The relationship between FR0 radio galaxies and GPS sources

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The sample and observations

- 34 objects from FR0CAT (Baldi et al., 2018) with $S > 30$ mJy at 1.4 GHz
- $z < 0.05$, $-09^\circ < Dec < 47^\circ$, $01^h < RA < 17^h$
- The Northern sector of the RATAN-600 radio telescope, frequencies: 1.28, 2.25, 4.7, 8.2, 11.2, 22.3 GHz
- Transit mode (the horizontal passage of the source in the meridian through the unmoving pattern of the telescope due to the Earth rotation)
- Quasi-simultaneous spectra were obtained as a result of averaging all records of the source passage over a timescale of 7-10 days
- Observations: February 2020 – currently
- 2-6 observing epochs for each object

f_0 (GHz)	Δf_0 (GHz)	ΔF (mJy/beam)	$HPBW_x$ sec	AR arcsec
22.3	2.5	70	1.0	11
11.2	1.4	20	1.4	16
8.2	1.0	25	2.0	22
4.7	0.6	5	3.2	36
2.25	0.08	40	7.2	80
1.28	0.06	175	15.4	170

Quasi-simultaneous spectra

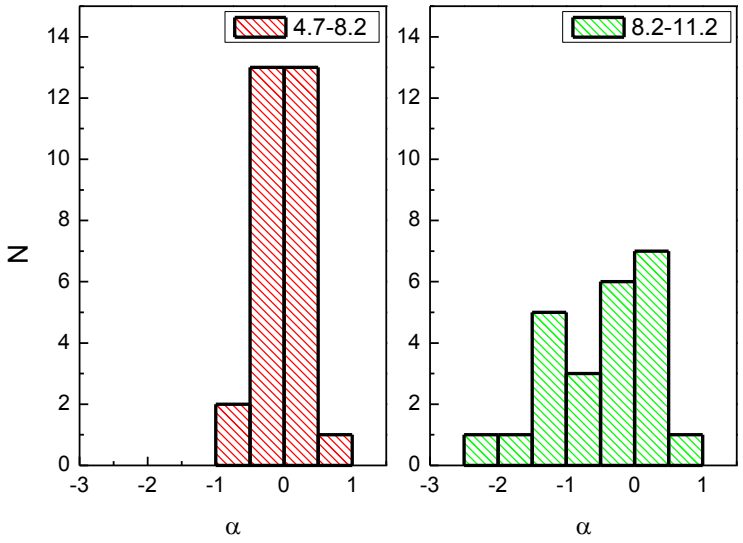
Type of a spectrum

	N	%
steep	7	29
inverted	3	12
peaked	10	42
upturn	4	17

Spectral indices

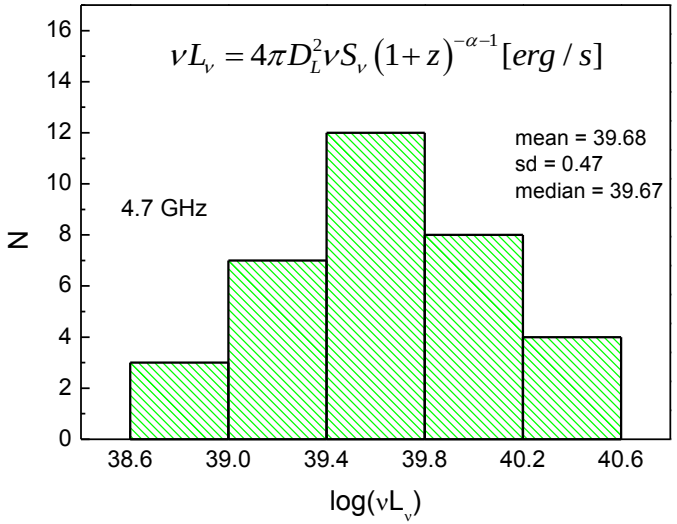
$$\alpha = \frac{\log S_2 - \log S_1}{\log \nu_2 - \log \nu_1}$$

range	N	mean	sd	median
2.25-4.7	5	-0.15	0.66	-0.03
4.7-8.2	29	-0.03	0.33	-0.11
8.2-11.2	24	-0.50	0.73	-0.34
11.2-22.3	7	-0.31	0.34	-0.29

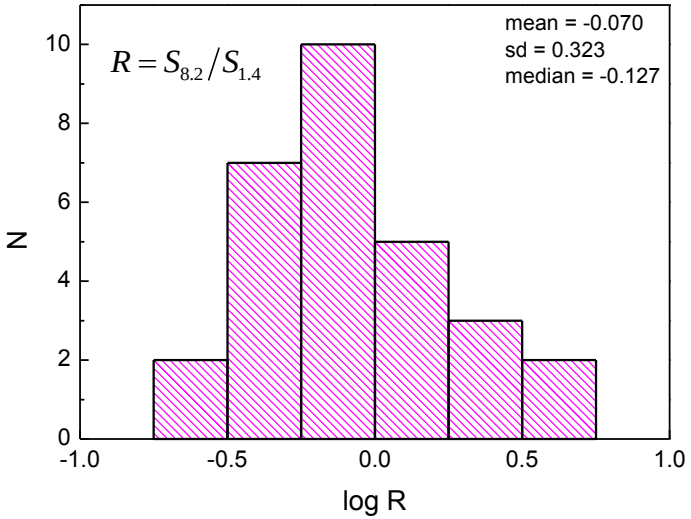


Radio properties

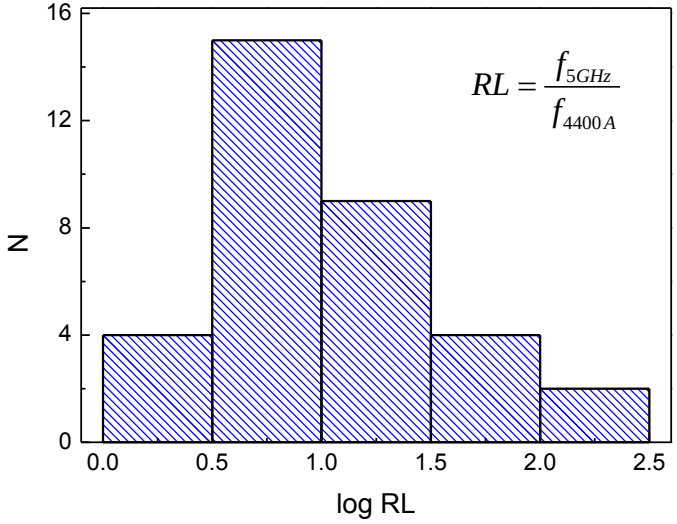
Radio luminosity

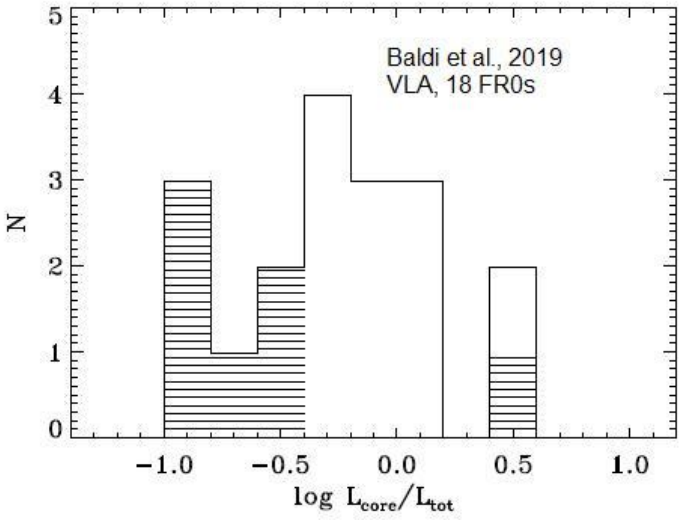


Core dominance parameter

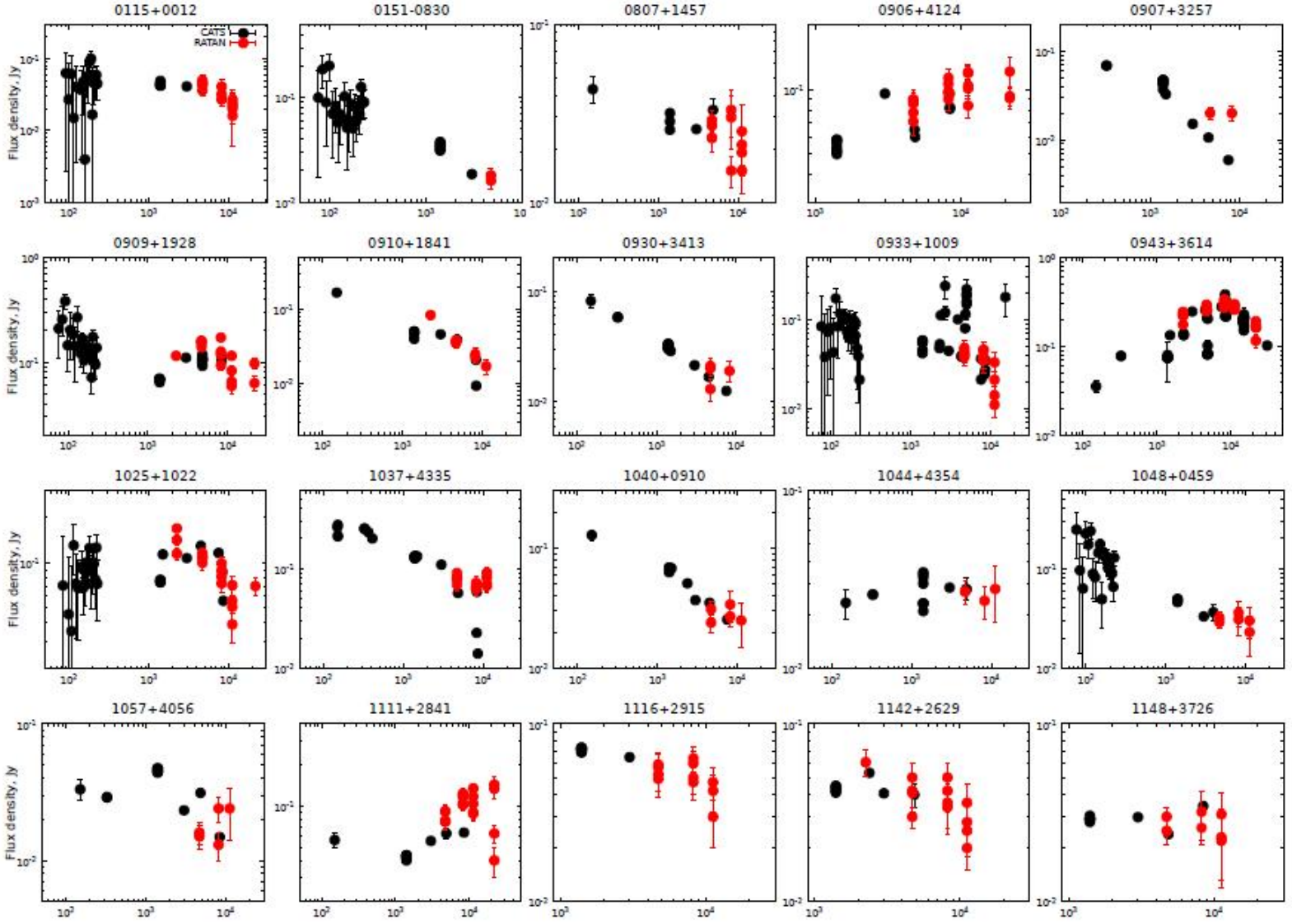


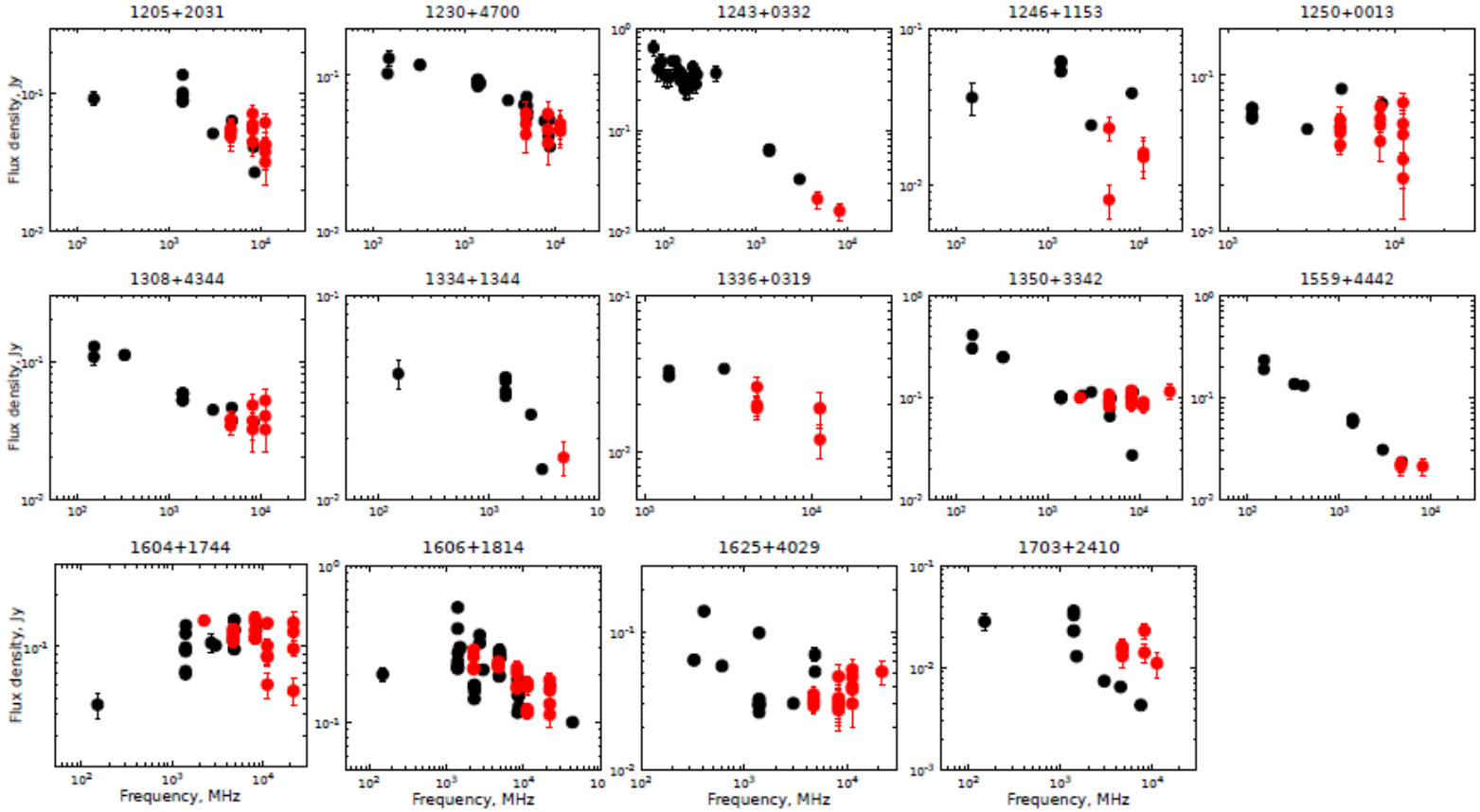
Radio loudness





The continuum radio spectra of FR0 radio galaxies





Red points are the RATAN-600 measurements
Black points are the literature data
(GLEAM, TGSS, LOFAR, NVSS, VLASS, VLA, VLBI)

FR0 and GPS

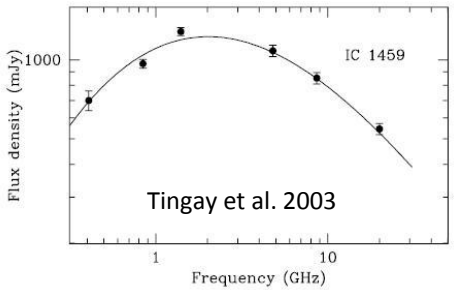
Criteria

O'Dea+ 91, de Vries+ 97

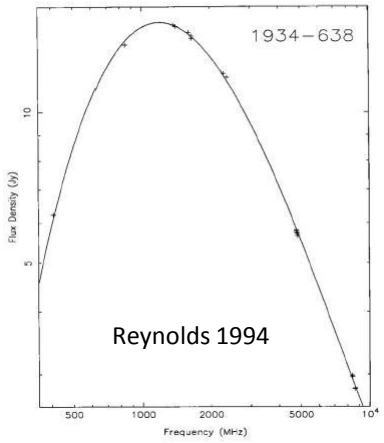
$$\alpha_{below} = +0.5$$

$$\alpha_{high} = -0.7$$

$$FWHM \approx 1.2$$



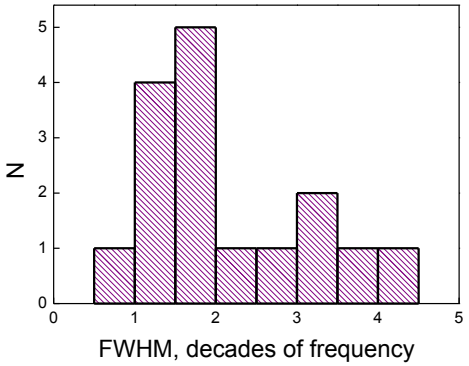
Tingay et al. 2003



Reynolds 1994

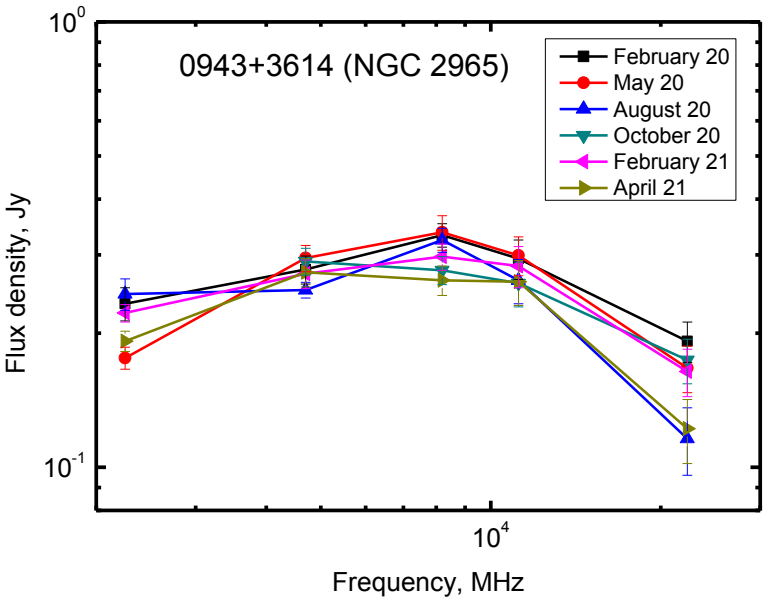
The source	α_{below}	α_{high}	ν_{peak} , GHz
0115+0012*	0.45	-0.79	0.48
0906+4124	0.32	-0.05	11(?)
0909+1928*	0.45	-0.79	4.63
0943+3614*	0.41	-0.71	8.34
1025+1022	0.37	-0.45	0.97
1057+4056	0.23	-0.64	0.84
1111+2841	0.50	-0.30	10.69
1142+2629	0.39	-0.44	2.93
1205+2031	0.03	-0.39	0.37
1246+1153	0.21	-0.62	0.29
1334+1344	?	-0.68	0.39
1336+0319	?	-0.36	1.16
1604+1744	0.21	-0.38	5.67
1606+1814	0.16	-0.25	0.54

FWHM of FR0s

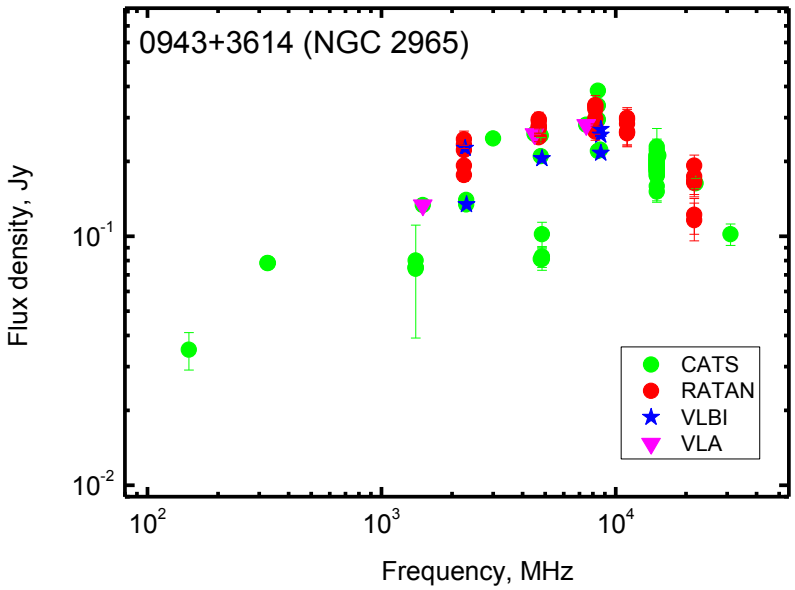


Candidates

Quasi-simultaneous spectra with RATAN-600



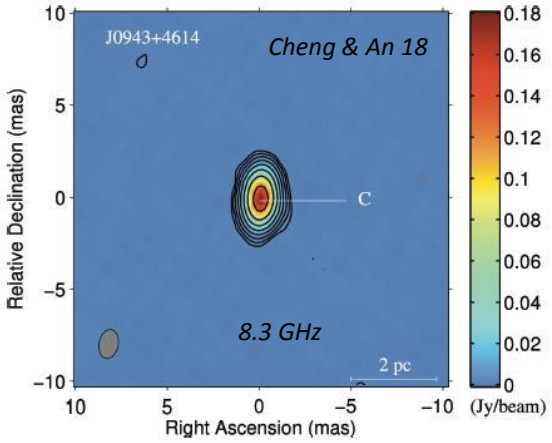
The broad-band radio spectrum



$M_{4.7} = 0.05$

$M_{8.2} = 0.09$

$M_{11.2} = 0.06$



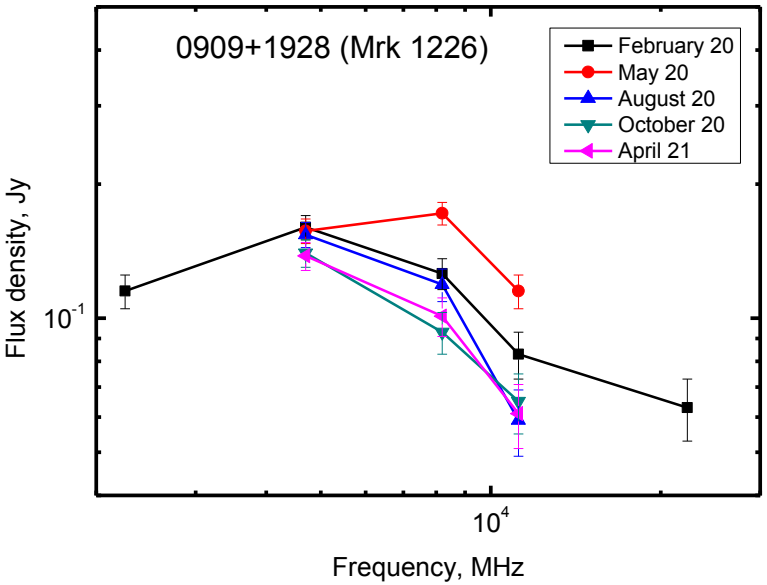
$\alpha_{below} = 0.41$

$\alpha_{high} = -0.71$

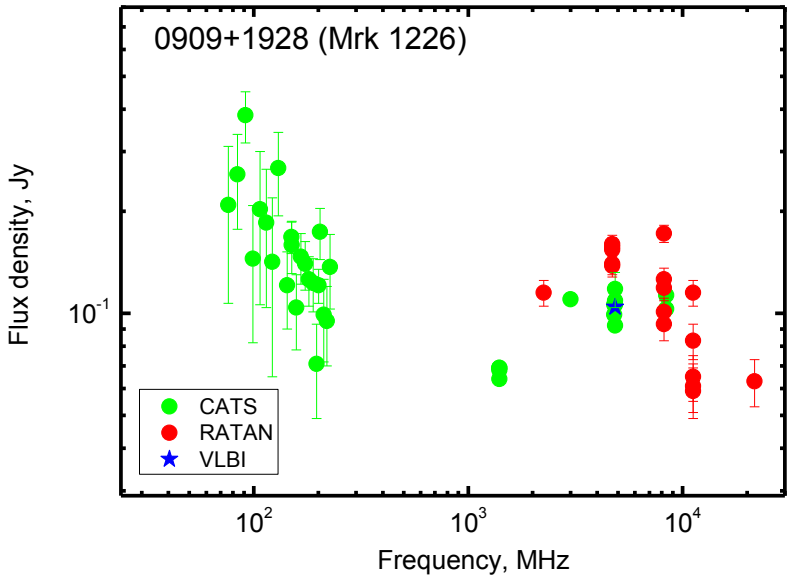
$\nu_{peak,GHz} = 8.3$

Candidates

Quasi-simultaneous spectra with RATAN-600



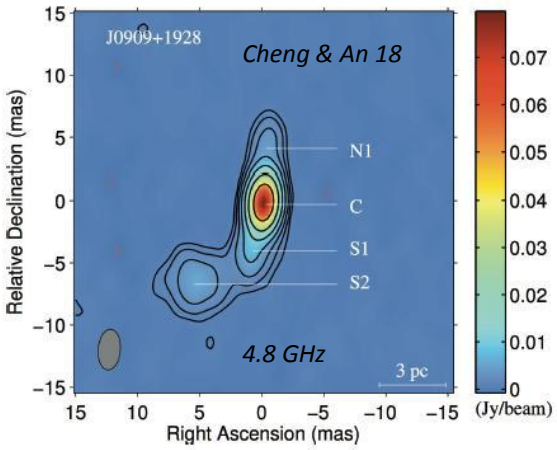
The broad-band radio spectrum



$M_{4.7} = 0.06$

$M_{8.2} = 0.23$

$M_{11.2} = 0.27$



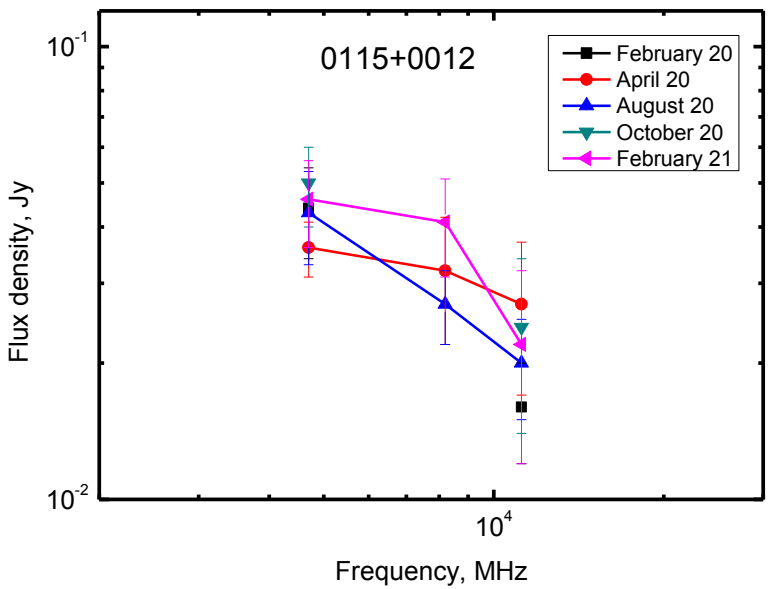
$\alpha_{below} = 0.45$

$\alpha_{high} = -0.79$

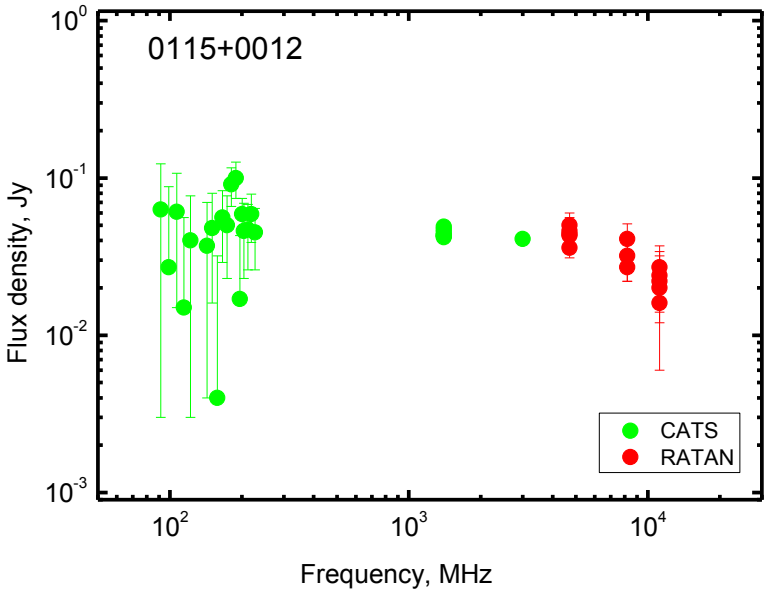
$\nu_{peak,GHz} = 4.6$

Candidates

Quasi-simultaneous spectra with RATAN-600



The broad-band radio spectrum



$M_{4.7} = 0.10$

$M_{8.2} = 0.17$

$M_{11.2} = 0.17$

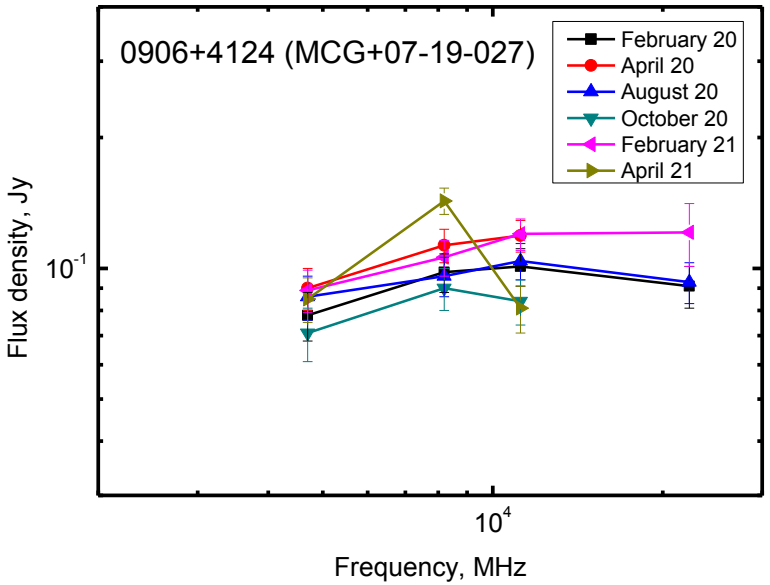
$\alpha_{below} = 0.45$

$\alpha_{high} = -0.79(?)$

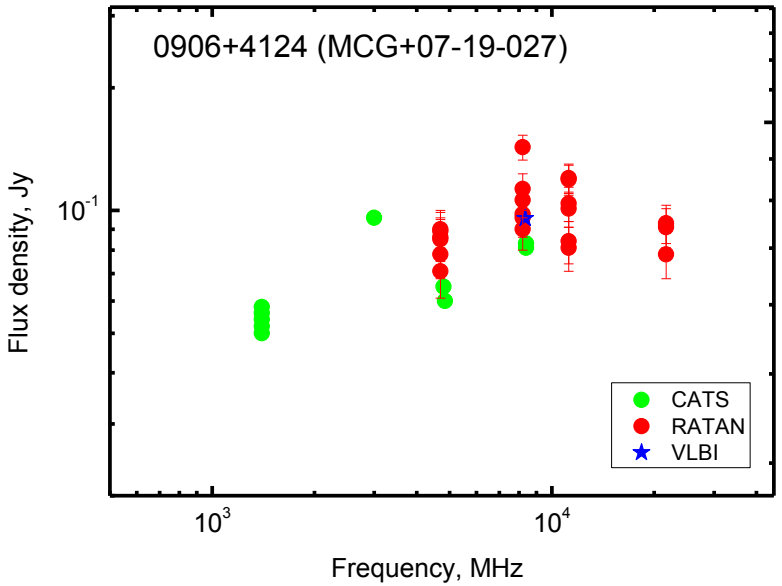
$\nu_{peak,GHz} = 0.5$

Candidates

Quasi-simultaneous spectra with RATAN-600



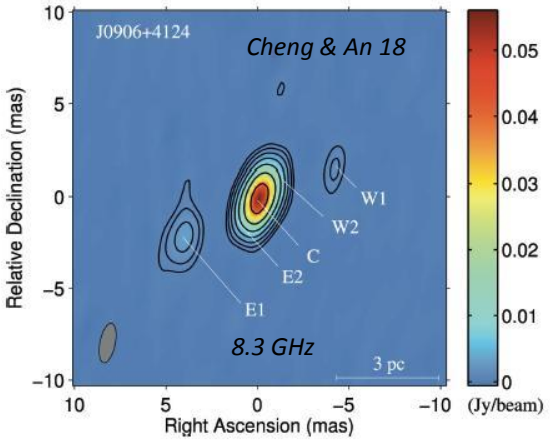
The broad-band radio spectrum



$M_{4.7} = 0.08$

$M_{8.2} = 0.16$

$M_{11.2} = 0.15$



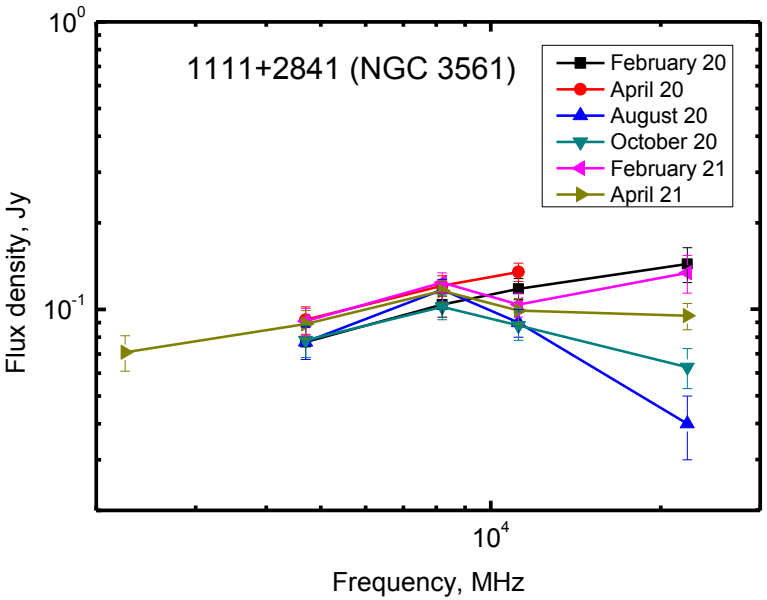
$\alpha_{below} = 0.32$

$\alpha_{high} = -0.05$

$\nu_{peak,GHz} \sim 11(?)$

Candidates

Quasi-simultaneous spectra with RATAN-600

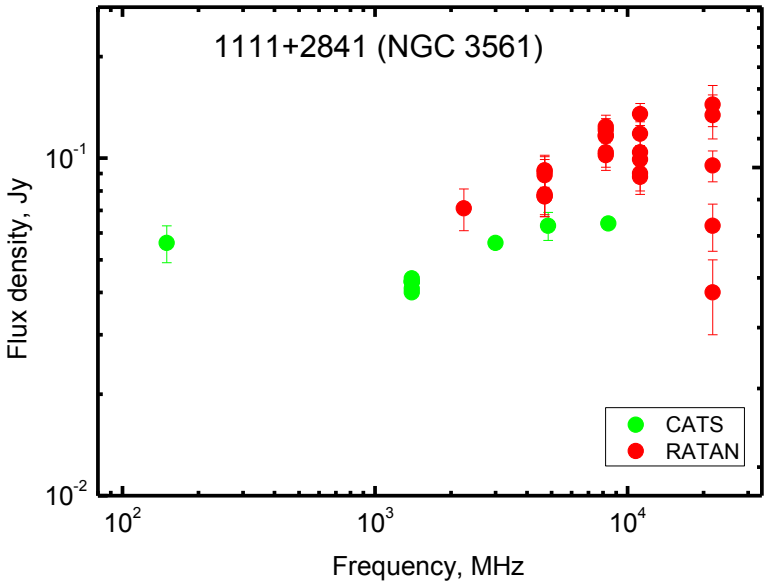


$M_{4.7} = 0.08$

$M_{8.2} = 0.07$

$M_{11.2} = 0.16$

The broad-band radio spectrum



$\alpha_{below} = 0.50$

$\alpha_{high} = -0.30$

$\nu_{peak,GHz} = 10.7$

Summary

- *We obtained radio spectra at 2.25-22.3 GHz for 34 FR0s.*
- *Quasi-simultaneous spectra of most objects (~40 %) have a peaked shape. Compared to the GPS sources, FR0s have lower spectral curvature.*
- *Some FR0s can be low power GPS sources.*

Problems

- *Variability properties.*
- *The relationship between FR0s and different classes of compact/extended radio sources.*

Thank you for your attention!