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Some physicists from different countries of the world and their major contributions

Name	Major contribution/discovery	Country of Origin
Archimedes	Principle of buoyancy; Principle of the lever	Greece
Galileo Galilei	Law of inertia	Italy
Christiaan Huygens	Wave theory of light	Holland
Isaac Newton	Universal law of gravitation; Laws of motion; Reflecting telescope	U.K.
Michael Faraday	Laws of electromagnetic induction	U.K.
James Clerk Maxwell	Electromagnetic theory; Light-an U.K. electromagnetic wave	U.K.
Heinrich Rudolf Hertz	Generation of electromagnetic waves	Germany
J.C. Bose	Ultra short radio waves	India
W.K. Roentgen	X-rays	Germany
J.J. Thomson	Electron	U.K.
Marie Sklodowska Curie	Discovery of radium and polonium; Studies on Poland natural radioactivity	Poland
Albert Einstein	Explanation of photoelectric effect; Germany Theory of relativity	Germany
Victor Francis Hess	Cosmic radiation	Austria
R.A. Millikan	Measurement of electronic charge	U.S.A.
Ernest Rutherford	Nuclear model of atom	New Zealand
Niels Bohr	Quantum model of hydrogen atom	Denmark
C.V. Raman	Inelastic scattering of light by molecules	India
Louis Victor de Borglie	Wave nature of matter	France
M.N. Saha	Thermal ionisation	India
S.N. Bose	Quantum statistics	India
Wolfgang Pauli	Exclusion principle	Austria
Enrico Fermi	Controlled nuclear fission	Italy
Werner Heisenberg	Quantum mechanics; Uncertainty principle	Germany
Paul Dirac	Relativistic theory of electron; Quantum statistics	U.K.
Edwin Hubble	Expanding universe	U.S.A.
Ernest Orlando Lawrence	Cyclotron	U.S.A.
James Chadwick	Neutron	U.K.
Hideki Yukawa	Theory of nuclear forces	Japan
Homi Jehangir Bhabha	Cascade process of cosmic radiation	India
Lev Davidovich Landau	Theory of condensed matter; Liquid helium	Russia
S. Chandrasekhar	Chandrasekhar limit, structure and evolution of stars	India
John Bardeen	Transistors; Theory of super conductivity	U.S.A.
C.H. Townes	Maser; Laser	U.S.A.
Abdus Salam	Unification of weak and electromagnetic interactions	Pakistan

By: Mr. Manish Mavi

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Link between technology and physics

Technology	Scientific principle(s)
Steam engine	Laws of thermodynamics
Radio and Television	Generation, propagation and detection of electromagnetic waves
Nuclear reactor	Controlled nuclear fission
Computers	Digital logic
Lasers	Light amplification by stimulated emission of radiation
Production of ultra high magnetic fields	Superconductivity
Rocket propulsion	Newton's laws of motion
Electric generator	Faraday's laws of electromagnetic induction
Hydroelectric power	Conversion of gravitational potential energy into electrical energy
Aeroplane	Bernoulli's principle in fluid dynamics
Particle accelerators	Motion of charged particles in electromagnetic fields
Sonar	Reflection of ultrasonic waves
Optical fibres	Total internal reflection of light
Non-reflecting coatings	Thin film optical interference
Electron microscope	Wave nature of electrons
Photocell	Photoelectric effect
Fusion test reactor (Tokamak)	Magnetic confinement of plasma
Giant Metrewave Radio Telescope (GMRT)	Detection of cosmic radio waves
Bose-Einstein condensate	Trapping and cooling of atoms by laser beams and magnetic fields.

FUNDAMENTAL FORCES IN NATURE

We come across several forces in our day-to-day lives eg., frictional force, muscular force, forces exerted by springs and strings etc. These forces actually arise from four fundamental forces of nature. Following are the four fundamental forces in nature.

- Gravitational force
- Weak nuclear force
- Electromagnetic force

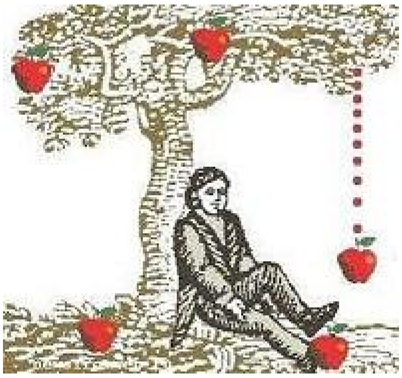
4. Strong nuclear force

Among these forces ***gravitational force is the weakest*** and ***strong nuclear force is the strongest force in nature.***

Gravitational Force

- The gravitational force is the force of mutual attraction between any two objects by virtue of their masses. It is a universal force. Every object experiences this force due to every other object in the universe.
- All objects on the earth, for example, experience the force of gravity due to the earth.

- Gravity is always attractive.
- It plays a key role in the large-scale phenomena of the universe, such as formation and evolution of stars, galaxies and galactic clusters.

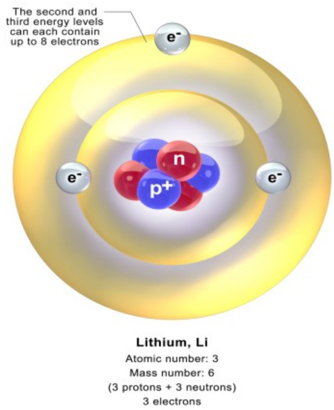


Electromagnetic Force

- Electromagnetic force is the force between charged particles.
- In the simpler case when charges are at rest, the force is given by Coulomb's law : attractive for unlike charges and repulsive for like charges.
- Charges in motion produce magnetic effects and a magnetic field gives rise to a force on a moving charge. Electric and magnetic effects are, in general, inseparable – hence the name electromagnetic force. Like the gravitational force, electromagnetic force acts over large distances and does not need any intervening medium.
- Electromagnetic force can be attractive or repulsive.

Strong Nuclear Force

- The strong nuclear force binds protons and neutrons in a nucleus. It is evident that without some attractive force, a nucleus will be unstable due to the electric repulsion between its protons.
- This attractive force cannot be gravitational since force of gravity is negligible compared to the electric force.
- The strong nuclear force is the strongest of all fundamental forces, about 100 times the electromagnetic force in strength.
- It is charge-independent and acts equally between a proton and a proton, a neutron and a neutron, and a proton and a neutron.
- Its range is, however, extremely small, of about nuclear dimensions (10^{-15}m). It is responsible for the stability of nuclei.
- The electron, it must be noted, does not experience this force.



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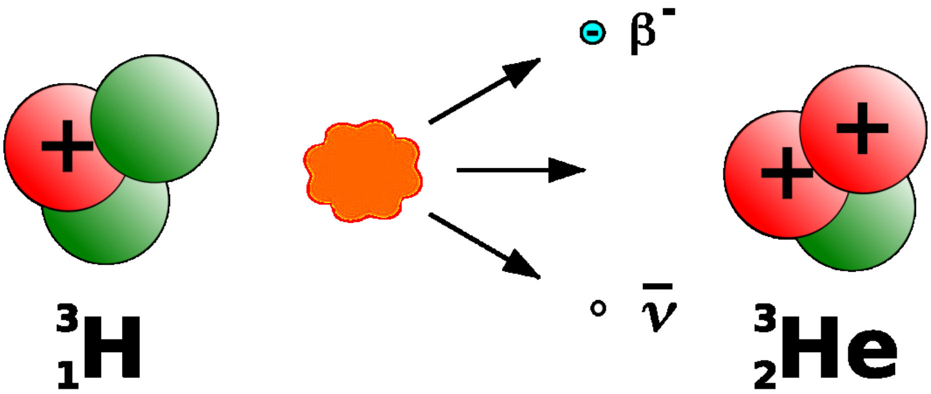
Weak Nuclear Force

- The weak nuclear force appears only in certain nuclear processes such as the β-decay of a nucleus.
- In β-decay, the nucleus emits an electron and an uncharged particle called neutrino.
- The weak nuclear force is not as weak as the gravitational force, but much weaker than the strong nuclear and electromagnetic forces.
- The range of weak nuclear force is exceedingly small, of the order of 10^{-16} m.



Unification of Forces

- There have been physicists who have tried to combine a few of the above fundamental forces. These are listed in table below.

Fundamental forces of nature

Name	Relative strength	Range	Operates among
Gravitational force	10^{-39}	Infinite	All objects in the universe
Weak nuclear force	10^{-13}	Very short, Sub-nuclear size ($\sim10^{-16}$m)	Some elementary particles, particularly electron and neutrino
Electromagnetic force	10^{-2}	Infinite	Charged particles
Strong nuclear force	1	Short, nuclear size ($\sim10^{-15}$m)	Nucleons, heavier elementary particles

NATURE OF PHYSICAL LAWS

A physical law, scientific law, or a law of nature is a scientific generalization based on empirical observations of physical behavior.

Empirical laws are typically ***conclusions based*** on repeated scientific experiments and simple observations, over many years, and which have become accepted universally within the scientific community.

The production of a summary description of nature in the form of such laws is a fundamental aim of science. Physical laws are distinguished from scientific theories by their simplicity. Scientific theories are generally more complex than laws; they have many component parts, and are more likely to be changed as the body of available experimental data and analysis develops. This is because ***a physical law is a summary observation of strictly empirical matters,*** whereas a theory is a model that accounts for the observation, explains it, relates it to other observations, and makes testable predictions based upon it. Simply stated, while a law notes that something happens, a theory explains why and how something happens. Conservation laws have a deep connection with symmetries of matter.

The law of conservation of energy is thought to be valid across all domains of nature from the microscopic to macroscopic symmetries of space and time and other types of symmetries play a central role in modern theories of fundamental forces in nature

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Progress in unification of different forces/domains in nature

Name of the physicist	Year	Achievement in unification
Issac Newton	**1687**	Unified celestial and terrestrial mechanics; showed that the same laws of motion and the law of gravitation apply to both the domains.
Hans Christian Oersted	**1820**	Showed that electric and magnetic phenomena are inseparable aspects of a unified domain : electromagnetism.
Michael Faraday	**1830**	
James Clark Maxwell	**1873**	Unified electricity, magnetism and optics; showed that light is an electromagnetic wave.
Sheldon Glashow, Abdus Salam, Steven Weinberg	**1979**	Showed that the 'weak' nuclear force and the electromagnetic force could be viewed as different aspects of a single electro-weak force.
Carlo Rubia, Simon Vander Meer	**1984**	Verified experimentally the predictions of the theory of electro-weak force.

CONSERVED QUANTITIES

Physics gives laws to summarize the investigations and observations of the phenomena occurring in the universe.
Physical quantities that remain constant with time are called conserved quantities.
Example, for a body under external force, the kinetic and potential energy change over time but the total mechanical energy (kinetic + potential) remains constant.
Conserved quantities can be scalar (Energy) or vector (Total linear momentum and total angular momentum).

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Conservation Laws

A conservation law is a hypothesis based on observation and experiments which cannot be proved. These can be verified via experiments.

Law of conservation of Energy

- According to the general Law of conservation of energy, the energies remain constant over time and convert from one form to another.
- The law of conservation of energy applies to the whole universe and it is believed that the total energy of the universe remains unchanged.
- Under identical conditions, the nature produces symmetric results at different time.

Law of conservation of Mass

- This is a principle used in analysis of chemical reactions.
- A chemical reaction is basically a rearrangement of atoms among different molecules.
- If the total binding energy of the reacting molecules is less than the total binding energy of the product molecules, the difference appears as heat and the reaction is exothermic.
- The opposite is true for energy absorbing (endothermic) reactions.
- Since the atoms are merely rearranged but not destroyed, the total mass of the reactants is the same as the total mass of the products in a chemical reaction.
- Mass is related to energy through Einstein theory, $E = mc^2$, where c is the speed of light in vacuum

Law of conservation of linear momentum

- Symmetry of laws of nature with respect to translation in space is termed as law of conservation of linear momentum.
- ***Example,*** law of gravitation is same on earth and moon even if the acceleration due to gravity at moon is 1/6th than that at earth.

Law of conservation of angular momentum

- Isotropy of space (no intrinsically preferred direction in space) underlies the law of conservation of angular momentum.