Exploring the very high energy γ-ray emission (E>100GeV) of the hard spectrum FERMI sources 1FGL J2001.1+4351 and B3-2247+381 with MAGIC

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Introduction

In recent years the window to the very high energy (VHE, E > 100 GeV) γ-ray sky has been opened wide: currently 121 sources of VHE γ-rays have been discovered [1]. Since however the most sensitive instruments are designed for pointed observations with a typical field of view in the order of a few degrees, full sky surveys are practically unfeasible. It is thus common practice to use already existing catalogues in the optical, X-ray or high energy γ-ray range to determine potential targets for pointed observations with VHE γ-ray telescopes. MAGIC, a system of two 17 m diameter imaging air Cherenkov telescopes (IACT) of the latest generation (see picture on the right), is sensitive to γ-rays between 50 GeV up to several tens of TeV.

1FGL J2001.1+4351

Following an agreement with the IACT groups (MAGIC, VERITAS and H.E.S.S.) the FERMI-LAT Collaboration provided a list of sources flagged as good VHE-candidates, which included 1FGL 2001.1+4351 (RA=300.304, Dec=43.886) as one of the most prominent candidates [2]. Remarkably it was at first detected only above 1 GeV [3]. The unknown identification of the object triggered a study by Bassani et al. [4] in the optical, radio and X-ray band. The most likely counterpart, MG4 J200112+4352 (a bright flat spectrum radio source), was subsequently classified as a high frequency peaked BL Lacertae object (an active galactic nucleus, whose jet it pointing towards our line of sight, a so-called "blazar"). The source was found to be variable both in the X-ray as well as the optical band. The redshift of this source is still unknown (identification of the optical host galaxy suggests z<0.2).

MAGIC observed 1FGL J2001.1+4351 from July until September 2010. Only one night, July 16th, showed a significant excess of 7.6 σ (pre-trial, Fig. 2, [5]). This corresponds to 22% of the Crab Nebula flux above 90 GeV. The preliminary analysis of *Swift* data obtained simultaneously with MAGIC indicates an enhancement in the X-ray flux by a factor of three with respect to the previous days, indicating a positive correlation of the VHE and X-ray flux for this source.

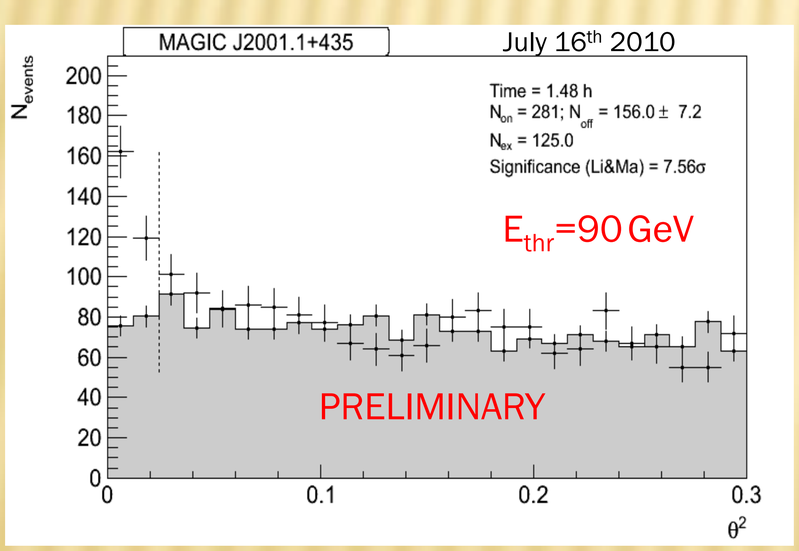

Fig. 2: Squared angular distribution with respect to the position of 1FGL J2001.1+4351 (Observation details in the inlay). The energy threshold of this preliminary analysis is ~90 GeV.

B3-2247+381

A redshift of z = 0.119 [6], an X-ray flux > 2 μJy [7] and the classification as high frequency peaked BL Lac object [8] made B3-2247+381 a promising target for VHE γ-ray observations. The source was also included in the list of potential TeV sources released to the IACT experiments by the FERMI-LAT Collaboration in October 2009 [2]. Observations with the single MAGIC-I telescope for 8.3 h in 2006 did not result in a detection and thus an upper limit of 5.2% of the Crab Nebula flux above 140 GeV was derived [9].

In September 2010 B3-2247+381 showed a significant increase in R-band emission [10], which triggered observations with MAGIC and Swift (Fig. 3). MAGIC observed the source for a total of 18.3 h and detected VHE γ-ray emission at a (preliminary) significance level of 5.6 σ with an estimated flux of 2% of the Crab Nebula flux above 150 GeV [11]. The measured flux is consistent with the upper limit from the 2006 observations. It is thus unclear if the source was in a high state in VHE γ-rays. However the X-ray light curve shows a significant enhancement of the flux during our observations as well as variability (Fig. 3).

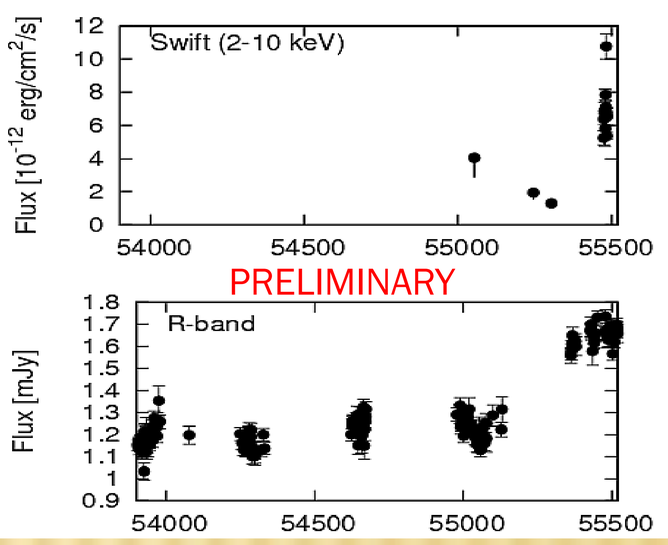

Fig. 3: Long term optical and X-ray light curves from B3-2247+381 obtained with Swift and the KVA telescope versus MJD.

Conclusions

- Both sources were detected during high X-ray states (B3-2247 additionally showed enhanced optical emission).
- Optical/X-ray triggers and pre-selection based on the FERMI γ-ray catalogue are successfully enhancing the detection probability of VHE γ-ray sources.
- The final results (including the spectral energy distributions) will be discussed in forthcoming journal publications.

References

[1] TevCat: http://tevcat.uchicago.edu/
[2] Fortin, P., Sanchez, D., Digel, S., and Paneque, D. (2009) priv. comm.
[3] A. A. Abdo et al. (Fermi Coll.), ApJS 188 (2010) 405
[4] L. Bassani et al., MNRAS 397 (2009) L55
[5] M. Mariotti et al. (MAGIC Coll.), Atel #2753
[6] E. Falco et al., ApJ 494 (1998) 47
[7] E. Nieppola et al., A&A 445 (2006) 441
[8] Donato, D. et al.. A&A 375 (2001) 739
[9] J. Aleksić et al. (MAGIC Coll.), ApJ 729 (2011) 115
[10] http://users.utu.fi/kani/1m/index.html
[11] M. Mariotti et al. (MAGIC Coll.), Atel #2910