Search for PSR B1951+32 with the GLAST LAT

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Abstract
PSR B1951+32 has the hardest spectrum of the six pulsars seen clearly in GeV gamma rays with EGRET, with no indication of a spectral break. The diffuse gamma background in the Cygnus region where it is located is so high that it is the only EGRET pulsar that was not also listed as an unspaced source in the 3rd catalog. These two properties make it an especially useful case to explore the selection cuts used to enhance the signals from gamma ray emitters observed with the GLAST Large Area Telescope (LAT). It is also a remarkable object to model our understanding of gamma ray pulsars: the high cut-off energy is attributed to its relatively low magnetic field, and the particle acceleration processes are believed to be strongly influenced by the surrounding supernova remnant CTT80. The poster will present Monte Carlo simulation results that illustrate both the instrumental and physics challenges offered by PSR B1951+32.

PSR B1951+32, the prediction of Mr Strom

The radio pulsar PSR B1951+32 was discovered by Kulkarni et al. (1998) and Clifton et al. in the core of the galactic SNR CTT80, as suggested by Strom (1997). The object is located at ~ 2 kpc with a period of 39.5 ms, its characteristic age is 1.1 x 10^6 yr, and its surface magnetic field is 4.9 x 10^9 G. EXOSAT (1987), Einstein (1994), and ROSAT (1995) detected pulsed emission in the X-ray regime, as did RXTE more recently at hard X-ray energies (1997). PSR B1951+32 is associated with a composite supernova remnant like the Crab, making it an interesting case to study interactions between the relativistic electron/positron wind and the external medium. Furthermore, the peculiar morphology of the SNR indicates a bow shock between the PWN and the SNR ejecta (Figure 5).

Pulsar spectrum simulation

Simulation parameters:
We have simulated the spectrum of PSR B1951+32 for the first year scanning survey observations using the GLAST Science Tools, as a power law with an exponential cutoff (eqn. 1). The background includes both galactic and extragalactic diffuse gamma ray flux, is the D2C standard cuts (class A8) and the current estimates of the instrument response. The pulse flux is fixed at 1.6 x 10^(-14) ph/cm^2/s/MeV.

Determination of the simulated parameters by likelihood analysis:
Figure 2 represents the differential gamma ray rate of the diffuse background and the pulsar, determined by a likelihood analysis for a region of interest of 0.5 deg and energy interval of [100 MeV–100 GeV]. The green and black lines are the extragalactic and galactic background fits, respectively. This blue line is a power law fit with an exponential cutoff convolved with the instrument response and the pink line is the sum of the three components. The blue triangles represent the data. The resulting flux is (1.7 x 10^(-15) photons/cm^2/s/MeV and the energy cutoff obtained is 31.6 x 9.9. The fit results agree with the initial parameters. The large uncertainty on the energy cutoff of PSR B1951+32 is due to low statistics at high energies.

Cut optimization for the faint source PSR B1951+32

Those light curves for PSR B1951+32 model the data from Ramanamurthy et al. [13] as 2 Lorentzian peaks. The one year simulation includes the detector physics, and the spacecraft geometry and orbital motion. Charged particle backgrounds, and galactic and extragalactic diffuse gamma rays, are taken from the second GLAST data challenge (DD2). For DD2, standard LAT event selection cuts were defined to reject most proton background. However, in the plane of the Milky Way, after standard cuts, diffuse gammas dominate the charged particle rates significantly. Consequently, for faint sources like PSR B1951+32, we can - loosen - the cuts to increase the number of gamma rays from the source without decreasing the signal significance (Figure 6). The diffuse gamma rate is still ~5x higher than the residual proton background.

REFERENCES