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Particle Acceleration in Young Supernova Remnants with Nonthermal X-ray and TeV Gamma-ray Observations

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Nonthermal (synchrotron) X-ray spectrum is the most powerful tool to study the nature of particle (electron) acceleration in shock wave of supernova remnant (SNR). For eleven young SNRs, we measure cutoff energy parameter (ε_0) in the synchrotron X-ray spectrum and Bohm factor (η) by the theoretically predicted relation of $\varepsilon_0 \propto v_{\rm sh}^2 \eta^{-1}$, where $v_{\rm sh}$ is shock velocity and η is defined as mean free path of electron over its gyro radius, i.e., indicative of acceleration efficiency. The obtained ε_0-$v_{\rm sh}$ plots show variations, depending on SNRs and even on regions inside each SNR. For example, we found ones well-reproduced by the theoretical prediction with constant η (Kepler's SNR and Tycho's SNR) or ones effected by the surroundings, in particular magnetic field orientation (SN 1006) and number density (Cassiopeia A). Putting all the eleven SNRs together, the η parameter tends to be smaller as the SNR evolves and becomes older, which implies a connection with turbulent production. We will discuss a possibility of acceleration up to PeV range (PeVatron) taking the time dependence on η into consideration. We also apply the inverse Compton scattering model to TeV gamma-ray observations of five SNRs. The gamma-ray spectrum is also utilized for estimation of η in the leptonic scenario, although the obtained η is larger than that with the X-ray observations.

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