Jet collimation study of the twin-jet in NGC1052

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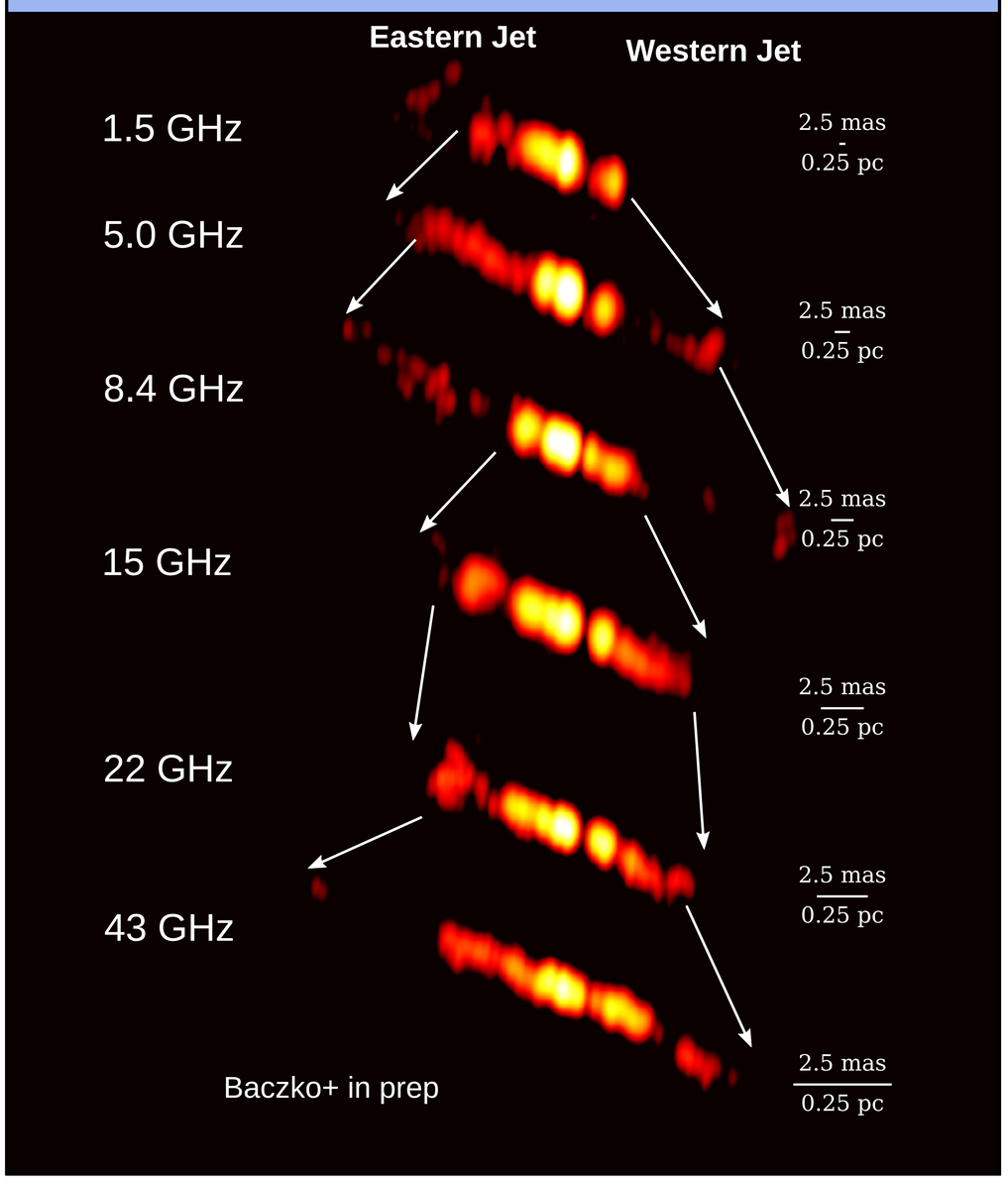
The nearby LINER galaxy NGC1052 shows a twin-jet system oriented in the plane of the sky. At cm-wavelength an emission gap between the two jet bases is visible, which is due to free-free absorption in a circumnuclear torus with a column density of 10^{22} - 10^{24}cm^{-2}. We present multi-frequency observations with the VLBA and Global VLBI at frequencies from 1.5 GHz up to 43GHz.

Distance: 20Mpc
BH mass: $10^{8.2}$ $M_\odot$
Scale: 1mas~0.1pc~6700 R_S
Inclination angle: nearly 90°
15GHz: β=0.26c (MOJAVE)
43GHz: β=0.5c (Baczko+ 19)
Polarisation:
- Low linear
- Circular (MOJAVE, ALMA)

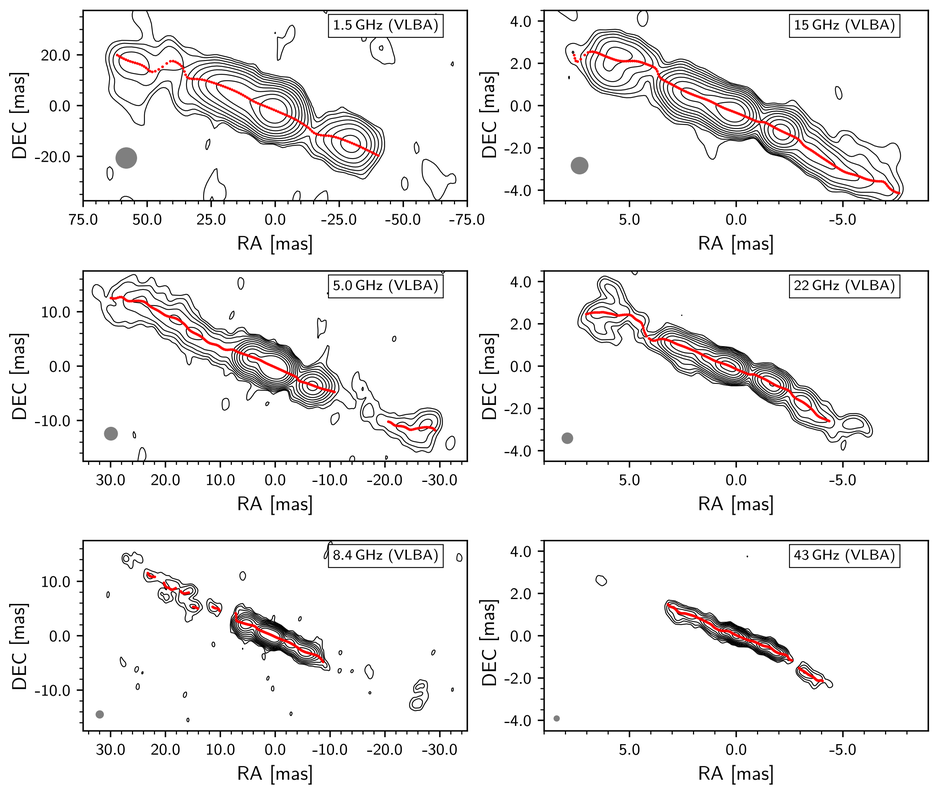
Observations

Date	Instrument	Obs. code	Frequency [GHz]
1995-2012	VLBA	MOJAVE	15
2005-2009	VLBA	BR099-130	22/43
2016/11	Global	GB079	22
2017/04	VLBA	BB377	1.5/5/8.4/15/22/43

VLBA: April 4, 2017 Frequency: 1.5 - 43GHz
- Aligned by a 2D - crosscorrelation
- Optically thick area masked during correlation

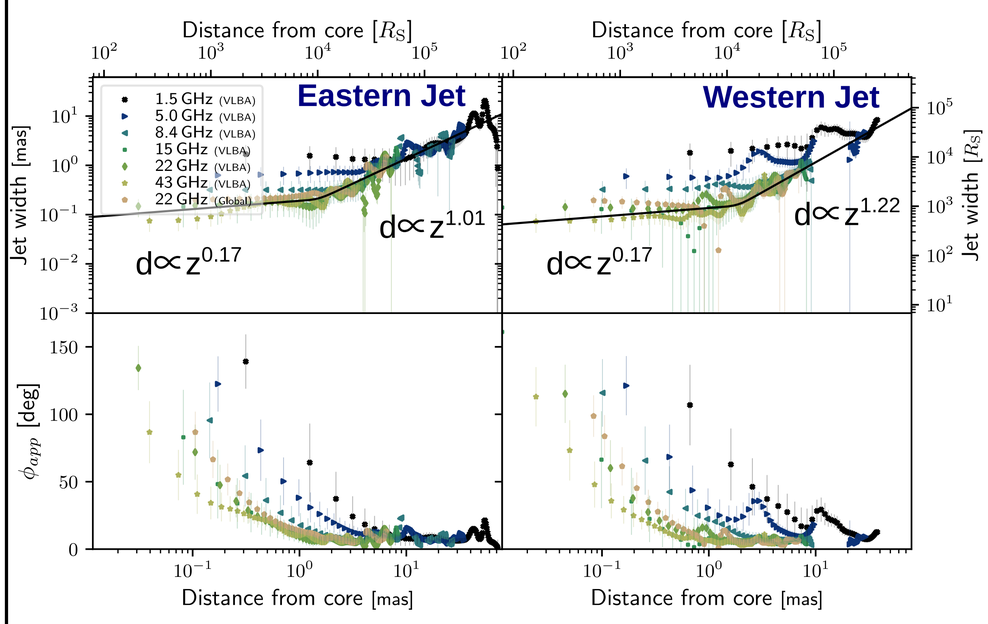


Ridge-line analysis



Exceptionally straight ridge-line at all frequencies with a slight bend in the western jet.

Broken power-law fit to deconvolved jet width
Multi-frequency single-epoch observations



VLBA: 2017 (BB377)
Frequency: 1.5GHz - 43GHz
Global: 2016 (GB079)
Frequency: 22GHz

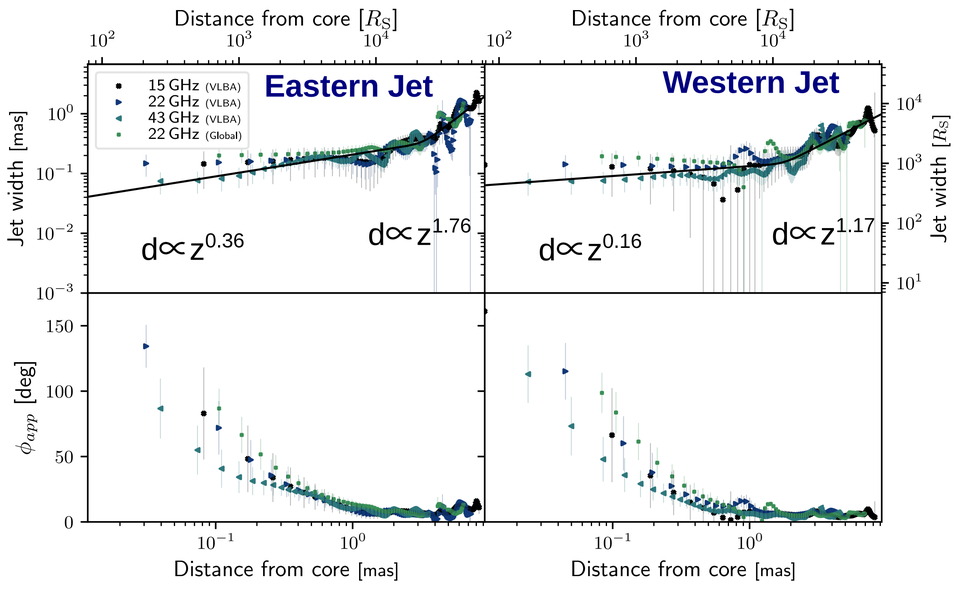
Jet width obtained from ridge-line fitting

Results:

- Break at z~2mas
- Upstream: nearly cylindrical
- Downstream: conical

<15GHz Western jet:
Deviations from power-law fit might be explained by scattering on the obscuring material (e.g. torus, ISM)

Power-law fit to ν ≥ 15 GHz



VLBA: 2017 (BB377)
Frequency: 15GHz - 43GHz
Global: 2016 (GB079)
Frequency: 22GHz

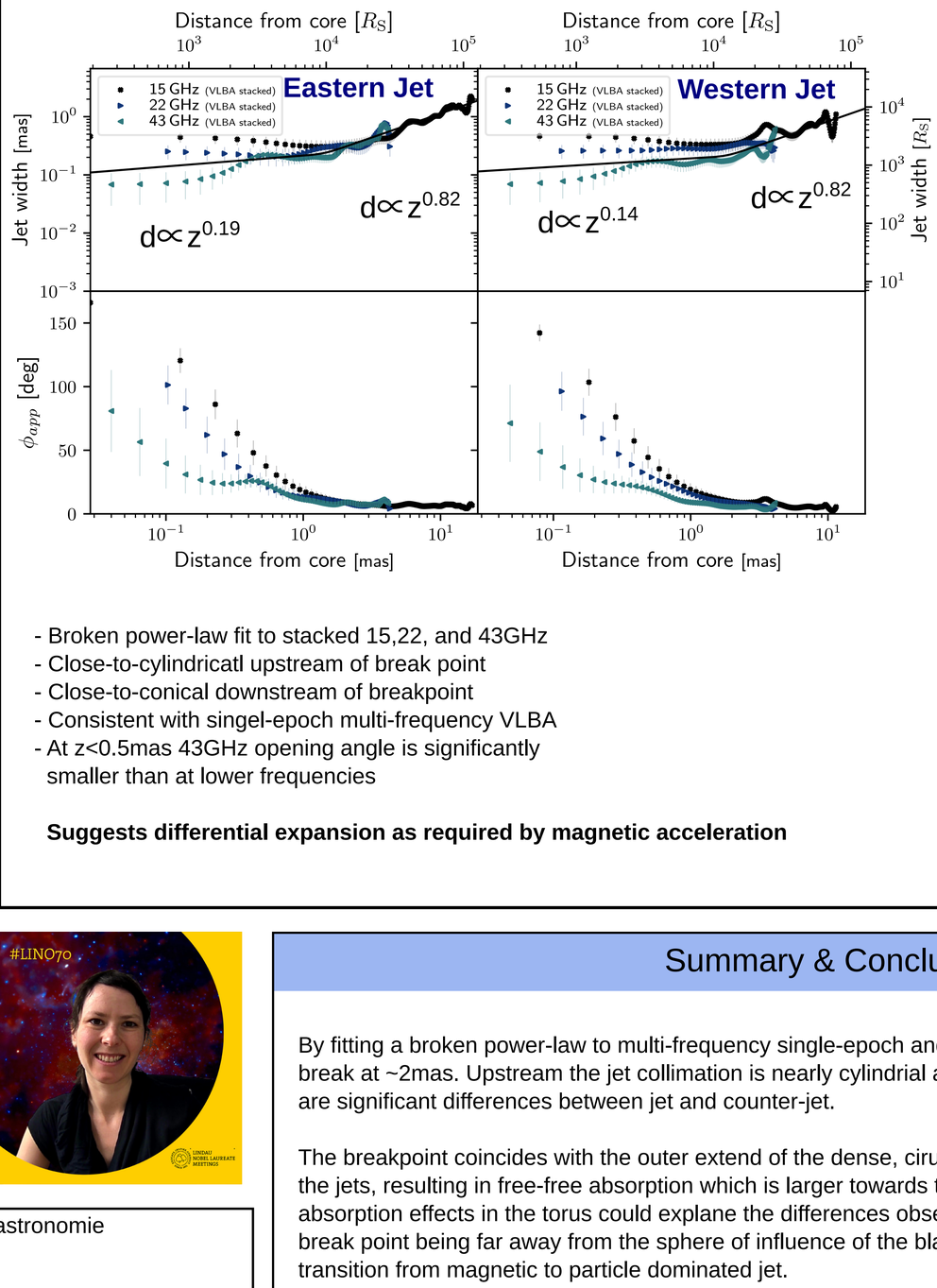
Broken power-law fit to higher frequency widths only

Results:

- Break at z~2mas
- Upstream: nearly cylindrical at least for western jet
- Downstream: conical

Significant difference of upstream power-law between eastern and western jet

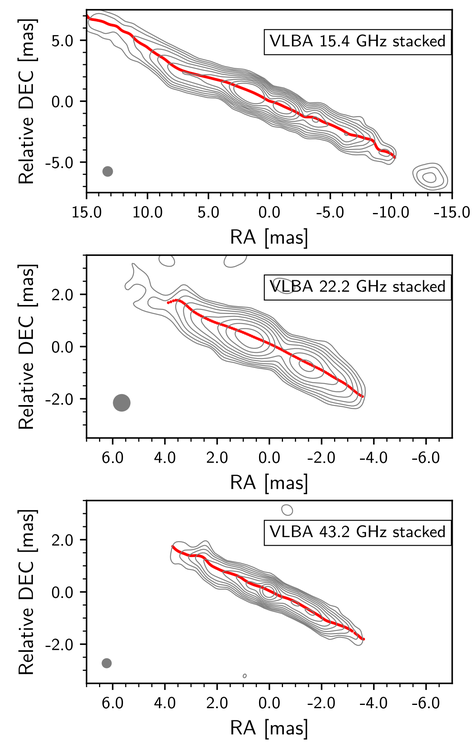
Broken power-law fit to deconvolved jet width
Stacked multi-frequency VLBA



- Broken power-law fit to stacked 15,22, and 43GHz
- Close-to-cylindricatl upstream of break point
- Close-to-conical downstream of breakpoint
- Consistent with singel-epoch multi-frequency VLBA
- At z<0.5mas 43GHz opening angle is significantly smaller than at lower frequencies

Suggests differential expansion as required by magnetic acceleration

VLBA: 1995-2012 (MOJAVE)
Frequency: 15GHz
VLBA: 2005-2009 (BR099-130)
Frequency: 22GHz & 43GHz



Summary & Conclusions

By fitting a broken power-law to multi-frequency single-epoch and stacked images of NGC1052 we found a break at ~2mas. Upstream the jet collimation is nearly cylindrial and downstream nearly conical. However, there are significant differences between jet and counter-jet.

The breakpoint coincides with the outer extend of the dense, cirumnuclear torus surrounding the inner part of the jets, resulting in free-free absorption which is larger towards the western jet. Hence, scattering and absorption effects in the torus could explane the differences observed between both jets. Furthermore, the break point being far away from the sphere of influence of the black hole at ~10^5 R_S most likely marks the transition from magnetic to particle dominated jet.

The upstream width measurements at 43GHz suggest a steepening of the profile at z < 0.5mas. Only by going towards higher frequencies we can finally investigate the collimation profile near the jet base. Ongoing 86GHz GMVA 3-epoch monitoring will give more insight into the morphology of NGC1052 in the collimation and acceleration zone.

References

Baczko et al. 2021 in prep
Baczko et al. 2019, A&A 623,A27
Lister et al. 2013, AJ 146,120
Kadler et al. 2004, A&A 426,481
Kadler et al. 2004, A&A 420,467
Kameno et al. 2001, PASJ 53, 169
Vermeulen et al. 2003, A&A 401, 113

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