

**Homework Set 7**

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**4/10/25****7.1) Form Factor**

- 7.1.1) [5] Instead of  $\alpha$  particles with  $E_{kin} = 6 \text{ MeV}$  as in 5.2), we now consider electrons scattered off gold at the same momentum transfer. Calculate the kinetic energy and the momentum of such an electron by neglecting the recoil energy as in 5.2)!
- 7.1.2) [2] Calculate the maximum momentum transfer  $|\vec{k}|$ !
- 7.1.3) [GS] [3] How many cross section minima will be visible, if you scan the form factor from zero to maximum momentum transfer assuming that the  $^{197}_{79}\text{Au}$  nucleus is a homogeneously charged sphere, see Table 5.1?
- 7.1.4) [GS] [2] Show that the form factor for  $\vec{k}^2 = 0$  is 1?

**7.2) Cosmic Radiation**

- 7.2.1) [4] Calculate the energy of a cosmic background radiation photon of  $2.73 \text{ K}$ , that hits a proton  $E_p = 6.38 \cdot 10^{20} \text{ eV}$  head on, in the universe and in the proton rest frame?
- 7.2.2) [5] Calculate the maximum energy of the scattered photon in the universe and its corresponding energy in the proton rest frame? Isn't it amazing how hard a soft photon can hit!

**7.3) Electron Pion Scattering**

- 7.3.1) [GS] [2] Formulate the differential cross section  $\frac{d\sigma}{d\Omega}$  for elastic electron pion scattering!
- 7.3.2) [GS] [2] Formulate the explicit four momentum dependence of the form factor using the mean square radius determined in the limit of  $K_\mu^2 \rightarrow 0 \frac{\text{MeV}^2}{c^2}$ !