerated across 6 billion volts of electrical potential. The electron beam smashes into a target placed at the center of the room, inducing nuclear reactions in the target and sending reaction products throughout the room, into our detectors which are 3 stories high. In the experiments, both electrons and protons are examined from the nuclear reactions. Saint Mary's researchers have used these tools to study the forces between quarks within the proton, as well as the forces between protons and neutrons themselves inside the nuclei.



Cosmic Rays
 Cosmic Rays are ultra-high energy particles that interact with our upper atmosphere in all directions, producing an "air shower" of unstable particles. Muons are the most abundant particles that can be detected using plastic scintillators at ground level. The *Imperial Oil Cosmic Rays in the Classroom* project incorporates these scintillators into high schools, where they will be integrated into the Grade 12 physics curriculum. This will help the students learn some hands-on modern physics. Left is a simulated air shower of muons. Website: www.ap.smu.ca/cosmicray

Dr. Rupnathji (Dr. Rupak Nath)

Interaction	PROPERTIES OF THE INTERACTIONS			
	Gravitational	Weak (Electroweak)	Electromagnetic	Strong
Mediated by	Gravitons	W ⁺ , W ⁻ , Z ⁰	Electric Charge	Color Charge
Acts on	All particles	Flavor	Electrically charged	Fundamental
Particles exchanging:	All particles	Quarks, Leptons	Quarks, Gluons	Residual
Strength relative to electromag for two u quarks at:	10 ⁻⁴¹	0.8	25	Not applicable to quarks
for two protons in nucleus	10 ⁻³⁶	10 ⁻⁴	60	20



**Advanced Concept
of
Aeronautical & Rocket
Technology**

**By
Dr.Rupnathji
(Dr.Rupak Nath)**



**Research Book
on
Aeronautical & Rocket
Technology**

By

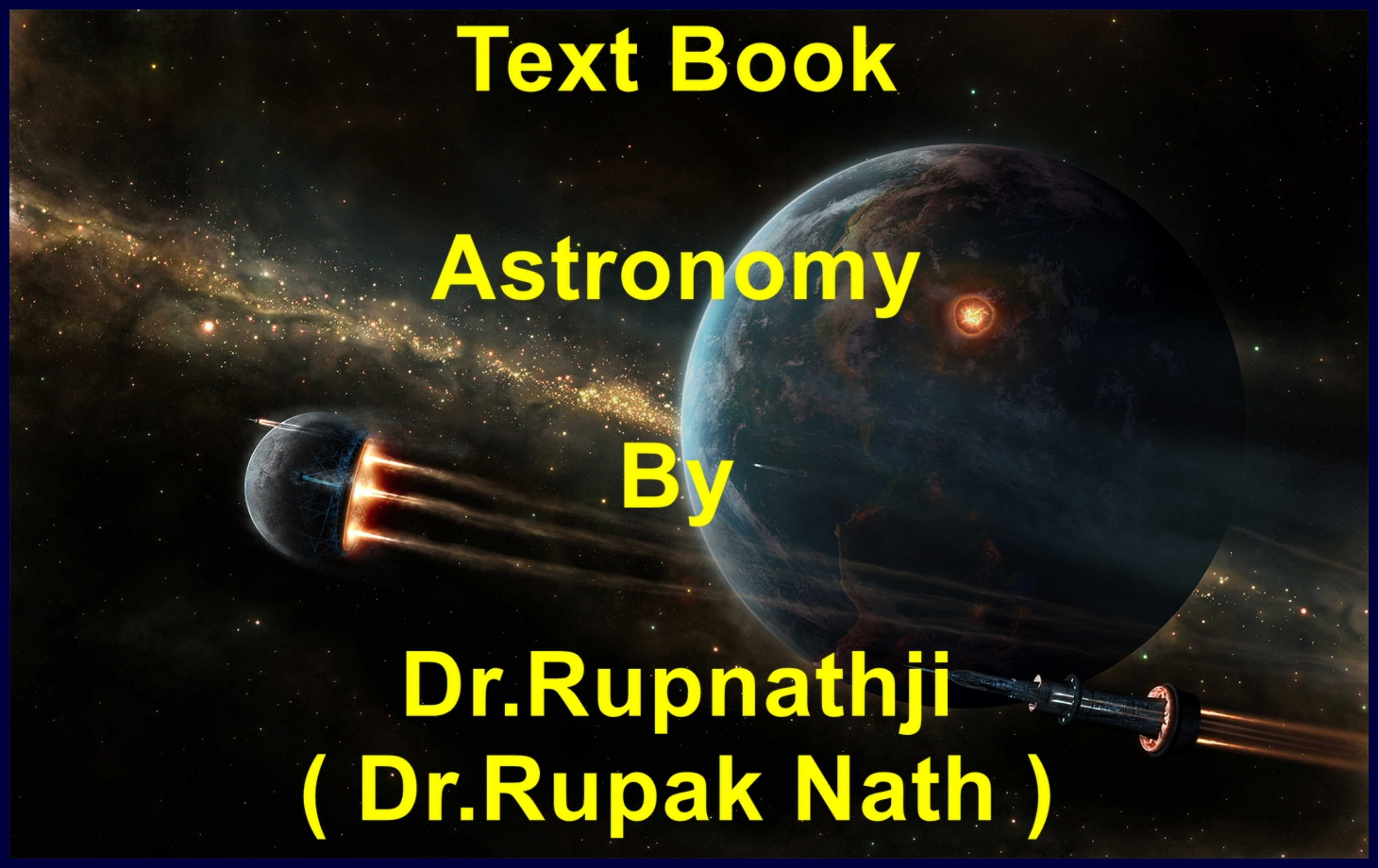
**Dr. Rupnathji
(Dr. Rupak Nath)**

Text Book

Astronomy

By

**Dr.Rupnathji
(Dr.Rupak Nath)**





Text Book

Advanced Astronomy

By

**Dr.Rupnathji
(Dr.Rupak Nath)**

Dark Energy & Quantum Universe



By

**Dr.Rupnathji
(Dr.Rupak Nath)**

SUBATOMIC PARTICLES

BOSON | FERMION | HADRONS | LEPTONS | QUARKS

Nuclear Science

PROTON

NUCLEUS

ATOM

By

d

\bar{d}

s

Quarks

Quark

Dr. Rupnathji

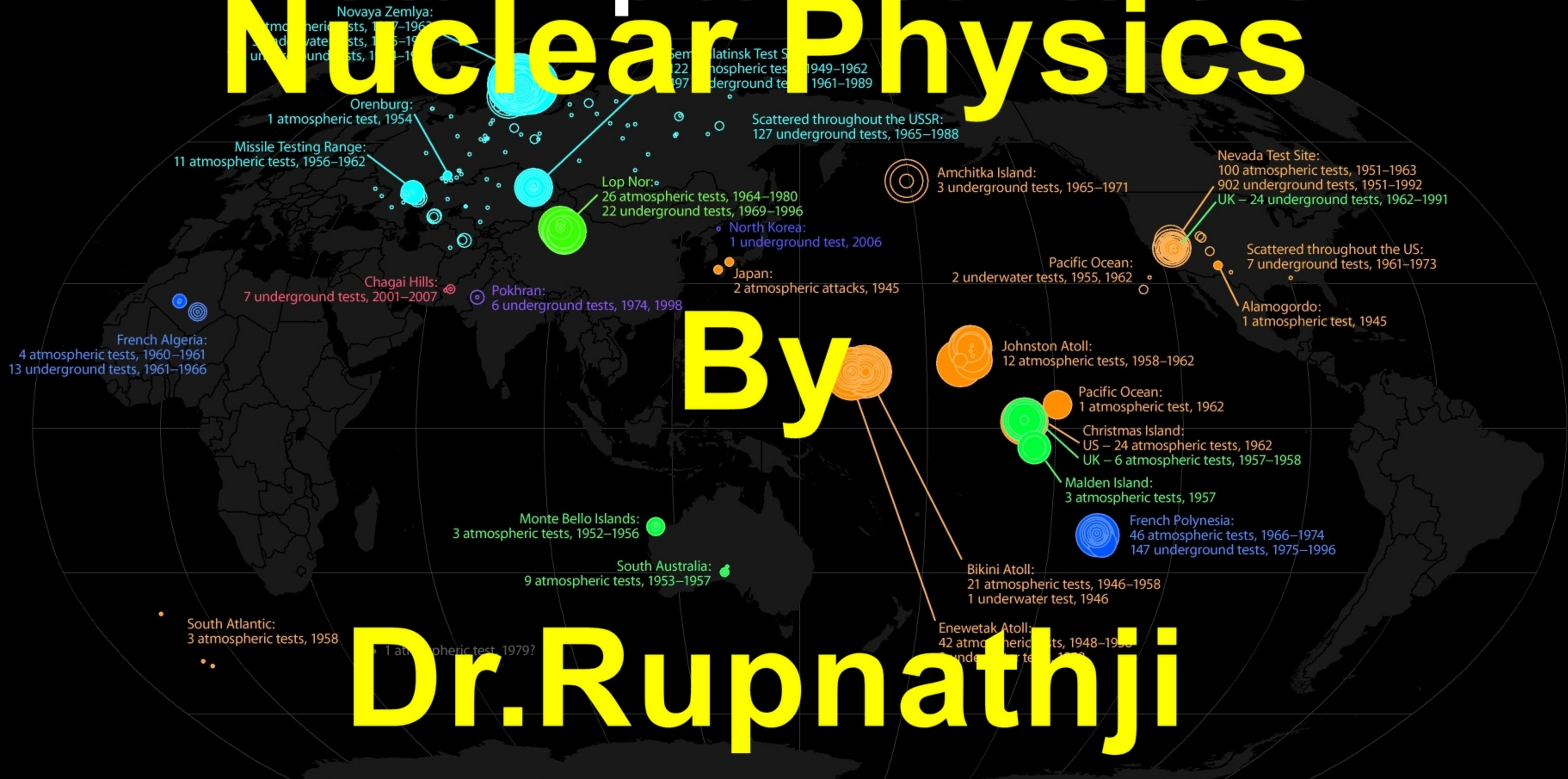
(Dr. Rupak Nath)

Neutron

Electron
(Lepton)

Nuclear Explosions since 1945

Nuclear Physics



Dr. Rupnathji

(Dr. Rupak Nath)

Each explosion is represented by a circle. Many of these circles overlap.

- atmospheric detonations
- underground or underwater tests

Country	Year of detonation	Number of atmospheric tests	Number of underground tests	Number of underwater tests
United States	1945	200	912	5
USSR	1949	223	756	3
United Kingdom	1952	21	24	0

more than 20 megatons
 2.5-5.1 megatons
 160-320 kilotons
 less than 15 kilotons

The size of each circle represents the yield of the blast. The scale is not linear:




Text Book

Radio Physics

By

Dr.Rupnathji
(Dr.Rupak Nath)

The background of the entire image is a photograph of the International Space Station (ISS) in orbit above the Earth. The station's complex structure, including multiple modules and large solar panel arrays, is clearly visible against the blackness of space. Below the station, the curved horizon of the Earth is shown, with a thin layer of white clouds and a deep blue ocean. The text is overlaid on this scene in a bold, red, sans-serif font.

Text Book
Space Science

By

Dr.Rupnathji
(Dr.Rupak Nath)

Text Book

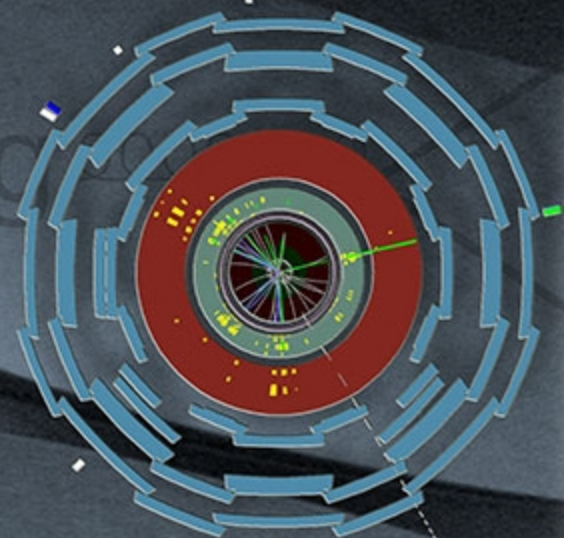
3D Technology

By

Dr. Rupnathji
(Dr. Rupak Nath)

TOP PHYSICS

The Top quark is by far the heaviest quark; it is nearly as heavy as a gold atom! Due to its mass, it was discovered only recently. The generation of enormous numbers of Top quarks at the LHC, together with the study of its coupling behaviour, will enable the ATLAS experiment to conduct detailed studies of their properties. The Atlantis event display image shows a top-antitop pair decaying into a cascade of particles including an electron and numerous jets.



Research Guide Book

PARTICLE PHYSICS

Of

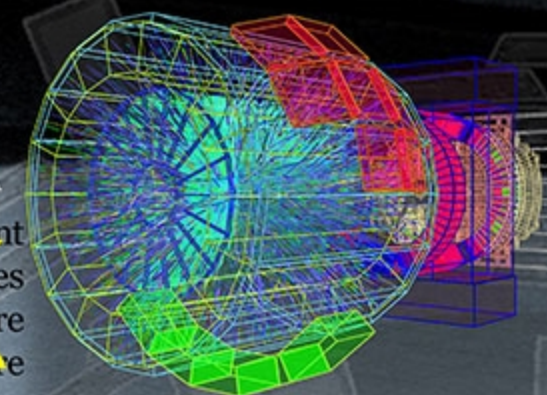
Modern Physics

GROUP

As one of the earliest research groups in the School of Physics and Astronomy, we investigate and search for the smallest constituents of the atom and make precise measurements of quarks and leptons. Most of our experiments are carried out at particle colliders in laboratories around the world (including CERN) where particles are accelerated towards one another at near light speed. The high energy collisions produce massive particles including the Z boson and the top quark. These experiments will allow us to find out whether supersymmetry, technicolour or dark matter are involved when the symmetry of the standard model is broken.

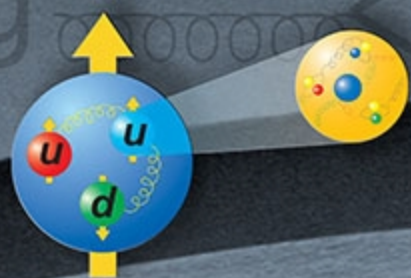
QUARK-GLUON PLASMA

The ALICE experiment will probe the conditions surrounding the formation of matter and the nature of the strong force. In particular, we will create and explore the first instants of the Universe, a few microseconds after the Big Bang when a primordial state of matter, the Quark-Gluon Plasma, is thought to have existed.

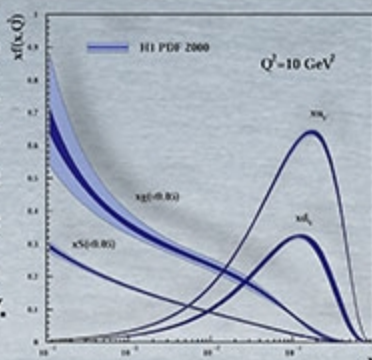


DEEP IN THE PROTON

It is well known that the proton is built from 2 up quarks and 1 down quark. Lesser known is the fact that due to the strong nuclear force, these valence quarks can radiate gluons, which in turn can split into sea quark-antiquark pairs, ultimately resulting in a very complex structure.



The H1 experiment studies high energy electron-proton collisions, equivalent to viewing the proton with an ultra-high resolution ($\sim 10^{-18}\text{m}$) microscope. The plot shows the resulting measurements of the valence and sea quark densities and the gluon density as a function of the fraction, x , of the proton's momentum which they carry.



CP VIOLATION

The BaBar experiment is investigating a subtle, but fundamental difference between the properties of matter and antimatter, known as CP violation. It has measured a significant difference between the decays of B^0 and anti- B^0 particles.



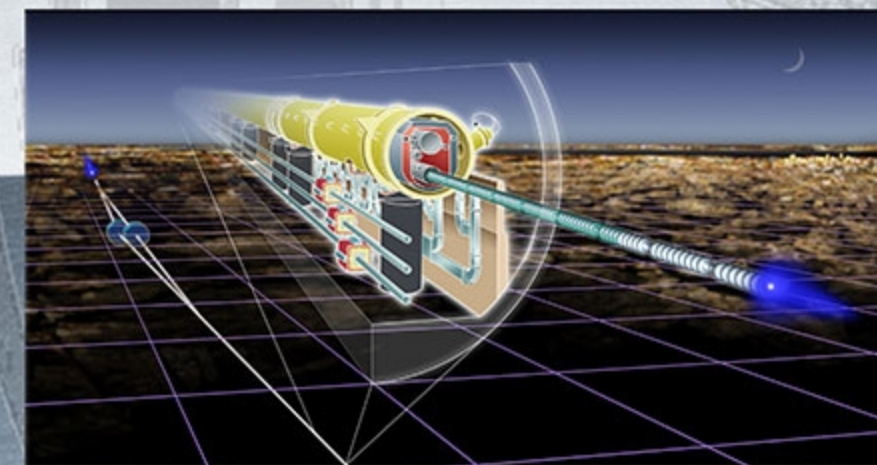
GRID COMPUTING



The LHC experiments have built truly massive detectors that will generate about 15 PB (petabytes) of data annually. That's enough to fill more than 500 3000GB iPods with 3 billion songs, 4 billion photos or more than 2000 years of video! No single institute is capable of providing the required computing and storage capacities. Birmingham, through its involvement in the GridPP collaboration, is contributing to the development of the world-wide grid which will pool together resources of participating institutes worldwide and give scientists access to resources levels never before available.

LOOKING AHEAD

The International Linear Collider is the next generation, high energy e^+e^- accelerator. We are studying both the novel use of CMOS MAPS sensors and more established technologies to measure electromagnetic energy with unprecedented precision. We are also leading global design efforts for collimation in the beam delivery system. Extensive test beam experiments world wide are essential to all of these activities.



DETECTOR AND TRIGGER DEVELOPMENT

We have excellent facilities and highly skilled staff working locally on the design, construction and testing of key components (e.g. readout hybrid) and software for the ALICE and ATLAS experiments at the Large Hadron Collider (LHC) at CERN. We are specialists in the design and production of electronic trigger systems use to select the collisions to be recorded. At the LHC, proton bunches are expected to collide at a rate of a thousand million every second. As we can only record and study a few hundred collisions every second, the trigger plays a critical role by only selecting the most interesting ones.



A satellite with large solar panels is shown in orbit above the Earth's surface, which is covered in white clouds and blue oceans. The satellite is oriented diagonally across the frame.

Text Book

Satellite Communication Technology

By

**Dr.Rupnathji
(Dr.Rupak Nath)**

Text Book

Theories

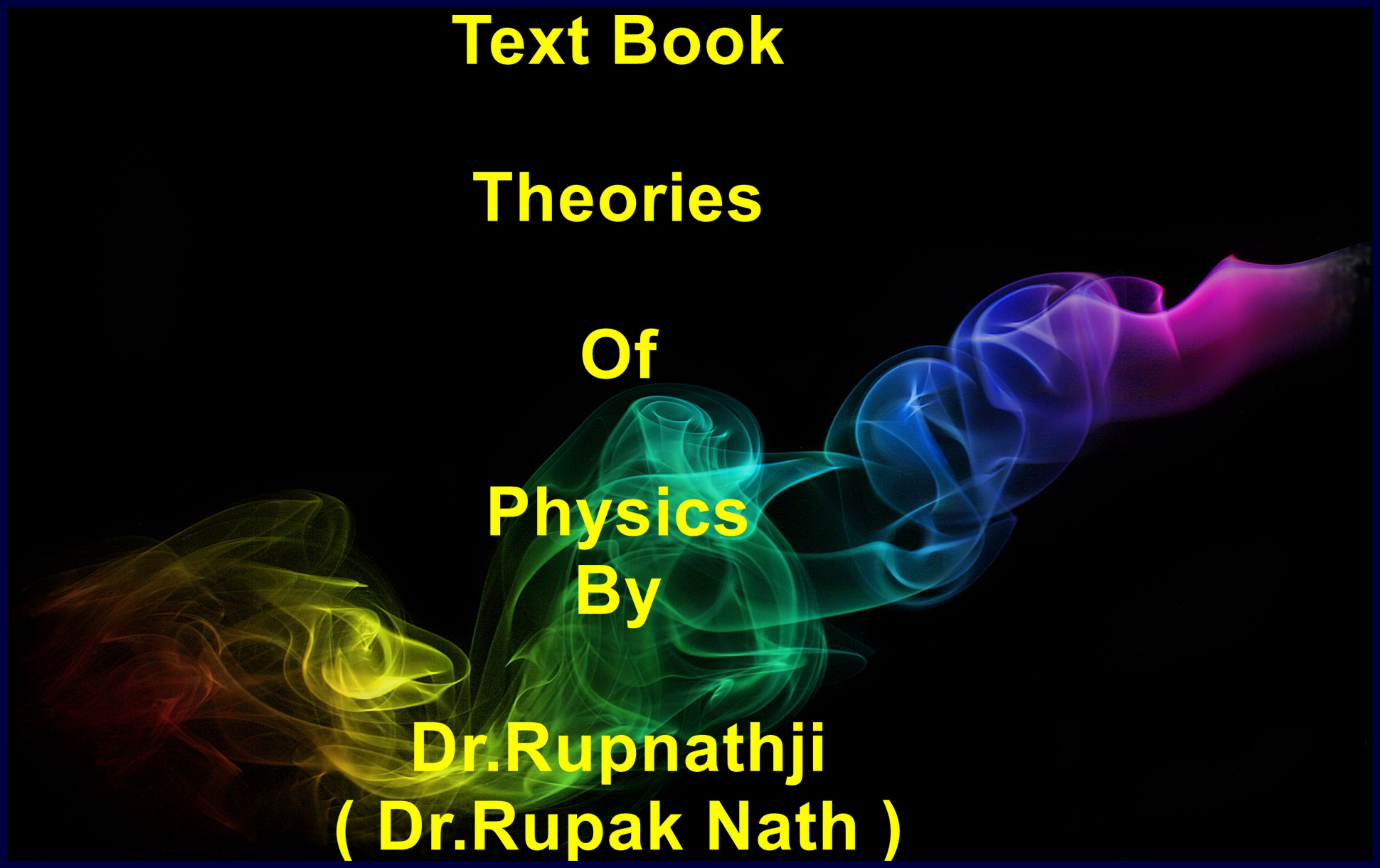
Of

Physics

By

Dr.Rupnathji

(Dr.Rupak Nath)



Rocket Science



By

Dr. Rupnathji
(Dr. Rupak Nath)

Research Book

**Advanced
Aeronautical Technology**

By

**Dr.Rupnathji
(Dr.Rupak Nath)**



Practicals Of Aeronautical Science

A white commercial airplane is shown from a low-angle perspective, flying upwards and to the right against a clear blue sky with some light, wispy clouds. The aircraft's two engines, wings, and tail are clearly visible.

By

Dr. Rupnathji
(Dr. Rupak Nath)

A stealth fighter jet, likely an F-35, is shown in flight over a desert landscape. The sky is filled with dramatic, colorful clouds in shades of red, orange, and purple. The jet is viewed from a low angle, emphasizing its sleek, angular design. The tail fin features the markings "ED 81005".

Advanced Aeronautical Technology

By

Dr. Rupnathji
(Dr. Rupak Nath)

A high-angle, wide shot of the Space Shuttle Atlantis inside the Vehicle Assembly Building. The shuttle is centered, oriented vertically, with its white orbiter and external tank and boosters clearly visible. The surrounding structure is a complex network of steel beams, walkways, and scaffolding, illuminated by overhead lights. The name "Atlantis" and the NASA logo are visible on the orbiter. The text "We're Behind You, Atlantis!" and "USA" are also visible on a banner at the bottom of the frame.

Guide Book Practicals Of Rocket Technology

By
— Dr. Rupnathji
(Dr. Rupak Nath)

The background of the image shows two fighter jets, likely F-16s, flying in a clear blue sky. One jet is in the foreground, viewed from a high angle, showing its wings, tail, and cockpit. The other jet is further back and to the left, also in flight. The overall scene is dynamic and emphasizes advanced aviation technology.

Text Book

**Practicals Of Aeronautical
Technology**

By

Dr.Rupnathji

(Dr.Rupak Nath)



Text Book
Advanced Concept
of
Aeronautical Technology

By
Dr.Rupnathji
(Dr.Rupak Nath)

A photograph of an astronaut in a white space suit floating in space, with the Earth's blue and white horizon visible in the background. The text is overlaid in red.

Text Book
New Space Suit
Technology
By
Dr.Rupnathji
(Dr.Rupak Nath)



Research Guide Book

**Of
Dark Energy Physics**

By

Dr. Rupnathji

**International Linear Collider
(Dr. Rupak Nath)**

Text Book

**Advanced
Jet Technology**

By

**Dr.Rupnathji
(Dr.Rupak Nath)**



Research Book

**Satellite
Communication
Technology**

**By
Dr.Rupnathji
(Dr.Rupak Nath)**



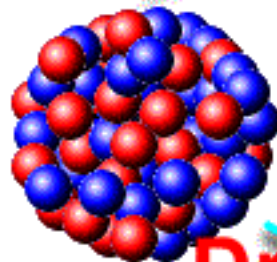
beta minus decay
Research Book

neutrino⁻

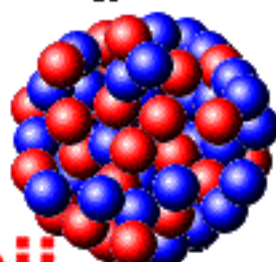
$^{228}_{88}\text{Ra}$

Physics

$^{228}_{89}\text{Ac}$



By



**Dr. Rupnathji
(Dr. Rupak Nath)**

β^- - particle = $^0_{-1}\text{e}$

A futuristic space scene featuring a bright sun in the upper right, a blue planet with a white atmosphere in the center, and a dark, curved structure on the right. The background is filled with stars and a dark, rocky landscape in the foreground.

Research Book Numerical Physics

By

Dr.Rupnathji
(Dr.Rupak Nath)



Research Book
Mathematical Physics

By
Dr.Rupnathji
(Dr.Rupak Nath)

Research Book Modern Physics

By

Dr. Rupnathji
(Dr. Rupak Nath)

Research Book



University Physics

By

Dr. Rupnathji

(Dr. Rupak Nath)



Research Book

College Physics

By

Dr. Rupnathji

(Dr. Rupak Nath)

Text Book

Physics

By

Dr. Rupnathji SCIENCE

(Dr. Rupak Nath)

Text Book

Numerical Physics

By

Dr. Rupnathji

(Dr. Rupak Nath)

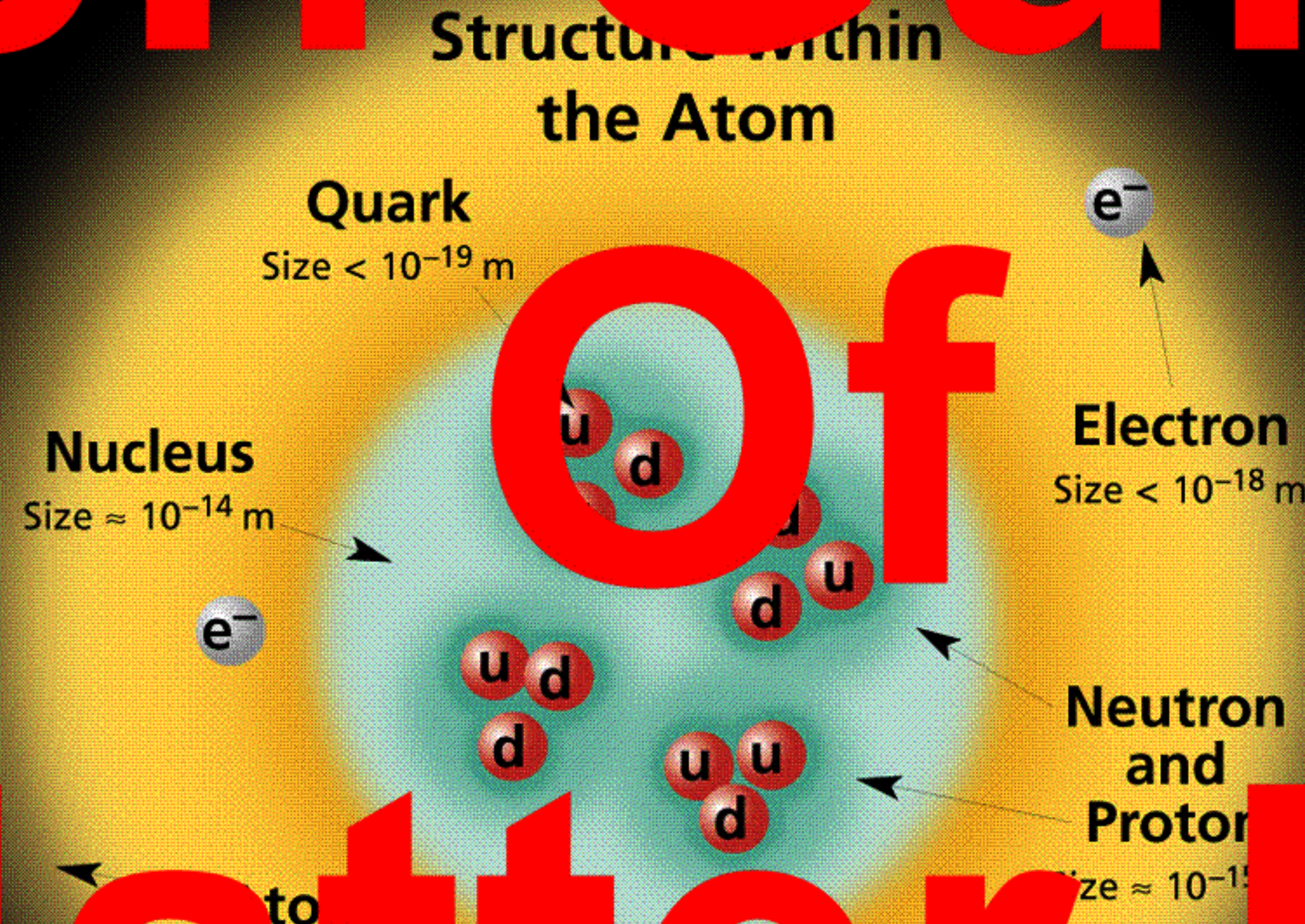
Standard Model of FUNDAMENTAL PARTICLES AND INTERACTIONS

Research Guide Book

The Standard Model summarizes the current knowledge in Particle Physics. It is the quantum theory that includes the theory of strong interactions (quantum chromodynamics or QCD) and the unified theory of weak and electromagnetic interactions (electroweak). Gravity is included on this chart because it is one of the fundamental interactions even though not part of the "Standard Model."

Leptons spin = 1/2		
Flavor	Mass GeV/c ²	Electric charge
ν_e electron neutrino	$<1 \times 10^{-8}$	0
e electron	0.000511	-1
ν_μ muon neutrino	<0.0002	0
μ muon	0.106	-1
ν_τ tau neutrino	<0.02	0
τ tau	1.7771	-1

Quarks spin = 1/2		
Flavor	Approx. Mass GeV/c ²	Electric charge
u up	0.003	2/3
d down	0.006	-1/3
c charm	1.3	2/3
s strange	0.1	-1/3
t top	175	2/3
b bottom	4.3	-1/3



Name	Mass GeV/c ²	Electric charge
γ photon	0	0
W^-	80.4	-1
W^+	80.4	+1
Z^0	91.187	0

Name	Mass GeV/c ²	Electric charge
g gluon	0	0

Color Charge
Each quark carries one of three types of "strong charge," also called "color charge." These charges have nothing to do with the colors of visible light. There are eight possible types of color charge for gluons. Just as electrically-charged particles interact by exchanging photons, in strong interactions color-charged particles interact by exchanging gluons. Leptons, photons, and W and Z bosons have no strong interactions and hence no color charge.

Quarks Confined in Mesons and Baryons
Quarks and gluons are confined in color-neutral particles called hadrons. The confinement (confinement) results from multiple exchanges of gluons among the color-charged constituents. As color-charged particles (quarks and gluons) separate, the energy of the color field between them increases. This energy eventually is converted into additional quark-antiquark pairs. The quarks and antiquarks then combine into hadrons; these are the particles seen to emerge. Two types of hadrons have been observed in nature: **mesons** $q\bar{q}$ and **baryons** qqq .

Residual Strong Interaction
The strong binding of color-neutral protons and neutrons to form nuclei is due to residual strong interactions between their color-charged constituents. It is similar to the residual electrical interaction that binds electrically neutral atoms to form molecules. It can also be viewed as the exchange of mesons between the hadrons.

Spin is the intrinsic angular momentum of a particle. Spin is given in units of \hbar , which is the quantum unit of angular momentum, where $\hbar = 6.626 \times 10^{-34} \text{ J}\cdot\text{s}$.

Electric charges are given in units of the proton's charge. In SI units the electric charge of the proton is 1.60×10^{-19} coulombs.

The **energy** unit of particle physics is the electronvolt (eV), the energy gained by one electron in crossing a potential difference of one volt. **Masses** are given in GeV/c^2 (remember $E = mc^2$), where $1 \text{ GeV} = 10^9 \text{ eV} = 1.60 \times 10^{-10}$ joule. The mass of the proton is $0.938 \text{ GeV}/c^2 = 1.67 \times 10^{-27}$ kg.

PROPERTIES OF THE INTERACTIONS

Baryons qqq and Antibaryons $\bar{q}\bar{q}\bar{q}$					
Baryons are fermionic hadrons. There are about 120 types of baryons.					
Symbol	Name	Quark content	Electric charge	Mass GeV/c ²	Spin
p	proton	uud	1	0.938	1/2
\bar{p}	anti-proton	$\bar{u}\bar{u}\bar{d}$	-1	0.938	1/2
n	neutron	udd	0	0.940	1/2
Λ	lambda	uds	0	1.116	1/2
Ω^-	omega	sss	-1	1.672	3/2

Property	Interaction	Gravitational	Weak (Electroweak)	Electromagnetic	Strong	
		Mass - Energy	Flavor	Electric Charge	Fundamental	Residual
Acts on:		Mass - Energy	Flavor	Electric Charge	Color Charge	See Residual Strong Interaction Note
Participating:		Gravitator (not observed)	Quarks, Leptons	Electrically charged	Quarks, Gluons	Hadrons
Particles mediating:		Graviton (not observed)	W^+, W^-, Z^0	γ	g	π, K, ρ, \dots
Strength relative to electromagnetic for two quarks at 10^{-17} m:		10^{-41}	10^{-6}	10^{-2}	25	Not applicable to quarks
Strength relative to electromagnetic for two protons in nucleus:		10^{-36}	10^{-13}	1	Not applicable to hadrons	20

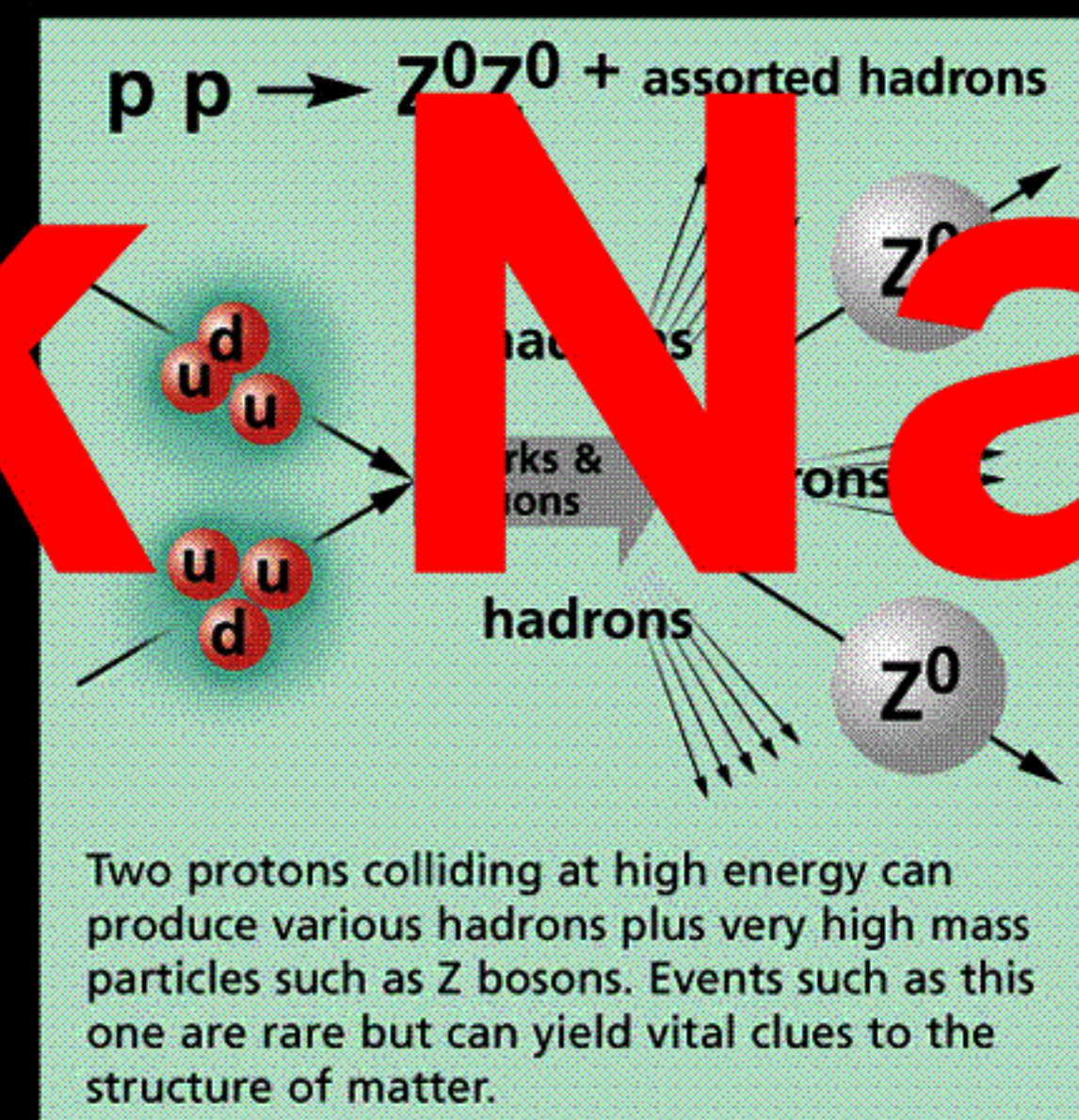
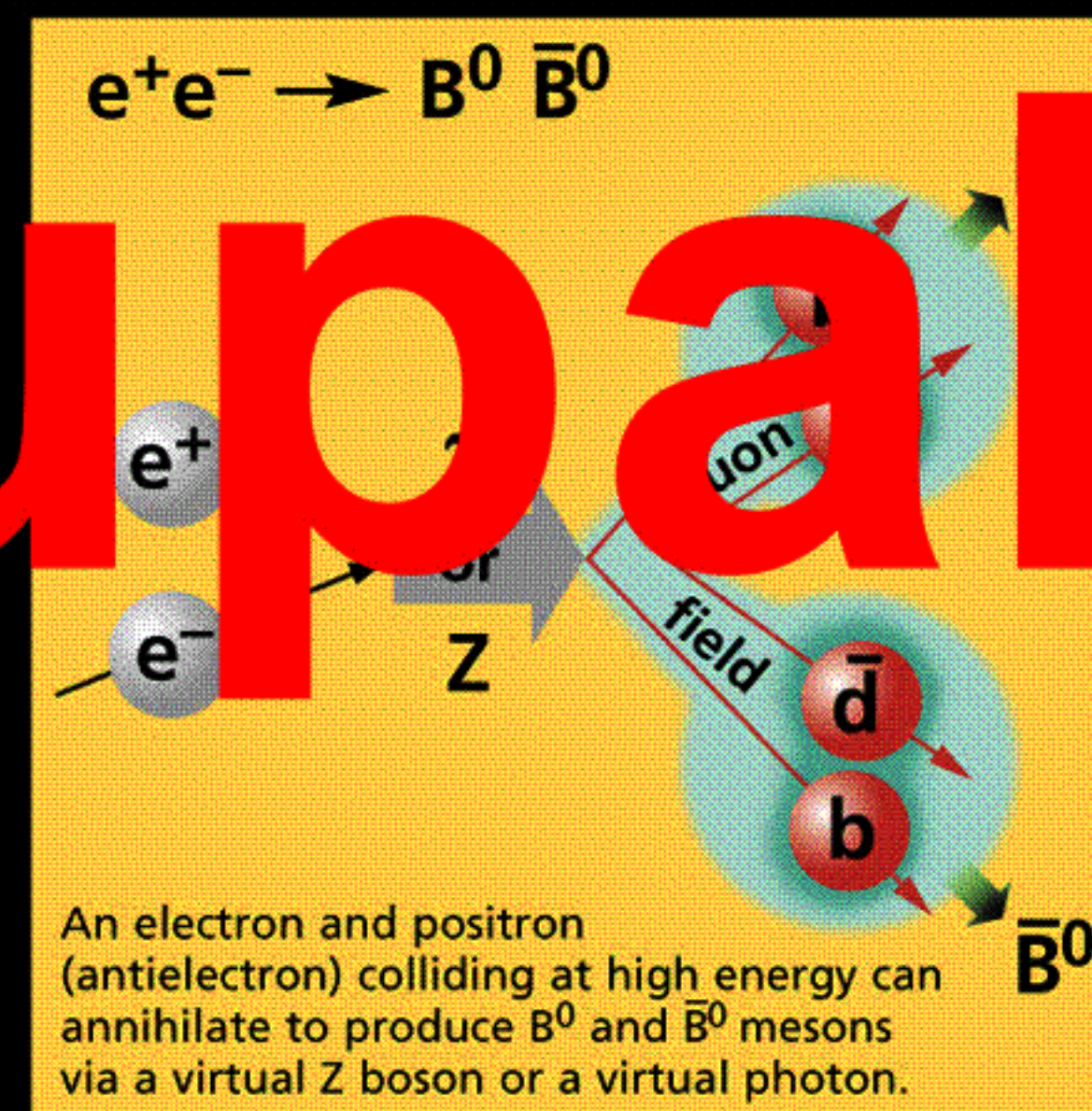
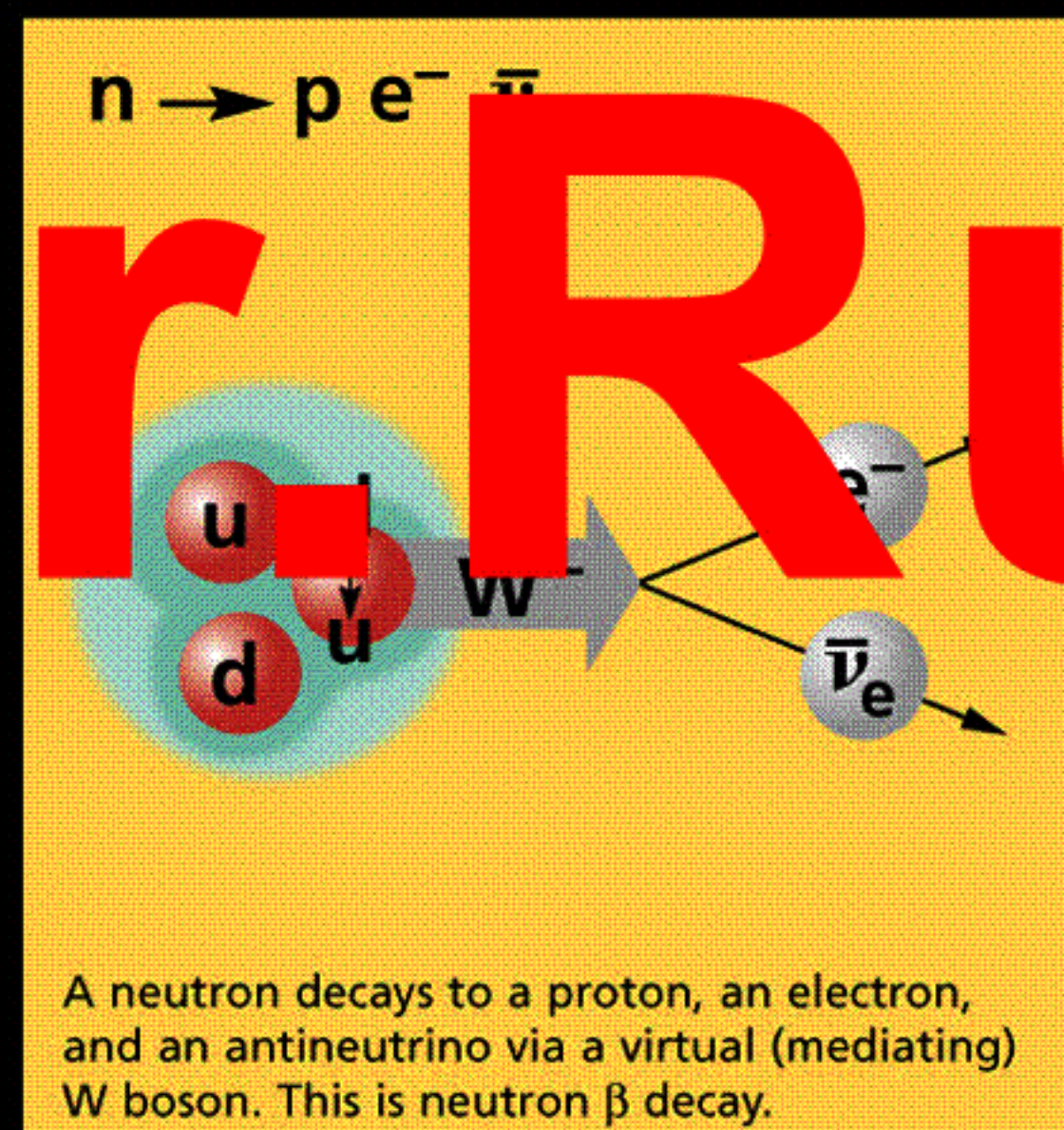
Mesons $q\bar{q}$					
Mesons are bosonic hadrons. There are about 140 types of mesons.					
Symbol	Name	Quark content	Electric charge	Mass GeV/c ²	Spin
π^+	pion	$u\bar{d}$	+1	0.140	0
K^-	kaon	$s\bar{u}$	-1	0.494	0
ρ^+	rho	$u\bar{d}$	+1	0.770	1
B^0	B-zero	$d\bar{b}$	0	5.279	0
η_c	eta-c	$c\bar{c}$	0	2.980	0

Matter and Antimatter

For every particle type there is a corresponding antiparticle, denoted by a bar over the particle symbol (unless + or - charge is shown). Particle and antiparticle have identical mass and spin but opposite charges. Some electrically neutral bosons (e.g., Z^0 , γ , and π^0 , but $K^0 \neq d\bar{s}$) are their own antiparticles.

Figures

These diagrams are an artist's conception of physical processes. They are **not** exact and have **no** meaningful scale. Green shaded areas represent the cloud of gluons or the gluon field, and red lines the quark paths.



The Particle Adventure

Visit the award-winning web feature *The Particle Adventure* at <http://www.cpep.org>

This chart has been made possible by the generous support of:

- U.S. Department of Energy
- U.S. National Science Foundation
- Lawrence Berkeley National Laboratory
- Stanford Linear Accelerator Center
- American Physical Society, Division of Particle and Fields
- BURLE INDUSTRIES, INC.**

©2000 Contemporary Physics Education Project. CPEP is a non-profit organization of teachers, physicists, and educators. Send mail to: CPEP, MS 50-308, Lawrence Berkeley National Laboratory, Berkeley, CA, 94720. For information on charts, text materials, hands-on classroom activities, and workshops, see:

<http://CPEPweb.org>

A vibrant space scene with a bright star, a ringed planet, and a crescent moon. The background is a deep red and orange nebula. A bright star is in the center, with a ringed planet to its right and a crescent moon to its left. The foreground shows a curved horizon of a planet with a blue and white atmosphere.

Text Book

Mathematical Physics

By

Dr. Rupnathji

(Dr. Rupak Nath)



Text Book

Modern Physics

By

Dr. Rupnathji

(Dr. Rupak Nath)

Text Book

University Physics

By

Dr. Rupnathji

(Dr. Rupak Nath)

The background is a futuristic, blue-toned tunnel with glowing lights and a glowing blue ring in the distance. The tunnel is composed of many parallel lines that create a sense of depth and perspective. The lights are small, bright blue dots and lines that are scattered throughout the scene. The overall atmosphere is high-tech and futuristic.

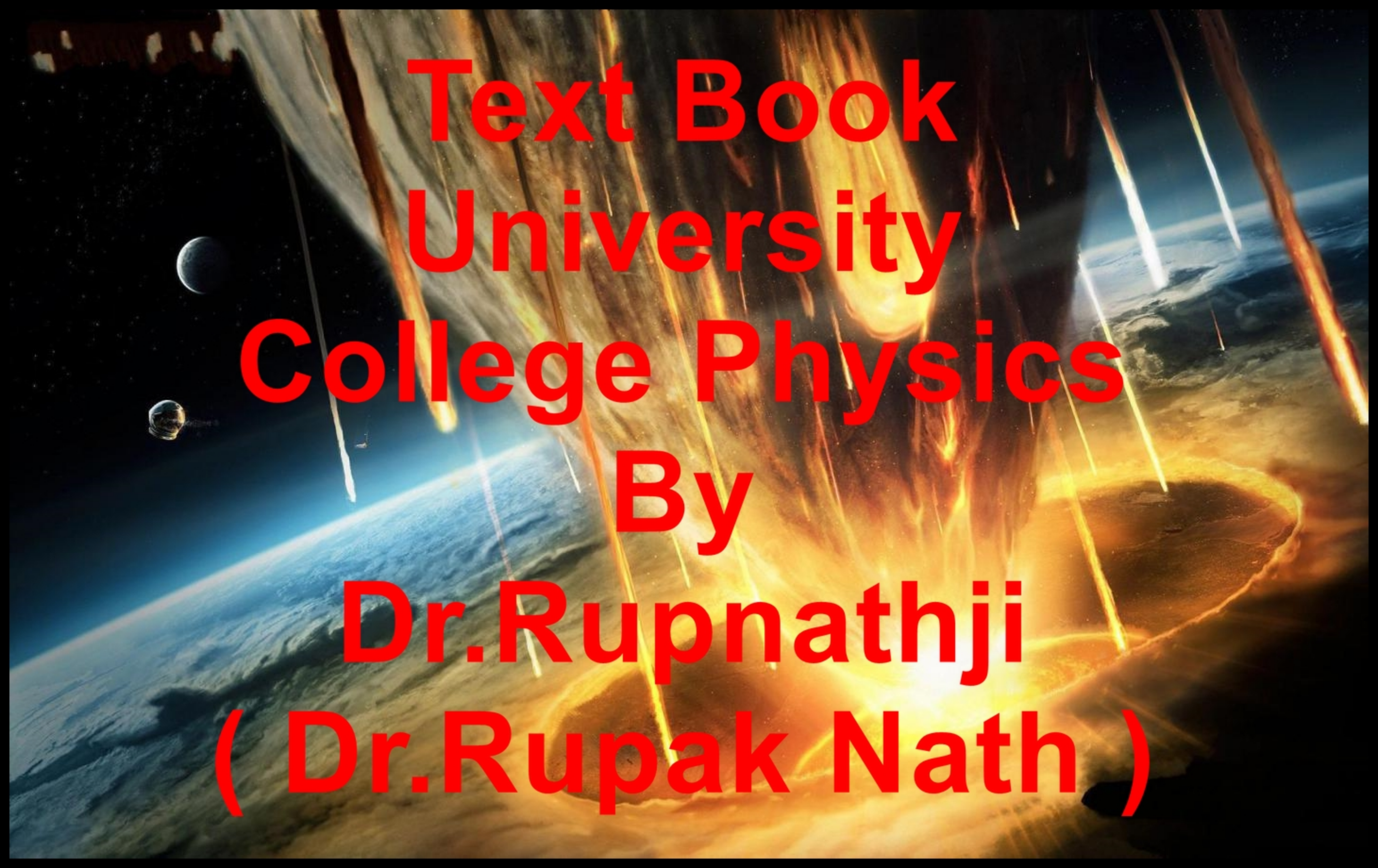
Text Book

College Physics

By

Dr. Rupnathji

(Dr. Rupak Nath)



**Text Book
University
College Physics
By
Dr. Rupnathji
(Dr. Rupak Nath)**



5680000000120036938643906042007957000086-v

Research Book

666 000 870 53 0023976010

Physics

By

F5-23 000010023661160900

Dr. Rupnathji

7 0043061-

061 700 45-5 N1

(Dr. Rupak Nath)



Research Book

Numerical Physics

By

Dr. Rupnathji

(Dr. Rupak Nath)

Research Book

Mathematical Physics

By

Dr. Rupnathji

(Dr. Rupak Nath)

Research Book

Modern Physics

By

Dr. Rupnathji

(Dr. Rupak Nath)



Research Book

University Physics

By

Dr. Rupnathji

(Dr. Rupak Nath)



The PARTICLE ZOO

Handmade Subatomic Particle Postcards, Stamps, Posters, Greeting Cards, Physics & beyond!

QUARKS



UP QUARK
A heavy little guy inside the proton and neutron, it is 2/3rd heavier with the down quark.



DOWN QUARK
A heavy little guy inside the neutron and proton, it is 1/3rd heavier with the up quark.



TOP QUARK
The heaviest known elementary particle, the heavy enough to make friends with anyone.



DOWN QUARK
A heavy little guy inside the proton and neutron, it is 2/3rd heavier with the up quark.



STRANGE QUARK
A heavy little guy inside the proton and neutron, it is 1/3rd heavier with the up quark.



BOTTOM QUARK
This slow elementary particle is the heaviest of the quarks.



FORCE CARRIERS



PHOTON
The invisible energy everywhere and here.



GLUON
The "glue" of the strong nuclear force.



ELECTRON-NEUTRINO
The invisible particle is so light, it is practically massless.



MIDNIGHT NEUTRINO
Like the other 2 neutrinos, but it is invisible, which makes it mysterious.



TAU LEPTON
Not a feeble guy, but still lighter than the electron!



W BOSON

Z BOSON
The "glue" particles of the weak nuclear force, it is the strongest glue.



ELECTRON
A familiar friend. It is responsible for electricity. However, don't let it fool you!



MIDNIGHT NEUTRINO
A "heavy neutrino" who runs fast and is invisible.



TAU LEPTON
A "heavy lepton" who is still slower than the electron!



TAU LEPTON
Not the most popular guy to meet, but for now he is the heaviest lepton to be discovered by us!



TAU LEPTON
Still unknown, yet theoretically predicted, he's the only lepton to be discovered.



TAU LEPTON
Still unknown, yet theoretically predicted, he's the only lepton to be discovered.



PROTON
The most stable of the particles in the universe but not the most "strong".



NEUTRON
Carries almost no net electric charge. Used to be called "neutral".



NEUTRON
The heaviest among them, difficult to see because he's so dark!



NEUTRON
The heaviest among them, difficult to see because he's so dark!



NEUTRON
The heaviest among them, difficult to see because he's so dark!

THEORETICALS

Visit the **ANTIPARTICLE ANNEX**



STAMPSHEET
Ready-made particles and a field of antiparticles "stamp".



Research Book

College Physics

By

Dr. Rupnathji

(Dr. Rupak Nath)

Book

Physics

By

Dr.Rupnathji

(Dr.Rupak Nath)



Book

Numerical Physics

By

Dr. Rupnathji

(Dr. Rupak Nath)

Book

Mathematical Physics

By

Dr. Rupnathji

(Dr. Rupak Nath)

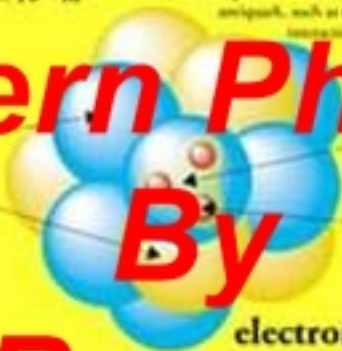
Book

The Nucleus

$(1-10) \times 10^{-17} \text{ m}$

At the center of the atom is a nucleus formed from nucleons: protons and neutrons. Each nucleon is made from three quarks held together by their strong interactions, which are mediated by gluons. In turn, the nucleus is held together by the strong interactions between the gluon and quark constituents of neighboring nucleons. Nuclear phenomena often are the exchange of massive particles which consist of a quark and an antiquark, such as the pion, to describe interactions among the nucleons.

neutron
 10^{-17} m
proton



strong field

quark
 $<10^{-17} \text{ m}$

electromagnetic field

distances typically up to 10,000 times the nuclear diameter. If the electron cloud were drawn to scale, this chart would cover a wall to ceiling.

Modern Physics

By

Dr. Rupnathji

Dr. Rupak Nath

A night sky with a green aurora borealis and a crescent moon. The aurora is a bright green light that curves across the sky, with a crescent moon visible in the center. The background is a dark blue and black sky with many stars and a faint galaxy.

Book

University Physics

By

Dr. Rupnathji

(Dr. Rupak Nath)

A satellite is shown in orbit against the backdrop of Earth. The satellite has a central cylindrical body with 'NSAT' written on it, two large solar panel arrays extending outwards, and a white rectangular antenna or sensor protruding from the top. A white service arm is visible extending from the satellite. The Earth's surface shows a mix of brown and green terrain, with a blue horizon line.

Text Book
New Space
Technology
By
Dr.Rupnathji
(Dr.Rupak Nath)



Text Book

**New Radio
Technology**

By

**Dr. Rupnathji
(Dr. Rupak Nath)**



Guide Book

Physics

By

Dr. Rupnathji

(Dr. Rupak Nath)

A cosmic scene featuring Saturn with its rings in the foreground, Earth in the mid-ground, and a bright star or galaxy core in the background. The text is overlaid in a bold, yellow font.

Guide Book

Numerical Astronomy

By

Dr. Rupnathji

(Dr. Rupak Nath)



Particle Physics

Text Book

Of

Particle Physics

By

Dr. Rupnathji

(Dr. Rupak Nath)

Gives me a Hadron

Guide Book

Mathematical Astro Physics

By

Dr.Rupnathji
(Dr.Rupak Nath)



Guide Book

**Modern
Astro Physics**

By

**Dr.Rupnathji
(Dr.Rupak Nath)**



Guide Book

**University
Astro Physics**

By

**Dr.Rupnathji
(Dr.Rupak Nath)**

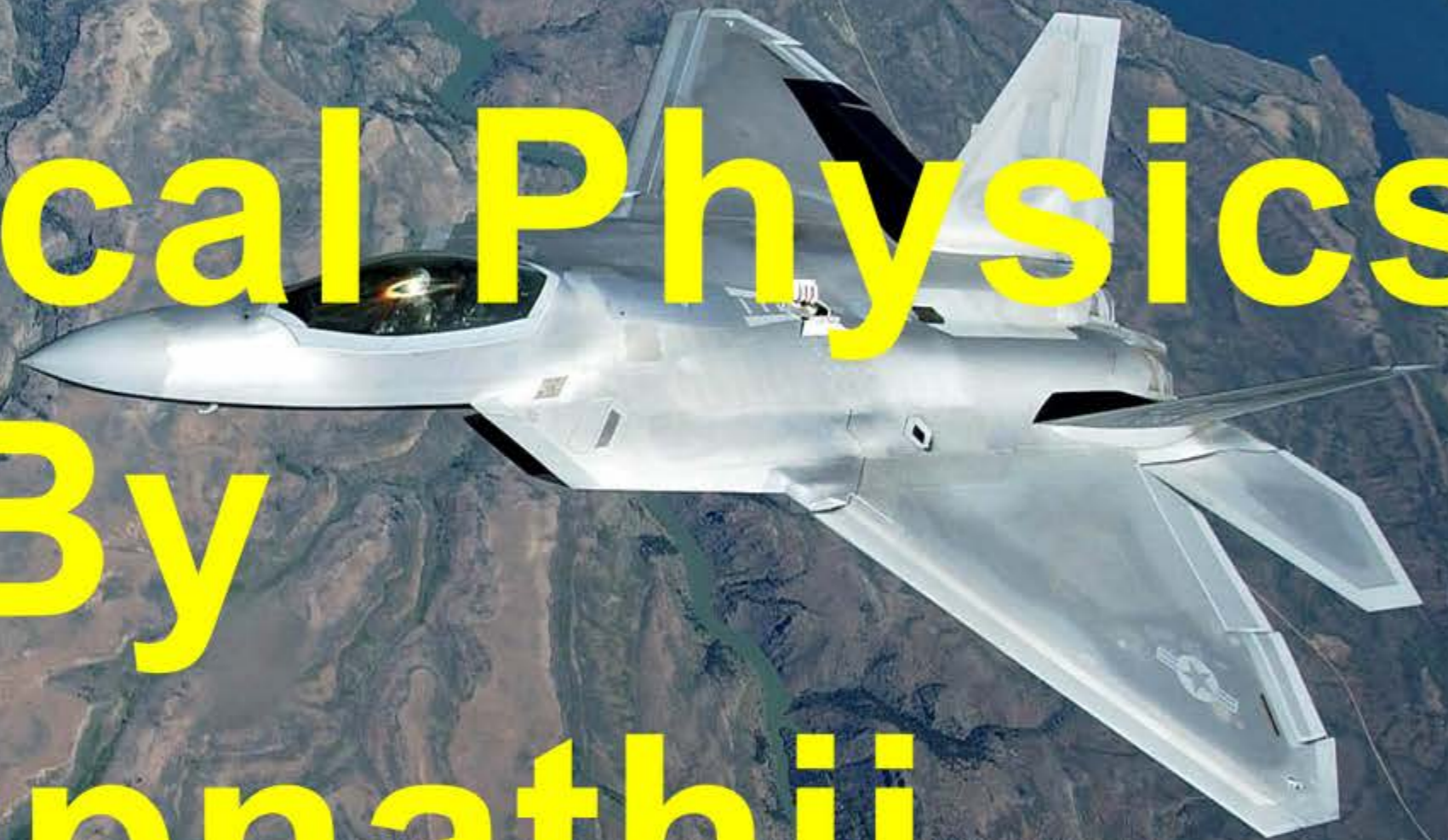
Guide Book

Aeronautical Physics

By

Dr. Rupnathji

(Dr. Rupak Nath)





Text Book

**Astro Physics
Encyclopedia**

By

**Dr.Rupnathji
(Dr.Rupak Nath)**



Text Book

**Numerical Astro
Physics Encyclopedia**

By

**Dr.Rupnathji
(Dr.Rupak Nath)**



Text Book

Mathematical Physics

Encyclopedia

By

Dr.Rupnathji

(Dr.Rupak Nath)

The background of the image is a deep space scene. On the left, a ringed planet, similar to Saturn, is partially visible. In the center, a bright, glowing star or galaxy core is surrounded by a nebula. To the right, there are several dark, rocky asteroids or planets of varying sizes. The overall color palette is dark with highlights of blue, orange, and white.

Text Book

**Modern
Astro Physics
Encyclopedia
By
Dr.Rupnathji
(Dr.Rupak Nath)**



Text Book

**University
Astro Physics
Encyclopedia**

By

**Dr.Rupnathji
(Dr.Rupak Nath)**



Text Book

**College
Astro Physics
Encyclopedia**

By

**Dr.Rupnathji
(Dr.Rupak Nath)**