

Indirect detection

1. Suppose you have a telescope with detecting area of 1 square meter. Suppose the J-factor (for annihilation) of a region around the Galactic center is 10^{22} GeV/cm^5 . For 100 GeV dark matter, which can annihilate to a 2-photon final state, how large an annihilation cross-section (to this final state) would you need in order to observe one annihilation photon per year from this region?
2. Repeat the question for 100 GeV dark matter decaying to two photons, for decays in the region around the Galactic center with a 2 kpc radius - how short a decay lifetime would you need in order to observe one decay photon per year from this region?

To compute the total number of DM decays, you may assume the DM density profile scales as $1/r$ between the location of the Earth and the Galactic Center, the DM density at the Earth is 0.4 GeV/cm^3 , and the distance to the Galactic Center is 8.5 kpc. To estimate the number of observed photons, you may further approximate the distance to all annihilations within this region as 8.5 kpc (even though their true distance varies between 6.5 and 10.5 kpc).