PROCEEDINGS OF SCIENCE

Multi-Wavelength Observations of PG 1553+113

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Since its detection in the very high energy (VHE; > 100 GeV) gamma-ray regime, several observations of the active galactic nucleus (AGN) PG 1553+113 have been performed with the Major Atmospheric Gamma-Ray Imaging Cherenkov (MAGIC) Telescope and the High Energy Stereoscopic System (H.E.S.S.). In July 2006, a Multi-Wavelength (MWL) campaign was conducted, in which apart from these two Cherenkov experiments the x-ray satellite Suzaku and the optical telescope KVA participated. Here the results of this MWL campaign are presented.

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1. Introduction: PG 1553+113

The active galactic nucleus PG 1553+113 was detected in the Palomar-Green survey of UV-excess objects [1]. According to its spectral features, the object was classified as BL Lac object [1, 2]. The AGN has been studied from the radio to the VHE regime. In 2003, a MWL campaign in the optical, radio and x-ray regime has been performed [3]. Since 2005, the source is also known in the VHE range [4, 5].

The redshift of PG 1553+113 is still unknown, as up to now no emission or absorption lines have been detected. In addition, the host galaxy is not resolved. Assuming the luminosity of the host galaxy, lower limits between $z < 0.09$ and $z < 0.3$ have been determined from the absence of emission lines [7, 8, 9, 10] From the VHE measurements, upper limits between $z > 0.42$ and $z > 0.74$ have been derived making assumptions on the intrinsic spectrum of the source and using the knowledge about the extragalactic background light (EBL) [4, 6, 12].

2. Multi-Wavelength Campaign

In July 2006, a MWL campaign has been performed including x-ray observations of the satellite Suzaku, optical observations of the KVA telescope and VHE observations of MAGIC and H.E.S.S. [13]. While the H.E.S.S. array is situated on the southern hemisphere in Namibia, MAGIC and the KVA are located on the Canary Island of La Palma. For these two telescopes, often coordinated observations are carried out providing simultaneous data like for example during the MWL campaign.

Suzaku obtained 41 ksec of continuous x-ray data on July 24th and July 25th. The other observations have been carried out around these dates: the H.E.S.S. array observed between July 22nd and July 27th, the MAGIC telescope between July 14th and July 27th and the KVA telescope between July 22nd and August 2nd. Consequently, the VHE and optical data cover not only the range of x-ray observations and also not their complete time range.

The data taken by MAGIC were affected by strong atmospheric absorption due to the Saharan Air Layer, i.e. sand-dust from the Sahara in the atmosphere above the telescope. Applying a correction method [16], the calculated flux and spectrum have been corrected.

3. Results

The data of the different energy ranges have been analyzed. In the following, the results will be discussed.

3.1 X-ray

From the Suzaku data a light curve (figure 2) and a spectrum (figure 1) have been determined. For the first time, a x-ray spectrum up to 30 keV has been measured for PG 1553+113. Compared to previous measurements, the source was found at an intermediate flux level. During the continuous measurement of 41 ksec, no significant variability was found.

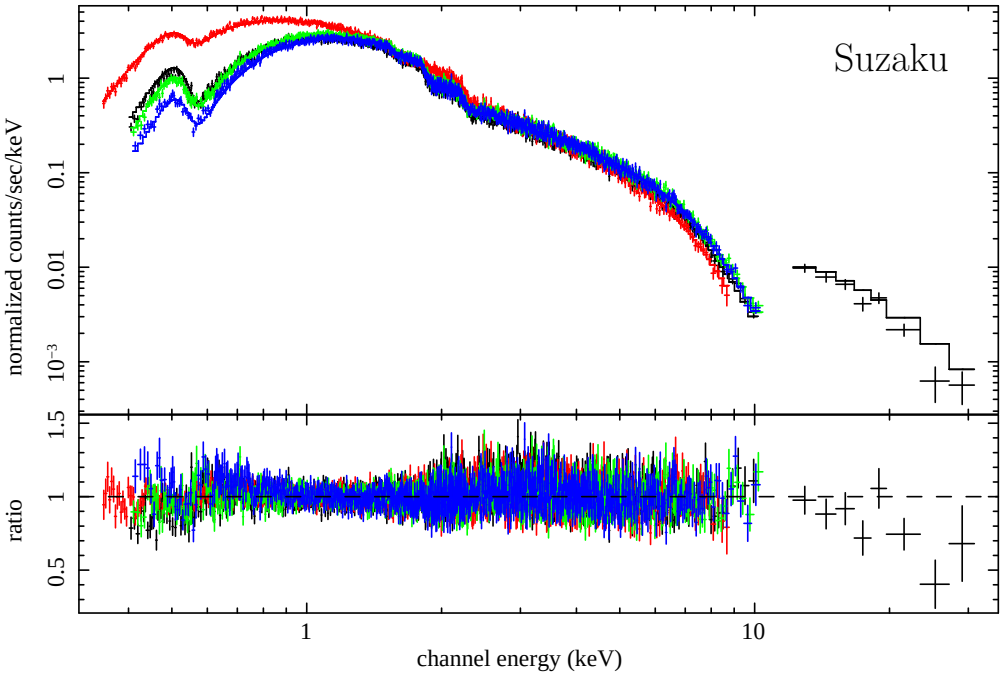

Figure 1: X-ray spectrum measured by the Suzaku satellite.

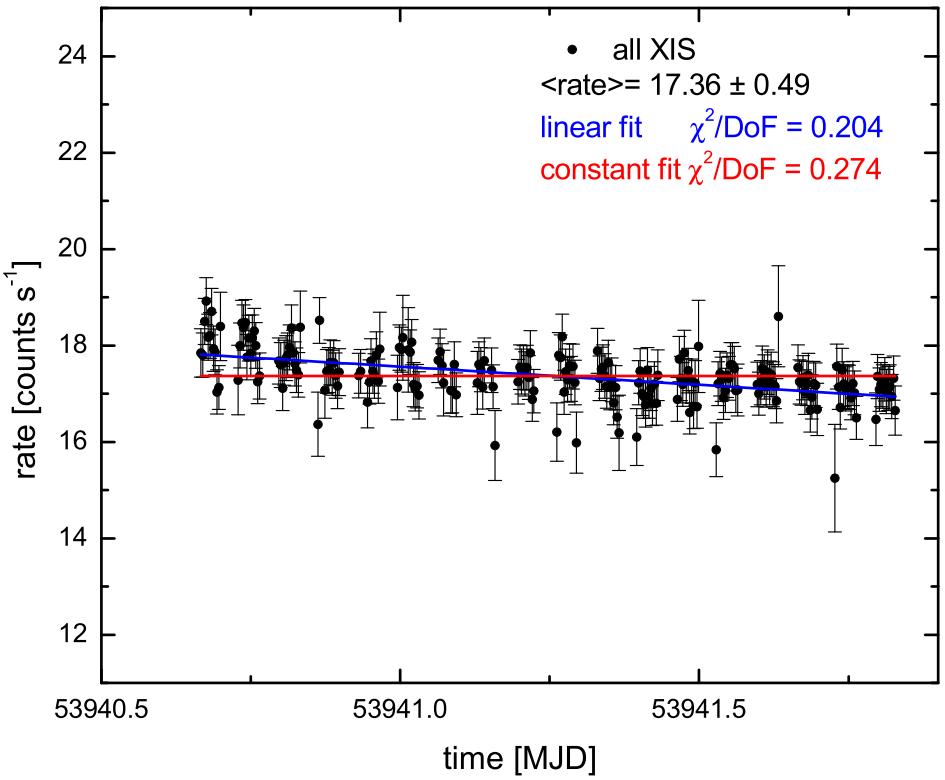

Figure 2: X-ray light curve measured by the Suzaku satellite.

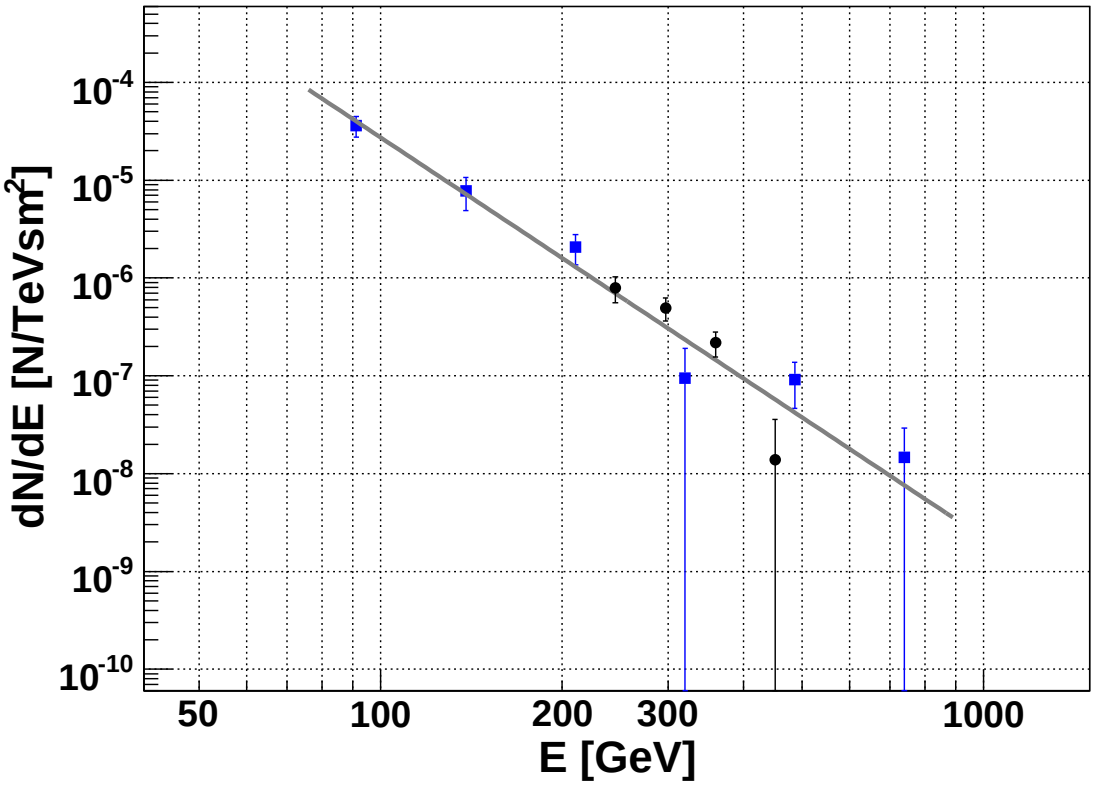

Figure 3: Combined VHE spectrum from the MAGIC data (blue squares) and the H.E.S.S. data (black circles).

3.2 Very High Energies

In the VHE range, a signal of PG 1553+113 was found with a significance of 5 sigma from 8.5 hours (MAGIC, [5]) and 6.7 sigma from 10.1 hours (H.E.S.S., [15]) of data.

From the data simultaneous with the Suzaku observations (3.1 hours for H.E.S.S. and 2.1 hours for MAGIC), the signal is too small to determine a reliable spectrum. As the spectral slope and the flux of the source are stable in the VHE range [6], the spectra of the whole data sets of July 2006 are used for the MWL studies. Also the integral flux above 150 GeV is consistent with measurements from other VHE observations [6].

3.3 Combined

The determined spectra are shown in figure 3 (MAGIC: blue squares, H.E.S.S.: black dots; [15, 14]). Fitting the combined spectrum with a power law between 75 GeV and 900 GeV, yields a spectral slope of 4.1 +/- 0.2, while it is 4.1 +/- 0.3 (MAGIC, [14]) and 5.0 +/- 0.7 (H.E.S.S., [15]) for the single spectra. The flux at 200 GeV is $(1.5 \pm 0.3) \cdot 10^{-6}/\mathrm{TeV}/\mathrm{m}^2/\mathrm{s}$ from the fit. This results are also consistent with other VHE measurements from the years 2005 to 2007 [4, 5, 6].

3.4 Variability

During the MWL campaign, no significant variability was found in any of the observed energy

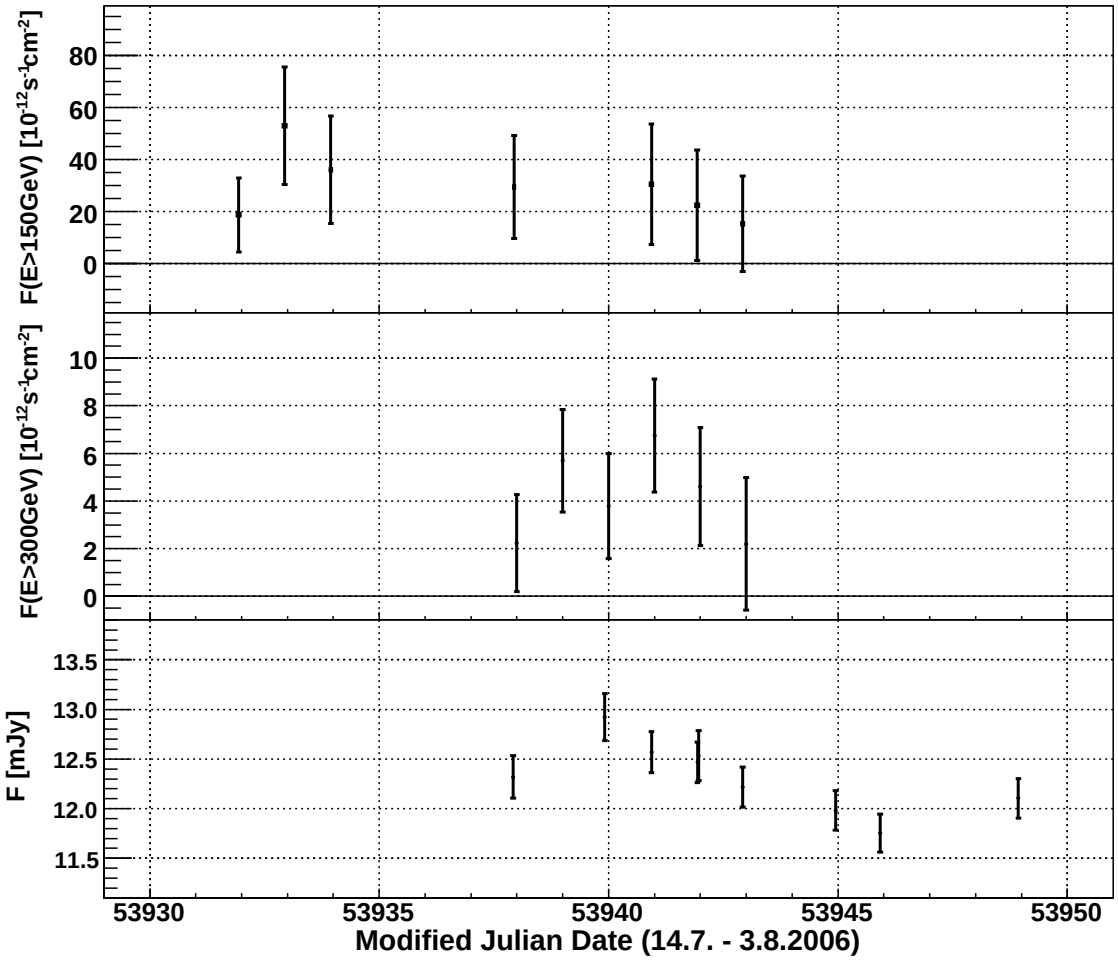

Figure 4: Light curves from different energies ranges of July 2006. Bottom panel: optical light curve measured by the KVA. Middle panel: integral flux above 300 GeV measured with the H.E.S.S. array. Upper panel: integral flux above 150 GeV measured by the MAGIC telescope.

ranges. The corresponding light curves of Suzaku, MAGIC (integral flux above 150 GeV), H.E.S.S. (integral flux above 300 GeV) and the KVA are shown in the figures 2 and 4.

3.5 Broadband Spectral Energy Distribution

From the data of the MWL campaign, a broadband spectral energy distribution has been determined, including also historical data in the radio, NIR and x-ray range. The VHE data have been corrected for the effect of the EBL assuming a redshift of z = 0.3 and using the best-fit model from Kneiske 2007.

4. Conclusions

With the MWL campaign of July 2006, for the first time simultaneous x-ray, VHE and optical data are available from PG 1553+113.

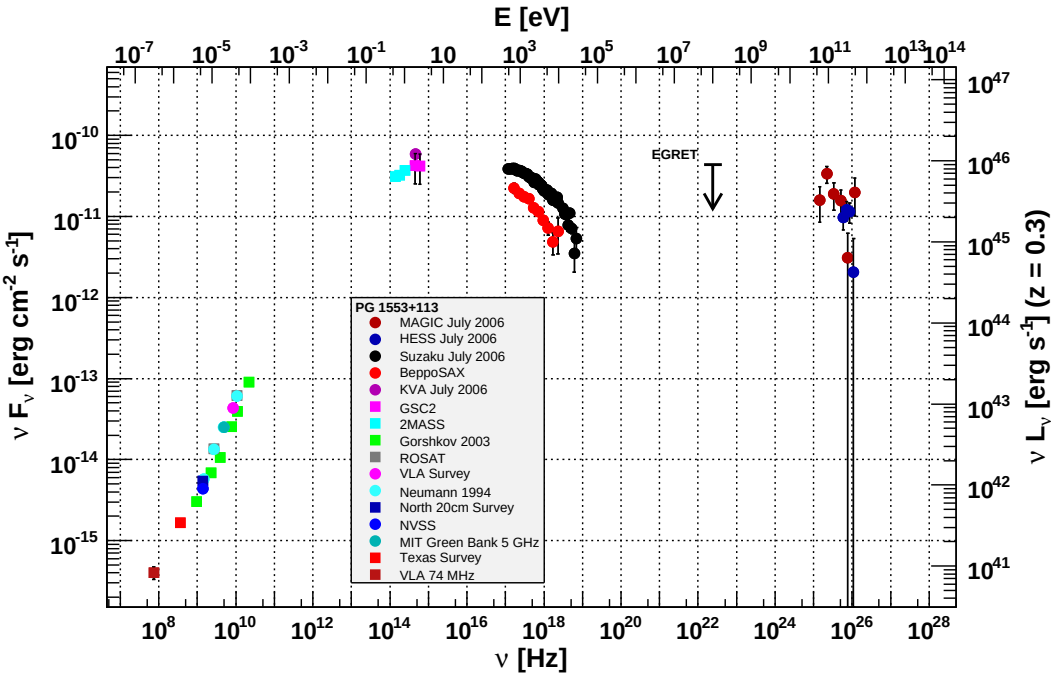

Figure 5: Broadband spectral energy distribution for PG 1553+113 including the VHE spectra of July 2006.

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