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Observation of AE Aquarii with the MAGIC telescope.

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Abstract: In August 2005, the MAGIC telescope observed the cataclysmic variable AE Aquarii. Observations were done during four consecutive nights within the context of a quasi-simultaneous multi-wavelength campaign covering the radio, optical, UV, and X-ray ranges. The analysis of these data has revealed no evidence for any steady or pulsed γ-ray emission. Upper limits have been caclulated for steady emission at the level of $\sim 8 \times 10^{-12}$cm^{-2}s^{-1} above 340GeV and $\sim 4 \times 10^{-12}$cm^{-2}s^{-1} for coherent pulsed emission at the first harmonic of the white dwarf frequency.

Introduction

AE Aquarii is a bright, nova-like cataclysmic variable, lying at a distance of ~ 100 pc. It consists of a magnetic white dwarf that accretes matter from a Roche-lobe filling companion. The orbital period of the binary system is 9.88 hours and the spin period of the white dwarf is $P = 33.08$ s, the shortest known. It is spinning down at a rate $\dot{P} = 5.64 \times 10^{-14}$ s s^{-1} (see [1] for a recent revision of the system ephemeris).

Although it was initially classified as a DQ Her accreting-disk cataclysmic variable [2], the special features that the system displays (such as single peaked Balmer emission lines which are inconsistent with those of an accretion disk) discredited this model. This system also displays flaring activity in radio [3], IR [4], optical, UV, X-rays [5] and TeV γ-rays. Now it is thought to be a former supersoft X-ray binary [6] and current magnetic propeller [7].

During 2005 August 28-September 2 a multiwavelength (radio, optical, UV, X and γ-rays) campaign was organized (see fig 1). The analysis of part of these data is published in [1], presenting results on photometric data from *Chandra X-ray Observatory* and archival data from *ASCA* and *XMM-Newton*.

Here we present MAGIC telescope observations of AE Aqr. We briefly discuss the observational technique and the implemented data analysis procedure, and we derive a VHE γ-ray flux limits for the pulsed and steady emission.

Observation and analysis

During 2005 AE Aqr was observed for a total of 15 hours by MAGIC. Data were taken during four consecutive nights, from August 28th to August 31st (see fig 1). The observations were performed using the MAGIC telescope on the Canary island of La Palma ($28.75°$N, $17.86°$W, 2225 m a.s.l.), from where AE Aqr was observed at zenith angles between $30 - 50°$.

The essential parameters of the currently largest air Cherenkov telescope are a 17 m diameter segmented mirror of parabolic shape, an f/D of 1.05 and a hexagonally shaped camera of 576 hemispherical photo-multiplier tubes (PMT) with enhanced quantum efficiency [8]. The field of view (FOV) of the camera is $\approx 3.5°$ mean diameter

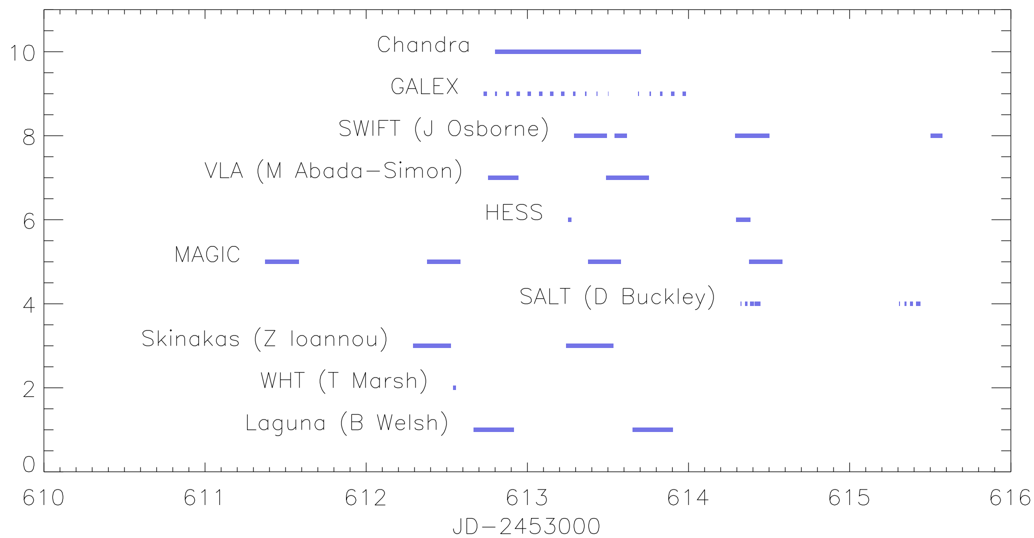

Figure 1: Instruments involved in the multiwavelength campaign and their corresponding observation time windows.

while the trigger area covers about $\approx 2.0^{\circ}$ formed by a coincidence of ≥ 4 neighboring pixels. The fast PMT analog signals are routed via optical fibers to the DAQ-system electronics in the counting house 80 m away. The signals are digitized by dual range 300 MHz FADCs. Further details of the telescope parameters and performance can be found in [9, 10].

All data were analyzed using the standard reconstruction and analysis software [11, 12].

The cosmic trigger rates during the four observation nights were noticeably low. The nearby optical telescopes Calsberg Maridiand and Mercator in fact confirmed that the atmospheric extinction was most higher most probably on account of the *calima* (Saharan dust). We used a set of special Monte Carlo simulations to correct the energy scale and the gamma efficiency of our analysis.

Results

No evidence for steady γ-ray emission has been found. The obtained integral flux upper limits are compared with the previous limits by Whipple instrument [13] in fig 2.

The optical behavior of AE Aqr exhibits large flares, highly coherent pulsations at a frequency $\nu_0 = 30.23$mHz, and quasi-periodic oscillations (QPO's). The keV X-ray emission is also pulsed at ν_0. And there were previously reported coherent pulsed VHE emission at these frequencies [14] obtained from the Nooitgedacht Mk I Cherenkov telescope.

We made two different studies for pulsed emission. Firstly we made a frequency scan around ν_0 and its first harmonic using the Rayleigh test. Second we produced the corresponding phaseograms for these frequencies.

No signal of a periodic nature has been found in excess of 2σ, so we can conclude that there is no significant periodic emission in any of the analyzed days. Therefore, upper limits to the pulsed emission have been set for all four days of observations and will be reported at the conference.

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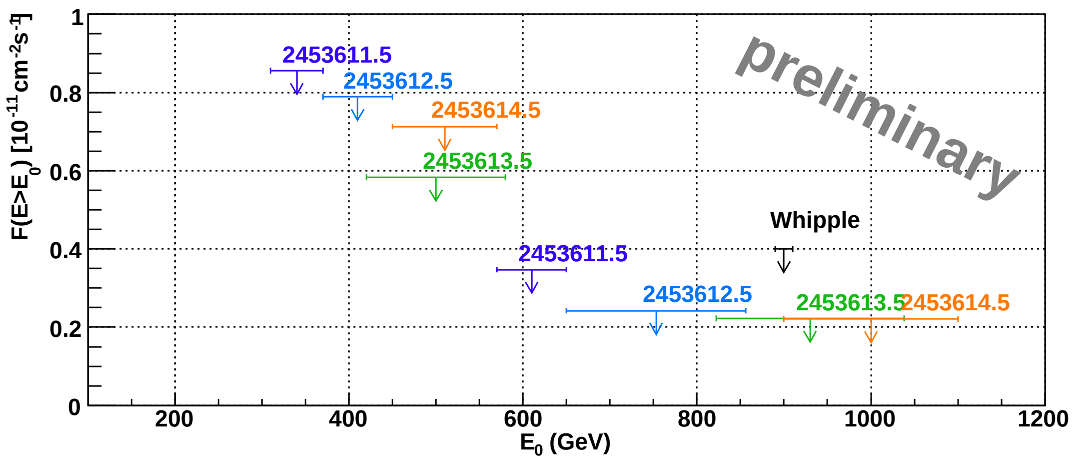

Figure 2: Upper limits for integral steady flux measured by MAGIC (different colors are given for each Julian Day). Upper limit from Whipple telescope is also given in black.

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