

Homework Set #6.

Due Date - Oral Presentation: Wednesday November 11, 2014

Due Date - Written Solutions: Friday November 20, 2014

1. Some particle Dark Matter model building

Consider the scalar QED process: scalar-electron scalar-positron pair-annihilation cross section into two photons, $\phi^+\phi^- \rightarrow \gamma\gamma$

- (a) Calculate the tree-level matrix elements for $\phi^+\phi^- \rightarrow \gamma\gamma$.
- (b) Calculate the cross section summing over all possible outgoing photon polarizations, in the center of mass frame.
- (c) Try to guess how the cross section you just calculated would change if the photon had a mass m_γ .
- (d) Suppose the Dark Matter in the universe was made of an equal number of scalar electrons and positrons with mass m , exchanging massive photons with a mass m_γ , with a fine structure constant α_{Dark} . Can you help particle Dark Matter model builders and find suitable combinations for m_γ and α_{Dark} to produce a (total) cross section of 10^{-36} cm^2 for $m = 10 \text{ GeV}$, and a cross section of 10^{-42} cm^2 for $m = 3.5 \text{ keV}$? If you can, you might think about writing papers on the Galactic center gamma-ray excess and on the mysterious 3.5 keV line from clusters...