A liquid hydrogen target of volume $10^{-4}\,\mathrm{m}^3$ and density $71\,\mathrm{kg\,m}^{-3}$ is exposed to a wide uniform monoenergetic beam of negative pions of flux 10^7 particles $\mathrm{m}^{-2}\,\mathrm{s}^{-1}$ and the reaction $\pi^- \mathrm{p} \rightarrow \mathrm{K}^0\Lambda$ observed. If the cross-section for this reaction is 0.4 mb, what is the rate of production of Λ particles?

A high-energy beam of neutrons of intensity $10^6\,\mathrm{s}^{-1}$ traverses a target of $^{238}\mathrm{U}$ in the form of a thin foil whose density per unit area is $10^{-1}\,\mathrm{kg\,m}^{-2}$. If the elastic and inelastic cross-sections are 1.4 b and 2.0 b, respectively, calculate: (a) the attenuation of the beam; (b) the rate of inelastic reactions; and (c) the flux of elastically scattered neutrons 5 m from the target, averaged over all scattering angles. (In practice the neutrons are emitted at small angles relative to the beam direction.)

Show that Eq. (9.26) reduces to (B.46b) in the region of the peak if $\Gamma^2 \ll M_Z^2$.

A beam of neutrons of kinetic energy 0.29 eV, intensity $10^5\,\mathrm{s}^{-1}$ traverses normally a foil of $^{235}_{92}\mathrm{U}$, thickness $10^{-1}\,\mathrm{kg\,m}^{-2}$. Any neutron–nucleus collision can have one of three possible results:

(1) elastic scattering of neutrons: $\sigma_e = 2\times10^{-30}\,\mathrm{m}^2$,
(2) capture of the neutron followed by the emission of a γ-ray by the nucleus: $\sigma_c = 7\times10^{-27}\,\mathrm{m}^2$,
(3) capture of the neutron followed by splitting of nucleus in two almost equal parts (fission): $\sigma_f = 2\times10^{-26}\,\mathrm{m}^2$.

Calculate:

(a) the attenuation of the neutron beam by the foil;
(b) the number of fission reactions occurring per second in the foil, caused by the incident beam;

In an electron–positron collider the particles circulate in short cylindrical bunches of radius 1 mm (transverse to the direction of motion). The number of particles per bunch is 5×10^{11} and the bunches collide at a frequency of 1 MHz. The cross-section for $\mu^+\mu^-$ creation at 8 GeV total energy is $1.4\times10^{-33}\,\mathrm{cm}^2$; how many $\mu^+\mu^-$ pairs are created per second? What is the rate of hadron production at this energy?