Probing the innermost regions of AGN jets and their magnetic fields

RadioAstron "Polarization KSP"

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Outline

- KSP scientific goals and status of AO-1 observations
- First polarization test at L-band
- Science observations of BL Lac at L-band
- Successful polarization 22 GHz observations of BL Lac
- Summary

GOAL

RadioAstron provides the first true fullpolarization capabilities for Space-VLBI.

Our goal is to develop, commission, and exploit the unprecedented high angular resolution polarization capabilities of RadioAstron to probe the innermost regions of AGN jets and their magnetic fields.

AO-2 TARGETS

- Observations proposed for 0716+714 (K-band), 1633+382 (K-band), and 3C345 (K and L-bands).
- Best uv-coverages for late 2014, early 2015.

AO-1 Observations

Target	Date	Band	Correlation
BL Lac	29 Sep. 2013	L	Prelim.
BL Lac	11 Nov. 2013	K	Yes
3C273	18 Jan. 2014	K	No
3C279	10 March 2014	K	No
OJ287	04 April 2014	K	No
3C273	13 June 2014	L	No

FIRST POLARIMETRIC TEST AT L-BAND

First polarimetric test observations were performed on March 9, 2013 at L-band on 0642+449 (GK047 proposal by Kovalev et al.)

This is a compact quasar at z=3.4 with a relatively flat spectrum and a total flux density of S=1.3 Jy at L-band, as measured from Effelsberg.

Low polarized source, with $m=1.61\pm0.16\%$

A total of 12 antennas participated in the ground array: EF, JB, (ON), SH, TR, UR, NT, WB, HH, GB, and ZC.

Observations were carried out in two blocks one day apart. Long-baseline 1-hour session included EF, JB, WB and RA.



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Ground-space baseline detections up to 6 D_{Earth} .



FIRST POLARIMETRIC TEST AT L-BAND

Instrumental polarization (D-terms) are solved using AIPS's task LPCAL, yielding a significant reduction in the polarization rms.

D-terms are found to be very consistent across the two IFs. Values below 10%, except for UR and HH.

D-terms for RadioAstron are particularly consistent across IFs, and show an amplitude below 7% for RCP and below 8% for LCP.

Ant 4	RA BX	= 9999999.000	00 BY= 9999	999.0000	BZ= 9999	9999.0000
Mount=0R	BI Axis offs	et= 0.0000 me	eters IFA		TFE	3
Feed pola	arization typ	e =	R		L	
Lin. app	ox. IF(1)	as amp, phase	= 0.0685,	-64.5	0.0819,	-116.1
Lin. app	ox. IF(2)	as amp, phase	=0.0701,	-64.6	0.0873,	-116.2

Confirmation of RadioAstron polarization capabilities at L-band

Ant 1 = EF Mount=ALAZ Axis Feed polarization	BX= 4033947.2566 BY= offset= 0.0130 meters	486990.7913 IFA B	BZ= 4900430.9950 IFB
Lin. approx. IF(1) as amp, phase = 0.0	256, -136.5	0.0228, -47.3
Lin. approx. IF(2) as amp, phase = 0.0	310, -138.4	0.0243, -29.0
Ant 2 = JB Mount=ALAZ Axis Feed polarization	BX= 3822625.8509 BY= offset= 0.0000 meters	-154105.3745 IFA B	BZ= 5086486.1905 IFB
Lin. approx. IF(1) as amp, phase = 0.0	126, -6.1	0.0353, 122.0
Lin. approx. IF(2) as amp, phase = 0.0	075, 159.5	0.0433, 115.9
Ant 3 = ON Mount=EQUA Axis Feed polarization	BX= 3370965.9082 BY= offset= 2.1500 meters	711466.2036 IFA B	BZ= 5349664.2021 IFB
Lin. approx. IF(1) as amp, phase = 0.0	000, 0.0	0.0000, 0.0
Lin. approx. IF(2) as amp, phase = 0.0	000, 0.0	0.0000, 0.0
Ant 4 = RA Mount=ORBI Axis Feed polarization	BX= 9999999.0000 BY= offset= 0.0000 meters	9999999.0000 IFA B	BZ= 9999999.0000 IFB
Lin. approx. IF(1) as amp, phase = 0.0	685, -64.5	0.0819, -116.1
Lin. approx. IF(2) as amp, phase = 0.0	701, -64.6	0.0873, -116.2
Ant 5 = SH Mount=ALAZ Axis Feed polarization	BX= -2831687.3922 BY= offset= -0.0020 meters	4675733.4890 IFA B	BZ= 3275327.5026 IFB
Lin. approx. IF(1) as amp, phase = 0.0	421, 27.1	0.0263, 159.3
Lin. approx. IF(2) as amp, phase = 0.0	362, 23.9	0.0283, 134.8
Ant 6 = TR	BX= 3638558.2512 BY=	1221969.9859	BZ= 5077036.8816
Mount=ALAZ Axis	offset= 0.0000 meters	IFA	IFB
Lin. approx. IF(1) as amp, phase = 0.0	797, 13.6	0.0717, 160.2
	2) as amp, phase = 0.0	871, 17.7	0.0760, 176.8
Ant 7 = UR	BX= 228310.2100 BY=	4631922.7617	BZ= 4367064.0710
Mount=ALAZ Axis	offset= -0.0040 meters	IFA	IFB
Lin. approx. IF(1) as amp, phase = 0.1	165, 124.7	0.0963, -157.6
Lin. approx. IF(2) as amp, phase = 0.1	332, 148.3	0.1168, -121.0
Ant 8 = NT Mount=ALAZ Axis Feed polarization	BX= 4934562.8353 BY= offset= 1.8310 meters	1321201.5494 IFA B	BZ= 3806484.7375 IFB
Lin. approx. IF(1) as amp, phase = 0.0	585, 101.3	0.0589, 25.3
Lin. approx. IF(2) as amp, phase = 0.0	531, 38.1	0.0536, -35.5
Ant 9 = WB Mount=EQUA Axis Feed polarization	BX= 3828445.4403 BY= offset= 4.9500 meters	445223.8755 IFA B	BZ= 5064921.7091 IFB
Lin. approx. IF(1) as amp, phase = 0.0	259, 29.7	0.0089, -47.6
Lin. approx. IF(2) as amp, phase = 0.0	196, 35.6	0.0070, -14.8
Ant 10 = HH Mount=EQUA Axis Feed polarization	BX= 5085442.7655 BY= offset= 6.6920 meters	2668263.8046 IFA B	BZ= -2768696.7456 IFB
Lin. approx. IF(1) as amp, phase = 0.2	170, 4.7	0.1988, -134.5
Lin. approx. IF(2) as amp, phase = 0.1	807, 51.5	0.0953, -65.2
Ant 11 = GB Mount=ALAZ Axis Feed polarization	BX= 882589.4212 BY= offset= -0.0880 meters	-4924872.3610 IFA B	BZ= 3943729.4258 IFB
Lin. approx. IF(1) as amp, phase = 0.0	535, 101.5	0.0512, 80.7
Lin. approx. IF(2) as amp, phase = 0.0	480, 90.3	0.0354, 100.6
Ant 12 = ZC Mount=ALAZ Axis Feed polarization	BX= 3451207.5372 BY= offset= -0.0080 meters	3060375.4274 IFA B	BZ= 4391915.0620 IFB
Lin. approx. IF(1) as amp, phase = 0.0	803, 13.6	0.0523, -68.4
Lin. approx. IF(2) as amp, phase = 0.0	952, -0.4	0.0721, -73.4

FIRST POLARIMETRIC TEST AT L-BAND



Contours show total intensity, color scale corresponds to polarized intensity and white bars indicate the EVPAs.

Absolute orientation of the EVPAs obtained from comparison with Efflesberg.

Uniform weighting FWHM: 1.85x1.00 mas 5σ sensitivity: 1.0 mJy/beam

FIRST SCIENCE OBSERVATIONS

First science observations were performed on September 29, 2013.

BL Lac was observed at L-band, together with 24 antennas on the ground array: SV, ZC, BD, EF, GB, WT, NT, TR, JD, ON, UR, KL, SH, EV and the VLBA.

Only a preliminary correlation has been obtained, with not fringes to some of the largest and most important antennas: GB, JB, EV, and KL.

Preliminary correlation includes 17 antennas: EF, BD, ON, SV, TR, UR, WB, ZC, SH, BR, FD, HN, NL, OV, PT, SC, and MK.

Simultaneous ground-only observations at C and X-bands.



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Simultaneous ground-only observations at C and X-bands.

Ground-space baseline detections up to 6.9 D_{Earth} .



FIRST SCIENCE OBSERVATIONS



Achieved angular resolution: FWHM: 3.53x0.40 mas

5σ sensitivity:
4 mJy/beam in Total
7.5 mJy/beam in Polarization
Recovered 4.84 Jy of 5.2 Jy (Effelsberg)

Total intensity image shows three different components, while polarization shows a single component with EVPAs in the direction of the jet.

Calibration of the EVPAs through comparison with Effelsberg.

FIRST SCIENCE OBSERVATIONS AT K-BAND

First science observations at 22 GHz were performed on November 11, 2013.

BL Lac was observed together with 26 antennas on the ground array: EF, YS, JD2, ON, NT, TR, MH, SV, ZC, MC, BD, KVN, SH, UR, and the VLBA.

Due to technical problems data was lost at FD, SC, YS, JB, TR, KVN (3), SH, and UR. A total of 16 antennas correlated, of which MC and BD contained bad data and were edited out.



FIRST SCIENCE OBSERVATIONS AT K-BAND

First science observations at 22 GHz were performed on November 11, 2013.

BL Lac was observed together with 26 antennas on the ground array: EF, YS, JD2, ON, NT, TR, MH, SV, ZC, MC, BD, KVN, SH, UR, and the VLBA.

Due to technical problems data was lost at FD, SC, YS, JB, TR, KVN (3), SH, and UR. A total of 16 antennas correlated, of which MC and BD contained bad data and were edited out.

Ground-space baseline detections up to 5 D_{Earth} .

Experiment scheduled to extent up to a maximum of 11.5 D_{Earth} , but no fringes have been obtained after EF stopped observing.



FIRST SCIENCE OBSERVATIONS AT K-BAND

Instrumental polarization (D-terms) are solved using AIPS's task LPCAL on BL Lac, yielding very consistent results across the two IFs.

D-terms for RadioAstron are particularly consistent across IFs, and show an amplitude below 9% for RCP and below 5% for LCP.

Ant	15 = RA		BX=	99999	999.0000	BY=	999999	9.0000	BZ=	9999	999.0000
Mount	t=ORBI A	xis of	fset	= 0.0	0000 mete	ers	IFA			IFB	
Feed	polariza	ation t	ype =	=			R			L	
Lin.	approx.	IF(1) as	amp,	phase 🚽	0.09	51, -	63.6	0.05	514,	147.1
Lin.	approx.	IF(2) as	amp,	phase 🛓	0.09	67, -	58.7	0.04	475 ,	142.8

Confirmation of RadioAstron polarization capabilities at 22 GHz

Ant								
Mount	1 = BR	BX=	-2112	065.2172 1200 mete	BY= -370	5356.5012	BZ=	4726813.6637
Feed	polarization	type	= 2.	1250 11000	R	•		L
Lin.	approx. IF(1) as	amp,	phase =	0.0064,	-80.8	0.01	24, -8.1
Lin.	approx. IF(2) as	amp,	phase =	0.0070,	-74.6	0.00	99, 12.2
Ant	2 = EF	BX=	4033	947.2477	BY= 48	5990.8022	BZ=	4900431.0021
Mount	=ALAZ AX1S	offset	= 0.	0130 mete	ers IF/	4		1FB
reea	polarization	type	=	nhaca -	A 1075	167 0	0 00	16 F0 6
L10. Lin	approx. IF(1) d5	amp,	phase =	0.10/5,	-10/.0	0.08	10, -38.0 73 _67.0
		2, 45	amp)	phase	011010,	1/215	0107	, , , , , , , , , , , , , , , , , , , ,
Ant	3 = HN	BX=	1446	374.8529	BY= -444	7939.6746	BZ=	4322306.1822
Mount	=ALAZ Axis	offset	= 2.	1300 mete	ers IF/	4		IFB
Feed	polarization	type	=		R			L
Lin.	approx. IF(1) as	amp,	phase =	0.0251,	82.1	0.01	23, 166.2
Lin.	approx. IF(2) as	amp,	phase =	0.0266,	62.9	0.01	00, 145.6
		5.4		~~~ ~~~~	5.4 5.6.5			
ΑΠΤ	4 = KP	BX=	-1995	6/8.8518 1210 mete	BY= -503	/31/.6923	BZ= .	335/328.0133
Food	POLOCIZATION	+vpe	= 2.	1510 mete		4		ILD
lin	annroy TE(1) ac	- >mn	nhace -	0 01/17	116 0	0 00	71 _117 7
lin.	approx. IF(2) as	amp,	phase =	0.0140.	108.3	0.00	98159.9
		2, 00	amp,	phase	0101.0,	10010	0100	50, 10010
Ant	5 = LA	BX=	-1449	752.5943	BY= -497	5298.5702	BZ=	3709123.8339
Mount	=ALAZ Axis	offset	= 2.	1310 mete	ers IF/	Ą		IFB
Feed	polarization	type	=		R			L
Lin.	approx. IF(1) as	amp,	phase =	0.0179,	-145.4	0.00	62, -25.2
L1N.	approx. IF(z) as	amp,	pnase =	0.0180,	-122.0	0.00	22, -32.1
∆n+	6 = NI	RX-	-130	872.5110	BY= _176	2317 0996	B7=	4226850 0030
Mount	=ALA7 Avie	DA- offset	= 2	072.JIIU 1300 mete	ors TF	7.0000	02- 1	TFB
Feed	polarization	type	= 21	mctt		•		L
Lin.	approx. IF(1) as	amp,	phase =	0.0240,	-108.2	0.03	63, -25.8
Lin.	approx. IF(2) as	amp,	phase =	0.0201,	-94.3	0.03	64, -26.8
	-							
Ant	7 = 0V	BX=	-2409	150.4168	BY= -4478	3573.1104	BZ=	3838617.3305
Mount	=ALAZ Axis	offset	= 2.	1300 mete	ers IF/	4		IFB
Feed	polarization	type	=		R 0112	20.0	0 01	
Lin.	approx. IF(1) as	amp,	phase =	0.0113,	39.8	0.01	92, 79.0 21 73.0
LTII.	approx. IF(2) dS	amp,	pliase -	0.0117,	14.1	0.02	21, 73.0
Ant	8 = PT	BX=	-1640	953.9498	BY= -5014	4816.0207	BZ=	3575411.7781
Mount	=ALAZ Axis	offset	= 2.	1370 mete	rs IF/	A		IFB
Feed	polarization	type	=		R			L
	/	-)				470.0	0 01	10 10 7
LlN.	approx. IF(1) as	amp,	phase =	0.0112,	1/0.8	0.01	43, 10./
Lin. Lin.	approx. IF(approx. IF(1) as 2) as	amp, amp,	phase = phase =	0.0112, 0.0103,	170.8	0.01	43, 10.7 11, 19.0
Lin. Lin.	approx. IF(approx. IF(1) as 2) as	amp, amp,	phase = phase =	0.0112, 0.0103,	170.8 174.1	0.01 0.01	43, 10.7 11, 19.0
Lin. Lin. Ant	approx. IF(approx. IF(9 = MH	1) as 2) as BX=	amp, amp, 2892	phase = phase = 584.8330	0.0112, 0.0103, BY= 1312	170.8 174.1 1715.6078	0.01 0.01 BZ=	43, 10.7 11, 19.0 5512640.1600
Lin. Lin. Ant Mount Feed	approx. IF(approx. IF(9 = MH =ALAZ Axis opolarization	1) as 2) as BX= offset type	amp, amp, 2892 = -0.	phase = phase = 584.8330 0020 mete	0.0112, 0.0103, BY= 131: ers IF/ R	170.8 174.1 1715.6078	0.01 0.01 BZ=	43, 10.7 11, 19.0 5512640.1600 IFB L
Lin. Lin. Ant Mount Feed Lin.	approx. IF(approx. IF(9 = MH =ALAZ Axis of polarization approx. IF(1) as 2) as BX= offset type 1) as	amp, amp, 2892 = -0. = amp.	phase = phase = 584.8330 0020 mete phase =	0.0112, 0.0103, BY= 131: rs IF/ R 0.0292.	170.8 174.1 1715.6078 A 160.6	0.01 0.01 BZ=	43, 10.7 11, 19.0 5512640.1600 IFB L 59. 31.6
Lin. Lin. Ant Mount Feed Lin. Lin.	approx. IF(approx. IF(9 = MH =ALAZ Axis of polarization approx. IF(approx. IF(1) as 2) as BX= offset type 1) as 2) as	amp, amp, 2892 = -0. = amp, amp,	phase = phase = 584.8330 0020 mete phase = phase =	0.0112, 0.0103, BY= 1312 ers IF/ R 0.0292, 0.0398,	170.8 174.1 1715.6078 A 160.6 143.2	0.01 0.01 BZ= 3 0.06 0.04	43, 10.7 11, 19.0 5512640.1600 IFB L 59, 31.6 38, 10.3
Lin. Lin. Mount Feed Lin. Lin.	approx. IF(approx. IF(9 = MH =ALAZ Axis polarization approx. IF(approx. IF(1) as 2) as BX= offset type 1) as 2) as	amp, amp, 2892 = -0. = amp, amp,	phase = phase = 584.8330 0020 mete phase = phase =	0.0112, 0.0103, BY= 1313 ers IF/ R 0.0292, 0.0398,	170.8 174.1 1715.6078 A 160.6 143.2	0.01 0.01 BZ= 1 0.06 0.04	43, 10.7 11, 19.0 5512640.1600 IFB L 59, 31.6 38, 10.3
Lin. Lin. Ant Mount Feed Lin. Lin.	approx. IF(approx. IF(9 = MH =ALAZ Axis (polarization approx. IF(approx. IF(10 = ON	1) as 2) as BX= offset type 1) as 2) as BX=	amp, amp, 2892 = -0. = amp, amp, 3370	phase = phase = 584.8330 0020 mete phase = phase = 605.7892	0.0112, 0.0103, BY= 131: rrs IF, R 0.0292, 0.0398, BY= 71:	170.8 174.1 1715.6078 160.6 143.2	0.01 0.01 BZ= 2 0.06 0.04 BZ= 2	43, 10.7 11, 19.0 5512640.1600 IFB L 59, 31.6 38, 10.3 5349830.9127
Lin. Lin. Ant Mount Feed Lin. Lin. Ant Mount	approx. IF(approx. IF(9 = MH =ALAZ Axis (polarization approx. IF(approx. IF(10 = ON =ALAZ Axis (colority)	1) as 2) as BX= offset type 1) as 2) as BX= offset	amp, amp, 2892 = -0. amp, amp, 3370 = -0.	phase = phase = 584.8330 0020 mete phase = phase = 605.7892 0080 mete	0.0112, 0.0103, BY= 1311 rrs IF, R 0.0292, 0.0398, BY= 71: rrs IF,	1/0.8 174.1 1715.6078 160.6 143.2 1917.7337	0.01 0.01 BZ= 2 0.06 0.04 BZ= 2	43, 10.7 11, 19.0 5512640.1600 IFB L 59, 31.6 38, 10.3 5349830.9127 IFB
Lin. Lin. Ant Mount Feed Lin. Lin. Ant Feed	approx. IF(approx. IF(9 = MH ==ALAZ Axis of polarization approx. IF(10 = ON ==ALAZ Axis of polarization	1) as 2) as BX= offset type 1) as 2) as BX= offset type	amp, amp, 2892 = -0. amp, amp, 3370 = -0.	phase = phase = 584.8330 0020 mete phase = phase = 605.7892 0080 mete	0.0112, 0.0103, BY= 131: rrs IF, R 0.0292, 0.0398, BY= 71: rrs IF, R 0.0220	1/0.8 174.1 1715.6078 160.6 143.2 1917.7337	0.01 BZ= 1 0.06 0.04 BZ= 1 BZ= 1	43, 10.7 11, 19.0 5512640.1600 IFB L 59, 31.6 38, 10.3 5349830.9127 IFB L 20, 20, 2
Lin. Lin. Ant Mount Feed Lin. Lin. Ant Feed Lin.	approx. IF(approx. IF(9 = MH ==ALAZ Axis of polarization approx. IF(10 = ON ==ALAZ Axis of polarization approx. IF(1) as 2) as BX= offset type 1) as 2) as BX= offset type 1) as 2) as	amp, amp, 2892 = -0. amp, amp, 3370 = -0. amp, amp,	phase = phase = 584.8330 0020 mete phase = phase = 605.7892 0080 mete phase = phase =	0.0112, 0.0103, BY= 131: rrs IF, R 0.0292, 0.0398, BY= 71: rrs IF, R 0.0329, 0.0316	1/0.8 174.1 1715.6078 160.6 143.2 1917.7337 -129.5 -121.8	0.01 BZ= 1 0.06 0.04 BZ= 1 BZ= 1	43, 10.7 11, 19.0 5512640.1600 IFB L 59, 31.6 38, 10.3 5349830.9127 IFB L 82, -28.2 64 - 28.9
Lin. Lin. Mount Feed Lin. Lin. Ant Feed Lin. Lin.	approx. IF(approx. IF(9 = MH polarization approx. IF(approx. IF(10 = ON =ALAZ Axis polarization approx. IF(approx. IF(1) as 2) as BX= offset type 1) as 2) as BX= offset type 1) as 2) as	amp, amp, 2892 = -0. amp, amp, 3370 = -0. amp, amp,	phase = phase = 584.8330 0020 mete phase = phase = 605.7892 0080 mete phase = phase =	0.0112, 0.0103, BY= 1311 rrs IF, 0.0292, 0.0398, BY= 711; rrs IF, R 0.0329, 0.0316,	170.8 174.1 1715.6078 160.6 143.2 1917.7337 -129.5 -121.8	0.01 BZ= 1 0.06 0.04 BZ= 1 0.04 0.04	43, 10.7 11, 19.0 5512640.1600 IFB L 59, 31.6 38, 10.3 5349830.9127 IFB L 82, -28.2 64, -28.0
Lin. Lin. Mount Feed Lin. Lin. Ant Feed Lin. Lin.	approx. IF(approx. IF(9 = MH =ALAZ Axis of polarization approx. IF(10 = ON =ALAZ Axis of polarization approx. IF(approx. IF(11 = SV	1) as 2) as BX= offset type 1) as 2) as BX= offset type 1) as 2) as BX=	amp, amp, 2892 = -0. amp, amp, 3370 = -0. amp, amp, 2730	phase = phase = 584.8330 0020 mete phase = 605.7892 0080 mete phase = phase = 173.6569	0.0112, 0.0103, BY= 1311 rrs IF, 0.0292, 0.0398, BY= 711 rrs IF, R 0.0329, 0.0316, BY= 1562	1/0.8 174.1 1715.6078 160.6 143.2 1917.7337 -129.5 -121.8 2442.8028	0.01 BZ= 1 0.06 0.04 BZ= 1 0.04 0.04 BZ= 1	43, 10.7 11, 19.0 5512640.1600 IFB L 59, 31.6 38, 10.3 5349830.9127 IFB L 82, -28.2 64, -28.0 5529969.1538
Lin. Lin. Mount Feed Lin. Lin. Ant Feed Lin. Lin. Ant Mount	approx. IF(approx. IF(9 = MH =ALAZ Axis of polarization approx. IF(approx. IF(approx. IF(approx. IF(11 = SV =ALAZ Axis of =ALAZ Axis of	1) as 2) as BX= offset type 1) as 2) as BX= offset type 1) as 2) as BX= offset	amp, amp, 2892 = -0. amp, amp, 3370 = -0. amp, amp, 2730 = -0.	phase = phase = 584.8330 0020 mete phase = 605.7892 0080 mete phase = phase = 173.6569 0070 mete	0.0112, 0.0103, BY= 131: rrs IF, R 0.0292, 0.0398, BY= 71: rrs IF, R 0.0329, 0.0316, BY= 1566; rrs IF,	170.8 174.1 1715.6078 160.6 143.2 1917.7337 -129.5 -121.8 2442.8028	0.01 BZ= 0.06 0.04 BZ= 0.04 BZ=	43, 10.7 11, 19.0 5512640.1600 IFB L 55, 31.6 38, 10.3 5349830.9127 IFB L 82, -28.2 64, -28.0 5529969.1538 IFB
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First polarization Space-VLBI image at 22 GHz

Achieved angular resolution: FWHM: 0.296x0.033 mas using uniform weighting with no amplitude error weighting. Achieved 5σ sensitivity of 20 mJy/beam.

Highest angular resolution polarization image obtained to date: 33 µas



Beam FWHM 0.343x0.059 mas at -22.747 deg.

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Achieved angular resolution: FWHM: 0.296x0.033 mas

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Highest angular resolution polarization image obtained to date: 33 µas

Image with uniform weighting provides an angular resolution of FWHM: 0.343x0.059 mas

and a 5σ sensitivity of 4 mJy/beam in total intensity and 7 mJy/beam in polarization.





- Total intensity shows a highly bent structure in the innermost 0.5 mas.
- Highest resolution in the direction of the jet.
- Two components.
- Core EVPAs perpendicular to the jet direction.
- Component with aligned EVPAs



- Comparison with Cohen et al. (2014a,b) observations reveals that our component at 0.3 mas corresponds to their C7.
- C7 is identify by Cohen et al. (2014a,b) as a recollimation shock.
- Our RadioAstron observations reveal that C7 has a polarization orthogonal to the core, and aligned with the jet direction.



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- C7 is identify by Cohen et al. (2014a,b) as a recollimation shock.
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- C7 swings in position angle, triggering Alfvén waves in the jet ridge line, like waves on a whip.



Comparison with other wavebands:

- Q-band: Due to technical reasons polarization data only available for 6 VLBA antennas: BR, HN, KP, LA, NL, PT.
- U-band: Similar situation, with only 7 VLBA antennas: BR, HN, KP, LA, NL, OV, PT.

Opacity and Faraday rotation analysis performed through comparison with BU and MOJAVE data.









Core moderately thick with $\alpha \approx 0.12$

Jet optically thin

MAP COMPARISON ACROSS 15, 22, AND 43 GHZ FOR RM ANALYSIS



MAP COMPARISON ACROSS 15, 22, AND 43 GHZ FOR RM ANALYSIS





Preliminar Faraday rotation analysis

- Core region shows a gradient in RM, decreasing in the jet direction. Values change from ~ - 1800 rad/m² to -300 rad/m²
- Jet shows RM ~ 500 rad/m²

Comparison with dedicated 3mm GMVA observations (PI Marscher) is underway.

SUMMARY

- Six RadioAstron observations carried out within our polarization KSP during AO-1. Continued observations throughout AO-2.
- First successful test polarization observations at Lband, showing small instrumental polarization, confirming RA polarization imaging capabilities.



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- First successful test polarization observations at Lband, showing small instrumental polarization, confirming RA polarization imaging capabilities.
- Observations of BL Lac at L-band with detections up to 6 D_{Earth}, providing first polarization 1.6 GHz space-VLBI image with 0.4 mas resolution.
- First successful space-VLBI polarimetric observations at 22 GHz, revealing the innermost magnetic field structure in BL Lac with an angular resolution of 33 µas, best to date.

RadioAstron allows polarization imaging with angular resolutions of ≤30 µas

• Preliminary science analysis through comparison with ground observations (BU, MOJAVE). Further comparison with dedicated GMVA observations.

