SCIENCE

SCATTERING OF LIGHT

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The scattering of light is one of the most important phenomena in daily lives. This phenomenon has been seen by everyone from their childhood like the blue colour of the sky, the colour of the rainbow, etc. The scattering of light is completely different from the reflection and refraction of light. In reflection of light, the light goes in a straight line whereas in the scattering of light the light ray gets scattered in different directions by the medium through which it passes.

The process by which small particles are present in the atmosphere causes the scatter in the light which in turn gives rise to optical phenomena such as the blue colour of the sky in which we term as the scattering of light.

Though not an appropriate means of study still Maxwell equation gives the basis of theoretical as well as computational methods in order to describe light scattering. Due to the lack of precision, it is mainly described on the basis of computational electromagnetics which deals with electromagnetic radiation scattering and absorption by particles.

When a light ray passes through a medium, it strikes the particles present in them. Due to this, some of the rays get absorbed while some get scattered in all directions.
Example- When light strikes the particles in the air, the particles absorb some light and radiate the rest in all directions except the incident direction. This is called "scattering of light". The wavelength of the light and the size of the particle which scattered the light assists in determining the strength of the scattering.

For example, when the sun rays enter the earth's atmosphere it strikes the particles which are present in the atmosphere. Some of these rays are absorbed by the particles and some are scattered in all directions. This can be seen from the given figure. Therefore, it can be said that the light can

get deflected from the incident path due to particles, irregularities, or interference between the two media. Hence, shorter wavelengths and high-frequency light result in more scattering.

There are several Examples of Scattering of light but the Two Main Examples of the Scattering of light are:

1. Reflection from rough surface
2. Reflection, refraction, or diffraction through impurities in the volume

RANDOM REFLECTION FROM A ROUGH SURFACE

All the surfaces in the environment are rough. The roughness of the surface and wavelength will describe the amount of light that is scattered. The rougher the surface, the more is the absorption of light. Also, it will scatter in different directions depending upon the wavelength of the light. The roughness of cars and pieces of jewellery are the best examples of random reflections from rough surfaces.

Reflection through the Presence of Impurities in Volume

Here, the light gets scattered by the charged particles. There are different types of scattering of light:

- Rayleigh scattering
- Mie scattering
- Electromagnetic scattering

Rayleigh Scattering

Rayleigh scattering is named after the 19th-century physicist Lord Rayleigh. It is the elastic scattering of light from the particles having a size less than the wavelength of the incident light. The sky looks blue due to this as the red colour has a large wavelength so it doesn't get scattered. Signal scattering through the optical fibre follows this phenomenon.

Mie Scattering

This scattering is Mie's solution to Maxwell's equation. In this type of scattering the size of the particle is more than the wavelength of the light. Hence, there is a non-uniform scattering. It is also an elastic type of scattering. Example-The sky looks blue and cloud white due to this, the fog and water droplets' colour is also the result of this type of scattering.

Electromagnetic Scattering

Electromagnetic scattering is a common type of scattering where electromagnetic waves get deflected continuously. It is of Two Types:

- Elastic Scattering
- Inelastic Scattering

Elastic scattering includes Rayleigh and Mie type of scattering whereas Raman and Compton's scattering is Inelastic scattering.

The Factors on Which Scattering of Light Depends are as Follows

The size of the molecule or particle by which the light is scattered.The wavelength of the incident light. If the wavelength of the incident light which strikes the earth's surface has less wavelength and more frequency as in the case of blue colour then it gets scattered more. While if the incident light has a large wavelength and small frequency as in the case of red color then it is deflected less.

The relation between the probability of scattering of light and wavelength of light is

$p \propto 1/\lambda^4$

Where

p= probability of scattering of light

λ= wavelength of the light

It is clear from the above equation that the probability of scattered light is higher for the light having a shorter wavelength as the probability is inversely proportional to the fourth power of the wavelength.

Application of Scattering of Light

There is a huge range of applications of light scattering known to date. They can be listed as follows:

- The sky appears blue as the light gets scattered by the particles present in the atmosphere.
- During sunset and sunrise, the sky appears red due to the scattering of light.
- In projectors
- In medical.
- It provides a brief account of the size, shape, number, and time independence of physical uniformities.
- It is used in the determination of critical phenomena.
- It helps in molecular weight determination.
- It plays a vital role in the air pollution analysis
- It gives an account of diffusion phenomena.