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Modeling the non-thermal emission from SN 1987A

The remnant of SN 1987A is the best-studied object of its kind. The rich data-set of its thermal and non-thermal emission across the electromagnetic spectrum poses a unique testbed for the elaboration of particle-acceleration theory.

We constructed a model of the ambient medium around SN 1987A based on the detected X-ray emission from the interaction of the SNR-shock with the dense material in the equatorial plane. Two cones along prominent features of the ambient medium are then used in our time-dependent acceleration code RATPaC to model the evolution of the non-emission of SN 1987A and compare it to observational data from Radio to gamma-ray energies.

We solve for the transport of cosmic rays and the hydrodynamical flow, in the test-particle limit. The simulation code relies on 1D profiles but the large expansion speed of the young remnant renders lateral transport unimportant.

We find that the increase in thermal X-ray emission predates the increase in the low-energy gamma-ray brightness by several years. The increase of the gamma-ray brightness at lower energies is followed by a smooth increase at the highest energies. The gamma-ray spectrum at the highest energies appears soft during the brightening but hardens as more material in the equatorial ring gets shocked. The gamma-ray emission from SN1987A is boosted by the presence of dense clumps in the equatorial ring whose presence is supported by the different behavior of the soft and hard X-ray emission. The X-ray and gamma-ray brightness remain almost constant once the SNR blast-wave passed the region of peak-density in the equatorial plane.

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