RadioAstron AGN survey

Yuri Kovalev (ASC Lebedev) for the RadioAstorn AGN survey team

RadioAstron AGN survey: the team

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GRTs: dedicated time and proposals

VLBI:
Kvazar network: Sv, Bd, Zc (Russia);
Kalyazin (Russia);
Evpatoriya (Ukraine);
Effelsberg (Germany);
WSRT (the Netherlands);
Torun (Poland);
Medicina, Noto, Sardinia (Italy);
Yebes (Spain);
Jodrell Bank 1 & 2 (UK);
Robledo (Spain);
Usuda (Japan);
Shanghai 25 & 64, Urumqi (China);
VLA, GBT, Arecibo (USA);
HartRAO (South Africa);
LBA.

Single-dish:
RATAN-600 (Russia);
ATCA (Australia);
WSRT (the Netherlands);
Urumqi (China);
Effelsberg (Germany);
Oven Valley (USA);
GBT (USA).



RadioAstron AGN survey: main goal

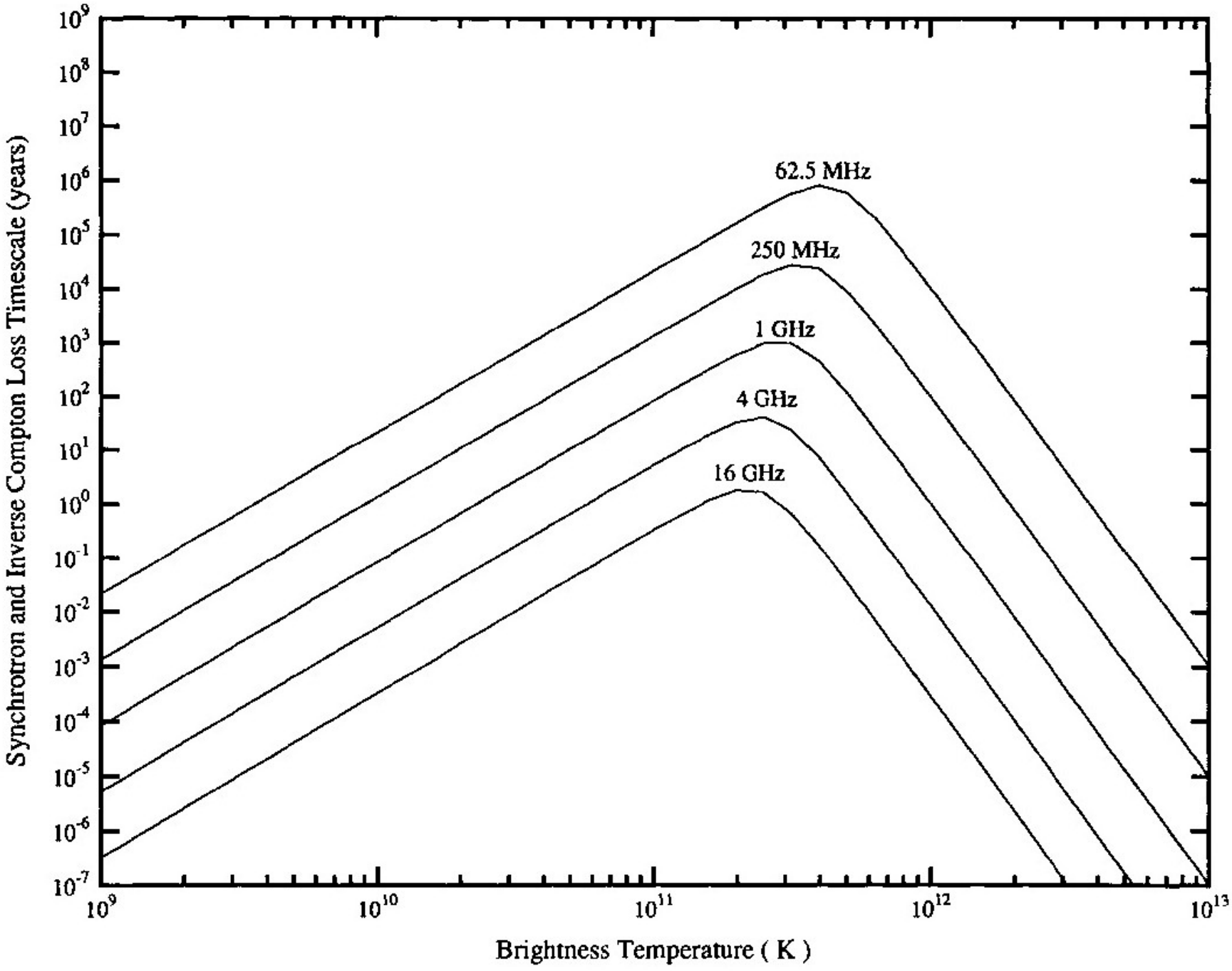
The goal:

Measure and study brightness temperature of AGN cores in order to better understand physics of their emission while taking interstellar scattering into consideration.

Estimate brightness temperature of most compact structure(s) in the AGN jet base. Test the predicted inverse-Compton limit (10^{12} K for electrons) boosted by the Doppler factor. Overcome the Earth-based T_b limit. This can not be done by going to higher frequencies on the ground; only Space VLBI.

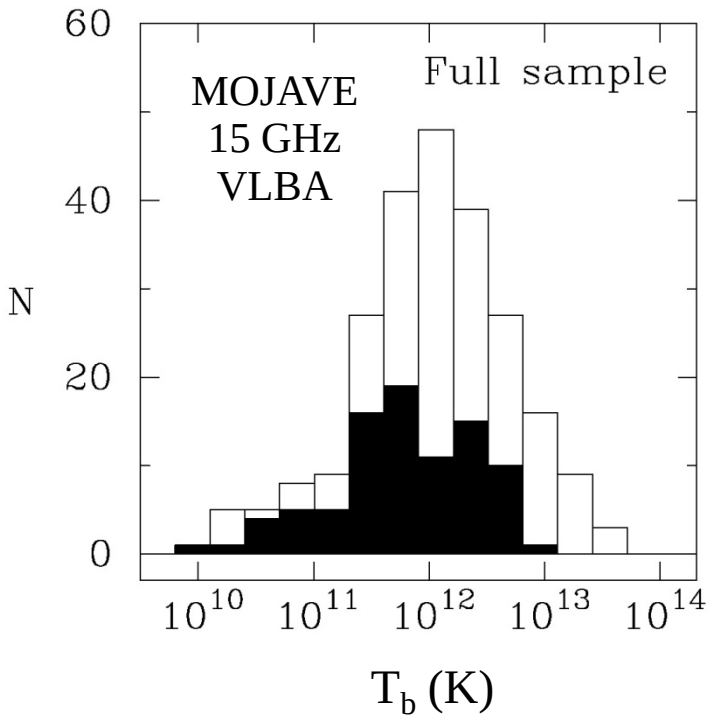
Critical to test emission mechanism. Introduce/support or “kill” exotic models.

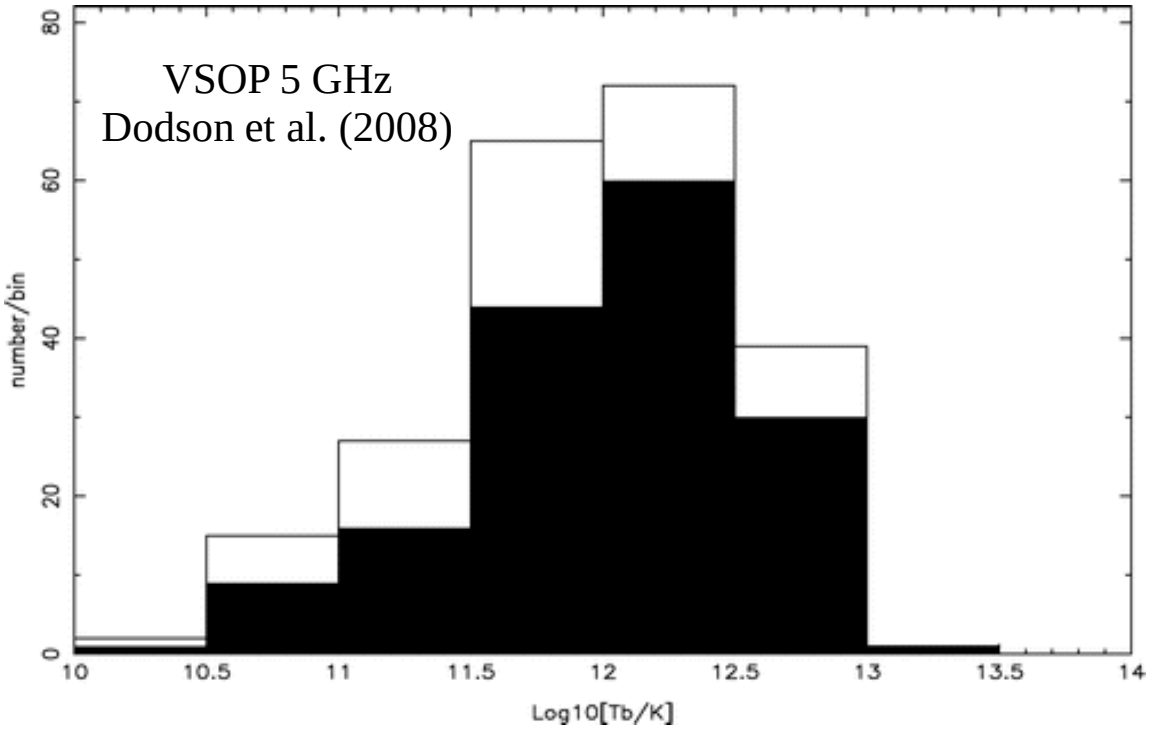
Radiation losses



Readhead (1994)

The brightness temperature inverse-Compton limit





Median $T_b = 10^{12}$ K, max T_b (limit) $= 5 \cdot 10^{13}$ K.

The inverse-Compton limit of 10^{12} K is confirmed if Doppler boosting is involved. And we know from VLBI kinematics measurements (Lorentz factors up to 50 are estimated) that jet emission is indeed boosted. But some lower limits are present in the distributions.

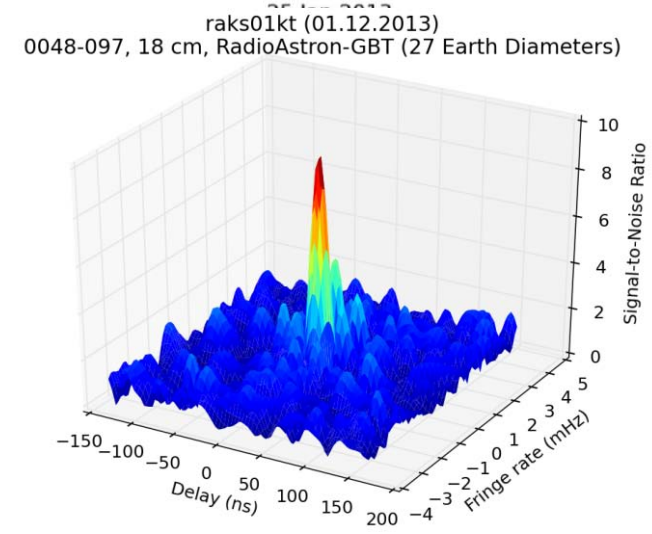
AGN survey results: statistics

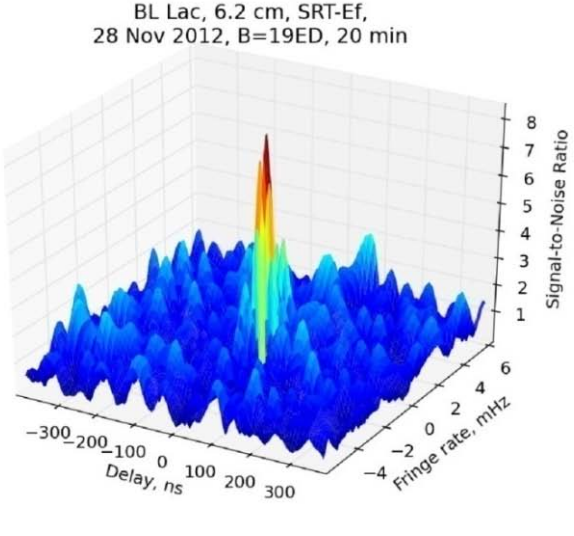
Sample: ~250 strong AGN

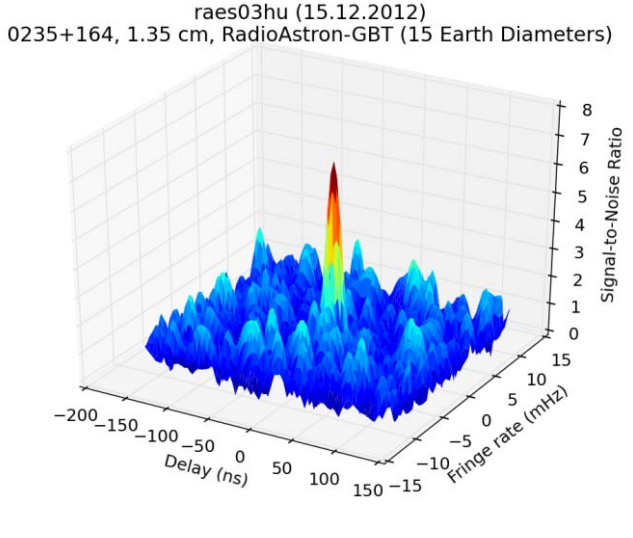
Correlated and post-processed to date: 1600 experiments, about 220 targets. Significant detections are found for 130 AGNs in 580 experiments at 18 and/or 6 and/or 1.3 cm up to 350,000 km.

The highest resolution: 0235+164 & OJ287 at 1.3 cm, 15 ED, about 14 μas.

Summary: typical Tb at least one order of magnitude higher than what was previously known.



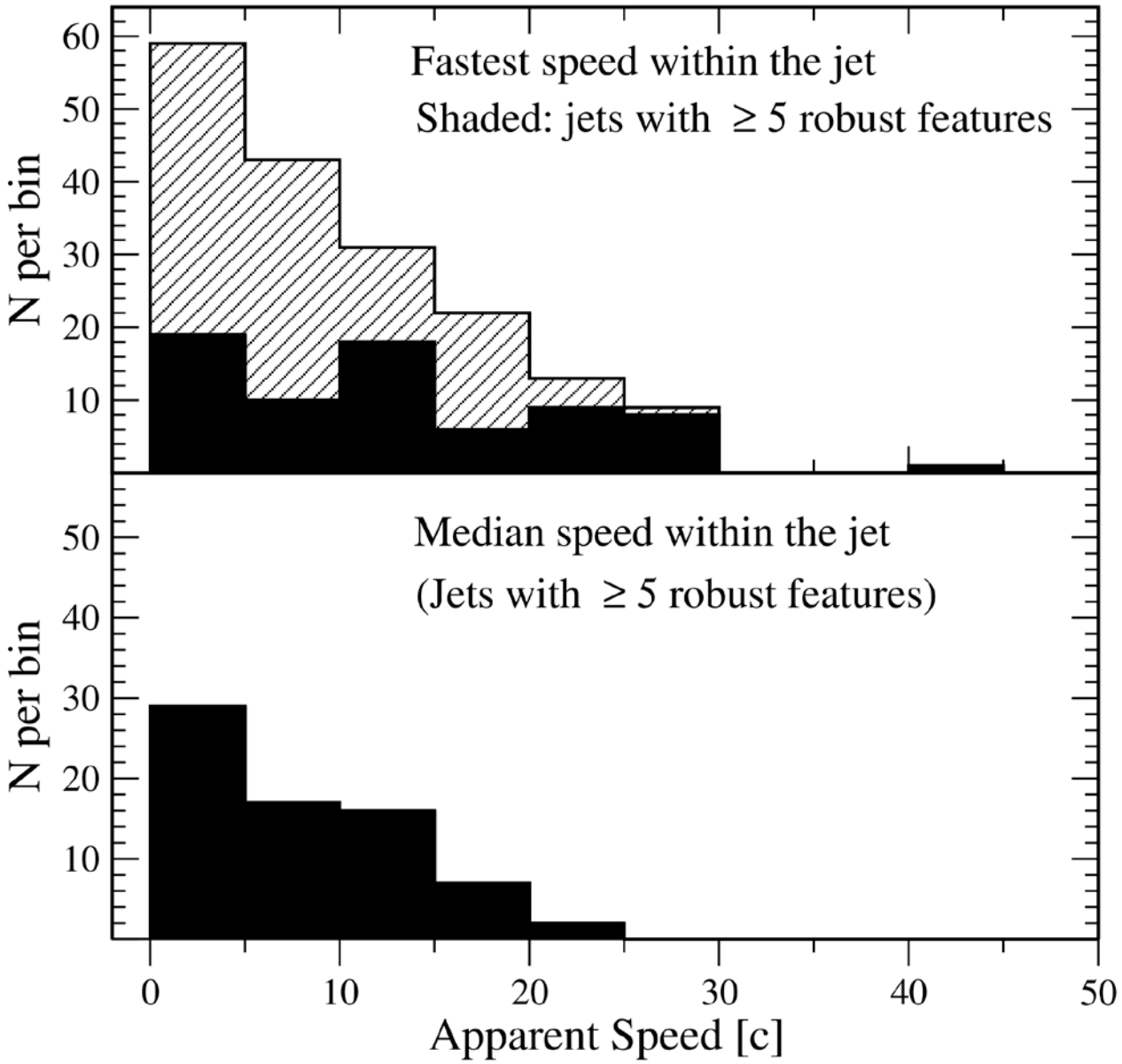




How to generate high brightness temperature?

- ✓ Protons – not straightforward, requires very efficient acceleration and high magnetic field.
- ✓ Coherent processes – requires very high magnetic field.
- ✓ Continuous (re-)acceleration several parsecs away from the central engine.
- ✓ Continuously “excited” core – not supported by single-dish and VLBI monitoring observations, flares do not happen all the time and should cool down within several days.
- ✓ Very high Doppler boosting with *typical* δ~100 – kinematics does not confirm it. Wrong kinematics?

VLBI kinematics of AGN jets (MOJAVE)



Lister et al. (2012); no news expected from an update to be released soon.

Summary

- AGN cores appear in RadioAstron observations at least about 10 times brighter that what was known before

- No apparent explanation why this could be the case

  Equipartition between particles and magnetic field does not look to be typical for AGN cores.

Thank you