Contributions to Photon Cross Section in Carbon and Lead

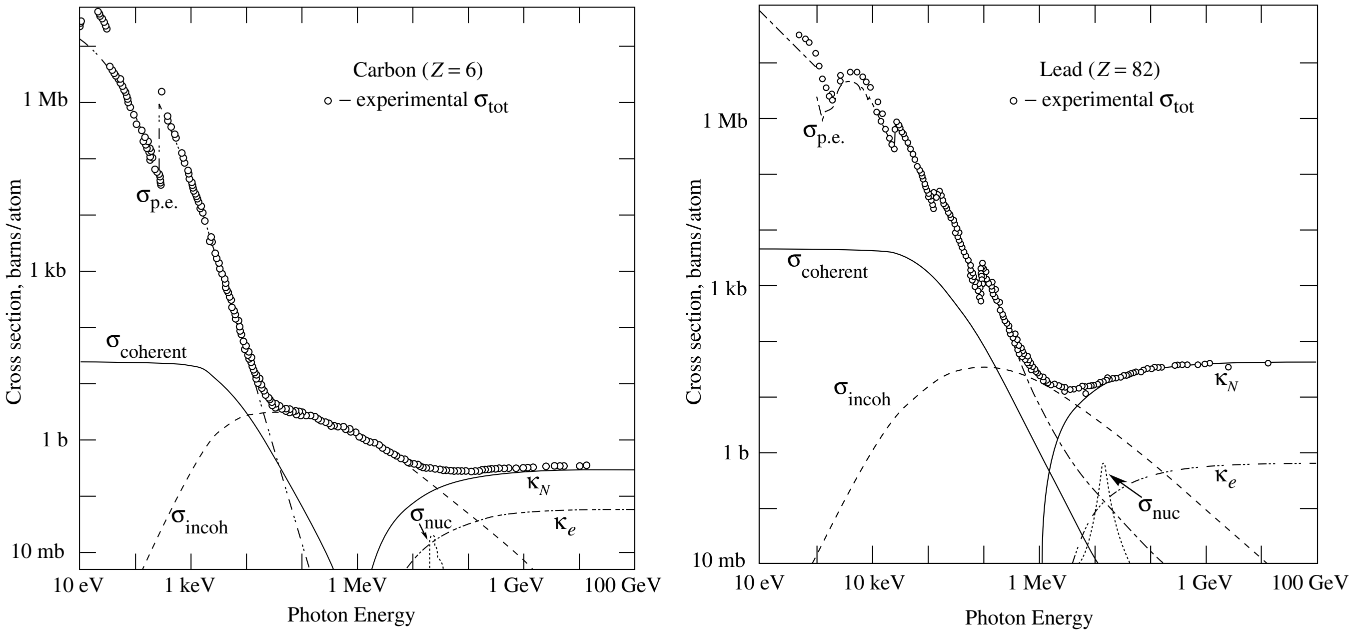

Figure 11.3: Photon total cross sections as a function of energy in carbon and lead, showing the contributions of different processes.

$\sigma_{\text{p.e.}}$ = Atomic photo-effect (electron ejection, photon absorption)

σ_{coherent} = Coherent scattering (Rayleigh scattering—atom neither ionized nor excited)

$\sigma_{\text{incoherent}}$ = Incoherent scattering (Compton scattering off an electron)

κ_n = Pair production, nuclear field

κ_e = Pair production, electron field

σ_{nuc} = Photonuclear absorption (nuclear absorption, usually followed by emission of a neutron or other particle)

From Hubbell, Gimm, and Øverbø, J. Phys. Chem. Ref. Data **9**, 1023 (80). The photon total cross section is assumed approximately flat for at least two decades beyond the energy range shown. Figures courtesy J.H. Hubbell.

Fractional Energy Loss for Electrons and Positrons in Lead

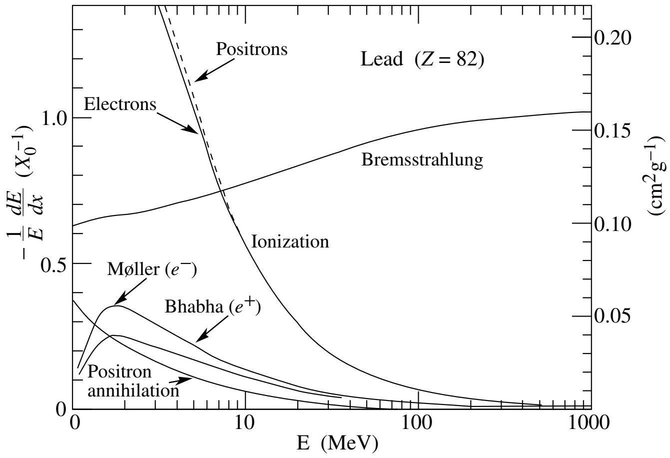

Figure 11.4: Fractional energy loss per radiation length in lead as a function of electron or positron energy. Electron (positron) scattering is considered as ionization when the energy loss per collision is below 0.255 MeV, and as Moller (Bhabha) scattering when it is above. Adapted from Fig. 3.2 from Messel and Crawford, *Electron-Photon Shower Distribution Function Tables for Lead, Copper, and Air Absorbers*, Pergamon Press, 1970. Messel and Crawford use $X_0(\text{Pb}) = 5.82\ \text{g/cm}^2$, but we have modified the figures to reflect the value given in the Table of Atomic and Nuclear Properties of Materials, namely $X_0(\text{Pb}) = 6.4\ \text{g/cm}^2$. The development of electron-photon cascades is approximately independent of absorber when the results are expressed in terms of inverse radiation lengths (*i.e.*, scale on left of plot).