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Spatially-Dependent Modelling of Pulsar Wind Nebulae

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Abstract content
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We present results from a leptonic emission code that models the spectral energy density of a pulsar wind nebula by solving a Fokker-Planck-type transport equation and calculating inverse Compton and synchrotron emissivities. We have created a time-dependent, multi-zone model to investigate changes in the particle spectrum as the particles traverse the pulsar wind nebula, by considering a time and spatially-dependent magnetic field, and spatially-dependent bulk particle motion causing convection, diffusion, as well as energy losses (synchrotron radiation, inverse Compton scattering and adiabatic). Our code predicts the radiation spectrum at different positions in the nebula, yielding the surface brightness versus the radius and the pulsar wind nebula size as function of energy. We calibrated our new model against more basic models using the observed spectrum of PWN G0.9+0.1, incorporating data from H.E.S.S. as well as radio and X-ray experiments. We also fit our predicted radiation spectra to data from G21.5-0.9, G54.1+0.3, and HESS J1356-645 and found that our model yields reasonable results for young pulsar wind nebulae. This model allows us to potentially constrain spatial properties of several quantities, e.g. the B-field, bulk flow speed, and diffusion coefficient. The development of this type of model is necessary in light of the development of the Cherenkov telescope array (CTA) which will yield far better resolution than current telescopes.

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