Spectral Index Mapping of the Blazar Zone of Fermi AGN with TANAMI

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Abstract

The TANAMI (Tracking AGN with Austral Milliarcsecond Interferometry) and associated programs provide the only comprehensive monitoring of Fermi-detected AGN for the southern third of the sky both at radio and higher energy wavebands. Exclusively, TANAMI is providing dual-frequency VLBI images of a large sample of gamma-ray bright AGN to pinpoint blazar-like flat-spectrum emission jet regions with parsec-scale resolution. Here, we present milliarcsecond scale images at 8.4 and 22 GHz along with associated spectral index images of Fermi/TANAMI AGN. We discuss these results in the context of our quasi-simultaneous IR/optical and X-ray observations of TANAMI sources and highlight results on key sources such as the nearby radio galaxy Centaurus A, whose blazar-zone is probed on scales of less than 0.013pc by TANAMI observations.

Background

- TANAMI provides parsec scale resolution monitoring of extragalactic gamma-ray sources south of -30 degrees declination at dual frequency (8.4 and 22 GHz) by making Very Long Baseline Interferometry (VLBI) observations with the Australian Long Baseline Array and associated telescopes (Fig 1) at intervals of about 2 months. See Ojha et al. 2010 A&A 519, A45

- VLBI observations are complemented by arcsecond resolution monitoring across the radio spectrum with the Australia Telescope Compact Array (PI: P. Edwards) and single-dish resolution with the Ceduna telescope of the University of Tasmania (PI: J. Lovell)

-The Ceduna Hobart Interferometer (CHI) provides a 1700km baseline for quick follow up of Fermi detections

- See talk by M. Kadler (Wed 14:15) on gamma-ray properties of TANAMI jets

Spectral Index Images

- Two point spectral indices from VLBI observations at 8.4 and 22GHz (Fig 2)

- Highest angular resolution at two radio frequencies

- Typically first ever 22 GHz VLBI observations

- Substantially improved image fidelity compared to previous southern hemisphere VLBI observations

- Clues to emission processes at parsec scale resolution

- Multiple epochs allow changes (especially those associated with LAT flaring) to be followed

- VLBI core, identified by its spectrum, is upper limit to size of blazar region (unless other optically thick region exists)

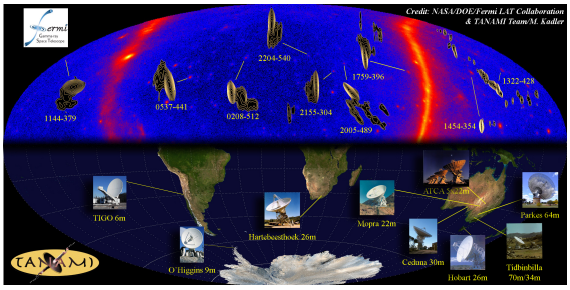

Fig 1: This collage shows the Southern Fermi/LAT sky in the top half with TANAMI images scaled up by a factor of ~1000. The bottom half shows the locations of the telescopes currently making up the TANAMI array.

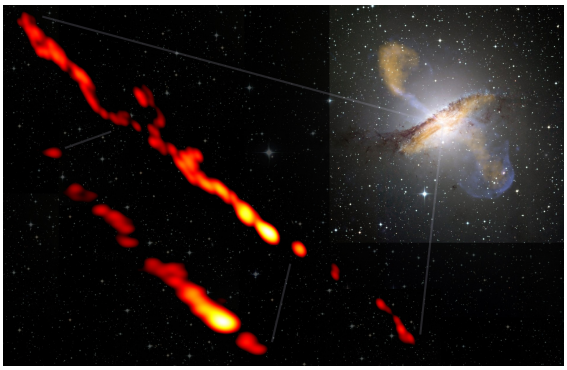

Fig 4: Highest resolution images of a radio jet (8 GHz, center) and simultaneous 22 GHz image (left). Credit for image on the right: ESO/WFI (optical); MPIfR/ESO/APEX/A. Weiss et al. (submillimeter); NASA/CXC/CfA/R. Kraft et al. (X-ray).

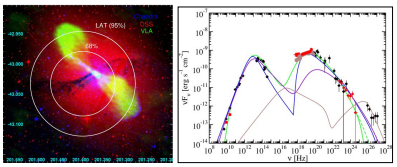

Fig 3: Nearest radio galaxy Cen A seen in four wavebands (left) and its broadband SED (right).

Broadband SED of Cen A

- Closest radio galaxy: 3.8 ± 0.1 Mpc away. (Harris et al. 2010 PASA 27, 457). Very well studied at all wavebands.

- Fig 3 (left) is a superposition of images from Gamma-ray (Fermi/LAT), X-ray(Chandra), Optical (DSS) and Radio(VLA) Bands

- Fig 3 (r) shows a broadband SED by Fermi/LAT Collaboration: Abdo et al. 2010, ApJ 719, 1433

- Constraints on emission mechanisms

Dual Frequency Imaging of Cen A

- Proximity means angular distance of 1 milliarcsecond corresponds to a linear size of just ~0.018 pc.

- Linear resolution of ~ 0.01pc achieved here (Fig 4)

- Simultaneous images at 8.4 and 22 GHz

- Sub-parsec scale resolved spectral index mapping

- Suggests multiple candidates for "blazar region". See Müller et al. 2011 arXiv 1104.0804, A&A, in press

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Fig 2: Parsec scale spectral Index maps of TANAMI sources. In each row, the left and right columns show the contemporaneous 8.4 and 22 GHz images respectively. The corresponding spectral index map is in the center column. The shaded ellipse on the bottom left of each image is the beam of the TANAMI array for that particular observation. **No core shift has been applied** with the exception of Cen A (1322-428; Müller et al. 2011) .