Five years of Observations of PG 1553+113 with the MAGIC Telescope

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MAGIC Major Atmospheric Gamma Imaging Cerenkov Telescope

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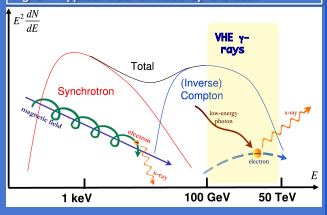
ABSTRACT -- Very High Energy (VHE) emission, above 100 GeV, from the blazar PG 1553+113 was discovered in 2005 by the MAGIC and H.E.S.S. Cherenkov telescopes simultaneously. Since then, follow up observations of the source were performed by the MAGIC telescope, in order to investigate its long term behaviour. Additional data were collected during multi-wavelength campaigns with optical, X-ray and gamma-ray instruments to study the source in different wavebands and determine a simultaneous broad band spectral energy distribution. In this poster, the results of five years of MAGIC observations, from 2005 to 2009, will be presented. Conversely to other blazars detected in the VHE regime, PG 1553+113 shows no strong flux variability above 100 GeV.

Very High Energy γ-rays from blazars

Blazars, radio-loud active galactic nuclei with a relativistic jet pointing toward Earth, are the majority of extragalactic γ-ray sources, both at GeV energies and above 100 GeV (VHE).

- The spectral energy distribution (SED) displays two broad peaks, widely interpreted as due to synchrotron and inverse Compton mechanism (Fig. 1).
- VHE part of the spectrum: long term and/or rapid variability, up to minute timescale.
- interaction with the extragalactic background light (EBL): partial/total absorption of VHE photons, depending on the source distance.

Fig 1 – Typical SED emitted by a blazar



The MAGIC Telescopes

MAGIC is a stereo system composed by two new generation Imaging Atmospheric Cherenkov Telescopes located on La Palma, Canary Islands, Spain at ~2200 m asl. MAGIC observes the VHE γ-ray sky at energies above 60 GeV. Data presented here was collected before Autumn 2009, when MAGIC was operating with a single telescope, referred as MAGIC-I.

Fig 2 – The MAGIC Telescopes

MAGIC-I parameters:

- Energy threshold: 60 GeV (25 GeV with a special trigger for pulsar observations)
- Sensitivity (t_{obs} = 50 h /5σ significant signal): 1.6 % Crab Nebula flux
- Energy resolution: < 20 % E> 200 GeV
- Angular resolution: ~ 0.1 deg

The source PG 1553+113 and its redshift

- PG 1553+113 is a BL Lac object (extremely weak emission lines in the optical spectra), located in the Northern hemisphere
- Discovered in 1986 by Green and until early 2010 its redshift was unknown
- Several attempts to determine its redshift were done in the past (indirect methods):
  - lower limit ranging from 0.09 to 0.78
  - Upper limit: from VHE observations + EBL: z < 0.42 and 0.58 [7]
  - Fermi + VHE: z ~ 0.34 ± 0.03 [8]
- Recent determination: z~0.4 [5]

5 years of MAGIC observations

The blazar PG 1553+113 was detected at VHE by MAGIC-I and H.E.S.S. telescopes in 2005 [1,2]. Since then, the source was monitored by MAGIC [3,4,7].
Table 1 reports the details of the good quality data selected after severe quality cuts (July 2006 data are not considered since the data quality was very poor).
Due to a change in each year telescope performances, data were analyzed separately.

Year	*Observations [hours]*	*Energy Threshold [GeV]*	*Flux (> 150 GeV) [cm^{-2} s^{-1}]*	*Flux (> 150 GeV) Crab %*	*Slope Γ*
2005+06	19	90	(2.8 ± 0.5)*10^{-9}	~9%	4.2 ± 0.2
2007	11.5	80	(1.40 ± 0.38)*10^{-9}	~4%	4.2 ± 0.3
2008	8.7 (6.9 flux)	150 (Calima)	(3.68 ± 0.47)*10^{-9}	~11%	4.0 ± 0.4
2009	8.5 (6.9 flux)	160 (Moon Obs)	(1.63 ± 0.45)*10^{-9}	~5 %	3.2 ± 0.7

Preliminary

Table 1 – Data collected by MAGIC from 2005 to 2009. The integral flux is estimated directly from the data, except for 2005-6 data (extrapolated from the fit [3]).

The energy threshold is ~90 and ~80 GeV for 2006 and 2007 observations respectively, ~150/160 GeV for 2008 (poor observing conditions) and 2009 data (moderate moon light observation) The zenith angle of the observations extends to 36 deg.

Lightcurve and VHE Spectra

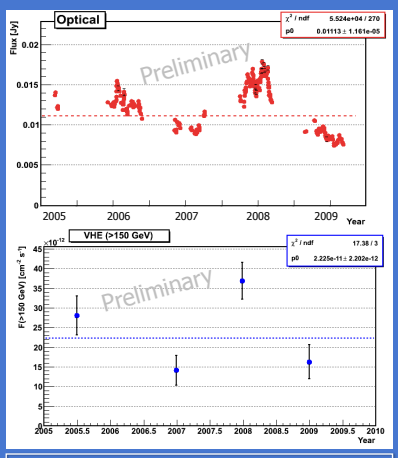


Fig. 3 – Optical (upper panel) and VHE (lower panel) lightcurves

- The integral flux above 150 GeV (Fig. 3) shows a trend in agreement with optical observations [9]: higher flux in 2005+2006 and 2008;
- No strong variability is evident
- The differential flux (Fig.4) can be well described by power laws of steep index Γ (Table 1);
- If corrected for EBL absorption (Franceschini model, 2008 [6]), the spectrum is compatible with a power law of index 2.8 ± 0.3.

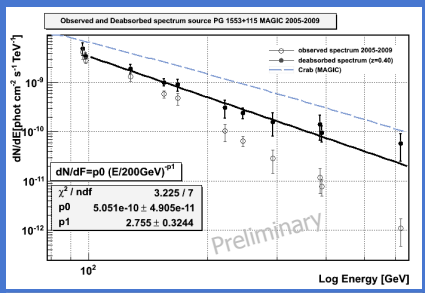


Fig. 4 – Differential photon spectra measured by MAGIC from 2005 to 2009 (filled points), and deabsorbed for EBL absorption (z=0.4)

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