Abstract

Shell-type Supernova remnants (SNRs) have long been known to harbour a population of ultra-relativistic particles, accelerated in the Supernova shock wave by the mechanism of Diffusive shock acceleration [1]. Experimental evidence for the acceleration of electrons up to energies of ~100 TeV was first provided by the detection of hadron synchrotron emission as e.g. in the shell of the young SNR SN1006 [2]. Furthermore, using theoretical arguments shell-type Supernova remnants have long been considered as the main accelerators of protons - Cosmic rays – in the Galaxy: definite proof of this process is however still missing. Pulsar Wind Nebulae (PWN) – diffuse structures surrounding young pulsars – are another class of objects known to be a site of particle acceleration in the Galaxy, again through the detection of hadron synchrotron radiation or gamma-rays above 100 GeV as in the Crab Nebula. Gamma-rays above 100 MeV provide a direct access to acceleration processes. Ultra-relativistic electrons emit gamma-radiation through inverse Compton scattering in ubiquitous photon fields such as CMBR, star light and dust emission or local synchrotron radiation, while protons emit gamma-radiation through the decay of π0, generated in proton-proton interactions with interstellar material such as gas clouds. Recent advances in ground-based gamma-ray astronomy, especially with instruments like the Cherenkov telescope H.E.S.S., have shown that both shell-type SNRs and PWN are classes of gamma-ray emitting objects in the Galaxy [3,4].

The upcoming GLAST Large Area Telescope (LAT) will be operating in the energy range between 30 MeV and 300 GeV and will provide excellent sensitivity, angular and energy resolution in a poorly investigated energy band. Shell-type SNRs as well as PWN provide natural targets for GLAST observations and detections and in this poster we will describe prospects for the investigation of these Galactic particle accelerators with GLAST.

GLAST Studies of Pulsar Wind Nebulae

EGRET found a number of bright variable Galactic objects that could possibly be associated with Pulsar Wind Nebulae (PWN). Recent advances in VHE gamma-rays above 100 GeV by H.E.S.S. have shown that there are at least 8 PWN emitting at gamma-ray energies detected in a survey of the southern Galactic plane. Most of these are expected to be visible in GLAST-LAT. For example, the right hand panel shows a simulation of GLAST data for the Casablanca region. The SED shows that the GeV emission should be dominated by the central pulsar. However, photoan analysis can cut out the pulsed component, revealing the > 100 MeV/PWN spectrum. This is also illustrated in the right hand figures, which shows the GLAST simulated 2D-map above 3 different energies. The upper figure above 100 MeV is completely dominated by the pulsed photons, the lower panel above 3 GeV for a large number of PWN and allow for detailed population studies. Because of the near continuous coverage and stable high sensitivity of GLAST, we expect that slow (month-year) variability of the PWN synchrotron component from the wind termination shock should be measurable in some cases providing a new probe of PWN dynamics.

Best Candidates for GLAST detections

Shell-type SNRs: The best candidates for finding gamma-ray emission are a) SNRs that have been detected in VHE gamma-rays or exhibit hard x-ray synchrotron emission in their shells and b) young SNRs that emit hard x-ray synchrotron emission in their shells. These objects include: a) PWN detected in VHE gamma-rays b) PWN detected in X-rays. About 30 X-ray PWN have been detected [8] mostly around young energetic pulsars as shown in the left-hand Figure. The most energetic ones are summarised in the following table.

Pulsar Wind Nebulae: The best candidates for gamma-ray PWN are a) PWN detected in VHE gamma-rays and b) PWN detected in X-rays. The best candidates for gamma-ray PWN are summarised in the following table.

Summary

The prospects for GLAST of detailed investigations of Supernova Remnants and Pulsar Wind Nebulae promise to provide a new probe of cosmic acceleration mechanisms in our Galaxy. Measurements in adjacent X-ray and VHE gamma-rays (above 100 GeV) energy bands allow for detailed predictions of possible gamma-ray signatures in the GLAST energy range. The best candidates for a gamma-ray signature with GLAST are then young supernova remnants that have been detected in VHE gamma-rays or exhibit hard x-ray synchrotron emission in their shells and PWN around energetic pulsars as detected in X-rays and VHE gamma-rays.

References

[8] PSR B1706-44