

Robust inference of the Galactic centre gamma-ray excess spatial properties

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The gamma-ray Fermi-LAT Galactic centre excess (GCE) has puzzled scientists for over 15 years. Despite ongoing debates about its properties, and especially its spatial distribution, its nature remains elusive. We scrutinize how the estimated spatial morphology of this excess depends on models for the Galactic diffuse emission, focusing particularly on the extent to which the Galactic plane and point sources are masked. Our main aim is to compare a spherically symmetric morphology—potentially arising from the annihilation of dark matter (DM) particles—with a boxy morphology—expected if faint unresolved sources in the Galactic bulge dominate the excess emission. Recent claims favouring a DM-motivated template for the GCE are shown to rely on a specific Galactic bulge template, which performs worse than other templates for the Galactic bulge. We find that a non-parametric model of the Galactic bulge derived from the VVV survey results in a significantly better fit for the GCE than DM-motivated templates. This result is independent of whether a GALPROP-based model or a more non-parametric ring-based model is used to describe the diffuse Galactic emission. This conclusion remains true even when additional freedom is added in the background models, allowing for non-parametric modulation of the model components and substantially improving the fit quality. When adopted, optimized background models provide robust results in terms of preference for a boxy bulge morphology for the GCE, regardless of the mask applied to the Galactic plane.

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