

# Limits on Large Extra Dimensions Based on Observations of Neutron Stars with the Fermi-LAT

Fermi-LAT Collaboration

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**Abstract.** We present limits for the compactification scale in the theory of Large Extra Dimensions (LED) proposed by Arkani-Hamed, Dimopoulos, and Dvali. We use 11 months of data from the Fermi Large Area Telescope (Fermi-LAT) to set gamma ray flux limits for 6 gamma-ray faint neutron stars (NS). To set limits on LED we use the model of Hannestad and Raffelt (HR) that calculates the Kaluza-Klein (KK) graviton production in supernova cores and the large fraction subsequently gravitationally bound around the resulting NS. The predicted decay of the bound KK gravitons to  $\gamma\gamma$  should contribute to the flux from NSs. Considering 2 to 7 extra dimensions of the same size in the context of the HR model, we use Monte Carlo techniques to calculate the expected differential flux of gamma-rays arising from these KK gravitons, including the effects of the age of the NS, graviton orbit, and absorption of gamma-rays in the magnetosphere of the NS. We compare our Monte Carlo-based differential flux to the experimental differential flux using maximum likelihood techniques to obtain

our limits on LED. Our limits are more restrictive than past EGRET-based optimistic limits that do not include these important corrections. Additionally, our limits are more stringent than LHC based limits for 3 or fewer LED, and comparable for 4 LED. We conclude that if the effective Planck scale is around a TeV, then for 2 or 3 LED the compactification topology must be more complicated than a torus.