# THE BIRTH OF QUASARS

Rachel Thorp *Mentor:* Colin Lonsdale



# Outline

- Introduction
  - Scientific backgroundModel
- 🗆 Data
  - Observations
  - Calibration example
  - Nature of the data
- Results
- Future work

# Scientific Background

- Active galactic nuclei (AGNs) influence the formation and evolution of galaxies, stars, gas, and dust
- Galactic-scale gravitational interactions trigger AGNs
- Study emergent AGNs:
  - How do radio jets interact with ISM?
  - How do interactions quench star formation and clear out dust and gas (feedback)?
- High resolution radio studies are key

# **Observed AGN Sample**

- Taken from the Wide-field Infrared Survey Explorer
  - (WISE) catalog
  - 500 million total objects
- Extremely red WISE colors
- Radio-loud (AGN)
- Extremely luminous
- 156 objects for detailed study



Obtained data for only 90 of these for the study



Relativistic AGN jet in clumpy ISM

(Wagner & Bicknell, 2011)



# Imaging Antenna Arrays



#### VLA



# **VLBA** Observations

- 90 targets, 90 phase-reference calibrators
- □ 48 hours total observing time, 4.8 GHz
  - 3-15 minutes of on-source integration
  - Significant instrumental problems, data loss
  - Phase-referencing mode
- □ 1-2 mas angular resolution, 50 µJy sensitivity
- Amplitude calibration, instrumental correction, fringe fitting, phase transfer, self calibration, deconvolution

# **Example: Fringe Fitting**



Must be able to average the data over both frequency and time without loss of coherence. If phase slopes are non-negligible, averaging data will null the signals.

# Data: UV Coverage

Not ideal coverage, but suitable for now...



Plot file version 2 created 01-AUG-2014 16:04:33 V vs U for J1642+4123 SPLIT 2 Source: J1642+41

### Data: Good or Bad?



#### Results

- 62/90 sources successfully imaged
- Peak brightness ranges from 0.3 to 70 mJy/beam
- Wide variety of structures observed
  - Point sources
  - Resolved single components
  - Double sources
  - Core-jets, and multi-component sources
- $\square \sim 25$  sources appear to be resolved out

	Source	Visibilities	RMS Noise (Jy/beam)	Restoring Beam Major Axis (arcsec)	Restoring Beam Minor Axis (arcsec)	Beam Position Angle (°)	Peak Flux (Jy/beam)	Min Flux (Jy/beam)	Comments
-	Α	441096	10.1 C		Sector 1		12.22.23	- a to	9 antennas
	J2212+3326	14366	6.16E-005	0.00246	0.00116	-8.26	3.43E-004	-3.57E-004	No image
	J2251 + 0106	13388	7.39E-005	0.00289	0.00126	-6.66	1.48E-002	-3.48E-004	Single component
	J2222+0951	12420	6.92E-005	0.00263	0.00117	-7.34	4.41E-004	-3.61E-004	No image
	J2226 + 0025	14024	7.15 E - 005	0.00279	0.0013	-10.33	1.77E-003	-4.27E-004	Weak single component
	J2126-0103	10470	7.74E-005	0.00291	0.00119	-9.84	3.76E-004	-3.92E-004	No image
			)5	0.00274	0.00116	-4.87	4.34E-004	-4.76E-004	No image
Source	Visibilities RMS Restoring Restoring Noise Beam Resm	g Beam Peak Flux Min Flux Commen Puddon (Jy/Jacam) (Jy/Jacam)		0.00297	0.00117	-7.07	5.24E-004	-4.35E-004	Very weak
-	Noise Beam Beam (Jy/beam) Majoe Minor Axis Axis (arcsec) (arcsec)	Angie (°)		0.00282	0.00107	-2.98	7.72E-003	-4.28E-004	Single component, possible extension
J2212+3326 J2251+0106 J2222+0031 J2226+0025 J2126-0103 J2226-0103	14000         6.182.306         0.02248         0.00116           12028         7.308.006         0.02288         0.00116           12426         6.202.406         0.02283         0.00117           14094         7.158.406         0.02293         0.00117           16094         7.158.406         0.02293         0.00118           12427         6.202.406         0.02293         0.00119           12421         7.348.406         0.02293         0.00119           12017         7.348.406         0.02293         0.00119           12017         7.348.406         0.02293         0.00119	9         9           4.06         3.021/041         3.021/041         3.021/041           7.4         1.021/041         3.021/041         3.021/041           7.4         1.021/041         3.021/041         3.021/041         3.021/041           7.5         1.702/041         3.021/041         3.021/041         3.021/041         3.021/041           9.5         1.702/041         3.021/041         3.021/041         3.021/041         3.021/041           9.6         3.021/041         4.021/041         4.021/041         3.021/041         3.021/041           9.7         5.261/041         4.021/041         4.021/041         3.021/041         3.021/041           9.7         7.021/041         4.021/041         4.021/041         3.021/041         3.021/041         3.021/041           9.7         7.021/041         4.021/041         4.021/041         3.02	nponent )5	0.00299	0.0011	-6.91	5.00E-004	-4.79E-004	No image
	LEMG         0.1021-00         0.02214         0.02115           LEMS         7.201-00         0.0228         0.00115           L2AS         0.0210-00         0.0228         0.00115           L2AS         0.0210-00         0.0208         0.00115           L2AS         0.0212-000         0.0208         0.00115           L2AS         1.020-00         0.0207         0.00115           L2AS         1.020-00         0.0027         0.00117           L2AS         1.020-00         0.0027         0.00117           L2AS         0.020-00         0.0027         0.00117           L2AS         0.020-00         0.0027         0.00117           L2AS         0.020-00         0.02027         0.00115           L2AS         0.020-00         0.00128         0.00127           L2AS         0.020-00	-0.33 1.77E-003 -4.27E-004 Weak sing -0.84 3.76E-004 -3.92E-004 No image -4.87 4.34E-004 -4.76E-004 No image -7.07 5.24E-004 -4.35E-004 Very weak	)5	0.0028	0.00119	-6.56	4.38E-003	-4.23E-004	Single component
J2133-1419 J2212-1253 J2325-0429 J2318+2537	Interface         7.81E-865         0.00274         0.00116           10411         7.84E-865         0.00274         0.00116           10411         7.84E-865         0.00274         0.00117           10441         7.84E-865         0.00274         0.00117           10440         8.42E-865         0.00295         0.00137           10468         8.42E-865         0.00295         0.00137           11867         6.34E-866         0.00275         0.00137           11268         6.42E-866         0.00275         0.00137           11268         6.34E-866         0.00275         0.00137           11268         8.42E-866         0.00226         0.00138           11268         8.42E-866         0.00226         0.00138           11268         8.42E-866         0.00226         0.00138	<ul> <li>2.8 7 722-003 -4.28E-004 Single-con- 6.31 5.00E-004 -4.78E-004 No image 6.56 4.38E-003 -4.23E-014 Single-con 2.8 4.31E-004 -3.72E-004 No image</li> </ul>	apsonent, possible extension D5	0.00273	0.00113	-2.8	4.31E-004	-3.72E-004	No image
J2345+3120 J0010+1643 J2331-1411 J0104-2750	11236 8.585-005 0.00278 0.00175 10242 6.41E-005 0.00262 0.00186 10080 8.525-005 0.00268 0.00186 9249 1.23E-004 0.00295 0.00105	1.01 2.68E-03 -5.00E-004 Weak use 1.72 2.25E-03 -5.73E-004 Weak use -4.92 1.68E-002 -5.64E-004 Strong ve -5.68 6.91E-004 -6.71E-004 No image	gral double de resolved component Il separated double	0.00278	0.00115	1.01	2.68E-003	-5.00E-004	Weak unequal double
B J0206+0920 J0244+1123 J0200+3901	392989 14247 6.632-005 0.00188 0.00146 13152 5.372-006 0.0048 0.00149 15467 5.430-006 0.0048 0.00149	8 actions -27.19 3.47E-004 -3.76E-004 No image -28.34 1.85E-003 -3.86E-004 Winds in 4.09 2.265.003 -3.86E-004 Simile on	de contracterent	0.00262	0.00116	1.72	2.25E-003	-3.73E-004	Weak single resolved component
30304+0520 30244+1123 30342+3753 30342+3753 30352+1947 30304-3108 30352+1947	392:00         0.00166         0.00166           11417         0.021616         0.00166         0.00166           11417         1.372-006         0.00168         0.00166           11417         1.372-006         0.00168         0.00166           11418         1.372-006         0.00164         0.00121           11418         1.372-006         0.00054         0.00121           11418         0.128-008         0.00054         0.00122           11418         0.128-006         0.00148         0.00122           11418         0.128-006         0.00148         0.00122           11418         0.128-006         0.00148         0.00123           1122-014         0.04024         0.00038         0.00176           1122-014         0.04024         0.00038         0.00112           11246         0.04024-001         0.00038         0.00111	1.97 4.14E-002 -8.30E-004 Strong, m 0.78 2.30E-003 -3.78E-004 Resolved, -4.76 5.72E-003 -3.17E-004 Slightly m -3.21 1.28E-002 -5.07E-004 Sughtly m	solved, possible symmetrical jets but questionable symmetries solved trive, her artifacta, high year	0.00268	0.00108	-4.92	1.68E-002	-5.46E-004	Strong well-separated double
J0306-3353 J0354-3308 J0404-2436 J0417-2816	1417         6.625 e05         0.00088         0.00169           1512         5.527 e06         0.0028         0.00169           1546         0.00261         0.0023         0.00123           1546         0.00263         0.00126         0.00121           1546         0.00263         0.00126         0.00121           1543         6.127 e06         0.00263         0.00123           1544         0.127 e06         0.00364         0.00122           1017         1.0216-06         0.00364         0.00112           1018         1.0240-06         0.00364         0.00111           12344         0.6621-06         0.00365         0.00111           12344         0.6621-06         0.00366         0.00111           12347         7.0718-006         0.00466         0.00114           12374         0.00469         0.00466         0.00134	-4.45 4.46E-003 -4.42E-003 Bod calls -5.46 3.63E-003 -6.22E-004 Penalide w -4.83 5.03E-003 -5.22E-004 No image -6.21 5.90E-003 -5.22E-004 No image	rator (no image) de duible, quite weak	0.00295	0.00105	-5.68	6.91E-004	-6.71E-004	No image
30409-1837 30404+0712 30443+0643 30519-0813	9652 1.225-004 0.00617 0.00225	100         9.5000         8.5700         8.5700           277         9.7712         3.776100         Nainage           247         9.7712         3.776100         Nainage           249         1.55000         Nainage         Nainage           249         1.55000         Nainage         Nainage           249         1.55000         Nainage         Nainage           247         1.364000         Nainage         Nainage           247         1.365000         A.355000         Residue           247         1.365000         A.355000         Residue           247         1.365000         A.355000         Residue           247         1.365000         A.355000         Residue           248         1.365000         A.355000         Residue           249         1.365000         A.355000         Residue           241         1.365000         A.3	opierent, senik plex structure (jet), d.r. limited light resolution, artifacts						8 antennas
C J0526-3225 J0536-2703 J0602-2741 J0814-0536	452941         10173         1.4.576.0h.         0.00225         0.00225           19173         1.4.576.0h.         0.01017         0.00225         0.00225           19174         1.4.576.0h.         0.0014         0.00125         0.00225           19174         1.457.0h.         0.00145         0.00145         0.00145           12105         2.726.0h.         0.0026         0.00146         0.00145           12105         2.726.0h.         0.00126         0.00156         0.00156           12105         2.726.0h.         0.00126         0.00156         0.00156           12105         2.726.0h.         0.00126         0.00156         0.00156           12105         2.726.0h.         0.00126         0.00156         0.00156         0.00156           12105         2.726.0h.         0.00126         0.00156         0.00156         0.00156           12105         0.00146         0.00156         0.00156         0.00156         0.00156           12105         0.00146         0.00156         0.00156         0.00156         0.00156           12105         0.00146         0.00156         0.00156         0.00156         0.00156           12105         0.0016	1.50         1.000000         1.000000         1.000000           3.8.5         1.1000000         2.222.5000         Slightly in           4.6.1         4.0000000         2.222.5000         Slightly in           4.6.2         4.0000000         2.225.5000         Slightly in           4.1.2         2.225.000         3.225.6000         Slightly in           4.1.2         2.225.000         3.225.6000         Slightly in           4.1.2         2.225.000         3.225.6000         Slightly in           2.23         5.125.0000         3.225.6000         Slightly in           2.24         5.125.0000         3.225.6000         Slightly in           2.25         5.125.0000         3.225.6000         Slightly in           2.26         3.275.6000         3.255.6000         Slightly in           2.26         3.275.6000         3.255.6000         Slightly in           2.27         3.275.6000         3.255.6000         Slightly in           2.27         3.275.6000         3.255.6000         Slightly in           2.27         3.255.6000         3.255.6000         Slightly in           2.27         4.256.6000         3.255.6000         Slightly in           2.27	nas solved	0.00488	0.00146	-27.19	3.47E-004	-3.76E-004	No image
30630-2120	22110 5.72E-005 0.0037 0.00145 15336 7.54E-005 0.00437 0.00146 20730 6.53E-005 0.00437 0.00156 15804 6.73E-005 0.00490 0.00156	1.82 Z.52E-003 - 3.63E 004 Single con 6.23 4.24E-004 -3.74E-004 Beautred, 0.07 3.59E-004 -3.43E-004 Very weak	nponent, quite weak	0.0048	0.00149	-28.34	1.85E-003	-3.56E-004	Weak single component
J0652-2006 J0652-2006 J0732-2808 J0737+1825 J0739+2347 J0634+5609	552981         1.812-0.04         0.10102         0.02222           19232         1.812-0.04         0.01002         0.02222           19232         7.162-0.05         0.02077         0.01352           19232         7.162-0.05         0.02077         0.01452           19235         7.162-0.05         0.02077         0.01452           19336         7.428-0.05         0.02047         0.01454           19336         7.428-0.05         0.02047         0.01454           19344         6.332-0.05         0.02047         0.01454           19868         7.428-0.05         0.02042         0.01152           19868         7.428-0.06         0.02042         0.01154           19868         7.428-0.06         0.02042         0.01154           19868         7.428-0.06         0.02042         0.01154           19868         7.488-0.06         0.02042         0.01154           29175         5.488-0.06         0.02042         0.02172           29155         5.498-0.06         0.02044         0.00164           29155         5.498-0.06         0.02044         0.00164	-0.52 8.79E-004 -3.81E-004 No image 2.73 5.19E-004 -4.16E-004 No image 12.63 4.37E-003 -5.30E-004 Single con 14.08 3.73E-004 -2.63E-004 Very weak	nporent )5	0.00251	0.00123	-4.09	2.26E-003	-3.89E-004	Single component
J0739+2347 J0634+3609 J0804+3607 J0641+3208	19864         0.1.32-300         0.103300         0.00139           19885         7.082-305         0.00431         0.00139           18670         9.442-405         0.00431         0.00132           22167         5.072-406         0.00434         0.00162           22153         8.998-405         0.00541         0.00162           22131         5.042-406         0.00544         0.00165           21814         5.042-406         0.00542         0.00165           21815         5.142-406         0.00524         0.00165           21801         4.752-406         0.00526         0.00158	12.15 3.77E-003 -4.50E-001 Wide-dog 6.98 5.71E-003 -3.87E-004 Single-com 12.71 4.36E-003 -3.05E-004 Clearly re 7.30 2.80E-004 -2.53E-004 Very senial	ble, resolved secondary approximit solved	0.00259	0.00121	1.97	4.14E-002	-8.30E-004	Strong, resolved, possible symmetrical jets
30729+6546 D 30811-2225 30929-2063		12.7 4.67E-003 -2.63E-004 Single con 10 anten 6.22 3.67E-004 -4.65E-004 Very weak 6.97 2.4252-003 -3.69E-004 Very weak som	nas )5	0.00263	0.00122	-2.78	2.36E-003	-3.78E-004	Resolved, but questionable symmetries
J1001-2141 J0823-0124 J0845+0303	000077	0         0.0000           4.00         3.00000         Very wait           2.00         3.000000         Very wait           2.01         3.000000         Neight on           3.01         3.000000         Neight on           3.01         3.000000         Neight on           3.02         3.000000         Neight on           3.000000         3.000000         Neight on           3.000000         3.000000         Neight on           3.0000000         3.000000         Neight on           3.0000000         3.0000000         Neight on           3.0000000         3.0000000         Neight on           3.00000000         3.0000000         Neight on           3.00000000         3.0000000         Neight on           3.000000000000000000000000000000000000	ny image moment, slightly resolved )5	0.00284	0.00122	-4.76	6.72E-003	-3.17E-004	Slightly resolved
J1049-0232 J0849+3033 J1107+3421	24512 5.94E-005 0.03849 0.00135 23798 4.42E-005 0.00289 0.00147 22676 5.32E-005 0.00289 0.00147	0.24 2.28E-003 -2.20E-004 Weak une 7.95 3.09E-004 -2.51E-004 No image 5.67 3.84E-002 -3.86E-004 Single con	nsal double 04	0.00338	0.00112	-3.21	1.28E-002	-5.97E-004	Apparent triple, but artifacts, high rms
J1048+3553 J1210+4750 J1212+4619	211437 0.000200 0.000200 0.000200 00030 2.805-005 0.00250 0.00257 23087 3.705-005 0.0028 0.00162 24674 4.525-005 0.00271 0.00143 23244 6.045-005 0.01268 0.01157	3.43 1.685-03 - 1.67E-03 No image 31.35 4.26E-03 - 2.0EE-01 Close dou 12.19 8.13E-004 -2.28E-004 Weak une	tio gasi double or con-jet	0.01503	0.00078	-4.45	4.46E-003	-4.42E-003	Bad calibrator (no image)
J1238+3249 J1025+6128 E J1232+7907	127889 3450 1.41E-004 0.00257 0.00145	72.27 5.11E-03 -4.11E-03 Char-ore 3.11 3.68E-04 -2.42E-04 Very weak 7 actemn 36.97 3.34E-03 -9.02E-04 Single con	as )4	0.00338	0.00111	-5.56	3.63E-003	-6.21E-004	Possible wide double, quite weak
J1257+7308 J1428+1113 J1501+1324 J1517+3523	3418 1.13E-004 0.00534 0.00138	36.37 3.345-003 -0.025-004 Single cm 21.73 6.505-004 -6.835-004 No image -21.59 8.426-004 -8.075-004 No image -20.71 3.205-003 -6.275-004 Reserved - -14.59 8.205-004 -7.755-004 Reserved -	sinch research )5	0.00356	0.00111	-6.63	5.05E-004	-5.29E-004	No image
J1535+7640 J1343-1136 J1305-3447	214 5.78E-003 0.01036 0.00654 2588 1.23E-004 0.00584 0.00146 1809 1.52E-004 0.00738 0.00146	14.65 2.75E-013 -4.22E-013 No (mage -19.06 5.02E-003 -7.18E-004 Single can -23.2 1.438-012 -1.54E-003 Possible on -0.197 1.072 (mage can be ca	argani desible )4	0.00345	0.00111	-6.21	6.99E-003	-5.07E-004	Single component
J1412-2020 J1541-1344 J1500-0649	2804         188008         0.0.0109           214         586001         0.00106         0.00304           2588         1285001         0.00184         0.00184           1869         1255001         0.00184         0.00184           2202         1264004         0.00771         0.00142           2380         1984.004         0.00994         0.00141           2420         1984.004         0.00994         0.00141           2431         1984.004         0.00994         0.00144           2641         1984.004         0.00994         0.00141	-2017. 2.225-043 - 6.275-046 Resolved -4.438 8.225-044 - 7.257-040 No. Image 14.65 2.750-043 - 7.4252-043 No. Image -0.956 1.5025-033 - 7.1552-043 No. Image -2.432 1.445-042 - 1.5452-043 No. Image -2.411 3.1755-033 - 2.452-043 No. Image -2.411 3.1755-033 - 2.452-043 No. Image -1.451 1.452-043 - 3.252-043 No. Image -3.452 - 1.452-043 - 3.252-043 No. Image -3.452 - 1.452-043 - 3.252-043 No. Image -3.452 - 1.452-043 - 3.4521-043 No. Image -3.452 - 1.452-043 - 3.4521-043 No. Image -3.452 - 1.452-043 - 3.4521-043 - No. Image -3.452 - 1.452-04 - 3.4521-043 - No. Image -3.452 - 1.452 - 3.4521-043 - No. Image -3.452 - 1.452 - 3.4521-043 - No. Image -3.452 - 3.452-04 - 3.4521-043 - No. Image -3.452 - 3.452-04 - 3.4521-043 - No. Image -3.452 - 3.452-04 - 3.4521-043 - 3.4521-043 - 3.4521-043 - 3.4521-043 - 3.4521-043 - 3.4521-043 - 3.4521-043 - 3.4521-044 - 3.45	D5	0.00364	0.00117	-6.22	2.18E-003	-4.18E-004	Single component, weak
J1634-0235 J1521+0017 F J1634-1721	ALTER ALTERPOOR DIAMETER		av )5	0.0049	0.00156	-26.76	1.61E-002	-7.99E-004	Rich, complex structure (jet), d.r. limited
J1653-0102 J1641-0548 J1702-0811 J1703-0517	2653001         265500         1.06E-005         0.050511         0.00114           9448         8.76E-005         0.00272         0.00124           7476         9.48E-005         0.00272         0.00124           7916         1.22E-004         0.00285         0.00112           8270         1.72E-004         0.00285         0.00112           6412         1.69E-004         0.00285         0.00112	9 articlem 9 articlem 12.64 5.635-004 - 5.635-001 - No image 4.88 5.285-003 - 5.005-001 - Single con 2.16 5.285-004 - 5.277-004 - No image 1.39 8.145-003 - 8.125-004 - Single con 1.7 5.6695-004 - 3.105-003 - Very weak 4.55 - 725-004 - 8.025-007 - Very weak 4.55 - 725-004 - 8.025-004 - Very weak	oponent oponent, possible extension	0.00476	0.00151	-26.32	3.65E-004	-4.03E-004	No image
J1707-0939 J2006-2802 J2021-2611 J2124-2814	6412         1.09E-004         0.00285         0.00114           5892         1.48E-004         0.03312         0.00398           8544         1.29E-004         0.0298         0.00104           6510         1.00E-004         0.0238         0.00104	-1.7 6.60E-004 -1.10E-003 Very weak 6.55 7.53E-004 -8.53E-004 No image -6.4 7.20E-004 -8.28E-004 No image -0.8 7.48E-004 -6.99E-004 No image	(Investigation of the G	0.00617	0.00225	-7.89	4.60E-003	-7.68E-004	Possible slight resolution, artifacts
J1717+3313 J1642+4123 J1708+2615 J1961-0420 J1968-0746	5862         1.482/004         0.03122         0.00998           8544         1.292/045         0.0104         0.03128         0.00104           8510         1.482/004         0.00228         0.00124         0.00124           8383         8.152/005         0.00124         0.00124         0.00124           7279         8.418-005         0.00272         0.00138         0.0158           6431         8.332-005         0.00272         0.00138         0.00128           8425         8.892-005         0.00202         0.00138         0.0127           9435         8.892-005         0.00301         0.00127         0.00127           9435         8.892-005         0.00301         0.00127         0.00127	4.55         7.5250/01         -8.53250/01         -8.63250/01         -8.6616           -0.85         7.64570/01         -8.6616         -8.6616         -8.6616           -0.85         7.64570/01         -6.6616         -8.6616         -8.6616         -8.6616           -0.85         7.64570/01         -6.6616         -8.661	cal artifacts sporent non-squippared triple	S. 2	- entranting	- 1. T. S.		Sectional	10 antennas
11958-0746 <u>J2285-2838</u> G J1634-1721 J1653-0102	9658 1.32E-004 0.00288 0.00104 486410	4.82 2.60E-003 -5.85E-004 Weak trip 0.66 2.35E-003 -1.55E-003 Single con 10 antem 0.66 4.25E-004 -4.48E-004 No image	he, suspicious negative masses 14	0.01002	0.00232	18.35	1.19E-002	-9.32E-004	Slightly resolved
J1641-0548 J1702-0811	13555         8.332 (ord. 0         0.0021         0.0112           17027         7.215 (ord. 0         0.0031         0.0013           16884         6.882 (ord. 0         0.0031         0.0013           15091         6.362 (ord. 0         0.0031         0.0013           15091         6.362 (ord. 0         0.0033         0.0013           15091         6.362 (ord. 0         0.0033         0.0013           15091         1.025 (ord. 0         0.0032         0.0013           12081         1.205 (ord. 0         0.0032         0.0014           12081         1.205 (ord. 0         0.0032         0.0015           12081         0.205 (ord. 0         0.0035         0.0015           12081         0.205 (ord. 0         0.0035         0.0015           12181         0.315 (ord. 0         0.0015         0.0015 <td><math display="block"> \begin{array}{cccccccccccccccccccccccccccccccccccc</math></td> <td>oponent, slightly resolved</td> <td>0.00377</td> <td>0.00139</td> <td>-6.24</td> <td>4.99E-003</td> <td>-4.17E-004</td> <td>Slightly resolved</td>	$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	oponent, slightly resolved	0.00377	0.00139	-6.24	4.99E-003	-4.17E-004	Slightly resolved
J1103-0517 J1702-0500 J2000-2802 J2021-2611 J2124-2814 J1717+5318 J1642+4123 J1705+2615	13291         4.958-1005         0.02015         0.02015           14303         1.0357-09         0.02015         0.02012         0.0212           12304         0.257-09         0.02012         0.0212         0.0112           12304         0.257-09         0.03022         0.00112         0.0113           12404         0.257-09         0.03022         0.00113         0.0114           12404         0.257-09         0.03022         0.00114         0.0114           12404         0.257-09         0.03024         0.0014         0.0114           12404         0.257-09         0.0016         0.0016         0.0114           12404         0.257-09         0.0016         0.0016         0.0016           12414         0.158-09         0.0016         0.0016         0.0016           124614         0.158-09         0.0016         0.0016         0.0016           12431         0.159-06         0.00253         0.0016         0.0018	-2.37         1.995-002         -7.425-040         Single res           -0.18         2.826-003         -5.226-004         Single res           -3.04         5.275-004         -5.032-001         No image           -4.03         5.275-004         -5.032-001         No image           -4.23         5.275-004         -5.032-001         No image           -6.22         5.020-014         -5.222-014         No image           -6.24         5.020-014         -5.222-014         No image           -6.27         5.020-014         -5.222-014         No image           -6.25         5.020-014         -5.222-014         No image           -6.59         1.435-0077         -5.645-004         Dorshive, yo           -17.26         2.692-004         -5.225-004         No image	)5	0.00358	0.00133	-2.54	1.24E-003	-4.15E-004	Weak
J1717+5313 J1642+4123 J1708+2615	17274 6.79E.005 0.0023 0.0014 17990 8.39E.015 0.0025 0.00145 12911 1.15E.015 0.00256 0.00147	-0.327-014 So (mag) -0.22 4 1.550-012 -0.106-004 Single con -0.13 5.742-013 -0.842-014 Single con -0.566 1.435-012 -0.562-014 Double, sp -0.561 2.455-014	applement applement remeterical artifacts	0.0034	0.00145	-1.82	2.52E-003	-3.03E-004	Single component, quite weak
J1961-0420 J1968-0746 J2235-2838	18045 7.312.005 0.02233 0.00145 13131 5.199-006 0.02549 0.00138 2142 1.042.005 0.02208 0.00733	-11.24 3.862-004 -4.15E-004 No image -3.48 2.55E-003 -3.25E-004 Complex i 24.51 8.09E-003 -4.80E-003 Single con	oponent, bad artifacts 05	0.00437	0.00166	-6.23	4.24E-004	-3.74E-004	Resolved, very weak
			)5	0.00402	0.00156	0.07	3.59E-004	-3.43E-004	Very weak

#### Selected Results --> New VLBA Proposal



# VLA Data

- $\square$  X-band A-array data (8 GHz)  $\longrightarrow$  0.25"
- Sources are unresolved
- □ Go to  $K_a$ -band (30-40 GHz)  $\longrightarrow$  0.06"
- Reduced data for 1 source: 60 GB, 1 hour observing time
- $\Box$  CASA is slow  $\mathfrak{S}$

### Future Work

- More VLA K-band imaging
- In-depth VLBA studies of subsample
  - Multi-frequency, polarimetry
  - 12 sources with complex structure
- MERLIN imaging
- Goal is comprehensive radio imagery across a broad range of size scales

# Summary

- AGNs affect almost all large-scale structures in the universe
- Properties of young radio jets in luminous quasars are still greatly unknown
- We've seen evidence of resolved structures that agree with previous models
- Time to get some better data:



# Summary

- AGNs affect almost all large-scale structures in the universe
- Properties of young radio jets in luminous quasars are still greatly unknown
- We've seen evidence of resolved structures that agree with previous models
- Time to get some better data:







# Acknowledgements

- Colin Lonsdale
- Vincent Fish & Lynn Matthews
- K.T. Paul, Heidi Johnson, Phil Erickson, Vincent Fish, & other program organizers
- National Science Foundation
- Entire Haystack staff