

Observations of 1ES1959+650 with the HEGRA System of Imaging Air Cherenkov telescopes

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Abstract

The nearby BL Lac object 1ES1959+650 ($z=0.047$) has been observed with the HEGRA system of imaging air Cherenkov telescopes. Based upon a data-set of 94 hrs taken from July 2000 until October 2001, a weak detection (5.4σ) has been obtained corresponding to a flux level of 8% of the Crab flux. During recent observations from May until July 2002, the source has been observed to undergo strong outbursts at TeV and X-ray energies. The energy spectrum during the flares is hard and exhibits curvature, whereas during the low-state a power-law with a photon-index of 3.3 ± 0.7 describes well the data.

HEGRA System of Imaging Air Cherenkov Telescopes



We have used the HEGRA system of IACTs to observe the nearby BL Lac object 1ES1959+650 ($z = 0.047$). The observations were carried out in the years 2000-2002 (see observation log).

Observation Log

Date	Exposure
7/31-9/10/2000	13 h
5/8-6/2/2001	12 h
6/8-6/28/2001	16 h
7/10-7/31/2001	5 h
8/8-8/30/2001	17 h
9/6-9/25/2001	15 h
10/9-10/30/2001	16 h
5/17-5/21/2002	10 h
5/28-6/18/2002	35 h
6/27-7/18/2002	18 h
Σ_{ij}	163 h

- Location: Canary Island La Palma (28°N, 17°W), 2 200 m asl.
- System of 5 imaging air Cherenkov telescopes (IACT) with an 8.5 m² mirror surface/telescope
- Sensitivity: Detection of the Crab-Nebula at 5σ within 15 min.

Detection and energy spectrum in 2000/2001

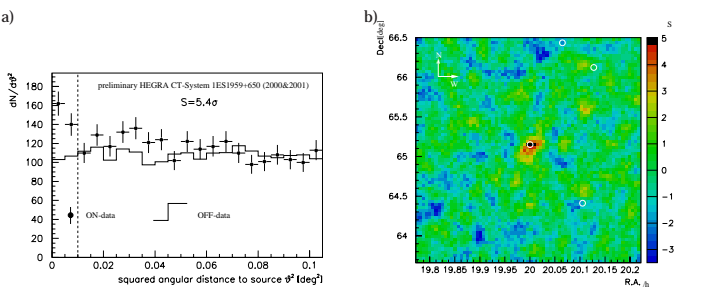


Fig. 1 a,b The source remained in a low state throughout 2000 and 2001. A deep observations of 94 hrs reveals a steady signal at the significance level of $S = 5.4 \sigma$. Within the field of view, no other source is detected (white circles indicate objects belonging to the 10th Véron-Cetty & Véron catalogue of bright quasars).

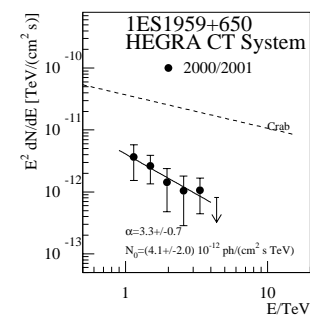


Fig. 2 The spectral shape is well described by a pure power-law with a photon index $\alpha = 3.3 \pm 0.7$ with an integral flux above 1 TeV corresponding to $\approx 8\%$ of the flux measured from the Crab-Nebula.

Observations in 2002

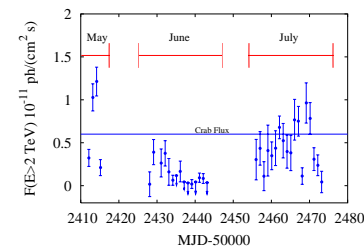


Fig. 3 The light curve during the year 2002 shows strong activity in the months May and July. The source remained at a lower flux level in June.

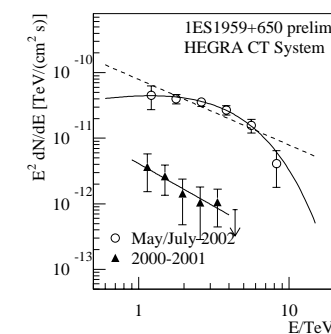
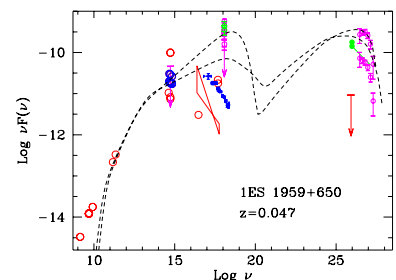


Fig. 4 The energy spectrum in the flaring state (May 18-20, 2002 & July 13-14, 2002) shows flattening and curvature. A pure power-law is not sufficient to describe the data (dashed curve, $\chi^2/d.o.f. = 10.7/4$, $\alpha = 3.0 \pm 0.1$). Here, an exponential cut-off for a fixed photon index $\alpha = 1.5$ has been used to fit the data-points. The cut-off energy is at $E_c = 2.4 \pm 0.4$ TeV ($\chi^2/d.o.f. = 0.78/4$).

Fig. 5 Preliminary modelling of the spectral energy density (SED) using a finite injection time SSC model (Chisellini et al. 2002): The red and blue data points are taken from a compilation of archival data by Beckmann et al. 2002. The green colored data are preliminary results from the May 17th flare detected by the Whipple group and RXTE all-sky monitor data. In magenta, the combined TeV-spectrum from May and July (see Fig. 4) are displayed. The upper magenta colored points are corrected for absorption using a model of the infra-red background light following Primack et al. 2001 (see also Aharonian et al. 2002).



Discussion

We have detected 1ES1959+650 ($z = 0.047$) at a low flux level after an exposure of 94 hrs in the years 2000 and 2001 with $S = 5.4 \sigma$. The integral flux above 1 TeV amounts to $\approx 8\%$ of the Crab-Nebula. The energy spectrum is described by a pure power-law with a photon-index of $\alpha = 3.3 \pm 0.7$. The source has shown increased activity during May and July 2002 reaching diurnal peak values of 1-2 times the flux from the Crab-Nebula. The spectrum during the flares exhibits curvature. A pure power-law results in a poor fit to the spectrum. The data is described by a hard power-law ($\alpha \approx 1.5$) with an exponential cut-off at $E_c = 2.4 \pm 0.4$ TeV (for a fixed photon index of 1.5).

References:

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