Problem 1: W boson branching fraction

The W boson decays via the weak interaction to leptons and neutrinos \([e^+\nu_e], (\mu^+\nu_\mu), (\tau^+\nu_\tau)\], or pairs of quarks \([u,d], (c,s)\] - why not \((t,\bar{b})\)? While we will study the weak interaction in much more details, we can already calculate branching fractions assuming that all fermions have the same weak charge. What is the branching fraction \(B(W^+ \to \mu^+\nu_\mu)\)?

Problem 2: Cross section and impact parameter

A beam of small balls (mass \(m\) and radius \(r\)) scatters elastically of a larger ball (mass \(M\) and radius \(R\)) with \(M \gg m\) and \(R \gg r\)

a) Calculate the differential and total geometrical cross section. Hint: use \(\sin(x+y) = \sin(x) \cos(y) + \cos(x) \sin(y)\).

b) How large is the fraction of small balls scattering under a scattering angle of \(\theta \leq 30^\circ\)?

c) The total cross-section for electron-proton scattering at HERA \(\sqrt{s} =\) is about 10 mb. Compare this to the geometrical cross-section of a proton assuming a radius of 0.862 fm. What does the result mean?
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