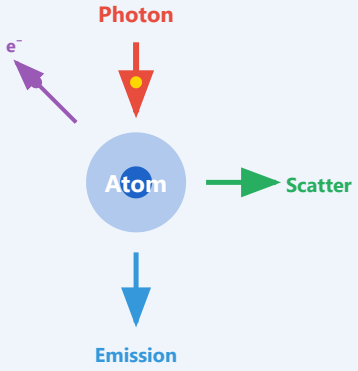
Photon-Matter Interactions



Different interaction pathways

Absorption

Photon energy transferred to molecule, excites electron to higher state. Cross-section σ(λ) determines probability.

Scattering

Elastic (Rayleigh, Mie) or inelastic (Raman). No energy absorption, direction change only.

Photoelectric Effect

Complete photon absorption, electron ejection (E > work function). Basis for X-ray imaging.

Compton Scattering

High-energy photon-electron collision, partial energy transfer. Important for gamma rays.

⚠ Biological Damage Thresholds

- **UV:** DNA damage, thymine dimers (<320 nm)
- **Ionizing (X-ray, γ):** Direct DNA breaks, ROS generation
- **Visible/NIR:** Generally safe, but high intensity causes thermal damage
- **Photobleaching:** Fluorophore destruction limits imaging time