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# Modeling Bright Gamma-ray and Radio Emission from Fast Cloud Shocks at Middle-aged SNRs

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Recent observations by the Large Area Telescope (LAT) onboard the Fermi satellite have revealed bright gamma-ray emission from middle-aged supernova remnants (SNRs) inside our Galaxy. These remnants which also possess bright non-thermal radio shells are often found to be interacting directly with surrounding gas clouds. We explore the non-thermal emission mechanism at these dynamically evolved SNRs by constructing a hydrodynamical model. Two scenarios of particle acceleration, either a re-acceleration of Galactic cosmic rays (CRs) or an efficient nonlinear diffusive shock acceleration (NLDSA) of particles injected from downstream, are considered. Using parameters inferred from observations, our models are contrasted with the observed spectra of SNR W44. For the re-acceleration case, we predict a significant enhancement of radio and GeV emission as the SNR undergoes a transituation into the radiative phase. If sufficiently strong magnetic turbulence is present in the molecular cloud, the re-acceleration scenario can explain the observed broadband spectral properties. The NLDSA scenario also succeeds in explaining the gamma-ray spectrum but fails to reproduce the radio spectral index. Efficient NLDSA also results in a significant post-shock CR pressure that limits the cooling compression and prevents the formation of a prominent dense shell. Some other interesting differences between the two models in hydrodynamical behavior and resulting spectral features are illustrated in detail.

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