



Observations of microquasars with the MAGIC telescope

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Abstract: Along its first two cycles of observations (May 2005 - April 2007) the MAGIC telescope has observed the microquasars GRS 1915+105, Cyg X-3 and Cyg X-1. The first two objects were observed in Targets of Opportunity mode relying on radio alerts. Cyg X-1 was monitored for 50 hours spanning a period of 3 months. Evidence for transient VHE emission is found in one of the three microquasars. The detection is simultaneous with an episode of enhanced X-ray emission. Here we give details about the observations carried out with MAGIC. Final results will be reported at the conference and in the final version of the Proceedings.

Introduction

Microquasars are X-ray binaries displaying relativistic radio jets. These systems consist of a compact object, either a neutron star or a black hole (BH) of stellar mass, and a companion star that loses mass into an accretion disk orbiting around the compact object. In general, most of the energy is radiated by the disk in the X-ray domain.

The current number of known microquasars is ~ 16 , among the 43 cataloged radio emitting X-ray binaries (REXBs). Some authors [5] have proposed that all REXBs are microquasars and the jets would be detected provided there was enough sensitivity and resolution in the radio observations. The existence of relativistic jets in these Galactic sources makes them unique cosmic laboratories that may allow a deeper insight into the complex phenomenon of the jets, also common in powerful extragalactic objects [9]. Being much closer to us than AGNs, the microquasars offer an opportunity for monitoring the jets over much shorter spatial and temporal scales. To gain insight into the physics of relativistic jets in the universe, synergy between knowledge of galactic and extragalactic BHs is needed. In addition, microquasars could

significantly contribute to the density of Galactic cosmic rays [7]. Since photons up to VHE are an expected by-product of cosmic ray production, microquasars have been a frequent target for γ -ray observatories.

Three X-ray binaries have been detected so far in this energy band, namely PSR B1259-63 [1], LS I+61 303 [3] and LS 5039 [2]. In the former object (and perhaps also in the two latter ones), the TeV emission is thought to be produced by the interaction of the wind from a young pulsar with that of the companion star. As of now, there is no conclusive experimental evidence of VHE emission from any galactic accretion-driven system.

In the final version of this paper we will report on the results of the observations of the three microquasars observed by MAGIC during cycles I and II, namely GRS 1915+505, Cygnus X-1 and Cygnus X-3. We have found a strong evidence for transient VHE emission, correlated with an episode of enhanced X-ray emission. In this preliminary version we briefly describe the observed objects and give some details about the observation strategies.

Observations

GRS 1915+105 is a low-mass binary system consisting of a black-hole candidate orbiting around a low mass, K-M star, with a period of about 33 days. Cygnus X-3 is formed by a high-mass, Wolf-Rayet type star, with a compact object of unknown nature orbiting around every 4.8 hours. Both binary systems vary unpredictably among different activity states (including radio outbursts), with time scales ranging from hours to months. The fluxes at radio and X-ray energies are among the highest detected in microquasars, being evidence of very powerful ejections that could emit at VHE γ -rays via synchrotron Self-Compton (SSC) in the case of GRS 1915+105, and via stellar inverse Compton or SSC in Cygnus X-3, although a hadronic mechanism cannot presently be discarded. The observations of these two objects with MAGIC were carried out in the “Target of Opportunity” (ToO) observation approach, by exploiting the correlation among the different wavelength fluxes to infer the source state and thus the observation was activated only when the VHE γ -ray emission was theoretically expected. We have accumulated a total of 15 hours of observations of GRS 1915+105 and 30 hours on Cygnus X-3.

Cygnus X-1 is the best established candidate for a stellar mass black hole and one of the brightest X-ray sources in the sky. It is composed of a $20 M_{\odot}$ black hole turning around an $09.7 M_{\odot}$ companion of $40 M_{\odot}$ [11] in a circular orbit of 5.6 days. The source is powered by accretion, displaying the canonical high/soft and low/hard X-ray spectral states depending on the accretion rate. The results from observations in the soft gamma-ray range with COMPTEL [8] and INTEGRAL [4] strongly suggest the presence of a higher energy non-thermal component. VLBA images have shown the presence of a one-sided, elongated radio structure (15 mas length) during the hard state [10], associated to the presence of a highly collimated (opening angle $< 2^{\circ}$) relativistic ($v \geq 0.6c$) jet. The interaction of the outflow from the jet with the interstellar medium appears to be producing a large-scale (~ 5 pc diameter), ring-like, radio emitting structure [6], which implies that most of the energy from the system is released by a radiatively inefficient relativistic jet. MAGIC has ob-

served this source during 40 good hours between June and November 2006 in a systematic way.

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