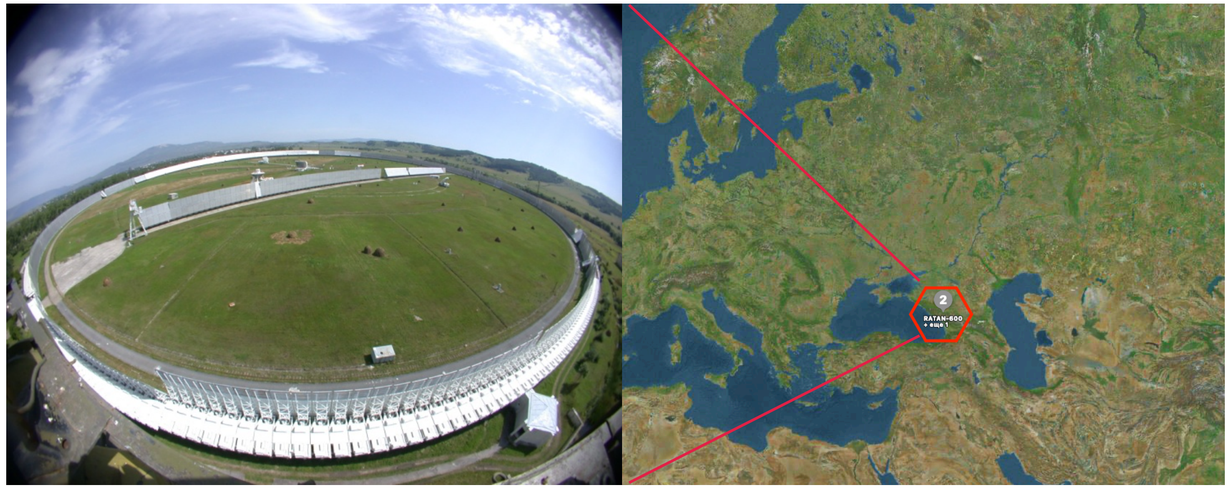
Radio properties of radio-loud high-redshift quasars at z>3

Mufakharov Timur (SAO RAS)

RATAN-600 blazar monitoring program

- RATAN-600 radio telescope stands out for its capability of obtaining **six-frequency measurements (1–22 GHz) simultaneously**
- ~3-10% typical uncertainty, sensitivity for each scan ~10 mJy, angular resolution up to 22" (see the table)
- **BLcat** catalogue contains >1800 blazars selected with $S_{1.4GHz}$ > 100 mJy for RATAN-600 monitoring at two radiometric complexes: 1.2, 2.3, 4.7, 7.7/8.2, 11.2, 21.7/22.3 GHz



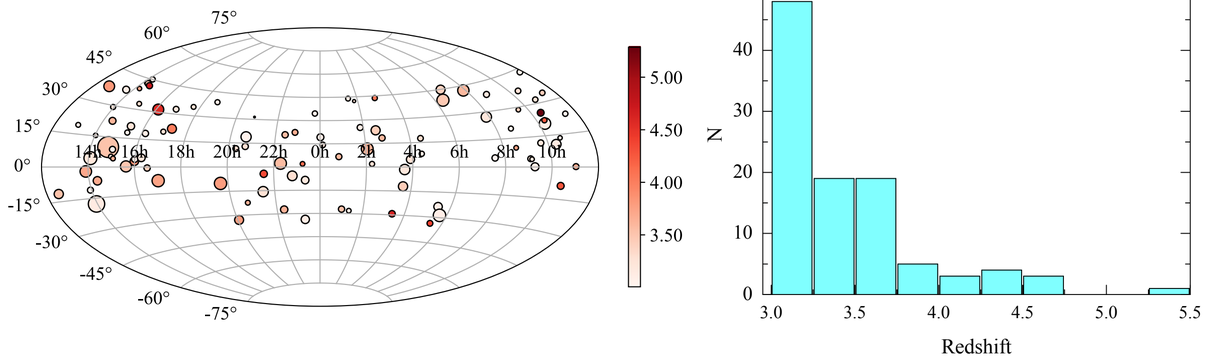
Sample

- 101 radio-loud ($S_{radio}/S_{optical}$>100) quasars with $S_{1.4GHz}$ > 100 mJy at -34°<δ<49°
- All redshifts are determined spectroscopically
- 48 of 101 are identified as blazars in BZCAT (Massaro et al. 2015) and only 7 have matches in 4FGL (Abdollahi et al. 2020)

f_0 (GHz)	Δf_0 (GHz)	ΔF (mJy/beam)	$HPBW_x$ sec	AR arcsec	f_0 (GHz)	Δf_0 (GHz)	ΔF (mJy/beam)	$HPBW_x$ sec	AR arcsec
22.3	2.5	50	1.0	11	22.3	2.5	95	1.5	16.5
14.4	**2.0**	**25**	**1.1**	**13**	**14.4**	**2.0**	**50**	**1.6**	**18**
11.2	1.0	15	1.4	16	11.2	1.0	30	2.1	23
8.2	1.0	10	2.0	22	**8.2**	**1.0**	**20**	**2.7**	**30**
4.7	0.6	5	3.2	35	4.7	0.6	10	4.8	53
2.25	**0.08**	**40**	**7.2**	**80**	**2.25***	**0.08**	**80**	**11**	**121**
1.28	**0.06**	**200**	**10**	**110**					

Data

RATAN-600 dedicated observations in 2017-2020 together with the CATS database catalogues including NVSS, FIRST, WENSS, ATCA20, TGSS, GB6, GLEAM measurements to extend the frequency and time range



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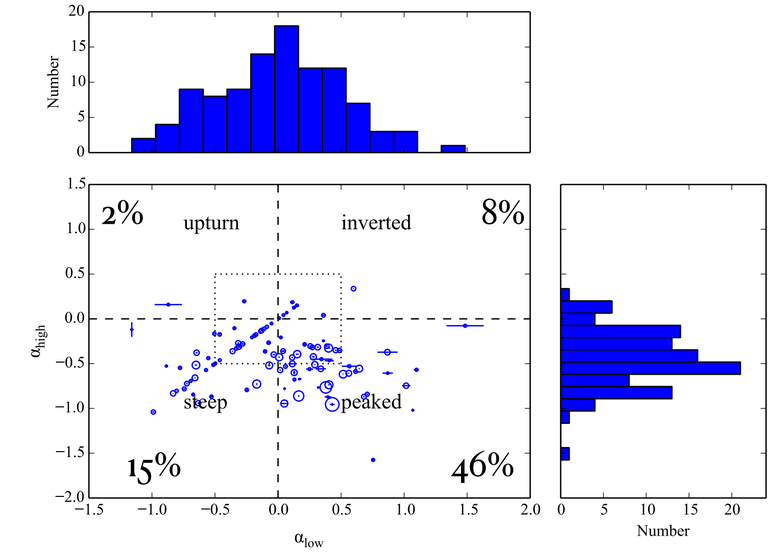
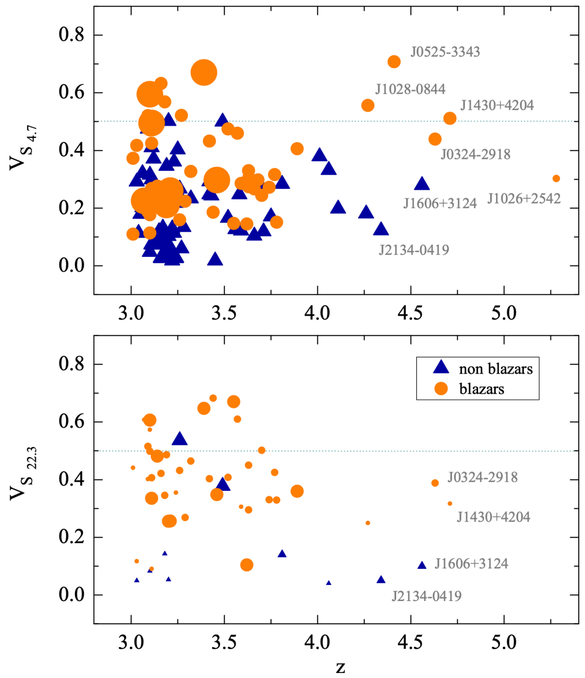
Summary of the results

- The high prevalence of sources with peak radio spectra (46%) indicates a significant population of young evolving AGN. Thus we found that peaked spectrum is a typical feature of blazars at high redshifts, and this distinguishes them from the flat spectrum low-redshift blazars. At the same time, no significant correlation of the spectral index with the redshift was found for quasars of our sample;
- We obtained a wide spread of radio variability on any time scale of the measurements. About half of the objects in the sample show a variability level (25–50%) comparable to that of the blazars at low redshifts. Some quasars demonstrate flux density variations of up to 60–90% at 8.2–22.3 GHz. The median values of the different variability indices are about 0.20 at 2.3–8.2 GHz and are higher at 22.3 GHz (0.28–0.36). The latter fact may suggests that the emission from the compact core dominates at higher frequencies, while at lower frequencies, the emission from jet components could blend with the core emission, shifting the distribution peak to lower values;
- The timescale of the variability of the quasars at z = 4-6 in a source's frame is τ_{rest} = 16-40 days, which corresponds to the very compact size of the radiation region of several tenths of a pc;
- We suggest seven new candidates for gigahertz-peaked spectrum (GPS) sources and five new megahertz-peaked spectrum (MPS) sources based on their spectrum shape and variability features. Only 6 out of the 23 sources previously reported as GPS demonstrate a low variability level typical of classical GPS sources (V_S<0.25) at 4.7–22.3 GHz.





Main results are published in:

1) Sotnikova Y., Mikhailov A., Mufakharov T., Mingaliev M., Bursov N., Semenova T., Stolyarov V., et al., 2021, MNRAS, 508, 2798. doi:10.1093/mnras/stab2114 arXiv:2109.14029

2) Sotnikova Y., Mikhailov A., Mufakharov T., An T., Kudryavtsev D., Mingaliev M., Udovitskiy R., et al., 2024, Galaxies, 12, 25. doi:10.3390/galaxies12030025 arXiv:2406.01458

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https://www.sao.ru/blcat/

Thank you for your attention!