

Collider Physics Homework Project 2: e^+e^- Reactions

Choose and do ONE of the following.

1. $e^+e^- \rightarrow u\bar{u}d\bar{d}$

Use MadEvent to study the reaction $e^+e^- \rightarrow u\bar{u}d\bar{d}$ for five different center-of-mass energies (you will have to run MadEvent five times, one for each choice), $E_{CM} = 150, 155, 160, 165, 170$ GeV. Describe the behavior of the cross section as a function of energy. Using a combination of Feynman diagrams and/or plots (at $E = 170$ GeV), try to explain why the cross section changes in the way you observe as you increase the energy. A very similar “energy scan” was actually done by the LEP-II collider.

2. $e^+e^- \rightarrow \mu^+\mu^-b\bar{b}$

Use MadEvent to study the reaction $e^+e^- \rightarrow \mu^+\mu^-b\bar{b}$ at a center-of-mass energy of 250 GeV. Looking at the invariant mass distributions of the $b\bar{b}$ and $\mu^+\mu^-$ systems, and comparing with the Feynman diagrams, discuss which virtual particles are contributing. Generate the reaction $e^+e^- \rightarrow \mu^+\mu^-u\bar{u}$ and explain the differences you see.

3. $e^+e^- \rightarrow \mu^+\mu^-\gamma$

Generate the process $e^+e^- \rightarrow \mu^+\mu^-\gamma$ using MadEvent at a center of mass energy of 200 GeV. Explain the invariant mass distribution of the $\mu^+\mu^-$ and the p_T distribution of the photon, based on the Feynman diagrams generated by MadEvent. (You can treat the matter fields as scalars when you argue, though MadEvent is treating them as fermions).