**DIPARTIMENTO
DI FISICA
E ASTRONOMIA
Galileo Galilei**

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Theory of Fundamental Interactions
Exercises IV

Exercise 1

Compute the differential cross-section $d\hat{\sigma}/d\hat{t}$ for the electromagnetic scattering process of one electron on a parton "$\mathcal{P}$" with charge $Q_{\mathcal{P}}$ and negligible mass

$$e^-(k)\mathcal{P}(p) \to e^-(k')\mathcal{P}(p')$$

where $\hat{t} = (k' - k)^2$. Consider two cases

1. The parton is a fermion with spin $1/2$

2. The parton is a boson with spin 0

Use the results to compute the structure functions F_1 and F_2 and show that in case "1." the Callan-Gross relation $F_1 = 2xF_2$ is valid while in case "2." $F_1 = 0$.

Exercise 2

Compute, with the parton model, the electromagnetic differential cross-section $d\sigma/dq^2$ for the process

$$pp \to \mu^+(k_+)\mu^-(k_-)X$$

where "X" denotes a generic hadronic final state and $q^2 = (k_+ + k_-)^2$. Consider only the contribution from the up, down and strange quarks in the initial protons.
Question: in which kinematical regime we expect the partonic calculation to reproduce the observations?