ATCA monitoring of gamma-ray loud AGN

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Introduction

As a critical part of the TANAMI program (Ojha et al. 2010), in November 2007 the Australia Telescope Compact Array (ATCA) started monitoring the radio spectra of a sample of southern hemisphere AGN that were selected as likely candidates for detection (as well as a control sample) by the LAT instrument aboard the Fermi Gamma Ray Space Observatory. The initial sample was chosen based on properties determined from AGN detections by the EGRET experiment. Most of the initial sample have indeed been detected by Fermi/LAT and with the addition of new detections the sample has grown to include 102 AGN. For the majority of these AGN, our monitoring program provides the only dynamic radio spectra available. The ATCA receiver suite makes it possible to observe several sources at frequencies between 4.5 and 41 GHz in a few hours, resulting in an excellent measure of spectral index at each epoch. By examining how the spectral index changes over time, we aim to investigate the mechanics of radio and γ-ray emission from AGN jets.

Blazar Variability

- Sources that showed spectral index variability between 2007 and now are shown in Figure 1. We used the method described in Angelakis et al. (2010) to select these sources.
- Blazar classification is from the Roma-BZCAT (Massaro et al. 2009). We label sources that are not in this catalogue as “unclassified”; 91% of our sources are blazars, while most others are Flat Spectrum Radio Sources (FSRS, Healey et al. 2007).
- To date, 59% of the Flat Spectrum Radio Quasars (FSRQs) and 64% of the BL Lacs show spectral index variation, while 52% of the unclassified sources show spectral index variation.
- For blazars that could not be neatly classified as a FSRQ or BL Lac in the Roma-BZCAT, we find that 99% displayed spectral index variation.

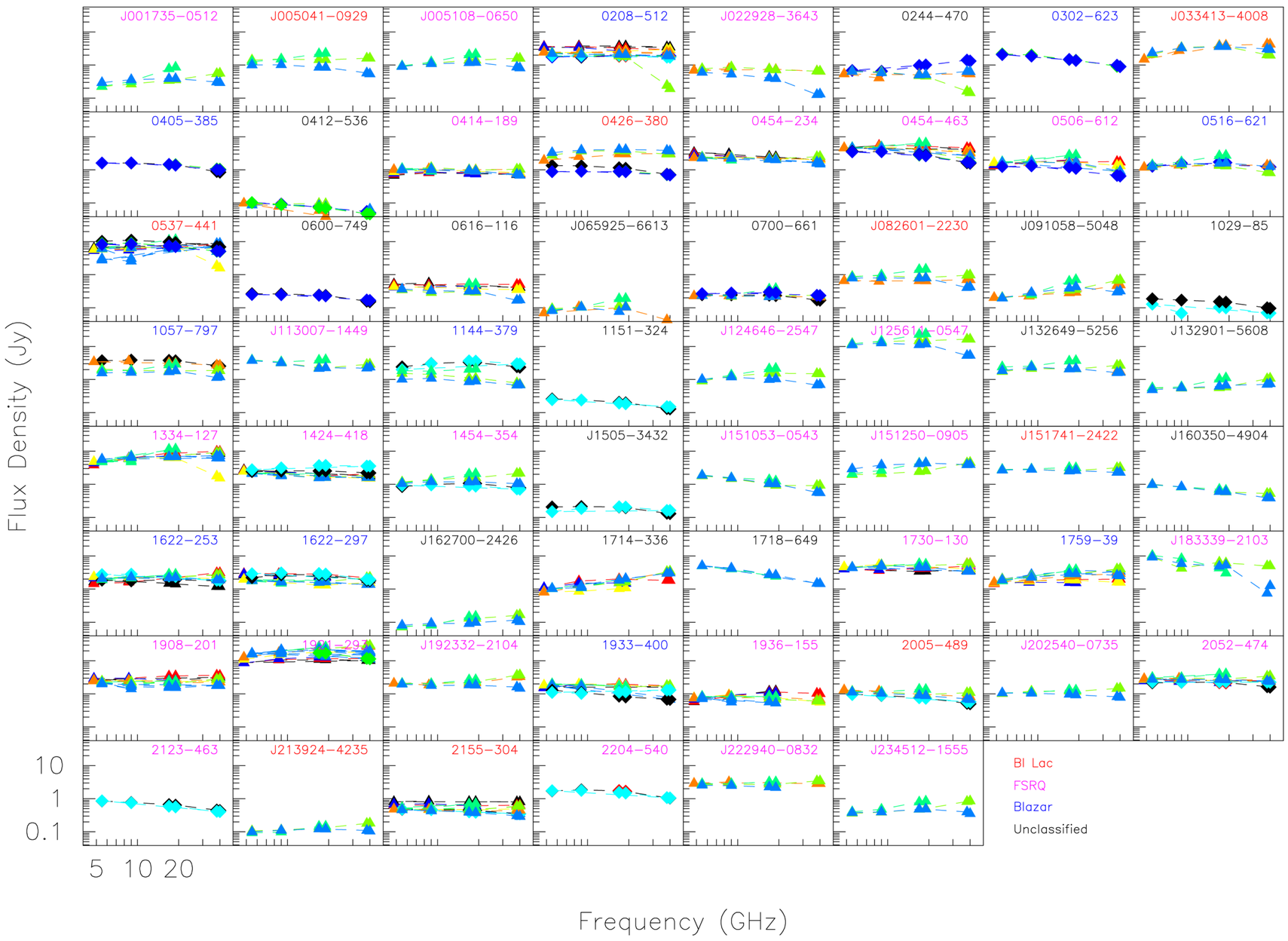

Figure 1: Measurements of all sources that have displayed spectral index changes during the ATCA monitoring campaign. Each epoch is shown as a different colour/symbol combination. The name of each source is coloured depending on its classification in Roma-BZCAT (Massaro et al. 2009), and the colour legend is shown at the bottom right of the plot. The frequency and flux density scales are the same for each plot, and are defined on the lower-left.

Ongoing Work

- Using the high-frequency (ν > 15 GHz) data, it may be possible to probe deep into the radio jet to where the γ-ray emission is likely generated (Lahteenmaki & Valtaoja 2003). Results from the EGRET era suggest that high-frequency radio flares precede γ-ray flares (Valtaoja & Terasranta 1995). Comparison of this dataset and Fermi-LAT light curves will help resolve questions about γ-ray emission regions.
- The ATCA receivers are capable of measuring polarisation accurately at all the frequencies observed by this project. It will therefore be possible to examine the polarisation position angle variability for these blazars and determine if the magnetic field direction is changing when the spectral index varies.
- The ATCA is able to rapidly observe AGN that are seen to flare in γ-rays; eg. the recent example of 0454-234 (ATel #3713). In this way, we have a higher probability of observing “interesting” AGN, and thus examining their temporal behaviour during flare events.
- The ATCA monitoring data provides information crucial in constructing the SEDs of AGN both in their flaring and their quiescent states. Quasi-simultaneous broadband SEDs are necessary to distinguish between competing models for the high energy emission from AGN (e.g. Boettcher 2007, Abdo et al. 2011). The ATCA data are also being used to look for changes in spectral index associated with the ejection of VLBI components from the AGN cores.

Summary

The ATCA has monitored a set of 102 AGN over multiple epochs for four years, and will continue to monitor even more in the future. Through a combination of regular monitoring and target-of-opportunity observations of flaring AGN, we will investigate the mechanisms responsible for both radio and γ-ray emission in their jets. More information can be found on the project website:

www.narrabri.atnf.csiro.au/people/Philip.Edwards/c1730.html

References

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