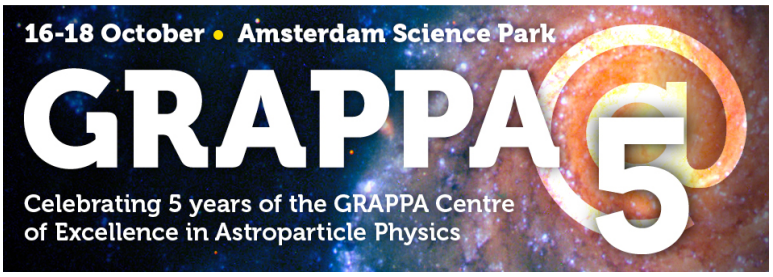


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# Better models of the gamma-ray sky with SkyFACT

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Template fitting of the gamma-ray sky has been quite successful in both understanding existing sources of emission and discovering new sources, such as the Fermi Bubbles and the GeV excess towards the center of the Milky Way. However, existing models still yield formally poor fits to the data with significant remaining residuals, which makes quantitative comparisons between different models difficult. We therefore introduce a new tool to fit gamma-ray data called SkyFACT, or Sky Factorization with Adaptive Constrained Templates. Rather than starting from fixed predictions from cosmic-ray propagation codes and examining the residuals to understand the quality of fits and the presence of excesses, we introduce additional fine-grained variations in the templates that account for uncertainties in gas tracers and the small scale variations in the density of cosmic rays. This yields high-dimensional models with approximately 100,000 parameters. We combine techniques from image reconstruction and adaptive template fitting, and use a penalized Poisson likelihood with maximum entropy regularization, along with the BFGS fitting algorithm, to efficiently handle this large number of parameters. We present results of fits to the inner Galaxy, and highlight the potential of this tool to study puzzling aspects of the gamma-ray sky, such as the nature of the GeV excess.

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