Radio polarimetry of AGN at high resolution

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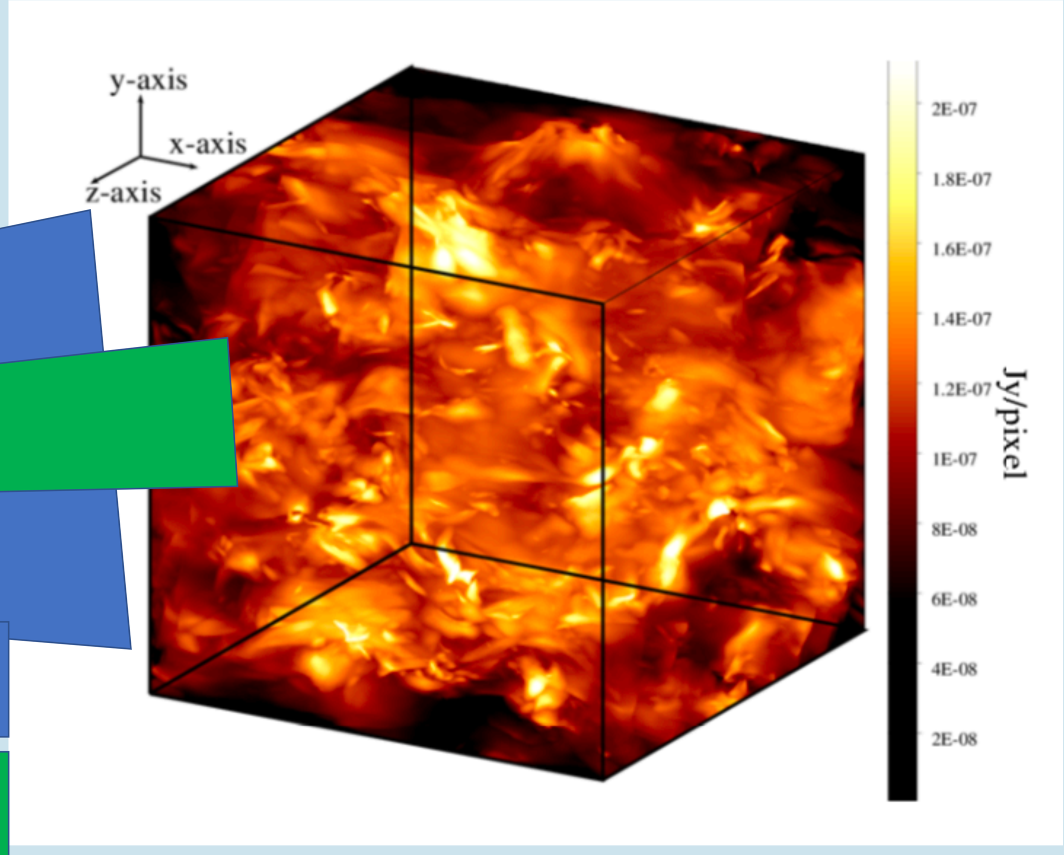
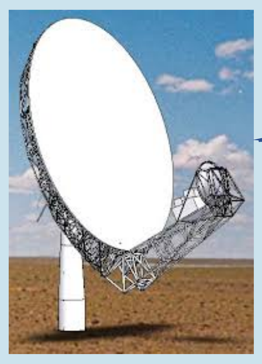
Radio polarimetry is an important tool that can be used to study the magneto-ionic medium surrounding radio-emitting plasma. High angular resolution is essential for overcoming the effects of beam depolarization, whereby polarization vectors of different angle and amplitude are averaged together within a beam. With the VLA, science on arcsecond scales is achievable, but ngVLA will be needed to probe subarcsecond scales (corresponding to tens to hundreds of pc at z~0.1 to >1) over a wide enough range of frequencies to disentangle Faraday-complex scenarios (beyond a simple foreground screen of plasma) that will occur in jet-cloud interactions.

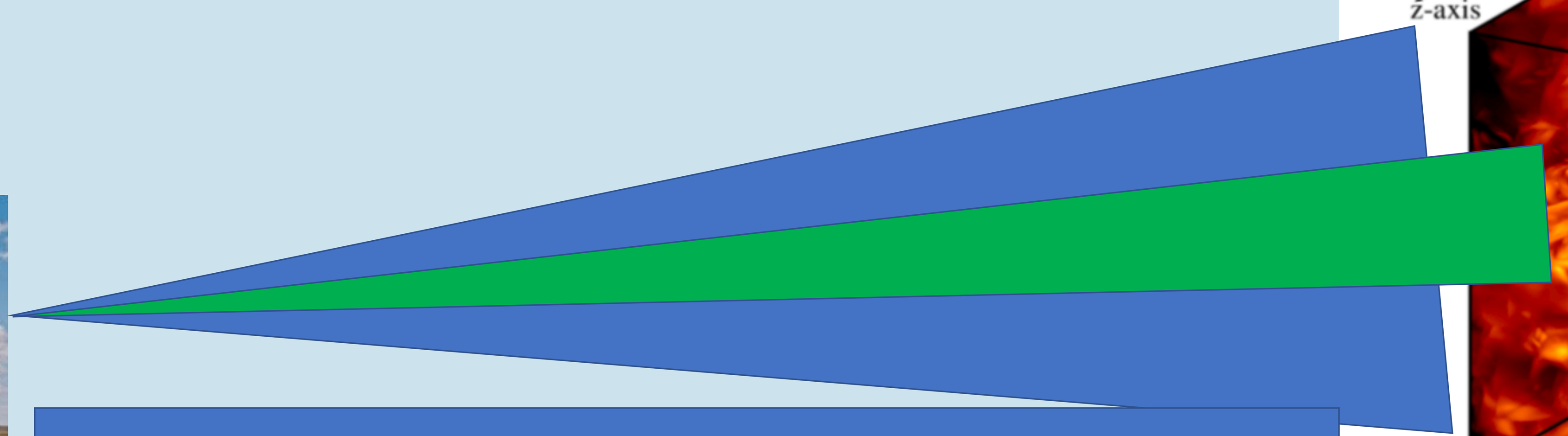
At very high (mlliarcsecond) resolutions, VLBI can study the polarization properties of the bright inner regions of jets, and test scenarios for jet formation that invoke a hot thermal wind to confine the jet in its early stages, and also constrain inflow into the black hole (e.g. for M87; Park+19). Combining the VLBA with ngVLA will allow these studies to be expanded beyond the most nearby black holes.

ISM simulation from Basu+19



500 pc (~0.5” at z=0.1)

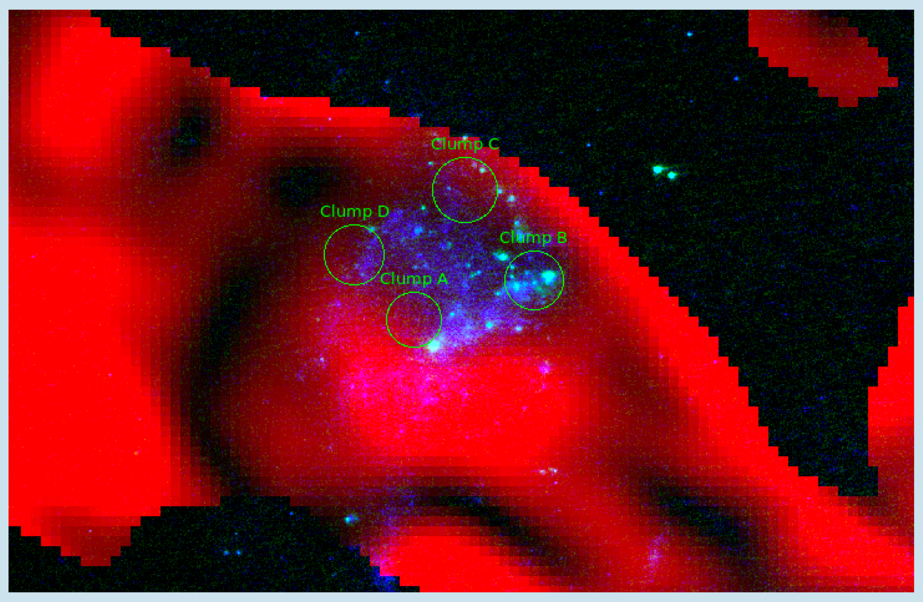




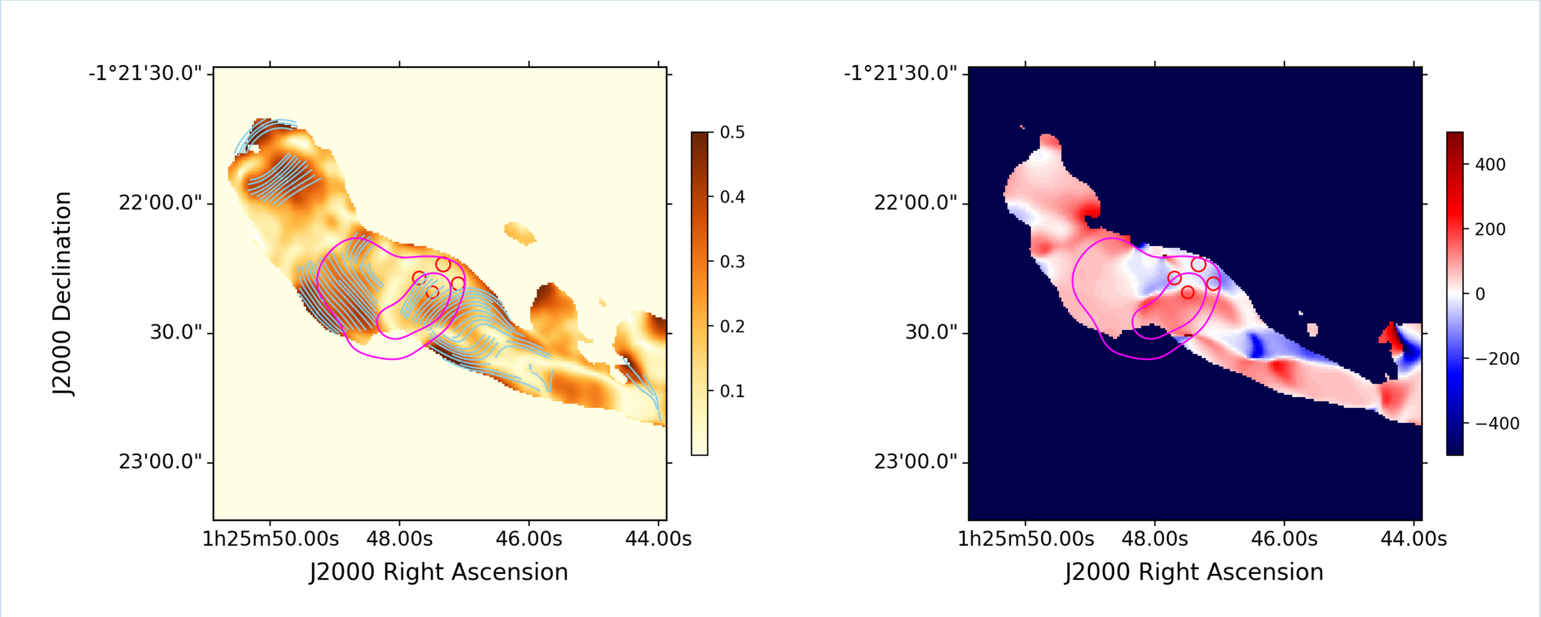
Current VLA: ~0.5” (low end of C-band in A-config)

ngVLA can achieve similar surface brightness sensitivity at ~0.2” resolution

Example science: Minkowski’s Object, a jet-galaxy interaction at z=0.0189. The radio jet is impacting a dwarf galaxy and inducing star formation (Croft+06; Lacy+17; Fragile+17). With ngVLA, this interaction could be studied at scales smaller than the CO clumps (~1”; 500 pc)

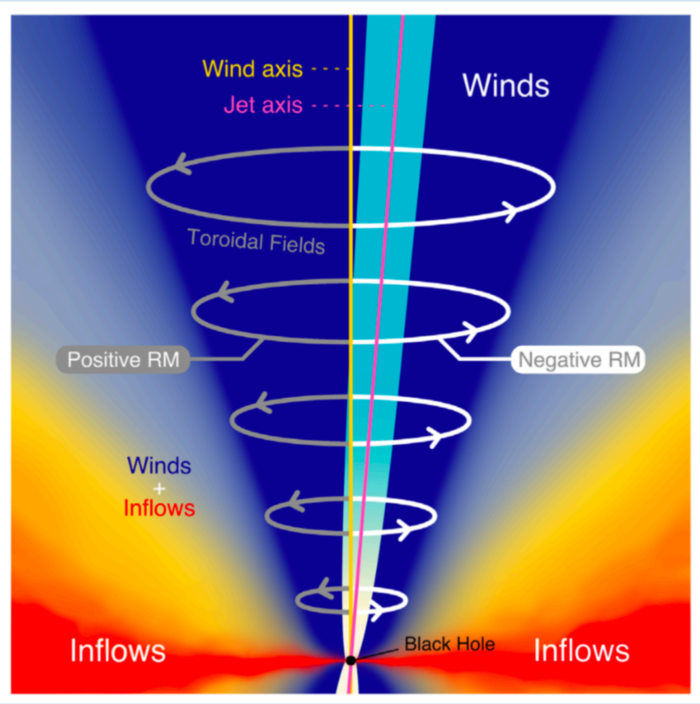


Fractional polarization in the jet is low where it interacts with the galaxy (HST image shown; green circles indicate the positions of CO clumps; Lacy+17)

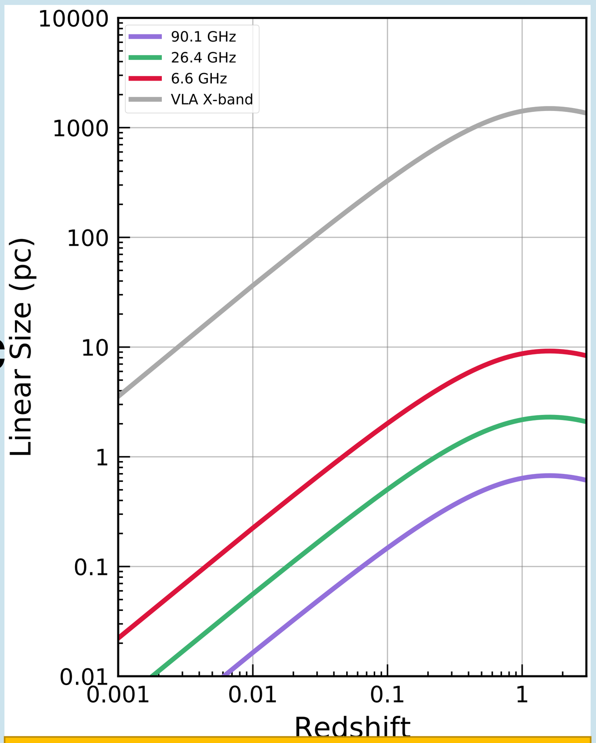


Left: fractional polarization and B-field lines (cyan). The HI cloud associated with Minkowski’s Object is shown in magenta contours, and the positions of the CO clumps as red circles. Right: rotation measure from RM synthesis.

The inner jet of M87



~1 pc



Resolution of integrated ngVLA/LBA (max baseline 8860 km)

Models suggest that Faraday rotation can arise from thermal winds, inflowing material, or thermal matter mixed with the jet plasma. Park+19 show that, at least in M87, mixing is negligible and the Faraday rotation most likely arises from a mis-aligned wind (which is also helping to collimate the jet).

References:
Croft, S. et al. 2006, ApJ, 647, 1040
Lacy, M. et al. 2017, ApJ, 838, 146
Fragile, C.P. et al. 2017, ApJ, 850, 171
Park, J. et al. 2019 ApJ, 871, 257

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