

HAWC results on TeV emitting blazars

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Since starting full operations, the HAWC γ -ray observatory has detected and monitored TeV emission of the nearby BL Lac objects Markarian 421 and Markarian 501. The HAWC Collaboration presented a follow-survey of Active Galactic Nuclei selected from the 3FHL Fermi Catalog covering 60% of the sky and up to redshift $z \leq 0.3$. Using over 4.5 years of HAWC data we found low-significance evidence for persistent TeV emission from other sources previously reported as flaring very-high energy sources.

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1. Introduction

A survey of active galactic nuclei (AGN) performed with the High Altitude Water Cherenkov (HAWC) γ -ray observatory was presented in [1]. That study was restricted to AGN within the predefined 40° field of view of HAWC and a redshift $z \leq 0.3$. It confirmed the detections of Markarian 421 and Markarian 501, and gave a maximum-likelihood test-statistic $TS \gtrsim 9$ evidence for TeV γ -rays from M87, TXS 0518+211 and TXS 1215+303. These five objects are part of the 32 GeV γ -ray active galactic nuclei (AGN) with positive TEV flags in the Third Catalog of Hard Fermi sources (3FHL), indicative of previously reported detections by atmospheric Cherenkov telescopes (ACT) prior to the publication of the 3FHL [2]. The positively flagged TeV sources did not account for the detection of 3C 264, reported shortly after the publication of the 3FHL by [3].

Extreme high-frequency peaked BL Lac objects (EHBL), defined in [4] show a synchrotron peak in the X-ray band, $h\nu_{sync} > 1$ keV, and most of them a hard spectral index (≤ 2). Recently, the MAGIC collaboration performed a study of EHBL sources reporting the detection of several AGN flagged as candidates (C) in the 3FHL catalog [5]. In here we revise the HAWC result on known TeV emitting AGN, accounting for the MAGIC results.

2. TeV AGN

This work follows on the survey performed in [1], restricted to HAWC pass-4 data in the declination range $\delta \in [+59^\circ, -21^\circ]$ for blazars within a redshift limit $z \leq 0.3$. Table 1 lists the objects studied by MAGIC [5], together with other known EHBL [6] that are within the HAWC sample. Some objects from [5] are not included as they do not conform the HAWC criteria: for example TXS 0637–128 has no known redshift. And RBS 0921 is not a 3FHL source. One important VHE addition from MAGIC is TXS 0210+515, a non-statistical warm-spot in the HAWC data. H 1426+428 appears to have had activity period in 2012 but was not detected by MAGIC. Other blazars are known to have temporary EHBL behavior, like Mrk 501 and 1ES 2344+514, but were not considered here. The sample in table 1 has a mean significance of $\mu [\sqrt{TS}] = +0.53$, which is only 0.15σ above null-expectation.

3. Summary

None of the EHBL objects studied by MAGIC or from the sample of [6] is detected by HAWC. Furthermore, there is no evidence for emission when taking all the sample together. One aspect to consider is the different energy responses of ACTs and HAWC. We also note that redshift and declination both are important factors for HAWC detectability. Another difference is the duty cycle of EHBL which are known to be flaring sources but may not have long-term persistent emission at a detectable level.

HAWC has revised its low energy response and the data are now been reprocessed (pass A). The study of AGN is one area where an improved sub-TeV sensitivity is due to have a big impact.

3FHL name	Counterpart	z	TeV flag (VHE)	TS
3FHL J0214.5+5145	TXS 0210+515	0.049	C (Y)	+2.63
3FHL J0232.8+2017	1ES 0229+200	0.140	P (Y)	-0.28
3FHL J0349.3-1159	1ES 0347-121	0.185	P	+0.74
3FHL J0416.8+0105	1ES 0414+009	0.287	P	+1.71
3FHL J0809.7+3457	BZB J0809+3455	0.083	C (N)	+0.27
3FHL J0847.2+1134	RBS 0723	0.198	P	+0.09
3FHL J0930.4+4952	1ES 0927+500	0.187	N (N)	-4.58
3FHL J1221.3+3010	PG 1218+304	0.184	P	+5.02
3FHL J1428.5+4240	H 1426+428	0.129	P (N)	+1.58
3FHL J2039.4+5219	1ES 2037+521	0.054	P (Y)	-0.94
3FHL J2042.0+2428	RGB J2042+244	0.104	C (Y?)	+0.58
3FHL J2314.0+1445	RGB J2313+147	0.162	C (N)	+1.37

Table 1: EHBL sources in the HAWC AGN survey. Parenthesis letter on TeV=C or N sources indicates detection or non-detection by MAGIC [5].

References

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