

Bonus Question 8

Due Wednesday, Nov. 6

The Z boson has a mass of 91.2 GeV and a width of 2.50 GeV. The cross section for $e^+e^- \rightarrow Z \rightarrow \text{hadrons}$ is well described by the relativistic Breit-Wigner formula

$$\sigma(e^+e^- \rightarrow Z \rightarrow \text{hadrons}) = \frac{\sigma_0 s \Gamma_Z^2}{(s - m_Z^2)^2 + s^2 \Gamma_Z^2 / m_Z^2}$$

where $\sigma_0 = 42$ nb is the hadronic cross section at the peak of the Z .

1. (7 pts) By how much does the Z tail shift R at $\sqrt{s} = 40$ GeV? (Note that this effect does not account fully for the Z contribution to R because the interference between $\mathcal{M}(e^+e^- \rightarrow Z \rightarrow \text{hadrons})$ and $\mathcal{M}(e^+e^- \rightarrow \gamma \rightarrow \text{hadrons})$ gives another contribution.)
2. (3 pts) What is the QCD correction to R at $\sqrt{s} = 40$ GeV? You will have to approximate α_s using the curve on p. 184 of M&S.