Electron and positron interactions with matter

Electron and positrons

-- They behave both as a wave and particle
-- They have the same absolute charge (e^- & e^+).
-- The interaction is mediated by electromagnetic force (parity and momenta are conserved)
-- Their rest mas is ~0.511 MeV.

Electron and positron interactions with matter

Interaction processes with matter

-- Elastic scattering
-- Inelastic scattering
  - Atomic excitations
  - Ionizations
-- Bremsstrahlung.
-- Positron anihilation

Electron and positron interactions with matter

Elastic scattering

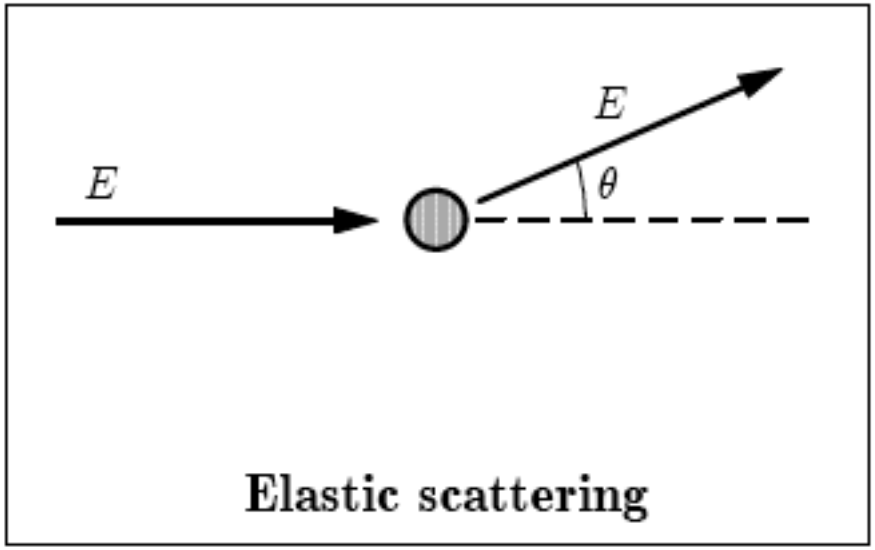
-- Charged particle may interact with matter through the electromagnetic field

-- The atom state remains unchange so the system kinetic energy is conserved

-- Energy losses are small

-- They are very important for energy distributions and particle penetration in matter because they may produce large angular deflections

Electron and positron interactions with matter



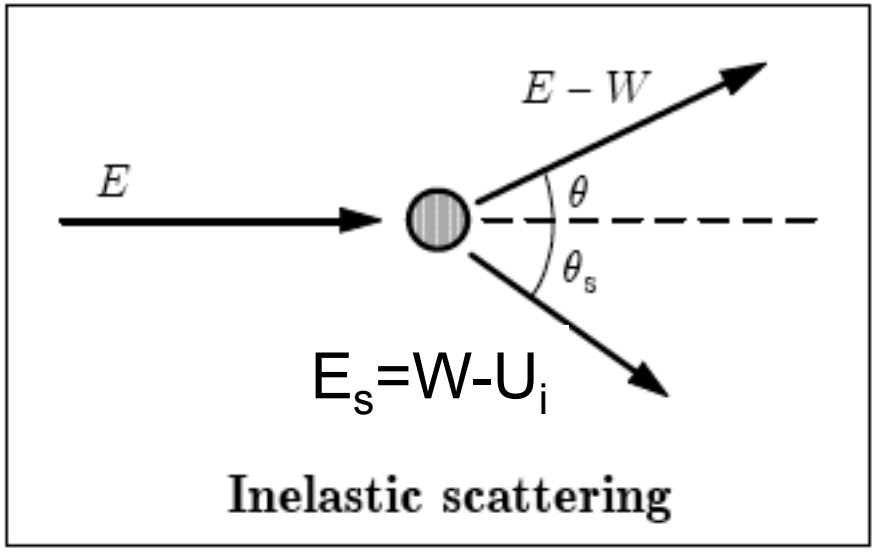
Elastic scattering

Electron and positron interactions with matter

Inelastic scattering

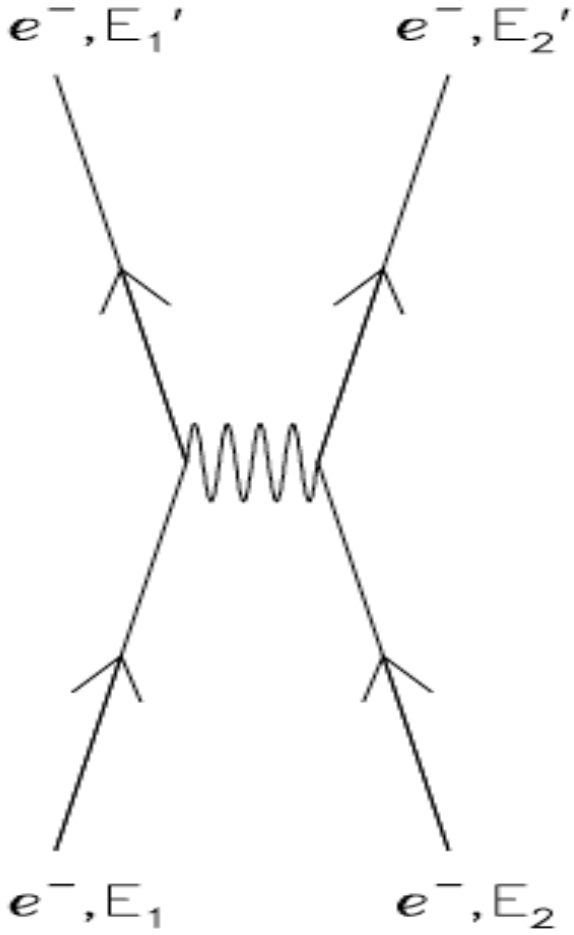
-- The projectile interacts with the atomic electrons, producing excitation or ionization of the target atom.
-- These collisions are responsible for most of the energly lost by the projectiles (primordial importance in radiobiology).
-- These interactions determine the collision stopping power.

Electron and positron interactions with matter



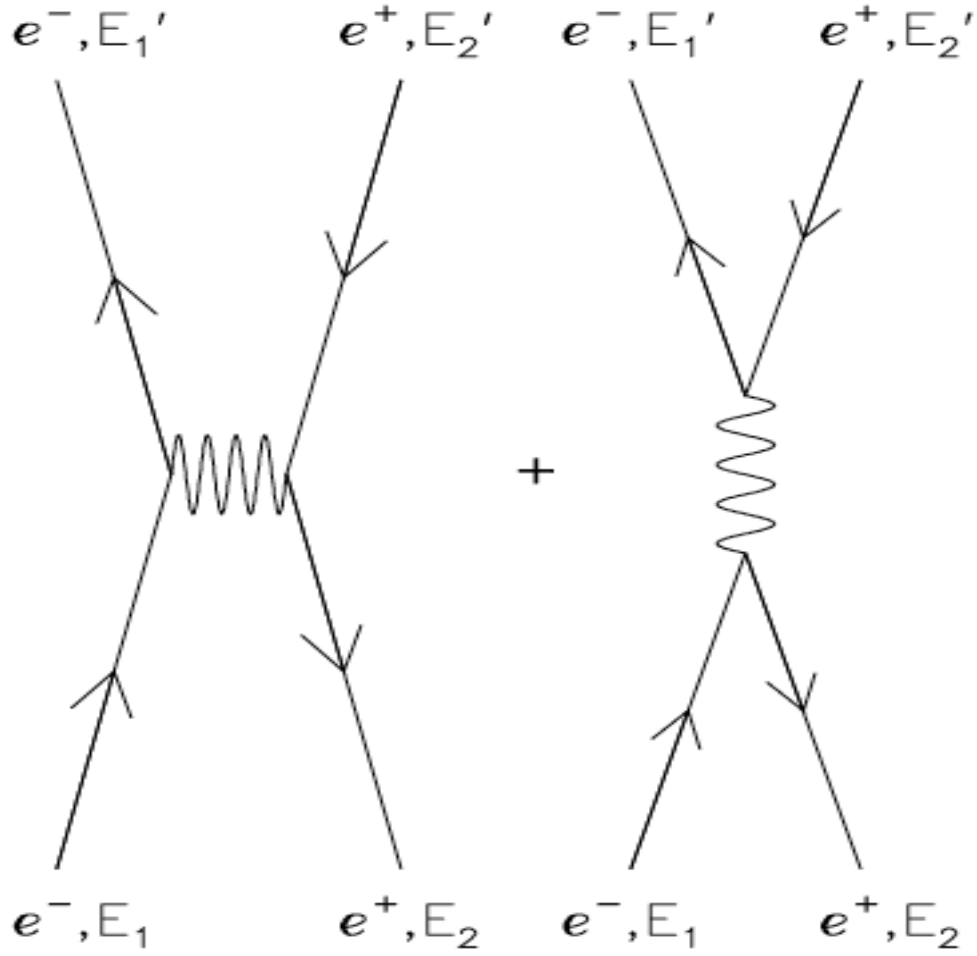
Electron and positron interactions with matter

Møller scattering
(electron-electron interaction)



Electron and positron interactions with matter

Bhabha scattering
(positron-electron interaction)

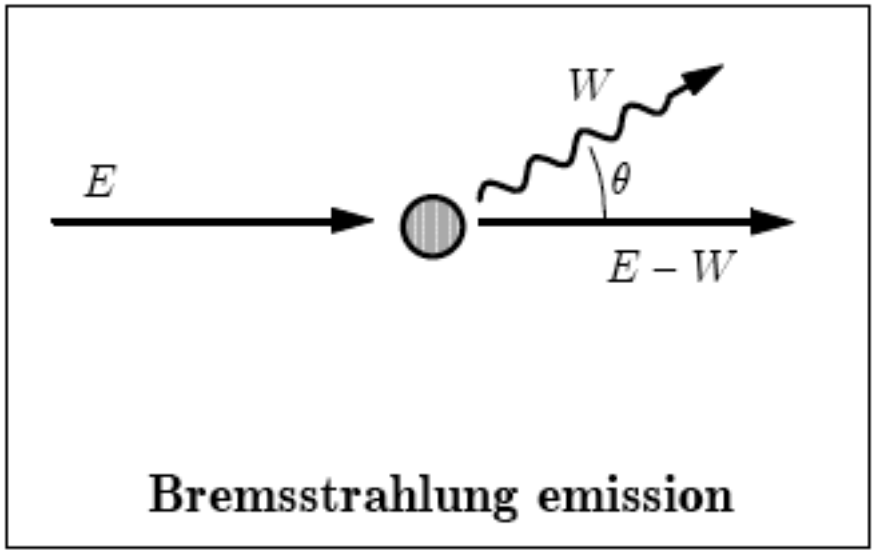


Electron and positron interactions with matter

Bremsstrahlung.

-- The charged particle is decelerates while interacting with the atomic nucleus electric field. It emits electromagnetic radiation.
-- X-rays are emitted with a continuous spectrum.
-- A charged particle ma lose all its energy through a Bramsstrahlung process.
-- This process is used to generate high energy photon beams (in linear accelerators)
-- It is one of the component of the radiative stopping power

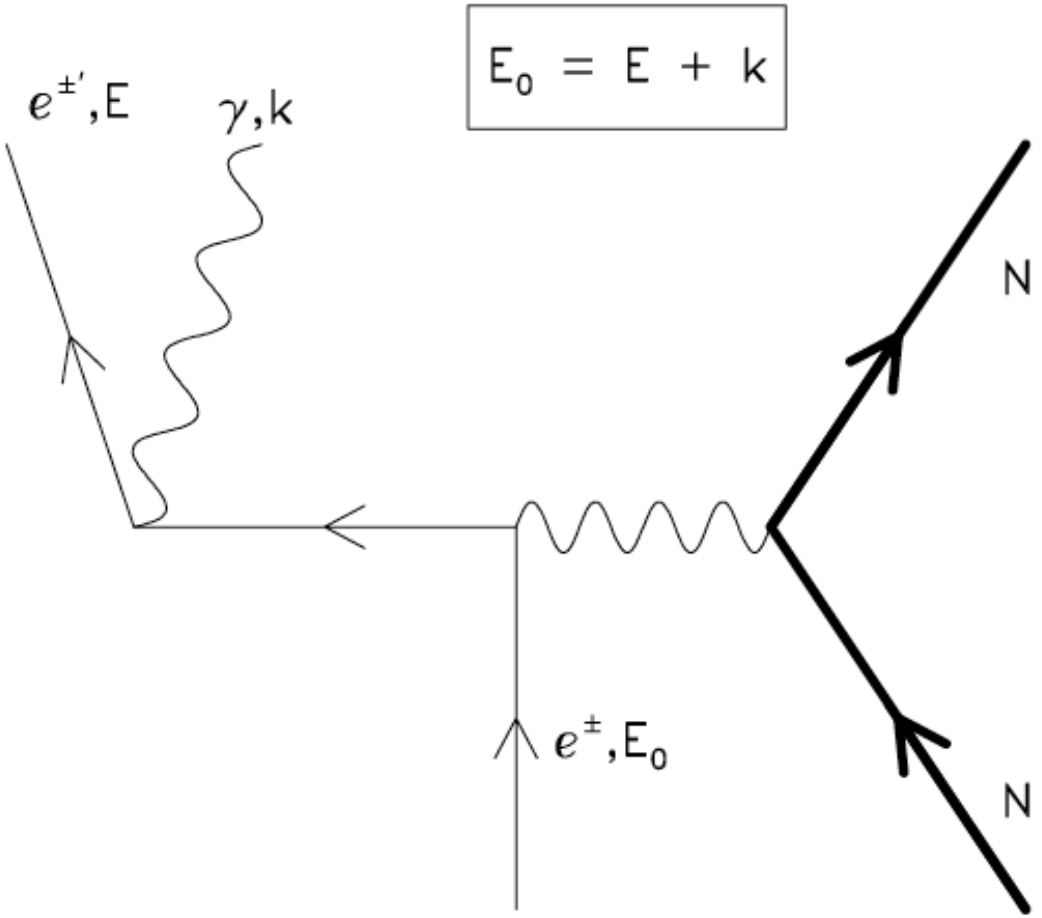
Electron and positron interactions with matter



Bremsstrahlung emission

Electron and positron interactions with matter

Bremsstrahlung

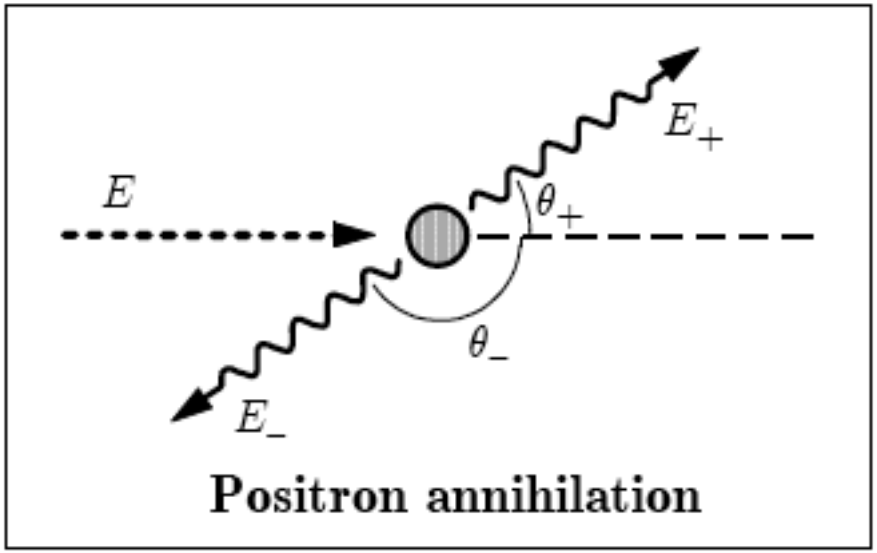


Electron and positron interactions with matter

Positron annihilation

-- A positron may annihilate while interacting with an electron, then moth particles disappear and two phtons are emitted with the same energies (two conserve the Center-of-mass moment).
-- It can occur in flight or at rest.

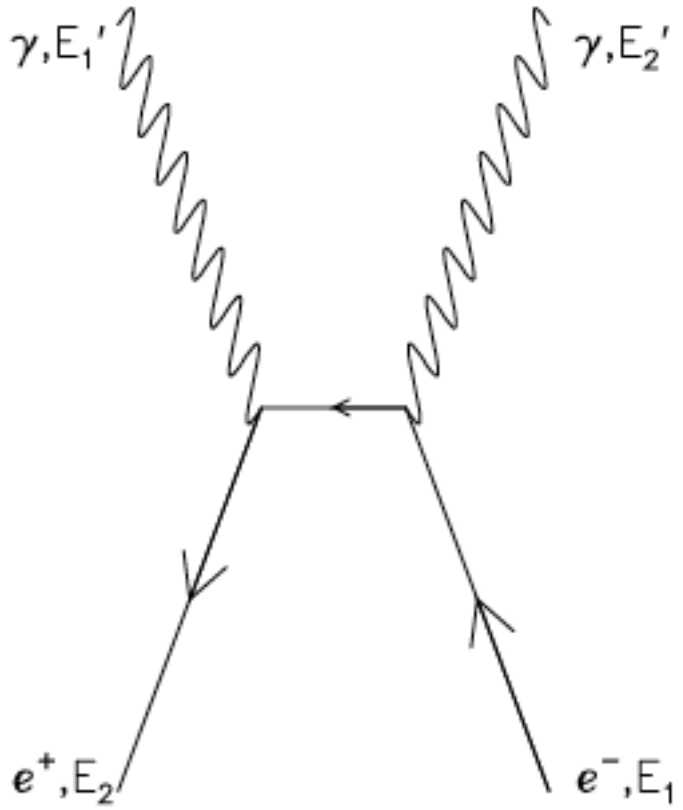
Electron and positron interactions with matter



$E_- = E_+ = (E + 2m_e c^2)/2$

Electron and positron interactions with matter

Aniqulación de pares

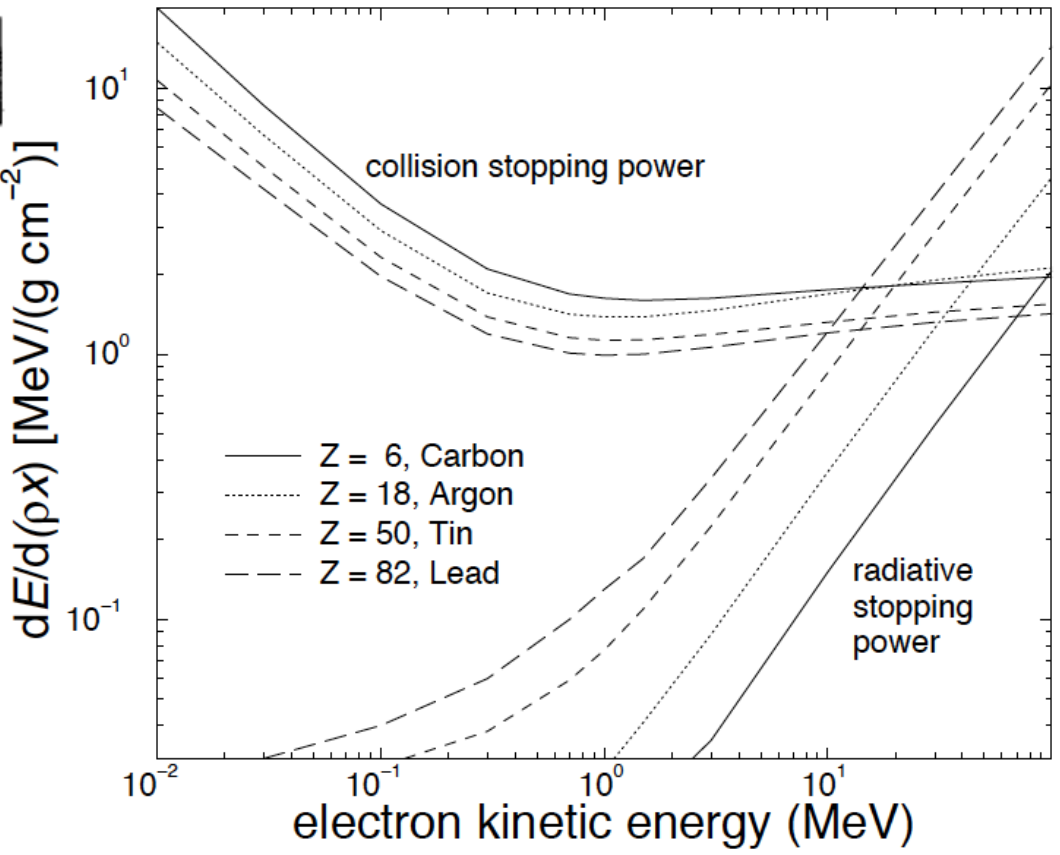


Electron and positron interactions with matter

Stopping power

$$\left(\frac{dT}{\rho dx}\right)_c = 2k\left[\ln\left(\frac{2m_0c^2\beta^2}{(1-\beta^2)I}\right) - \beta^2\right]$$

$$k \equiv \frac{2Cm_0c^2z^2}{\beta^2}$$



Electron and positron interactions with matter

Stopping power. Density (Fermi) correction