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Observing Dark Matter Decays to Gravitons via Graviton-Photon Conversion

Tuesday, 9 December 2025 11:00 (30 minutes)

Since dark matter is only known to have gravitational interactions, it may plausibly decay to gravitons on cosmological timescales. Although such a scenario can be easily realized, there are currently no known limits on this possibility based on indirect detection searches. We find that the gravitons produced in dark matter decays can convert to photons in large-scale magnetic fields along the line of sight to an observer. These conversions primarily occur within cosmological filaments which occupy a large (order unity) volume fraction and contain ~10–100 nG fields with ~ Mpc coherence lengths. Thus, dark matter decays to gravitons predict an irreducible population of extragalactic photons, which we constrain using the extragalactic gamma-ray background measured by the Fermi-LAT telescope. Using this conservative method, we place the first limits on the dark matter lifetime in the 0.1GeV–108 GeV mass range, assuming only decays to gravitons. We also make projections for the Advanced Particle-astrophysics Telescope, which can improve sensitivity to this DM decay channel by an order of magnitude beyond those we set using Fermi-LAT data.

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