

Frequency- and timescale-dependent variability of ALMA blazar calibrators for the AMT

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HEASA Conference

2 October 2026

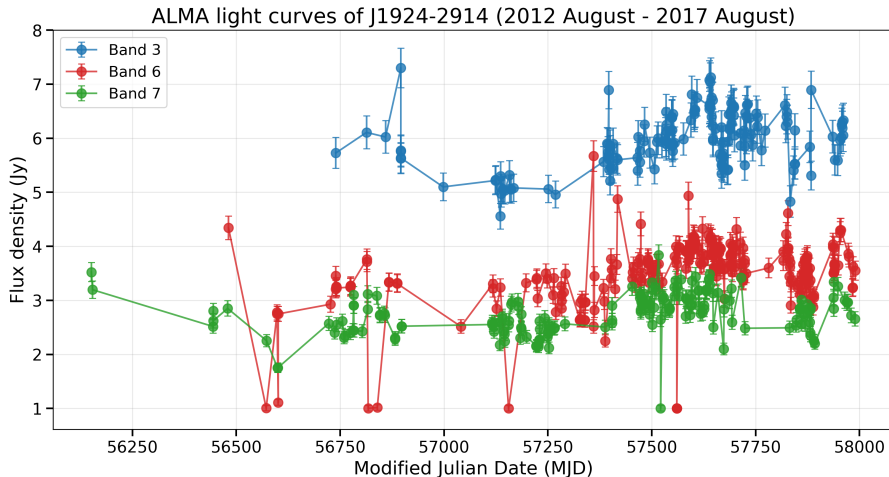


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- Initial efforts towards a homogeneous ALMA blazar calibrator variability catalogue for science with the Africa Millimetre Telescope
- The focus is on ALMA bands 3, 6 and 7 → AMT bands

ALMA Band	Frequency Range (GHz)	Wavelength Range (mm)
3	84–116	2.58–3.57
4	125–163	1.84–2.40
5	158–211	1.42–1.90
6	211–275	1.09–1.42
7	275–373	0.80–1.09
8	385–500	0.60–0.78
9	602–720	0.42–0.50
10	787–950	0.32–0.38

- Construct multi-epoch ALMA light curves of blazar calibrators
- Quantify variability using several complementary indices
- Identify statistically significant variable sources
- Determine how variability amplitude depends on observing frequency
- Determine how variability changes with sampled timescale
- Produce a homogeneous reference catalogue, with particular emphasis on **Bands 3, 6 and 7** for **AMT science preparation**
- **Workflow:** ALMA archive → light curves → variability indices → frequency/timescale analysis → AMT CAL



Sadler et al. 2006

$$\bar{S} = \frac{1}{N} \sum_{i=1}^N S_i, \quad s^2 = \frac{1}{N-1} \sum_{i=1}^N (S_i - \bar{S})^2, \quad \overline{\sigma^2} = \frac{1}{N} \sum_{i=1}^N \sigma_i^2$$

Modulation index

$$m = \frac{s}{\bar{S}}$$

Fractional variability amplitude

$$F_{\text{var}} = \frac{\sqrt{s^2 - \overline{\sigma^2}}}{\bar{S}}$$

S_i : flux density; σ_i : measurement uncertainty; N : number of measurements.

Error-adjusted variability index

$$VI = \frac{(S_{\max} - \sigma_{\max}) - (S_{\min} + \sigma_{\min})}{(S_{\max} - \sigma_{\max}) + (S_{\min} + \sigma_{\min})}$$

Constant-flux test

$$\bar{S}_w = \frac{\sum_{i=1}^N S_i / \sigma_i^2}{\sum_{i=1}^N 1 / \sigma_i^2}, \quad \chi^2 = \sum_{i=1}^N \frac{(S_i - \bar{S}_w)^2}{\sigma_i^2}$$

Upper-tail probability

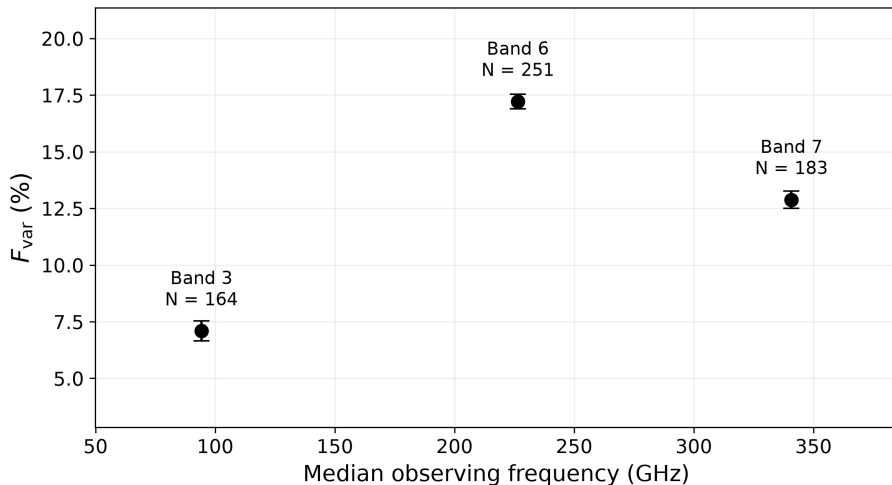
$$p = P(\chi_{N-1}^2 \geq \chi_{\text{obs}}^2)$$

Observed peak-to-trough range

$$V_{\text{range}} = S_{\max} - S_{\min}$$

Source	Band	N	Baseline (yr)	$\bar{S}$ (Jy)	m	F_{var}	VI	χ^2	p	V_{range}
J1924–2914	3	165	3.35	5.9749	0.0869	0.0709	0.1826	509.147	2.91e-37	2.7437
J1924–2914	6	251	4.13	3.5035	0.1795	0.1722	0.6738	15093.6	0	4.6710
J1924–2914	7	183	5.03	2.7593	0.1384	0.1288	0.5516	2406.85	0	2.8318

J1924-2914: fractional variability versus frequency



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LFRC	OC	IRC	XC	γ C	z	class
PKS 1921-293	Gaia 6758696945147732352	WISEA J192451.05-291430.1	SWIFT J1924.9-2918	4FGL J1924.8-2914	0.353	FSRQ
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Summary

- The AMT will provide a new opportunity to extend long-term millimetre variability studies of relativistic jets from Namibia
- ALMA CAL provides the historical baselines
- AMT CAL has well-characterised ALMA blazars for future AMT monitoring and provides a statistical reference against which such observations can be interpreted

Next steps

- Inter-band correlation analysis of the variability diagnostics
- Expand AMT CAL to include sources from outside of ALMA CAL
- Morphology and kinematic investigations of gas surrounding calibrators - Bollo et al. 2024

Thanks for listening!

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