Science and Technology Class 16

20th September, 2023 at 9:00 AM

C V RAMAN (09:09 AM)

- He was a Nobel laureate in Physics.
- He received the Nobel Prize in 1930 for a discovery named after him.
- The frequency of incident light changes after inelastic scattering of light particles (Photons) after interaction with a molecular sample.
- The energy and hence frequency of light can increase or decrease.
- This phenomenon has application in **spectroscopy**.
- **Spectroscopy** involves analyzing patterns of wavelengths that materials emit, absorb, transmit, reflect or scatter.
- Different materials interact with different wavelengths of light in different ways which depends upon temperature and composition of material.
- Raman's spectroscopy has applications across various industries such as chemical, Pharma, and Electronics among others.
- This is because of the following **reasons**:
- It is non-destructive i.e. despite repetitive experiments, it does not compromise the integrity of the sample.
- It can work on a very small sample and provide key information easily and quickly.
- It is very sensitive to even small changes in material structure.
- It is used to analyse even living cells and tissues.
- It can work on almost all materials except pure metals.
- We celebrate **National Science Day on February 28 to commemorate the discovery Raman effect in 1928.**
- Dr. Raman was given Bharat Ratna in 1954.

DR S CHANDRASHEKHAR (09:45 AM)

- **Dr. Chandrashekhar** was an Indian American astrophysicist who was awarded the 1983 Nobel Prize for the theoretical studies of the structure and evolution of stars.
- He worked on theoretical models of later evolutionary stages of massive stars.
- **Stars undergo many phases-**
- A Protostar Emerging in a Nebula
- **The main sequence** in which hydrogen fuses to Helium. This is the longest phase.
- **Red giant-** As hydrogen fuel depletes, a star starts fusing Helium while the outer layer expands, and the core collapses. This can finally lead to a glowing shell of gas called a **planetary Nebula.**
- **White Dwarf-** It is the remnant core of an average low-mass star that has shed its outer layers. Over time it cools down and eventually, it can become a black dwarf.
- **Supernova**
- Dr Chandrshkhar hypothesized for a heavy star (greater than 1.4 times the mass of the sun- known as Chandrashekhar limit) the gravitation collapse triggers a powerful explosion known as a supernova.
- It releases an enormous amount of energy and can briefly outshine an entire galaxy.
- **Neutron star or Blackhole**
- Depending upon the mass of the collapsing core, it can result in the formation of a neutron star or a black hole.
- Neutron stars are comprised of tightly packed neutrons.
- A spinning neutron star produces a powerful beam of energy called a **Pulsar**.
- A very heavy neutron star is called **Magnetar**.
- A Blackhole is a region of space-time with extremely strong gravitational forces from which nothing can escape including light.

DARK MATTER AND DARK ENERGY (10:20 AM)

- Visible matter does not have enough gravitational strength to hold galaxies together. In fact, there are many gravitational anomalies that can not be explained only accounting for the matter we can see.
- Scientists believe that dark matter which does not interact with electromagnetic radiation, however, has mass and hence its gravity can be felt.
- It remains a theoretical speculation.
- The universe has been expanding since the Big Bang. The two most important pieces of evidence for the Big Bang and the expansion of the universe are-
- **Red Shift** of light from distant galaxies.
- **Cosmic microwave background radiation-** It is a faint glow that fills the entire universe and is essentially the remnant of intense heat that existed shortly after the Big Bang.
- Because of mutual gravitational attraction among galaxies, scientists thought that expansion should slow down but rather than slowing down the experimental data tells us expansion is accelerating.
- The term dark energy is used to explain this. However, we know nothing of its nature and origin.

SATENDRANATH BOSE (11:05 AM)

- Dr. Bose was a theoretical physicist widely known for his work on bosons (a class of particles named after him).
- Bosons obey Bose-Einstein statistics.
- Dr. Bose figured out using ideas of quantum mechanics, how a group of photons will behave assuming them to be identical.
- Thus, he led the foundation of quantum statistics.
- He sent his paper to Einstein in Germany, Einstein recognised the value of this calculation and got it published.
- Einstein further hypothesized that there would be other particles following similar statistical distribution law. They are called **Bosons**.
- He further predicted that at very small temperatures all the atoms will occupy the lowest energy state which will lead to a new state of matter known as **Bose-Einstein condensate (Fifth state of matter).**

STANDARD MODEL OF PARTICLE PHYSICS (11:33 AM)

- It is a theory of fundamental particles and how they interact.
- The basic building of the universe comprises two groups of particles called **Leptons and Quarks.**
- There are six Leptons- Electron, Muon, Tau and Electron- Neutrino, Muon- Neutrino and Tau-Neutrino.
- There are also six Quarks- up, down, top, bottom, charm and strange.
- These fundamental particles interact via electromagnetic interaction, strong interaction and weak interaction which are mediated by Bosons. Hence Bosons are called force carrier particles.
- The standard model does not account for gravity.
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Fundamental interactions	**Affected particles**	**Range**	Force carrier Boson	Significance
Strong	Quarks, Gluons	Short	Gluon	Nuclear stability
Electromagnetic	Charges	Long	Photon	Atomic and molecular change
Weak	Quarks, Leptons	Short	W and Z boson	Some nuclear reactions (Beta Decay)
Gravitational	mass	Long	Graviton	Planets, stars and galaxies

- **Note**- In the above-mentioned table, the strength of forces will decrease from top to bottom.

TOPIC OF THE NEXT CLASS- DISCUSSION ON PARTICLE PHYSICS (TO CONTINUE), ROBOTICS