Contribution ID: **165** Type: **Poster**

Morphology of SNRs and their halos

Tuesday, 13 April 2021 18:55 (5 minutes)

Supernova remnants are known to accelerate particles to relativistic energies on account of their non-thermal emission. The observational progress from radio to gamma-ray observations reveals more and more morphological features that need to be accounted for when modeling the emission from those objects.
We use our time-dependent acceleration code RATPaC to study the formation of extended gamma-ray halos around supernova remnants and the morphological implications that arise when the high-energetic particles start to escape from the remnant.
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 a volume large enough to keep all cosmic rays in the simulation.
We find strong difference in the morphology of the gamma-ray emission in supernova remnants at later stages dependent on the emission process. At early times both - the inverse-Compton and the Pion-decay morphology - are shell-like. However, as soon as the maximum-energy of the freshly accelerated particles starts to fall, the inverse-Compton morphology starts to become center-filled whereas the Pion-decay morphology keeps its shell-like structure. Escaping high-energy electrons start to form an emission halo around the remnant at this time. There are good prospects for detecting this hard emission-spectra with the future Cerenkov Telescope Array as there are for detecting variation of the gamma-ray spectral index across the interior of the remnant. Due to the projection effects there is no significant variation of the spectral index expected with current-generation gamma-ray observatories.

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Session Classification: Binaries/Galactic/Pulsars/SNR/Solar-1

Track Classification: SNR