Observations of Active Galactic Nuclei by the Solar Tower Atmospheric Cherenkov Effect Experiment (STACEE)

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Abstract

We present new results from observations of Active Galactic Nuclei (AGN) by the STACEE experiment. STACEE is a detector for 50-500 GeV gamma rays which uses the array of heliostat mirrors at the National Solar Thermal Test Facility (NSTTF) located at Sandia Laboratories, Albuquerque, New Mexico, USA. STACEE uses 64 of these heliostats at night to collect Cherenkov light from air showers due to high energy gamma rays. With a large collecting area, STACEE has good sensitivity below 100 GeV. This allow us to search for gamma rays from extragalactic sources at larger redshift distances (to z of 0.2 or more) than can be studied by more conventional imaging Cherenkov telescopes operating at higher energy thresholds. We summarize recent STACEE observations of W Comae (also known as ON+231), Markarian 421, and H 1426+428. Analysis of observations on these sources in ongoing, and new results will be presented at the conference. We also briefly describe plans for future STACEE observations of AGN in the context of multiwavelength campaigns.

1. Introduction

Extragalactic sources remain one of the most active and exciting areas for ground-based gamma-ray astronomy. At least five AGN have now been reliably detected by ground-based experiments at ∼TeV energies, some with very high signal-to-noise and accurate spectra (see *e.g.* [8].) Most of these sources are highly variable, with major flux changes taking place on timescales of days or

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even hours [6].

During the past few years, gamma-ray observations, together with observations over the entire spectrum, particularly in the x-ray band, have provided an increasingly compelling picture of emission mechanisms in some extragalactic sources. Specifically, multiwavelength campaigns of x-ray selected blazars demonstrate a clear correlation between time-variable emission in the x-ray band and TeV gamma emission. The characteristic spectral energy distribution (SED) for these sources can often be well-explained using a single population of accelerated electrons. In these models such electrons generate both synchroton x-rays and inverse-Compton-scattered gamma-rays (see *e.g.* [3].) This picture has been especially effective at explaining nearby TeV blazars such as Markarian 421 and Markarian 501.

2. The STACEE Instrument

With a low energy threshold, STACEE is particularly well-suited for observations of AGN for two main reasons: First, STACEE can provide spectral data in the energy regime from below about 300 GeV down to 50 GeV that is inaccessible by current Cherenkov telescopes. Measuring spectra in this range is important because at these energies gamma-rays are much less attenuated by intergalactic absorption and also because they appear at a particularly interesting range of the SED – typically near the rounded point of the inverse-Compton peak. Second, with a low threshold, STACEE is able to observe and detect sources that are located at larger redshift distance which would be undetectable by experiments operating at higher energies.

STACEE has been operating in its final configuration (64 heliostats) since early 2002 [5]. A large fraction of the STACEE observing program is dedicated to extragalactic sources. Figure 1 shows the integrated observing time for all sources observed during the last two observing seasons.

3. Results from STACEE observations of selected AGN

3.1. Markarian 421

Markarian 421 has been observed extensively by ground-based gamma-ray detectors. STACEE observed this source during the outburst in 2001 and detected the source with high significance. Results from these observations, including a measured integral flux at a median energy of about 140 GeV have already been reported elsewhere [2]. STACEE observations of Mrk 421 during 2001 are correlated in time with emission seen at x-ray energies [4] and by the Whipple experiment at TeV energies [7]. During 2002-2003, Mrk 421 was observed again by the STACEE. Analysis of these observations will be reported at the conference.

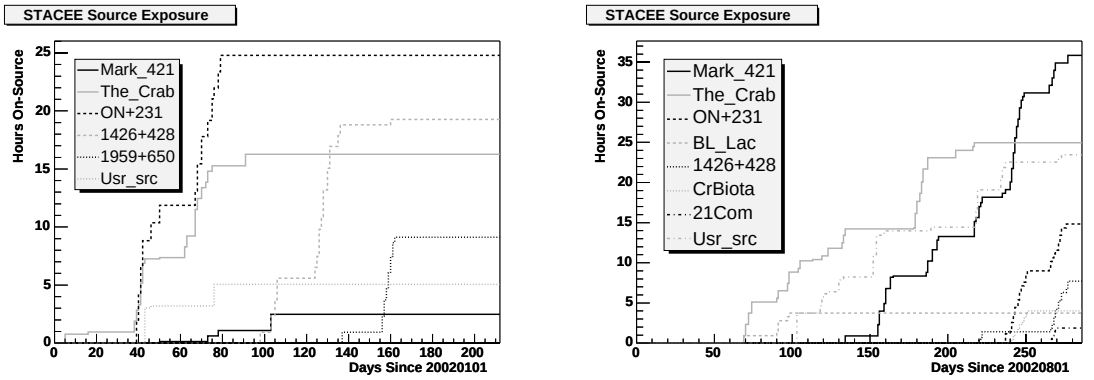

Fig. 1. Integrated source exposure acquired by STACEE on a number of sources during the first half of 2002 (left) and during the 2002-2003 observing season (right). Data are as of May 12, 2003

3.2. W Comae (ON+231)

The extragalactic source W Comae has long been a candidate for TeV observations because of its low redshift (z=0.1) and its strong hard EGRET flux. However, to date this source has not been reliably detected by any ground-based gamma-ray experiment. X-ray data place strong constraints on lepton emission models which should cut off sharply above 100 GeV. However, hadronic jet models predict that the emission should go to higher energies. Thus a detection of this source in the STACEE energy range might prove conclusive for distinguishing between leptonic and hadronic emission processes [1]. STACEE observed W Comae extensively during 2002 and is currently observing the source in 2003. Figure 2 shows a preliminary upper limit from the 2002 observations along with the extrapolated flux from the EGRET data points. Further results from a complete analysis including the 2003 data will be presented at the conference.

3.3. H 1426+428

Another object that has been extensively observed by TeV telescopes is H 1426+428. With a redshift of z=0.129 it is the most distant detected source by ground-based experiments. STACEE observations will provide important results at lower energies where the impact of attenuation on the observed spectra is less severe. STACEE has already begun observing this source during 2003.

4. Future Observations of Extragalactic Sources

To date, STACEE observations of AGN have been directed toward very low-redshift blazars, such as Mrk 421, which have been detected at TeV energies. But more distant sources are also very attractive for STACEE. For example, 3C

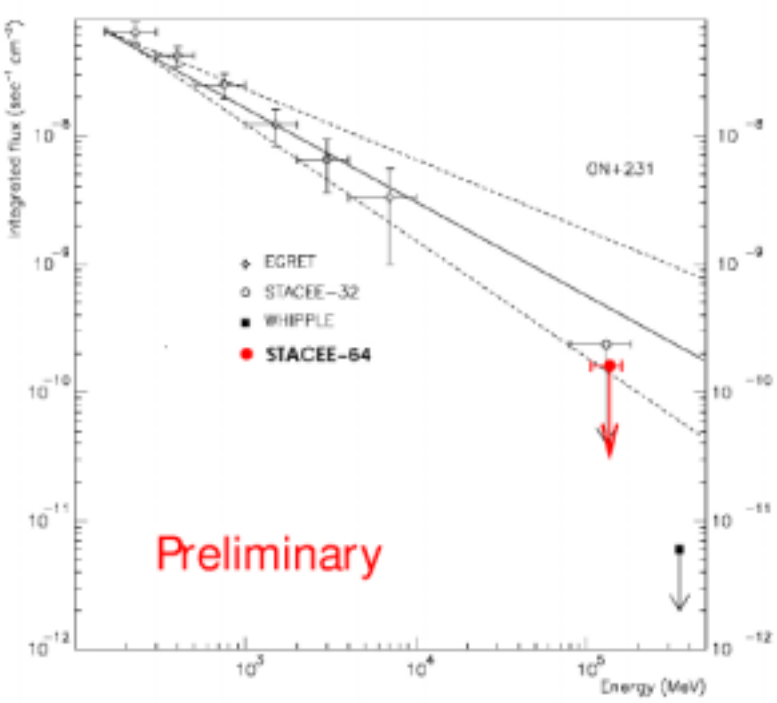

Fig. 2. Preliminary results from STACEE observations of W Comae (ON+231) during 2002. Results from 2003 observations will be presented at the conference.

66A (z=0.44) has x-ray properties that make it an exciting candidate for a new source detection along with the potential that STACEE may observe absorption features. STACEE is planning an extensive observing campaign of 3C 66A for the Fall/Winter of 2003-2004. Simultaneous observations of the source will be conducted in the x-ray band by RXTE.

5. References

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