A Search for Very High Energy Gamma-ray Emission From Four Galactic Pulsars

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Abstract

This thesis presents the results of observations of four potential $\gamma$-ray sources with the CANGAROO and BIGRAT imaging Cherenkov telescopes. As part of this effort, a theoretical investigation into the CANGAROO telescope is given using the Monte Carlo simulation technique. Previous results, from groups operating telescopes in the southern hemisphere have indicated the presence of unpulsed TeV $\gamma$-ray emission from three of these objects. This work provides an independent analysis of further observations of these objects.

The set of Monte Carlo simulations are used to develop a set of analysis methods which are sensitive to $\gamma$-ray detection, and which reject the cosmic ray background most efficiently. These methods are then used in the analysis of all CANGAROO data. Observations of the Crab nebula from 1996 to 1998, Vela pulsar/nebula in 1997 and the highly eccentric binary PSRB1259--63 in 1997 are presented. These observations show no evidence of steady TeV emission. However, new $3\sigma$ upper limits of $9.3 \times 10^{-13}$ photons cm$^{-2}$ s$^{-1}$ at 12 TeV for the Crab nebula, $2.5 \times 10^{-12}$ photons cm$^{-2}$ s$^{-1}$ at 2.7 TeV for the Vela pulsar/nebula and $3.2 \times 10^{-12}$ photons cm$^{-2}$ s$^{-1}$ at 2.7 TeV for PSRB1259--63 are given and compared with previously published results. The possible reasons for these non-detections are also presented and discussed.

Observations of the Vela pulsar/nebula in 1994 and 1996 and PSRB1706--44 from 1995 to 1996 with the BIGHAT telescope are also presented. These observations show no evidence of steady TeV $\gamma$-ray emission, a new set of upper limits for these sources at an energy threshold of 0.5 TeV is given. These are $3.8 \times 10^{-11}$ photons cm$^{-2}$ s$^{-1}$ for the Vela pulsar/nebula and $3.0 \times 10^{-11}$ photons cm$^{-2}$ s$^{-1}$ for PSRB1706--44.