Two years of observations of LS I +61°303 with MAGIC

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Abstract: In the last two years, the MAGIC telescope has performed an observational campaign on the X-ray binary LS I +61°303. Observations during the first year covered 6 orbital cycles and resulted in the first detection of the source above ~200 GeV. LS I +61°303 was also found to be variable. The second campaign spanned 4 more orbital cycles, covering orbital phases which had not been explored before and allowing us to map variability. The total amount of ~150 hours of observation time allowed for a very detailed study of this source. In this talk we report on the results of these campaigns.

Introduction

The X-ray binary system LS I +61°303 is composed of a B0 main sequence star with a circumstellar disc, i.e. a Be star, located at a distance of ~2 kpc. A compact object of unknown nature (neutron star or black hole) is orbiting around it, in a highly eccentric (e = 0.72 ± 0.15) orbit [2].

LS I +61°303 was first observed in gamma rays by the COS-B experiment. Later more precise EGRET measurements showed hints of variability of the γ-ray flux [12].

The orbital period is 26.496 days. Periastron passage is at phase φ = 0.23 ± 0.02 [2].

Radio outbursts are observed every orbital cycle at phases varying between 0.45 and 0.95 with a 4.6-year modulation [5]; often a double-peak structure is visible.

X-ray outbursts, starting around phase 0.4 and lasting up to phase 0.6, have also been detected [6]. Orbital X-ray periodicity has also been found using RXTE/ASM data [10], which currently reveal a broad maximum covering phases 0.4 – 0.6. Similar results have recently been obtained at higher energies with INTEGRAL [7].

Although previously considered a microquasar [9], a recent VLBA high resolution radio imaging of the source showed no evidence for extended jet-like features [3], but rather an extended structure which evolves with the orbital period and may be related to the shock where the companion star and a pulsar winds interact (see [4] for a description of the model).

Observation and Analysis

The Major Atmospheric Gamma Imaging Cherenkov (MAGIC) is a telescope for very high energy (VHE, E ≥ 50 – 100 GeV) γ-ray observation exploiting the Imaging Air Cherenkov technique [8]. It is located on the Canary Island of La Palma (Spain) at, 28°45'30"N, 17°52'48"W and 2250 m above sea level.

LS I +61°303 was observed with MAGIC in the past two years. In a first campaign of observations, 54 hours were recorded between October
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2005 and March 2006 [1]. During a second campaign 112 hours of observations were performed from September to December 2006.

Our measurements show that the VHE \( \gamma \)-ray emission from LS I +61°303 is variable. The integral \( \gamma \)-ray flux coming from the direction of LS I +61°303 in a day-by-day basis is presented in Figure 1. The maximum flux is detected around phase \( \Phi = 0.6 - 0.7 \).

The VHE spectra derived from both data samples between \(~\text{200 GeV} \text{ and } ~\text{5 TeV}\) are shown in Fig. 2. The reference red dotted line is for cycle I data (averaged for phases 0.4-0.7), fitted to a power law with spectral index \(2.6 \pm 0.2\). For cycle II, spectrum for phase 0.6-0.7 is presented in green points. The spectral slope obtained from the power law fit is in agreement with that of cycle I spectrum. No significant change in the spectral index is observed.

Conclusions

MAGIC has observed the X-ray binary LS I +61°303 in two consecutive years for 54 and 112 hours respectively. We briefly discuss the observational technique and analysis, derive a VHE \( \gamma \)-ray spectrum and a daily light curve for the two observational campaigns.

Further results will be presented at the conference, including a search for periodicity in the variable signal and the variability on short timescales.

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References

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Figure 2: Differential energy spectrum of LS I +61°303 for energies between 200 GeV and 4 TeV and averaged for maximal flux orbital phases. The dashed line corresponds to the measured flux in cycle I [1]. The flux points correspond to cycle II.


