



Discovery of VHE gamma-rays from the BL Lac object PKS 0548-322 with H.E.S.S

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Abstract: Observations and monitoring of active galactic nuclei (AGN) are a key part of the scientific observation programme of the High Energy Stereoscopic System (H.E.S.S). The instrument was used to search for very high energy (VHE: > 100 GeV) gamma rays coming from PKS 0548-322, a BL Lac object visible from the Southern Hemisphere. An excess of VHE gamma rays ($\sim 6\sigma$) from the object is detected. The broad-band spectral energy distribution (SED), including the VHE spectrum ($\Gamma = 2.8 \pm 0.3_{\text{stat}}$) is presented.

Introduction

PKS 0548-322, at a redshift of $z = 0.069$ is among the closest blazars of the Southern sky. This extreme BL Lac is a promising source for VHE emission [1] so H.E.S.S dedicated time (~ 45 hours) between 2004 and 2006 to its observation. The X-ray spectrum of this source has a rich history. The reported spectral indices show significant scatter (see [2] and [3]), with no well-defined correlation to the X-ray intensity. The X-ray fluxes and spectral indices of PKS 0548-322 show that the frequency of the synchrotron peak can vary from less than 1 keV to more than 20 keV, without any apparent correlation with the X-ray flux ([4]).

Analysis Technique and Results

A total of 21.3 hours of good-quality data remain after application of quality-selection criteria and dead-time correction. The data are analyzed with the 3D-model method [5], where a model is used to reconstruct a 3D picture of the detected shower. For each detected shower, the direction, energy and 3D-width (used for gamma-hadron separation) are reconstructed.

Gamma-ray-like events are selected using cuts on image size, 3D-width, and telescope multiplicity.

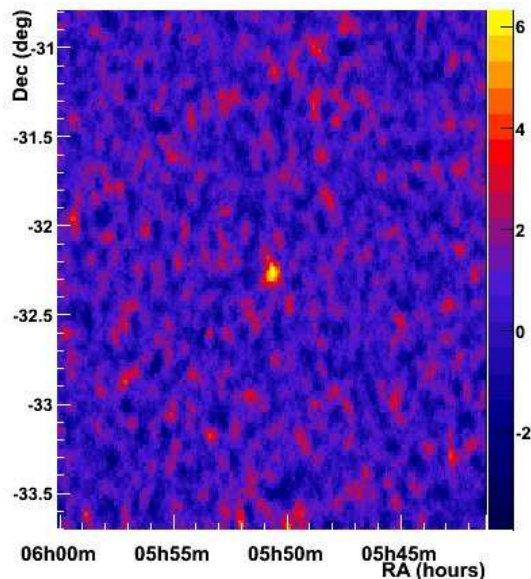


Figure 1: Preliminary significance map centred on the position of the point-like source PKS 0548-322.

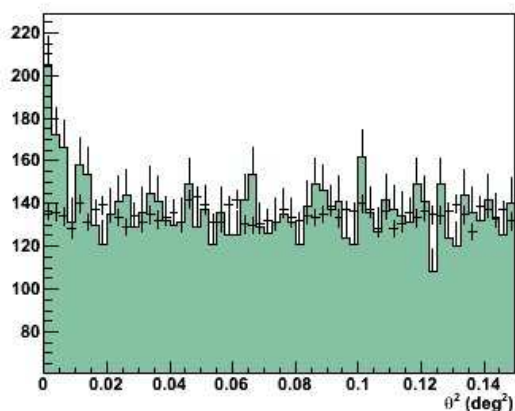


Figure 2: Distribution of θ^2 for on-source and normalized off-source events (preliminary). The excess is clearly visible in the region $\theta^2 \leq 0.01 \text{ deg}^2$ corresponding to a statistical significance of 5.8σ .

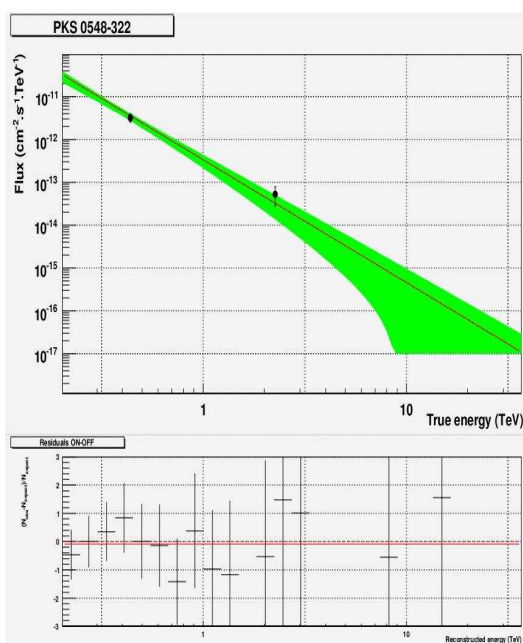


Figure 3: VHE spectrum of PKS0548-322 (preliminary). The shaded region represents the 1-sigma confidence bounds of the fitted spectrum (power-law hypothesis).

For this analysis, only events that triggered at least three telescopes are kept, in order to have better gamma-hadron separation.

The significance map of PKS 0548-322 is shown in Figure 1. The distribution of squared angular distance from the source is given in Figure 2. The analysis yields an excess of 181 gamma rays, corresponding to a significance of 5.8 standard deviations. The differential energy spectrum is presented in Figure 3. For a simple power-law hypothesis, the likelihood maximization yields a spectral index of $2.8 \pm 0.3_{\text{stat}} \pm 0.1_{\text{sys}}$ and an integral flux above the energy threshold: $(I > 200 \text{ GeV}) = (3.3 \pm 0.7) 10^{-12} \text{ cm}^{-2} \text{ s}^{-1}$. This correspond to $\sim 1.4\%$ of the HESS Crab Nebula flux [6] above the same threshold. No evidence for flux variability is seen in these data.

Spectral Energy Distribution

A simple homogeneous one-zone synchrotron self Compton (SSC) model (code from G.Dubus) is used to characterize the SED of PKS 0548-322 :

- the low-frequency emission, extending up to X-ray energies, is most likely due to synchrotron radiation of high-energy electrons.

- the VHE emission is believed to be produced through Compton upscattering of seed photons by the same population of relativistic electrons.

This model is adapted to the data of a soft state (X-ray data from BeppoSAX and RXTE) as well as of a hard state (BeppoSAX only). The HESS data derived from the spectrum (circles -opened: observed data, filled: intrinsic spectrum, i.e with the effects of EBL absorption removed using the upper limit of [7]) are well fitted, simultaneously, with either of these two sets of archival X-ray data.

Conclusions

Observations performed by H.E.S.S from 2004 up to 2006 have established PKS 0548-322 as a VHE gamma-ray source. It is among the closest TeV blazars discovered. Given its X-ray behaviour, the source is a very interesting object for understanding its VHE emission and discriminating between different models. Quasi-simultaneous Swift data

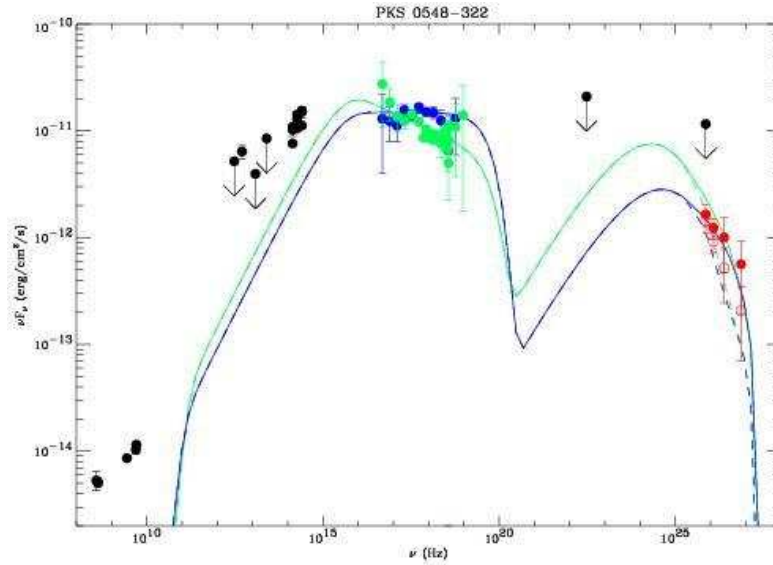


Figure 4: Preliminary spectral energy distribution of PKS 0548-322, modelled for both a soft and a hard X-ray state. Using a model with a reasonable set of parameters provides a satisfactory fits to the archival X-ray and VHE data. The emitting region is characterised by a Doppler factor $\delta = 20$, a magnetic field $B = 0.6$ G and a region blob size of $R \sim 2 \times 10^{15}$ cm.

were taken during the 2006 H.E.S.S. observations and will later be used in a more detailed SED study.

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