STUDY OF MEV/GEV/SOURCES
TEV EXTENTION OF FIRST CGRO EGRET CATALOGUE SOURCES
MULTIWAVELENGTH BLAZAR STUDIES
A SEARCH FOR TEV EMISSION FROM BURSTS DETECTED BY BATSE

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1. Introduction

The Whipple Gamma Ray Collaboration was formed in 1982 with the aim of improving the sensitivity of the ground-based atmospheric Cherenkov technique by the use of imaging cameras on large optical detectors. The approach was successful and the discipline of ground-based TeV astronomy was established. The first confirmed galactic source was discovered by the Whipple Collaboration as were the first two extragalactic sources. The technique has now matured and several new and important astrophysical results have been produced.
The γ-ray group of the Smithsonian Astrophysical Observatory is a key component of the Whipple Gamma Ray Collaboration. With all its members resident in Arizona, all its activities are devoted to research in ground-based γ-ray astronomy.

2. Supernova Remnants

The canonical theory of cosmic ray origins suggests that they emanate in shell-type SNRs. High energy γ-ray observations can indicate which SNRs have a large content of relativistic cosmic ray hadrons, and TeV γ-ray observations, in particular, have the sensitivity and angular resolution to reduce background confusion. EGRET measurements of SNRs are not definitive because the detector has low angular resolution at 100 MeV and measurements are masked by gas clouds. Collisions of cosmic ray nuclei with the interstellar medium result in the production of neutral pions which subsequently decay into γ-rays. These processes result in a secondary γ-ray spectrum which follows the primary cosmic ray spectrum at energies above $\sim$10 GeV up to $\sim$1/10 of the maximum proton energy of $\sim$ 100 TeV.
Calculations indicate that the luminosity of nearby SNRs should be sufficient for detection by the most sensitive VHE γ-ray telescopes. If there is a density enhancement from a molecular cloud, current ACTs and EGRET should already be able to detect the γ-ray emission from some objects. For a source spectral index of α=2.1, Drury et al. (1994) estimate the integral γ-ray flux at earth to be

$$F(>E) \approx 9 \times 10^{-11} \left(\frac{E}{1\ \mathrm{TeV}}\right)^{-1.1} \left(\frac{\theta E_{SN}}{10^{51}\mathrm{erg}}\right) \left(\frac{d}{1\ \mathrm{kpc}}\right)^{-2} \left(\frac{n}{1\ \mathrm{cm}^{-3}}\right)\ \mathrm{cm}^{-2}\mathrm{s}^{-1} \qquad (1)$$

where θ is defined as the fraction of the supernova energy E_{SN} converted into cosmic rays, d is the distance to the SNR, and n is the average density of the ISM around the remnant.
Assuming $\theta \approx 0.15$, a fairly conservative value for the average density of $n \approx 0.2\mathrm{cm}^{-3}$ and the canonical value $E_{SN} \approx 10^{51}$ ergs, gives a flux $F(> 200\ \mathrm{GeV}) \approx 1.6\times10^{-11}(d/1\ \mathrm{kpc})^{-2}$photons $\mathrm{cm}^{-2}\mathrm{s}^{-1}$.
This flux lies close to the sensitivity limit of the current generation of TeV telescopes.
For several of the unidentified EGRET sources there is now evidence for an association with a SNR (γ-Cygni, IC443 and W44. Observations by the Whipple telescope do not confirm the expected extension of the γ-ray spectrum (Buckley et al. 1998).

3. Unidentified EGRET Sources

Despite extensive searches for counterparts at long wavelengths for the 30 odd low latitude unidentified EGRET sources close to the galactic plane, no identifications have been made and their nature is unknown. A search for counterparts at high energies is justified because many of the sources exhibit flat spectra and the imaging ACTs have good source location capabilities. The Whipple telescope has been used to observe a number of these (Buckley et al. 1997) but no significant emission has been seen.

References

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Appendix

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(3) Boyle, P.J., Buckley, J.H., Burdett, A.M., Bussons Gordo, J., Carter-Lewis, D. A., Catanese, M., Cawley, M. F., Fegan, D. J., Finley, J. P., Gaidos, J. A., Harris, K., Hillas, A. M., Krennrich, F., Lamb, R. C., Lessard, R., Masterson, C., McEnery, J. E.,Mohanty, G., Moriarty, P., Quinn, J., Rodgers, A. J., Rose, H. J., Samuelson, F. W., Sembroski, G. H., Srinivasan, R., Weekes, T. C., and Zweerink, J. "Large Search for TeV Counterparts in Gamma Ray Bursts" Proceedings of the 25th International Cosmic Ray Conference (Durban, South Africa), Publ. Potchefstroom University, Eds. M.S.Potgieter, C.Raubenheimer, D.J. van der Walt; (1997) 3, 61.

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