Studying magnetic fields in several parsec-scale AGN jets using Faraday Rotation

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  - 0738+313
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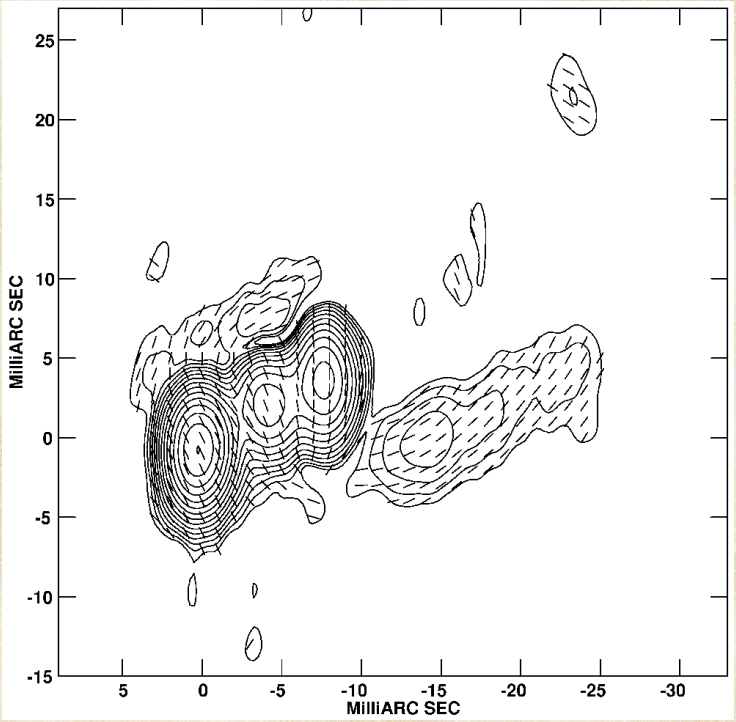
The project

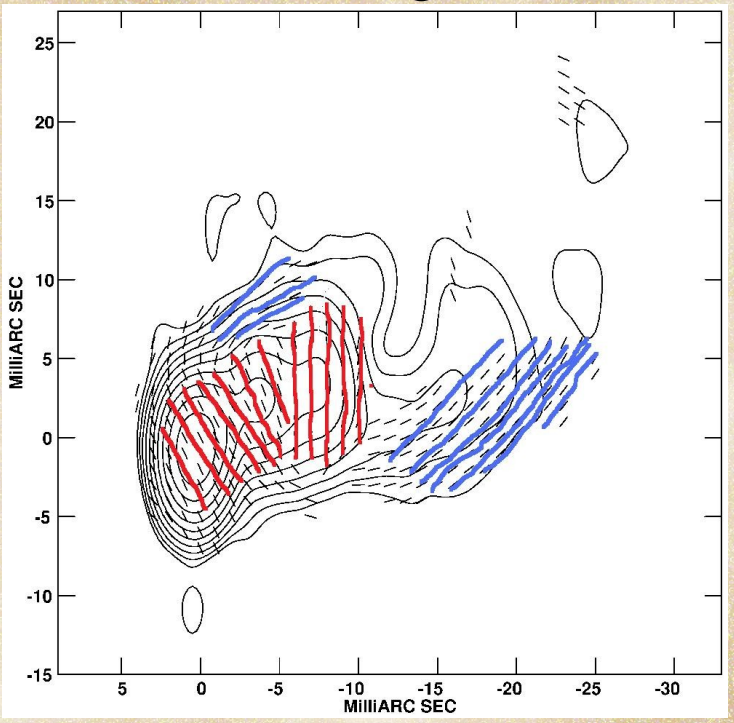
- 24 AGN selected from the MOJAVE sample (spine- sheath- polarization structure) divided into 2 experiments (A and B)
- Frequencies:15.34, 12.92, 8.86, 7.9, 5.0, 4.6 GHz
- Antennas: VLBA (without SC)
- Observed 27th & 28th of September 2007

Spine-sheath-polarization structure

Quasar 1055+018, 5 GHz, VLBA+Y1, Attridge et al. 1999



Linear polarization distribution, contours of p, ticks show the orientation of the magnetic field



Total intensity contours + ticks showing the orientation of the magnetic field

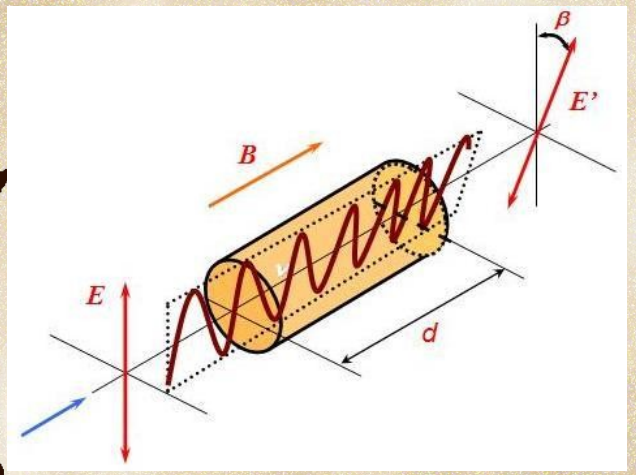
Faraday Rotation

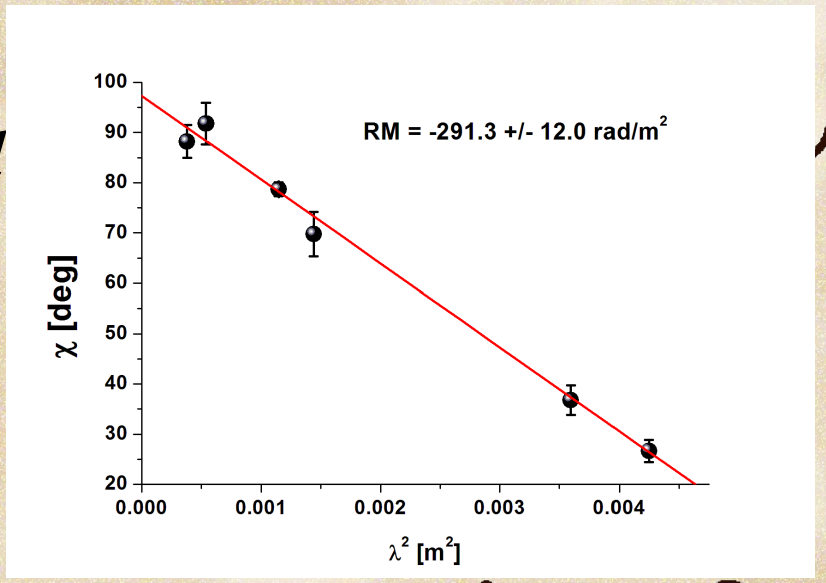
When the linearly polarized EM wave travels through magnetized plasma, the plane of the linear polarization rotates (because of different speeds of RCP and LCP components traveling through plasma).

The amount of rotation is prop. to λ^2 and the sign of rotation is determined by the direction of the LoS B field.

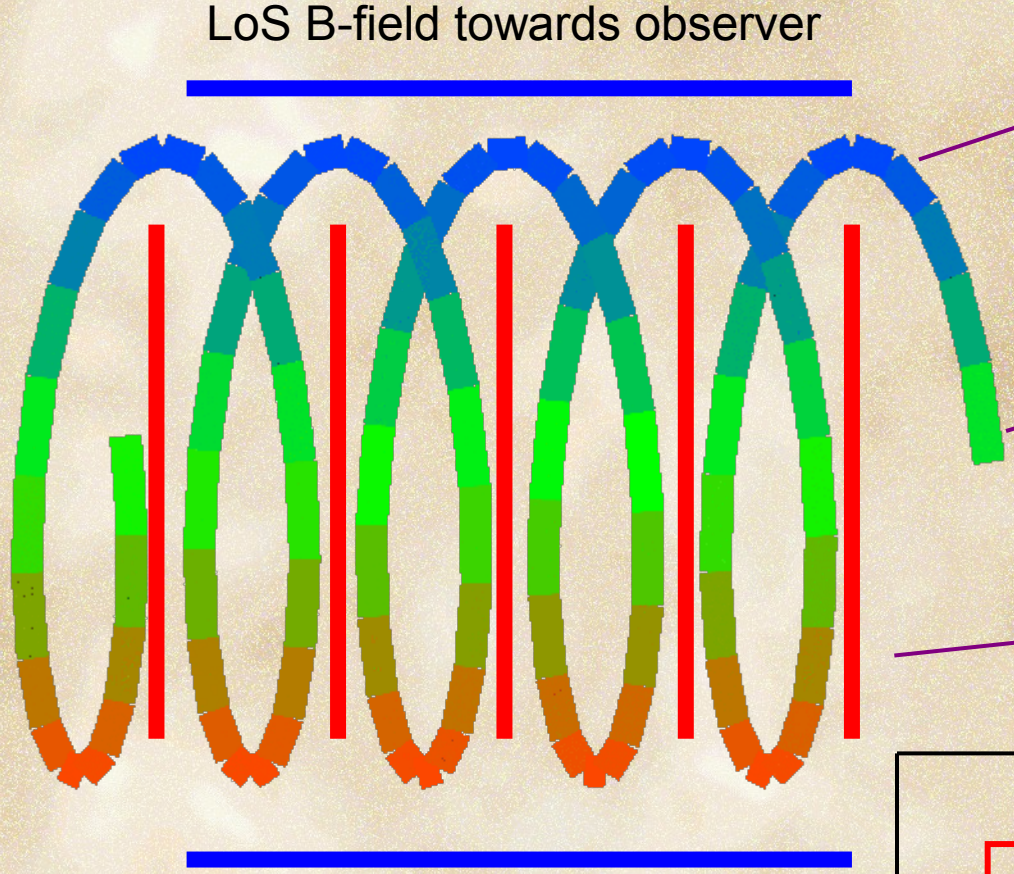
$$\chi = \chi_0 + RM \times \lambda^2$$

$$RM \propto \int n_e B_{||} dl$$





Helical B-field



Positive RM

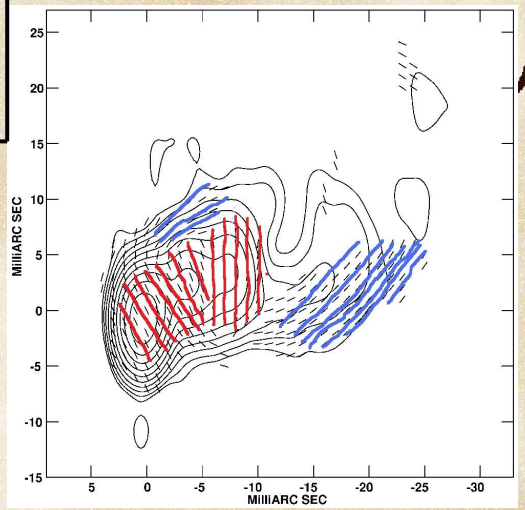
RM ≈ 0

Negative RM

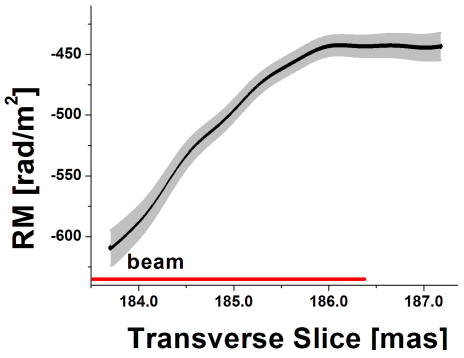
Gradient in RM is a hint for helical B field

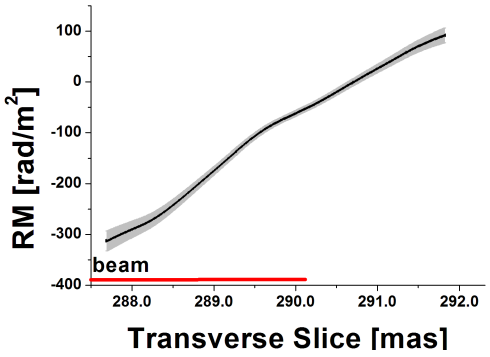
spine

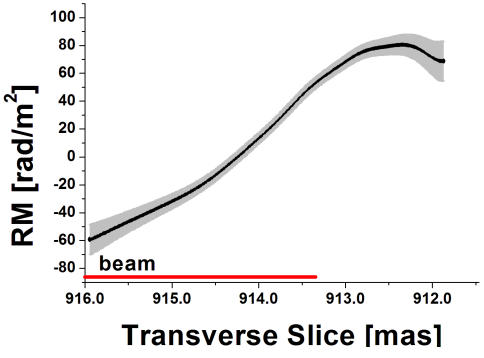
sheath

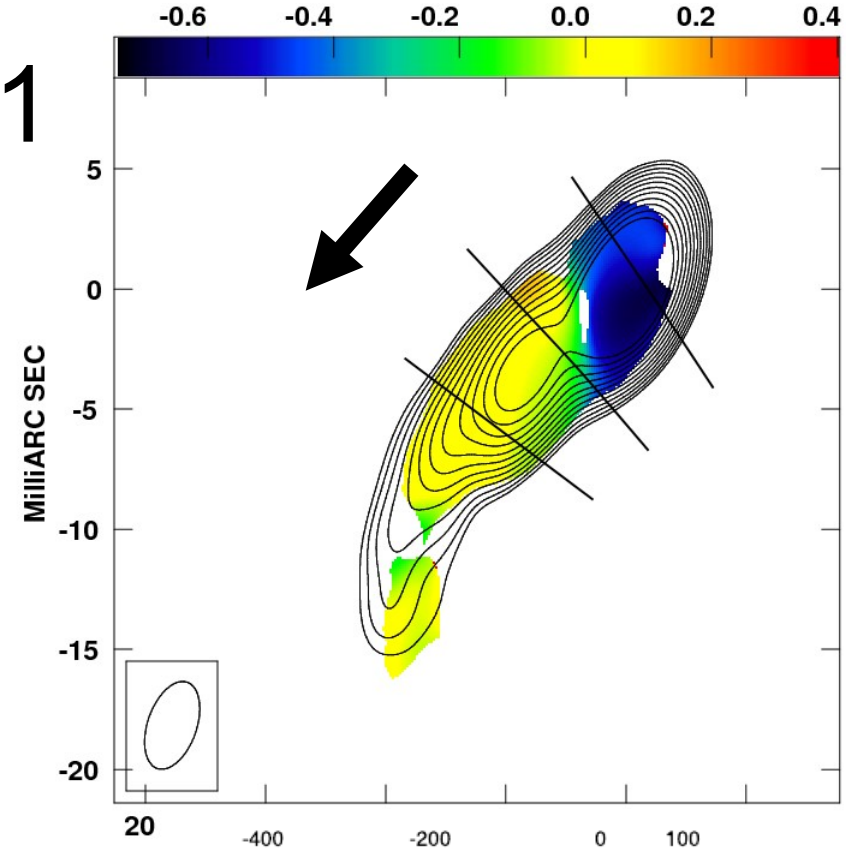


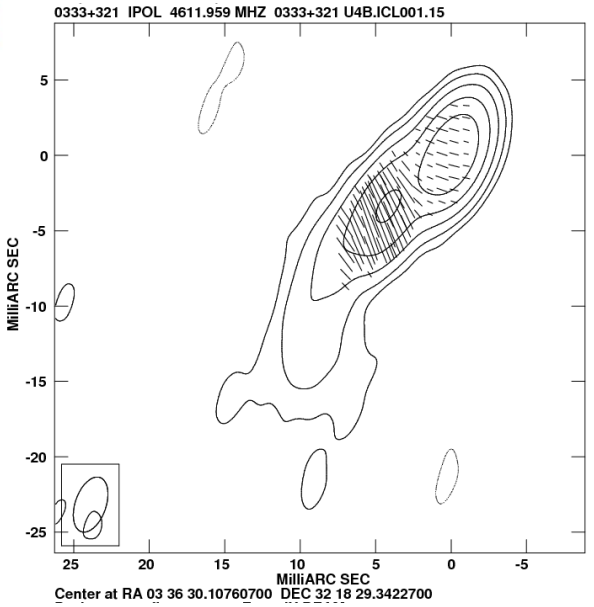
0333+321

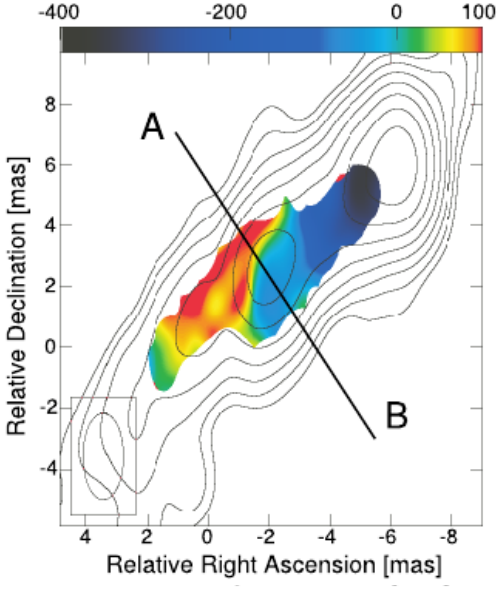


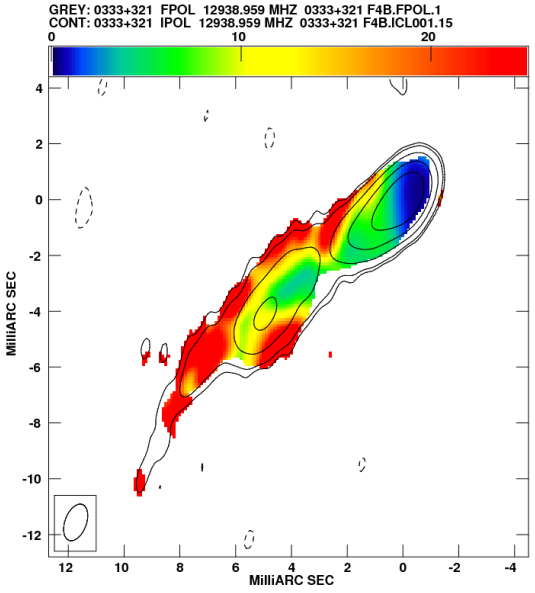




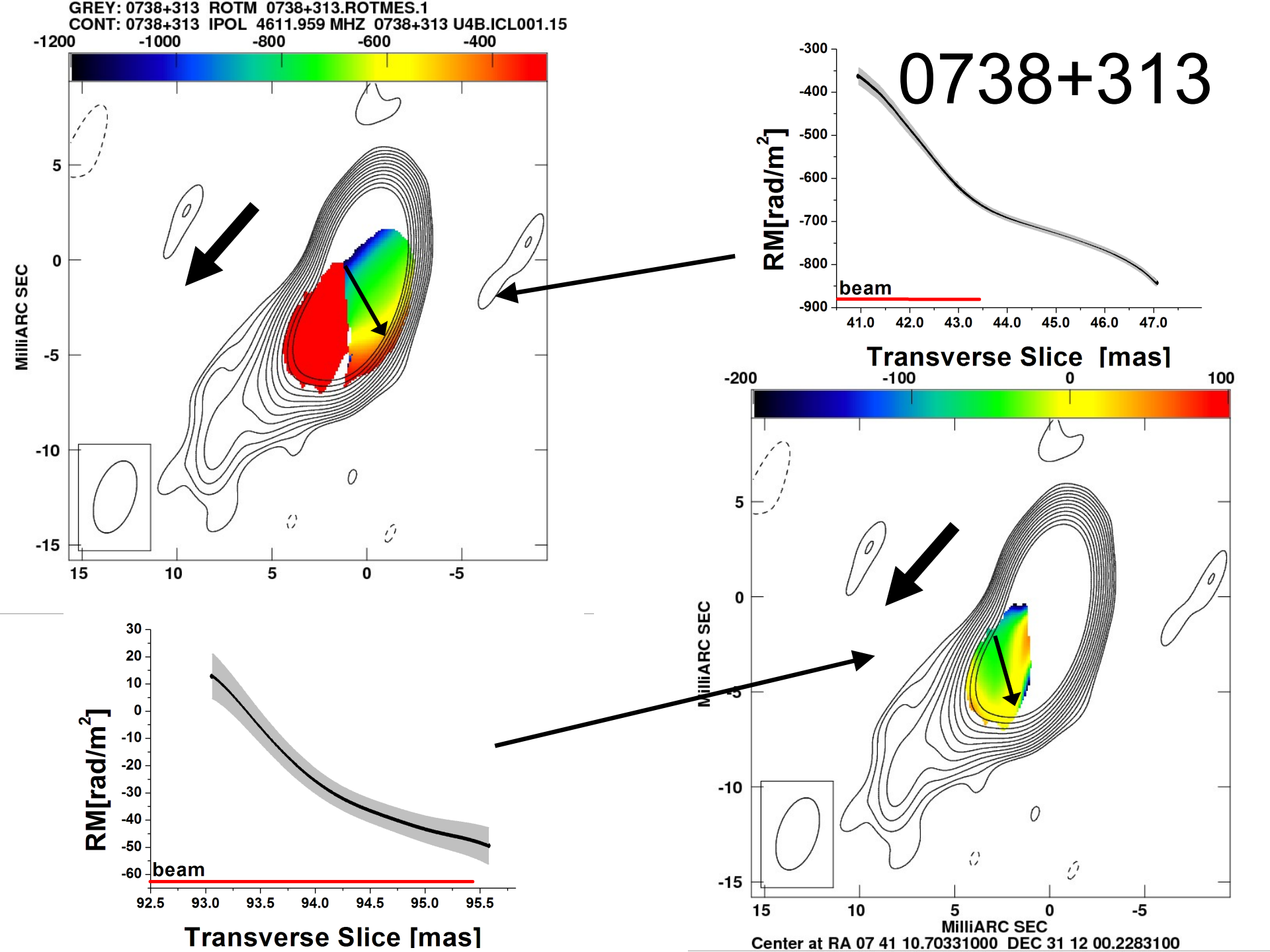








Asada et al. 2008, ApJ, 682, 798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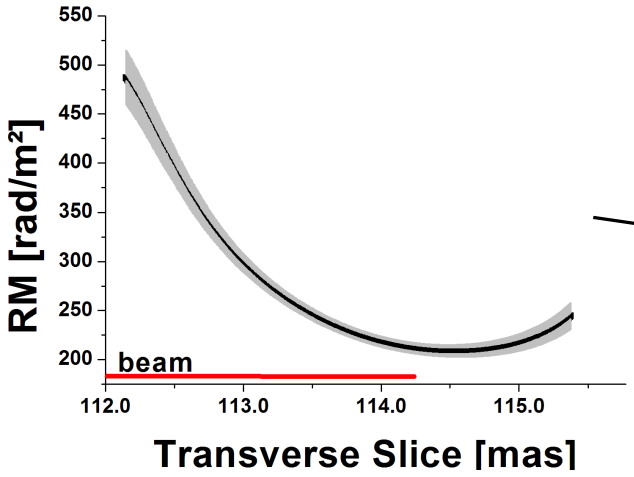
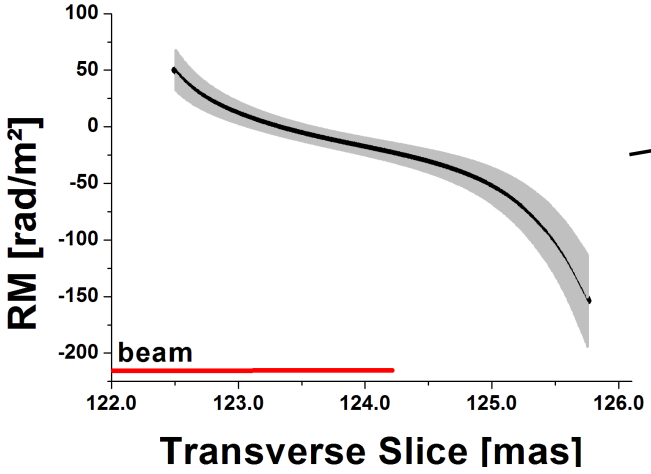
MilliARC SEC
0738+313
RM[rad/m^2]
beam
Transverse Slice [mas]
-200 -100 0 100
MilliARC SEC
RM[rad/m^2]
beam
Transverse Slice [mas]
Center at RA 07 41 10.70331000 DEC 31 12 00.2283100

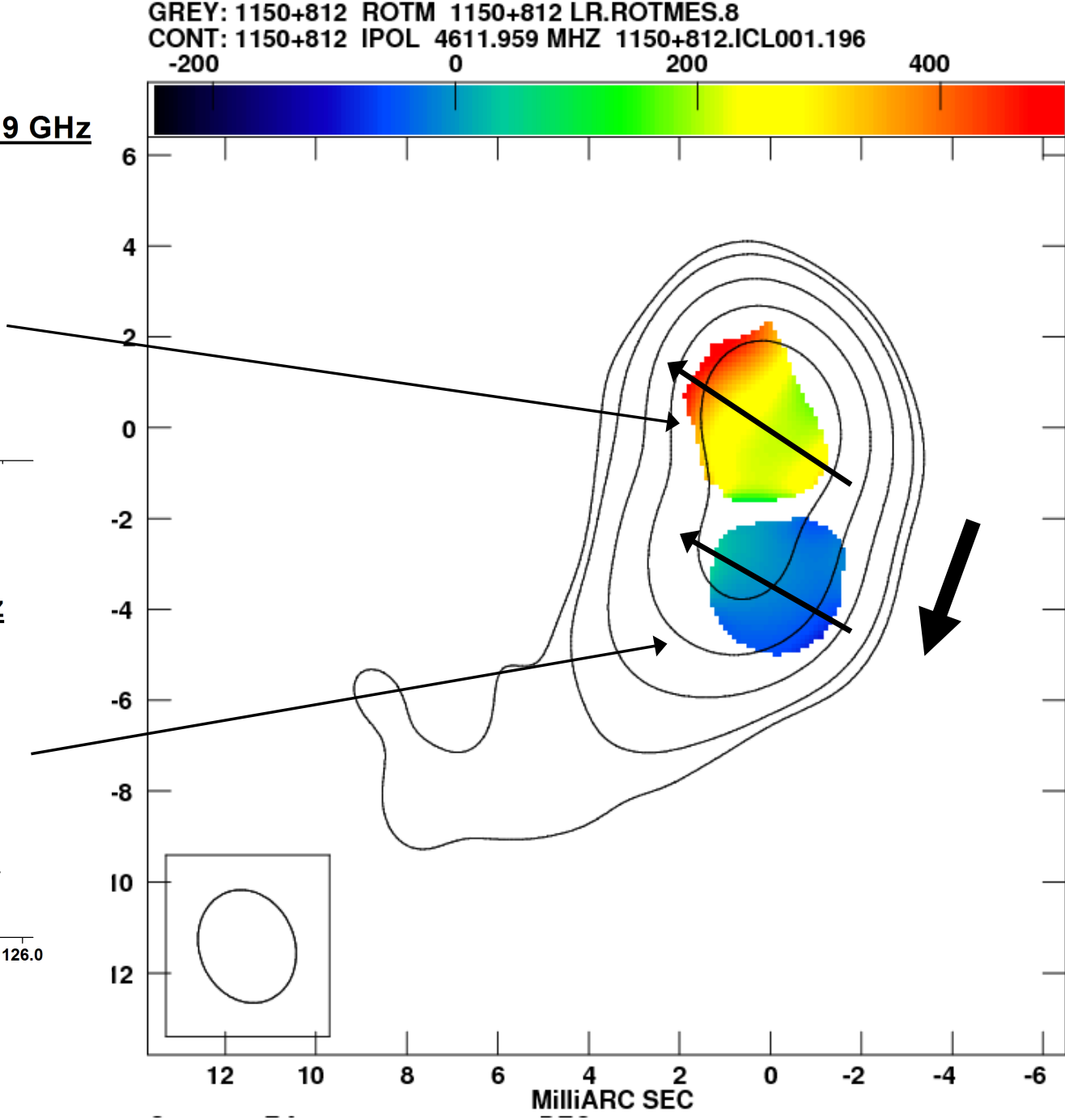
1150+812

1150+812 Core Region 4.6 - 8.9 GHz

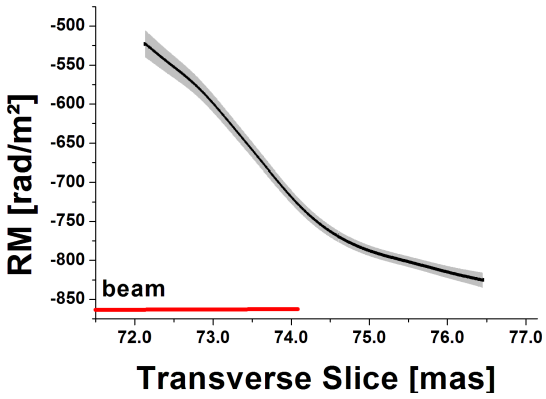


1150+812 Jet 4.6 - 8.9 GHz

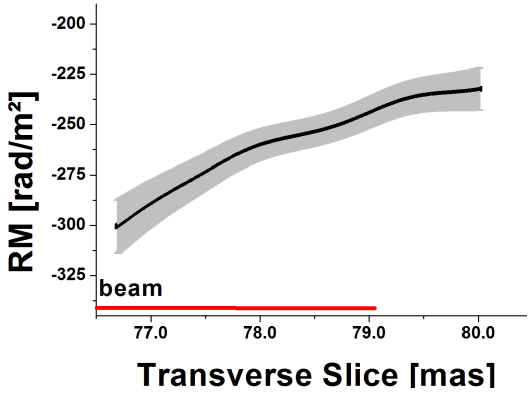




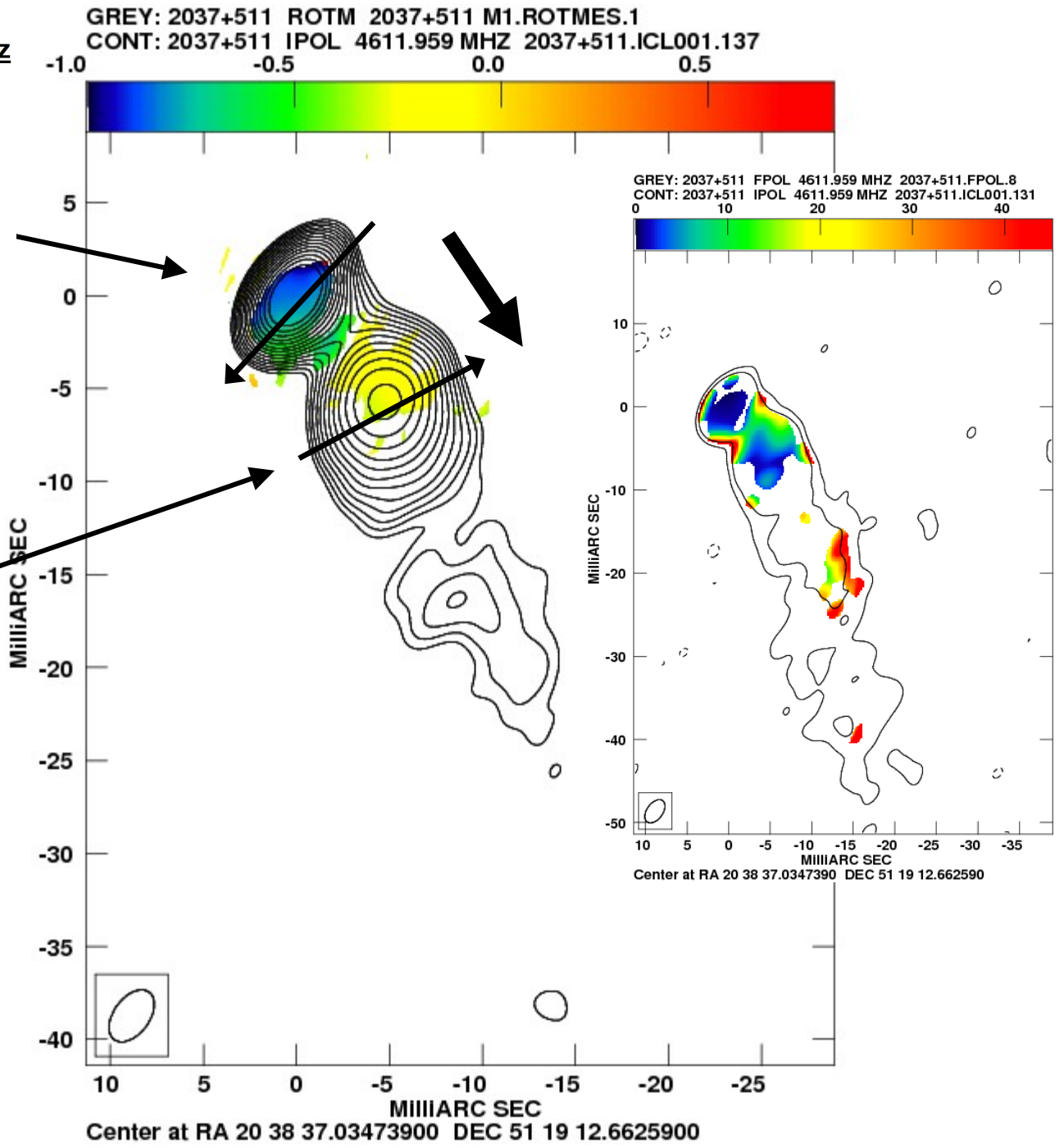
2037+511 Core Region 4.6 - 15.3 GHz



2037+511 Jet 4.6 - 15.3 GHz



2037+511



Summary/Conclusions

- Faraday Rotation gives information about direction of LoS B-field
- Transverse RM gradients visible in 7 (4 examples in this talk) out of 12 sources
- Simplest explanation of gradients and spine-sheath structure is a helical B-field wrapped around jet
- Confirmation of gradient found by Asada et al. 2008 in 0333+321
- Direction of RM gradient can change with distance along jet. This could be due to a “nested-helix” B-field structure (see Mahmud et al. 2009)
- Fractional polarization increases towards the edges

Future Work

- 18-22cm VLBA polarization observations of some of my sources (see Colm Coughlan's talk)
- 3-13 mm VLBI data of 1633+382 (and others) in collaboration with Thomas Krichbaum
- Circular Polarization analysis in collaboration with Vasilii Vitrishchak

Thank you!!