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Leptonic Nonthermal Emission from Supernova Remnants Evolving in the Circumstellar Magnetic Field

The very-high-energy gamma-ray emission observed from a number of Supernova remnants (SNRs) indicates particle acceleration to high energies at the shock of the remnants and a potentially significant contribution to Galactic cosmic rays. It is extremely difficult to determine whether protons (through hadronic interactions and subsequent pion decay) or electrons (through inverse Compton scattering on ambient photon fields) are responsible for this emission. For a successful diagnostic, a good understanding of the spatial and energy distribution of the underlying particle population is crucial. Most SNRs are created in core-collapse explosions and expand into the wind bubble of their progenitor stars. This circumstellar medium features a complex spatial distribution of gas and magnetic field which naturally strongly affects the resulting particle population. In this work, we conduct a detailed study of the spectro-spatial evolution of the electrons accelerated at the forward shock of core-collapse SNRs and their non-thermal radiation, using the RATPaC code that is designed for the time- and spatially dependent treatment of particle acceleration at SNR shocks. We focus on the impact of the spatially inhomogeneous magnetic field through the efficiency of diffusion and synchrotron cooling. It is demonstrated that the structure of the circumstellar magnetic field can leave strong signatures in the spectrum and morphology of the resulting non-thermal emission.

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