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Systematic Effects in Extracting a "Gamma-Ray Haze" from Spatial Templates

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Recent claims of a gamma-ray excess in the diffuse galactic emission detected by the Fermi Large Area Telescope with a morphology similar to the WMAP haze were based on the assumption that spatial templates of the interstellar medium (ISM) column density and the 408 Mhz sky are good proxies for neutral pion and inverse Compton (IC) gamma-ray emission, respectively. We identify significant systematic effects in this procedure that can artificially induce an additional diffuse component with a morphology strikingly similar to the claimed gamma-ray haze. To quantitatively illustrate this point we calculate sky-maps of the ratio of the gamma-ray emission from neutral pions to the ISM column density, and of IC to synchrotron emission, using detailed galactic cosmic-ray models and simulations. In the region above and below the galactic center, the ISM template underestimates the gamma-ray emission due to neutral pion decay by approximately 20%. Additionally, the synchrotron template tends to under-estimate the IC emission at low energies (few GeV) and to over-estimate it at higher energies (tens of GeV) by potentially large factors that depend crucially on the assumed magnetic field structure of the Galaxy. The size of the systematic effects we find are comparable to the size of the claimed "Fermi haze" signal. We thus conclude that a detailed model for the galactic diffuse emission is necessary in order to conclusively assess the presence of a gamma-ray excess possibly associated to the WMAP haze morphology.

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