Summary of X-Ray–γ-Ray Interactions

Process	Interaction	Z, E, ρ effects	Comments
Photoelectric absorption	Photon energy > electron binding energy, photon absorbed, electron ejected from shell with kinetic energy equal to $E_{photon} - E_{BE}$	$\tau \propto Z^3/E^3$	Atom is ionized; high imparted energy; characteristic radiation is be released; generates maximum differential signal
Rayleigh scattering	Photon interacts with bound atomic electron without ionization; photon is released in different direction without loss of energy	$\sigma_R \propto 1/E^{1.2}$	No energy absorption occurs; photons mainly scattered in forward direction
Compton scattering	Photon interacts with "free" electron, ionizes atom; energy of incident photon shared with scattered photon and recoil electron	$\sigma \propto \rho$ $\sigma \propto E^{0*}$ $\sigma \propto 1/E^{\dagger}$	Displaced electron energy is absorbed locally; interaction produces attenuation and partial absorption
Pair production	Photon energy > 1.02 MeV interacts with nucleus and conversion of energy to e^-–e^+ charged particles; e^+ subsequently annihilates into two 511-keV photons	$\pi \propto (E - 1.02\ MeV) \times Z$	Probability of interaction increases with increasing energy, unlike other processes

*Within diagnostic x-ray energy range of 10–100 keV.

†At energies > 100 keV.

E_{BE} = electronic binding energy.