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Gamma-rays from young SNRs in dense circumstellar environments

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Supernova remnants are known to accelerate cosmic rays on account of their non-thermal emission of radio waves, X-rays, and gamma rays. However, the ability to accelerate cosmic-rays up to PeV-energies has yet to be demonstrated. The presence of cut-offs in the gamma-ray spectra of several young SNRs led to the idea that PeV-energies might only be achieved during the very initial stages of a remnant's evolution.
We use our time-dependent acceleration code RATPaC to study the acceleration of cosmic rays in dense environments around massive stars where the plenty target material might offer a path to the detection of gamma-rays by current and future experiments.
We performed spherically symmetric 1-D simulations in which we simultaneously solve the transport equations for cosmic rays, magnetic turbulence, and the hydrodynamical flow of the thermal plasma in the test-particle limit. We investigated typical CSM-parameters expected around RSG and LBV-stars expected for free-expanding winds as well as structured ambient media due to photoionization-confined shells or episodes of enhanced mass-loss prior to the SN-explosion.
We show that potentially detectable gamma-ray signals can be expected in the Fermi-Lat band weeks to months after the explosion for free expanding wind-zones. Likewise does the interaction with dense shells enhance the gamma-ray luminosity which is accompanied by a re-brightening in thermal X-rays that might be used as trigger for dedicated gamma-ray observations. The maximum achievable might be limited due to the strong magnetic fields close to the progenitor star that enhances turbulence-damping due to cascading.

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