



Email: shaoxi@shao.ac.cn

# The spectral behaviours and variability of narrow-line Seyfert 1 galaxies with Australia Telescope Compact Array (ATCA) observations



Xi Shao , Phil Edwards, Jamie Steven

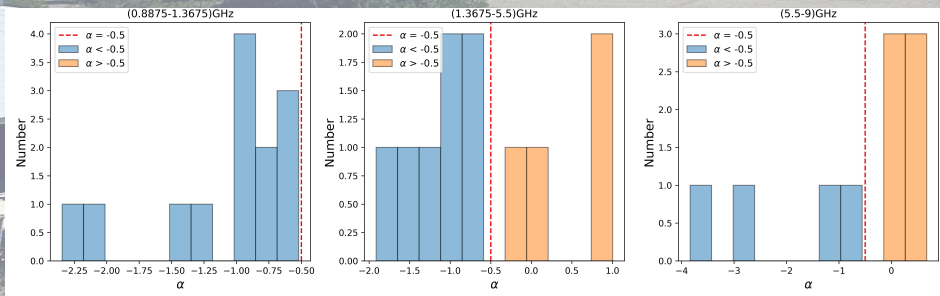
## Background

Narrow-line Seyfert 1 galaxies (NLS1s) are a subclass of active galactic nuclei (AGNs) firstly studied by Osterbrock & Pogge (1985) and defined by their slight broader line from the broad line region ( $FWHM(H\beta) < 2000 \text{ km s}^{-1}$ ) and weaker [O III] emission line ( $[OIII]/H\beta < 3$ ), relatively strong Fe II emission. They usually have low black hole masses, behave prominent soft X-ray excess, some are hosted in spiral galaxies. There are around 20 NLS1s detected in  $\gamma$ -ray band called  $\gamma$ -ray NLS1s, nine of them are listed in Fourth Fermi-LAT source catalog (4FGL). Majority of them show the core-jet morphology on parsec/kiloparsec scale in radio observations.

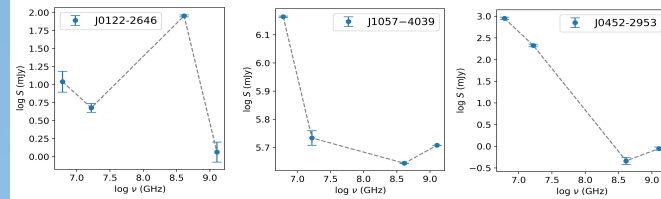
## Spectral index of general NLS1s

1) We have observed 21 sources with ATCA at 5.5 and 9 GHz, and collect their RACS (low 887.5 MHz and mid 1.3675 GHz) data.

2) Assume the flux density and spectral index convention of  $S \propto \nu^\alpha$ , so spectral index  $\alpha = \frac{\log(S_2/S_1)}{\log(\nu_2/\nu_1)}$ .  $\alpha < -0.5$ : steep spectrum,  $\alpha > -0.5$ : flat spectrum



Three types of spectrums of sources detecte at four bands:



a. steep-flat-steep b. steep-flat-flat c. steep-steep-flat

## Long-term radio and $\gamma$ -ray light curves of three $\gamma$ -ray NLS1s

☉ **PMN J0948+0022 (0946+006)**: there are two flares at the beginning and one flare at the end of ATCA light curves, Meanwhile, there is a small clump of small flares at the beginning of the  $\gamma$ -ray light curve, but it shows sparse data at the end.

☉ **PKS1502+036**: the radio flare peaked at aroud MJD=60000, but  $\gamma$ -ray variation hasn't formed a complete flare; the flux density still increases.

☉ **PKS 2004-447**: the radio light curves contain several small flares but don't show a similarly obvious flare like that in the  $\gamma$ -ray light curve.

