

Scattering = EM interacts with matter and changes direction, usually without changing energy

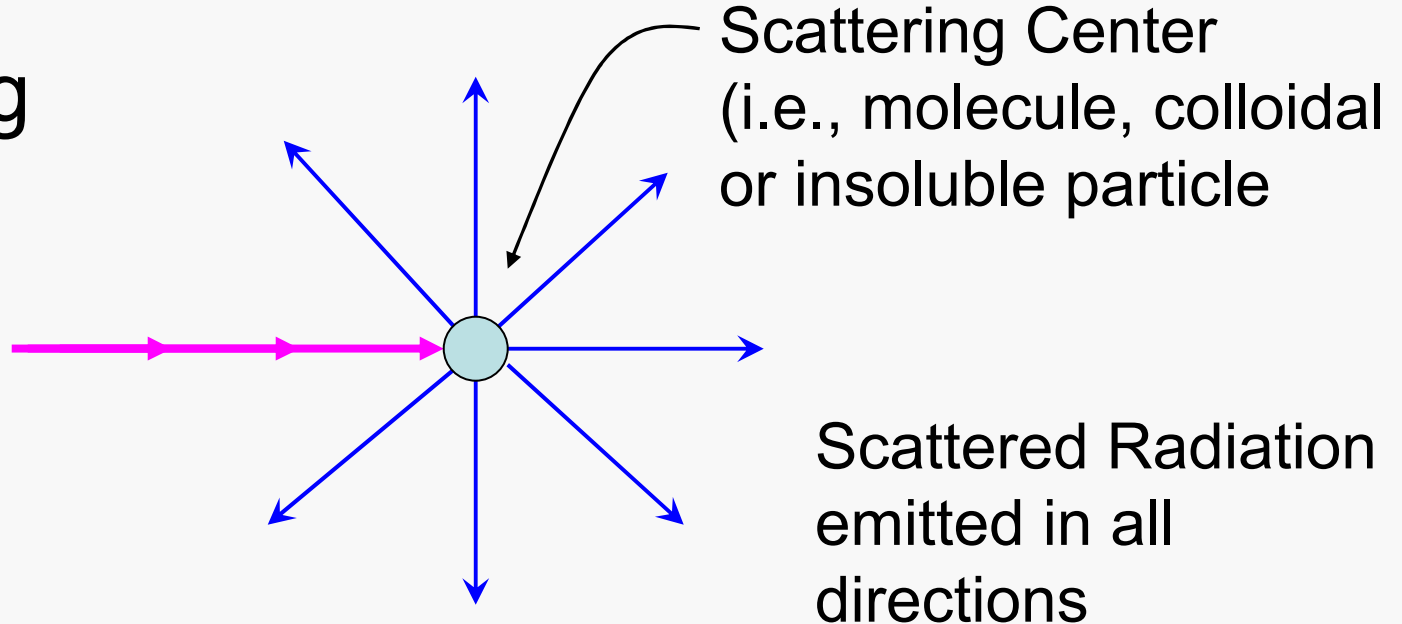
This can be described using both the wave or particle nature of light:

- 1) Wave – EM induces oscillations in electrical charge of matter \Rightarrow resulting in oscillating dipoles which in turn radiate secondary waves in all directions = scattered radiation
- 2) Particle (or Quantum) – EM interacts with matter to form a virtual state (lifetime 10^{-14} s) which reemits in all directions.

Raman effect = when some molecules return to a different state \Rightarrow change in frequency

Scattering

Incident beam



Many types of scattering exist depending on several parameters characterizing the system, we will be concerned with:

Rayleigh Scattering, Large Particle Scattering and the Raman Effect (Raman Scattering or Raman Spectroscopy)

Rayleigh Scattering – scattering by particles whose longest dimension is $< 5\%$ to 10% of λ with no change in observed frequency

The diagram shows the Rayleigh Scattering equation with arrows pointing from descriptive labels to the corresponding variables in the formula:

$$I_s = \frac{8 \pi^4 \alpha^2}{\lambda^4 r^2} (1 + \cos^2 \theta) I_o$$

Labels and their corresponding variables:

- scattering intensity $\rightarrow I_s$
- wavelength $\rightarrow \lambda$
- polarizability $\rightarrow \alpha$
- distance from scattering center to detector $\rightarrow r$
- angle between incident beam & scattered beam $\rightarrow \theta$
- incident beam intensity $\rightarrow I_o$

Notice the fourth power dependence on wavelength meaning short wavelengths are scattered more efficiently \Rightarrow sky is blue

Polarizability (α) is measure of how well a given frequency induces a dipole in a substance

α Tends to be large for large molecules (e.g., proteins)

Large Particle Scattering – particle dimensions $< 10\% \lambda$ to 1.5λ

Applies in techniques like turbidimetry and nephelometry

Large particles do not act as a point source & give rise to various interference phenomena

Forward scatter becomes greater than back scatter