MULTI-BAND STUDIES OF SOME BLAZARS WITH THE OPTICAL AND RADIO TELESCOPES OF SAO RAS

Vlasyuk Valery V. & Sotnikova Yulia V.
on behalf of SAO RAS MALBRICS team

International Scientific Conference
«Active galaxies at different scales and wavelengths», Nyznniy Arknyz, 14-17.10.2024

Optical and radio study of blazars

SAO RAS




610 Collective use centers

360 Unique scientific facilities

7 Megascience class facilities

- **Big Telescope Azimuthal (BTA): 6 m**
- **RATAN-600 radio telescope: 600 m**

Research: stars, planets and protoplanet systems, the Solar system and the Sun, the Galaxy, galaxies, CMB, the interstellar medium, Instruments and Methods.

Nizhny Arkhyz, Karachai-Cherkessian Republic
Russia 369167
admsao@sao.ru
www.sao.ru
+7(87878) 46336
+7(87878) 46315

BTA, Zeiss-1000 & AS-500/2 parameters

BTA PARAMETERS	
Main mirror diameter	6.05 m
Focal length	24 m
Light collecting area	25.1 sq.m
Wavelength range	0.3 - 10 mkm
Angular resolution	0”.6
Angular resolution with the speckle interferometry	0”.02
Limiting magnitude for images	26.8 (S/N=5, T_{exp}=1800 s, 1.5”)
Limiting magnitude for low-resolution spectra	24 (S/N=10 in continuum, T_{exp}=7200 sec)

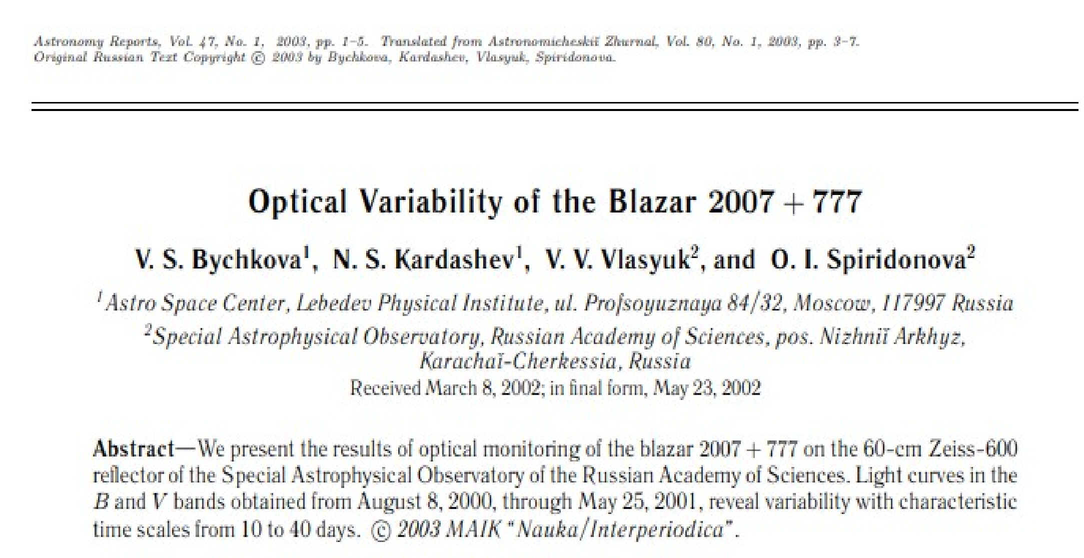
ZEISS-1000 PARAMETERS	
Main mirror diameter	1016 mm
Ritchey - Cretien system	
Focal length	13.3 m
Photometer field diameter	7’
Coude system	
Focal length	36.5 m
Spectral resolution	40000,80 000
Wavelength range	0.3 - 10 mkm
Angular resolution	0”.8
Spectral resolution (long slit)	500-1500
Limiting magnitude for images, V band	23.5 (T_{exp}=1800 sec, seeing 1.5”)

AS-500/2 PARAMETERS	
Main mirror diameter	508 mm
Primary focus f/3	
Focal length	1.4 m
FOV diameter (w/corrector)	1.3°
Cassegrain focus f/8	
Focal length	4.0 m
FOV diameter	35’
FOV /Andor EM CCD 512x512	7’
Data sampling	0”.82
Angular resolution	0”.9
Limiting magnitude for images,V band	23.0 (T_{exp}=3600 sec, seeing 1.5”)

OUR SMALL TELESCOPES

- 1-м и 60-см инструменты

OUR FIRST RESULTS – BLAZAR 2007+777 (2000-2001)



Astronomy Reports, Vol. 47, No. 1, 2003, pp. 1–5. Translated from Astronomicheskiĭ Zhurnal, Vol. 80, No. 1, 2003, pp. 3–7.

Optical Variability of the Blazar 2007 + 777

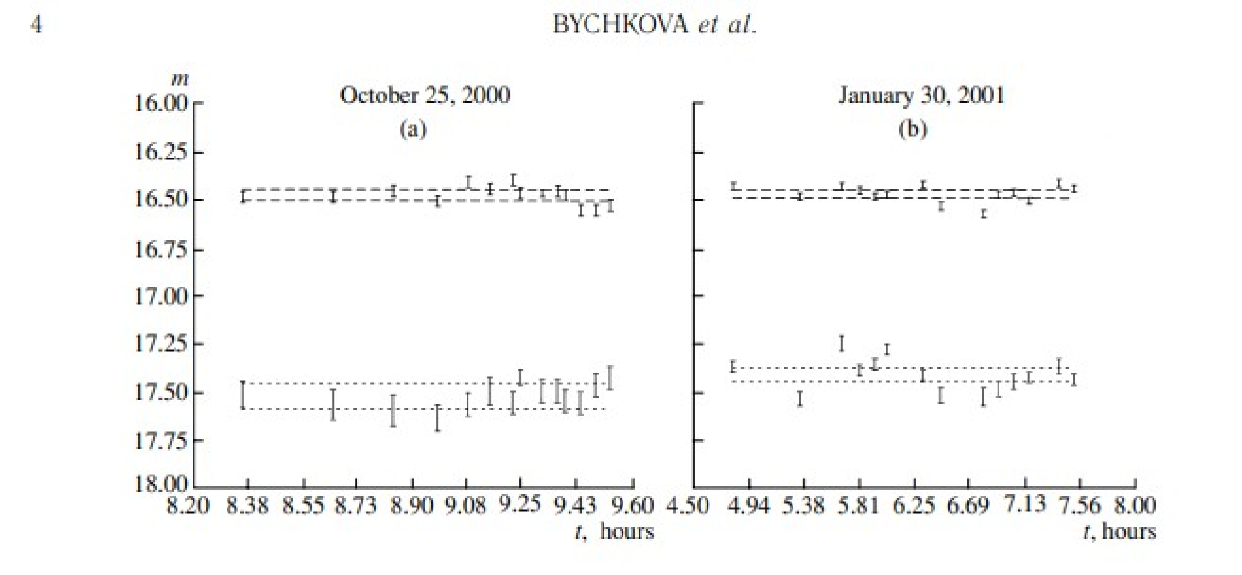
V. S. Bychkova[1], N. S. Kardashev[1], V. V. Vlasyuk[2], and O. I. Spiridonova[2]

[1] *Astro Space Center, Lebedev Physical Institute, ul. Profsoyuznaya 84/32, Moscow, 117997 Russia*

[2] *Special Astrophysical Observatory, Russian Academy of Sciences, pos. Nizhniĭ Arkhyz, Karachaĭ-Cherkessia, Russia*

Received March 8, 2002; in final form, May 23, 2002

Abstract—We present the results of optical monitoring of the blazar 2007 + 777 on the 60-cm Zeiss-600 reflector of the Special Astrophysical Observatory of the Russian Academy of Sciences. Light curves in the *B* and *V* bands obtained from August 8, 2000, through May 25, 2001, reveal variability with characteristic time scales from 10 to 40 days. © *2003 MAIK "Nauka/Interperiodica"*.



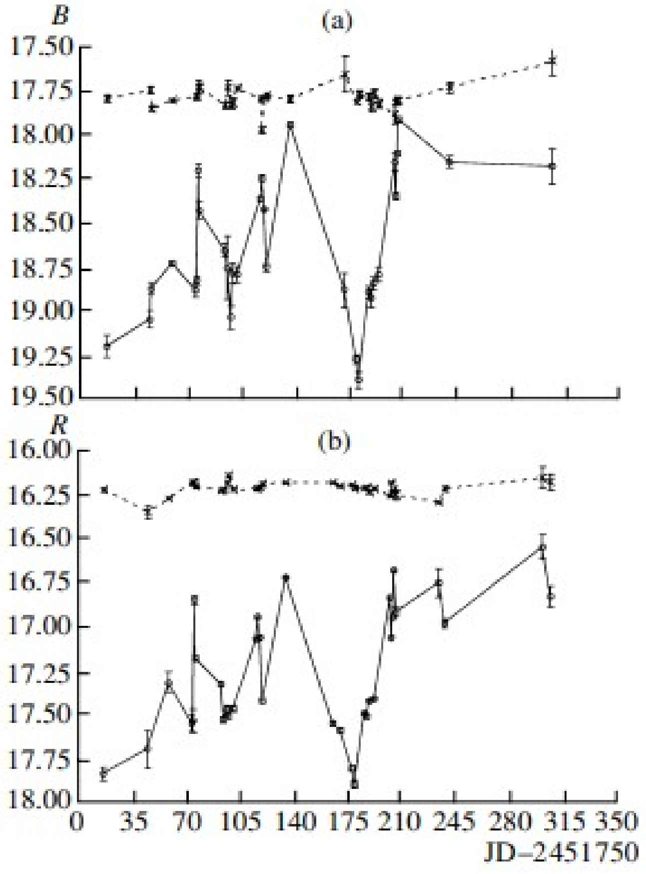


Fig. 3. Light curves of the blazar 2007 + 777 in the (a) *B* and (b) *R* bands over the entire period of our observations (solid lines with points). The dashed lines with crosses in the upper part of each panel show the light curves for control star 3. The figure shows the mean brightnesses for each night.

THE PROGRAM OF N.S.KARDASHEV AT ZEISS-1000 (2001-2018)

The method – simultaneous BVRI-photometry using by CCD-photometer of 1-m telescope and radio observations RT-22 of Crimean observatory.

The main aim – search of variability in optical and radio ranges, determination of time delay to measure parameters of supermassive BH in

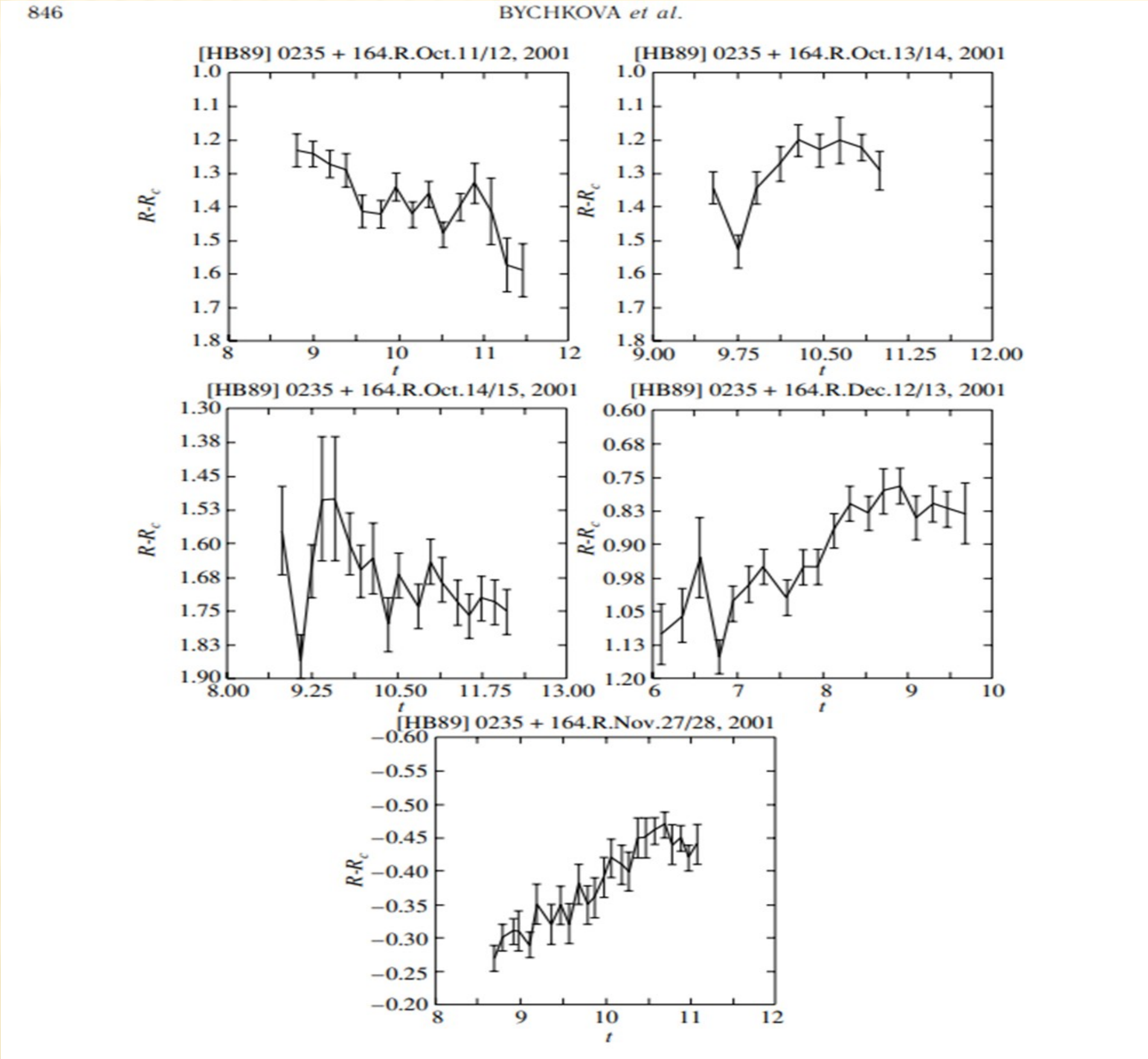
Table 1. List of observed objects

Source Name	Coordinates (J2000)						z
	α			β			
[HB89] 0235+164	02^h	38^m	38.9^s	+16°	36′	59″	0.940
TXS 0917+624	09	21	36.2	+62	15	52	1.446
[HB89] 0954+658	09	58	47.2	+65	33	55	0.368
[HB89] 1308+326	13	10	28.6	+32	20	44	0.99
J 1819+3845	18	19	26.6	+38	45	02	0.54

Source name	Coordinates, 2000						z
	α			δ			
DA 55	01^h	36^m	58.6^s	+47°	51′	23″	0.859
4C 38.41	16	35	15.5	+38	08	04	1.814
2134 + 004	21	36	38.6	+00	41	54	1.94
2145 + 067	21	48	05.4	+06	57	39	0.99
3C 454.3	22	53	57.7	+16	08	54	0.859

THE FIRST RESULTS FROM ZEISS-1000

The Blazar AO 0235+164



The Blazar S4 0954+658

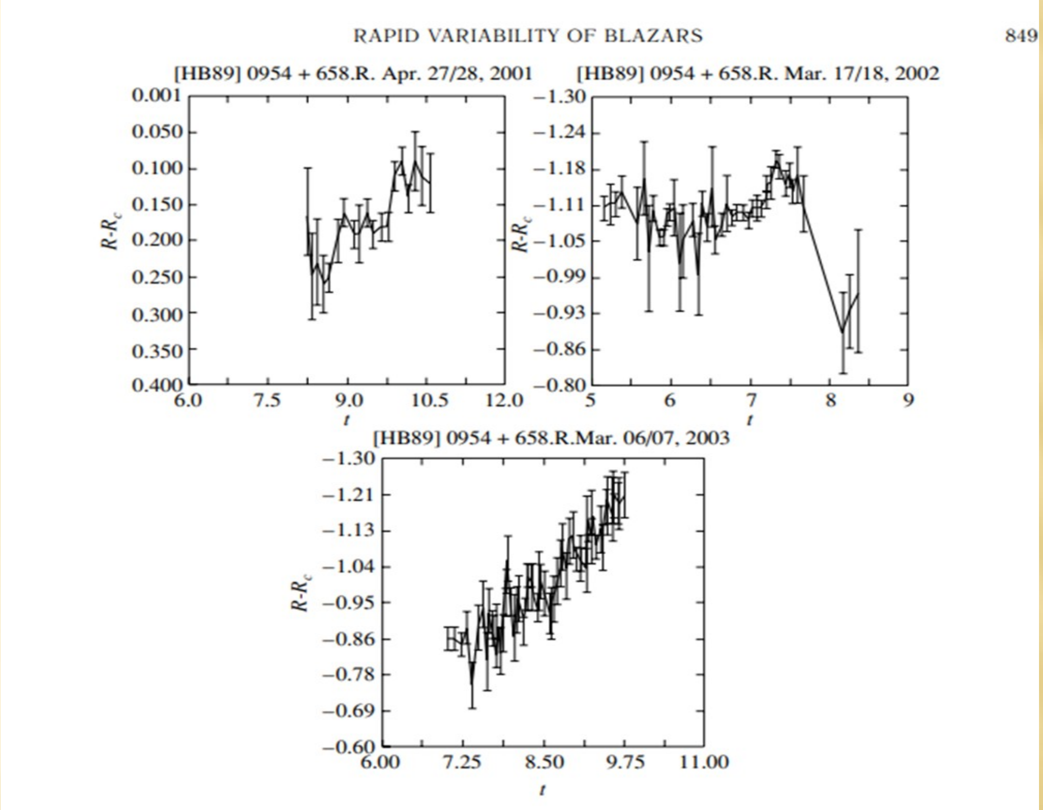


Fig. 4. *R* light curves of the blazar [HB89] 0954+658 for individual nights. The horizontal axis plots the time in hours, and the vertical axis plots the difference between the magnitudes of the target and a reference star. The header notation is the same as in Fig. 1.

THE MOST POWERFUL OUTBURST OF BLAZAR S4 0954+658 IN 2015

ISSN 1063-7729, Astronomy Reports, 2016, Vol. 60, No. 12, pp. 1035–1045. © Pleiades Publishing, Ltd., 2016.
Original Russian Text © A.E. Volvach, V.S. Bychkova, M.G. Larionov, N.S. Kardashev, L.N. Volvach, V.V. Vlasyuk, O.I. Spiridonova, A. Lähteenmäki, M. Tornikoski, M.F. Aller, H.D. Aller, G. Pooley, L. Carrasco, A. Porras, E. Recillas, 2016, published in Astronomicheskii Zhurnal, 2016, Vol. 93, No. 12, pp. 1012–1022.

Non-stationary Emission of the Blazar S4 0954+658 over a Wide Range of Wavelength

A. E. Volvach[1,2*], V. S. Bychkova[3], M. G. Larionov[3], N. S. Kardashev[3], L. N. Volvach[1,2], V. V. Vlasyuk[4], O. I. Spiridonova[4], A. Lähteenmäki[5], M. Tornikoski[5], M. F. Aller[6], H. D. Aller[6], G. Pooley[7], L. Carrasco[8], A. Porras[8], and E. Recillas[8]

[1] *Crimean Astrophysical Observatory, Russian Academy of Sciences, Nauchnyi, Russia*

[2] *Institute of Applied Astronomy, Russian Academy of Sciences, St. Petersburg, Russia*

[3] *Astro Space Center, Lebedev Physical Institute, Russian Academy of Sciences, Profsoyuznaya ul. 84/32, Moscow, 117997 Russia*

[4] *Special Astrophysical Observatory, Russian Academy of Sciences, Nizhnii Arkhyz, Karachaevo-Cherkesskaya Republic, 369167 Russia*

[5] *Metsähovi Radio Observatory, Aalto University, Helsinki, Finland*

[6] *Department of Astronomy, University of Michigan, Ann Arbor, MI 48109-1042, USA*

[7] *Cavendish Laboratory, Cambridge University, Cambridge, United Kingdom*

[8] *National Institute of Astrophysics, Optics, and Electronics, Luis Enrique Erro 1, Tonantzintla, Puebla, Mexico*

Received March 28, 2016; in final form, June 18, 2016

Abstract—Data from long-term multi-frequency monitoring are used to analyze variations in the flux density of the active galactic nucleus S4 0954+658. These data were obtained at the Crimean Astrophysical Observatory, the Metsähovi Radio Observatory of Aalto University, the University of Michigan Radio Astronomy Observatory, the Cavendish Laboratory of Cambridge University, the Special Astrophysical Observatory, and the National Institute of Astrophysics, Optics, and Electronics; 0.1−300-GeV data from the Fermi space gamma-ray observatory were also used. Radio data at 4.8, 8, 14.5, 15, 22.2, and 36.8 GHz are considered together with optical and near-infrared data in the R, J, H, and K filters.

In the framework of a model in which binary supermassive black holes (SMBHs) are present in active galactic nuclei, harmonic and structural analyses are carried out to establish the orbital ($T_{orb} \approx 780$ yrs) and precessional ($T_{pr} \approx 7800$ yrs) periods in the rest frame of the source.

The development of the most powerful flare ever observed in this object, which occurred in February 2015, is considered. The delay in the flare's development in different wavelength ranges from the gamma-ray to the radio is determined. both the magnitude of the delays and the durations of the flares themselves suggest that the physical characteristics of S4 0954+658 are similar to those of the blazar S5 0716+714, which displays evidence of a high γ factor for the jet motion and high superluminal speeds in the jet. The masses of the components of the binary SMBH (M and m), the dimensions of their orbit, and the velocity of the lower-mass SMBH about the central SMBH are estimated. The derived physical characteristics are subject to a comparative analysis.

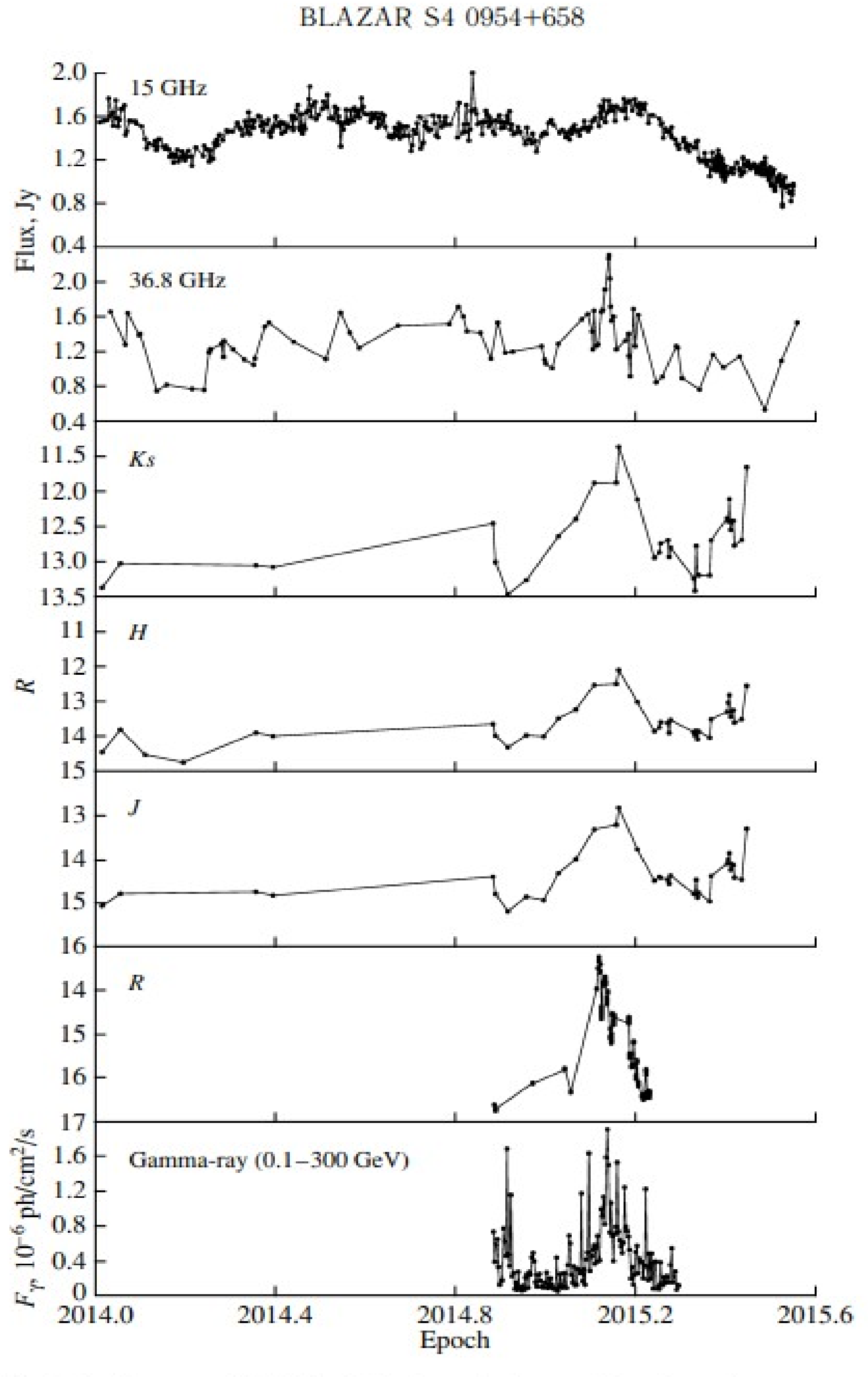
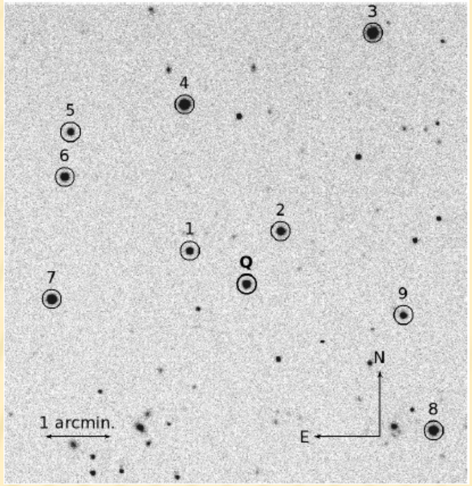


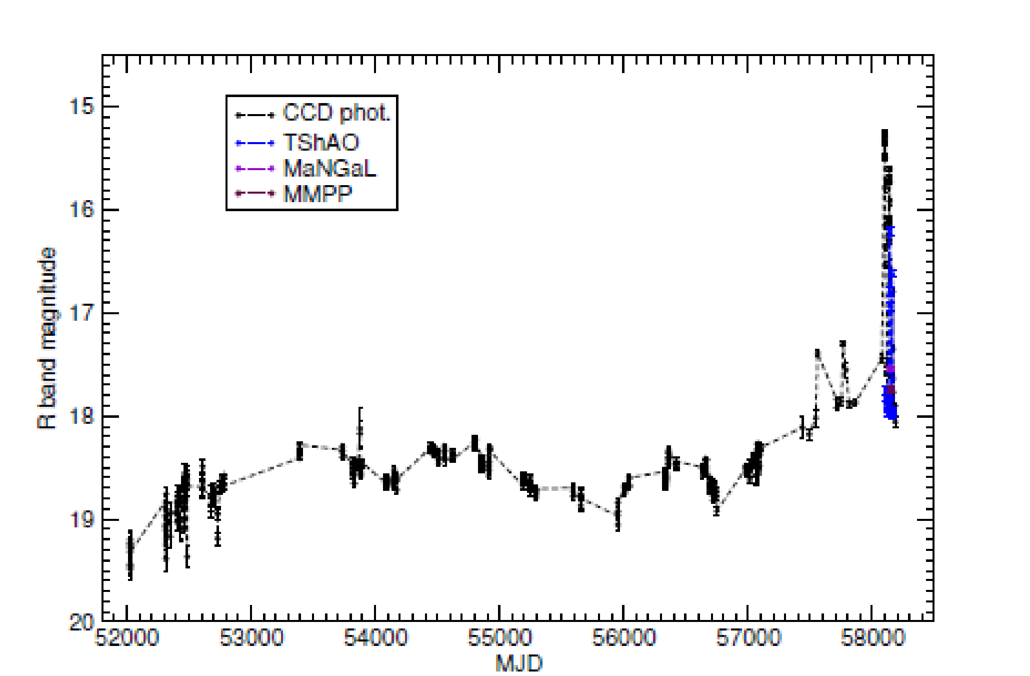
Fig. 1. Light curves of S4 0954+658 in the optical, near-IR, radio, and gamma-ray.

FSRQ TXS0917+624 – AN UNIQUE MULTIPLE FLARE IN 2017-2018

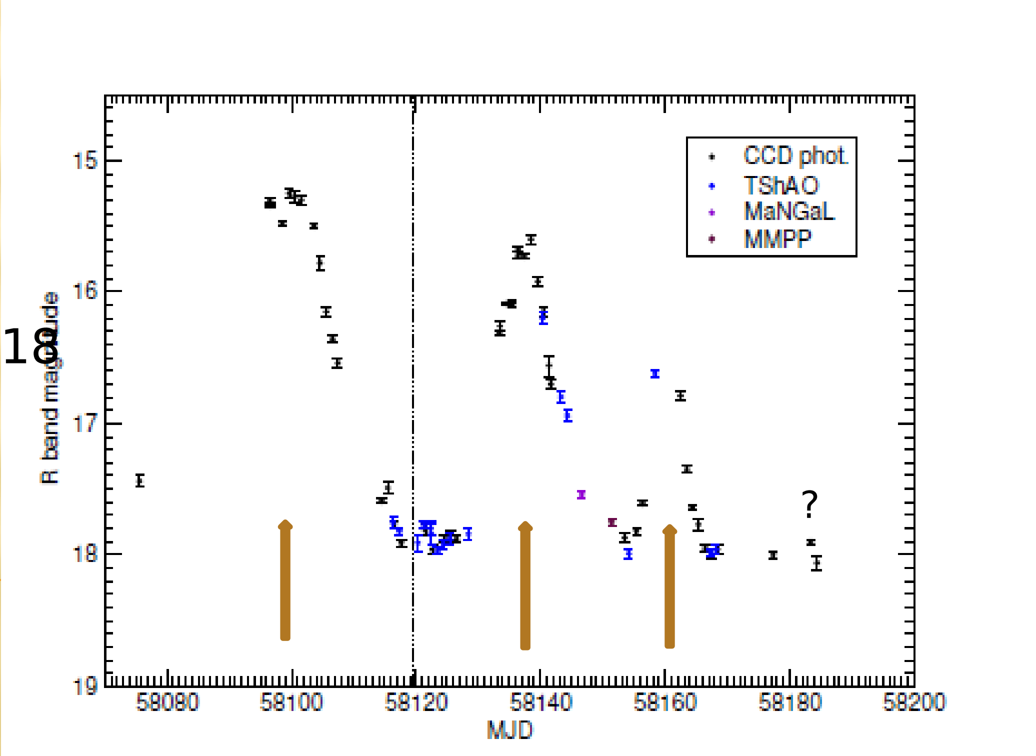
Source field with standard stars



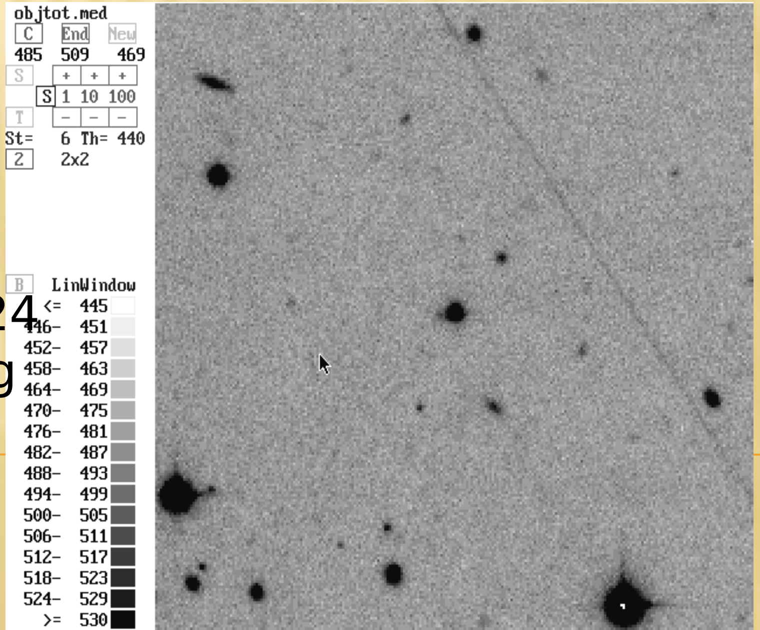
The light curve of TXS 0917+624 in 2002-2018



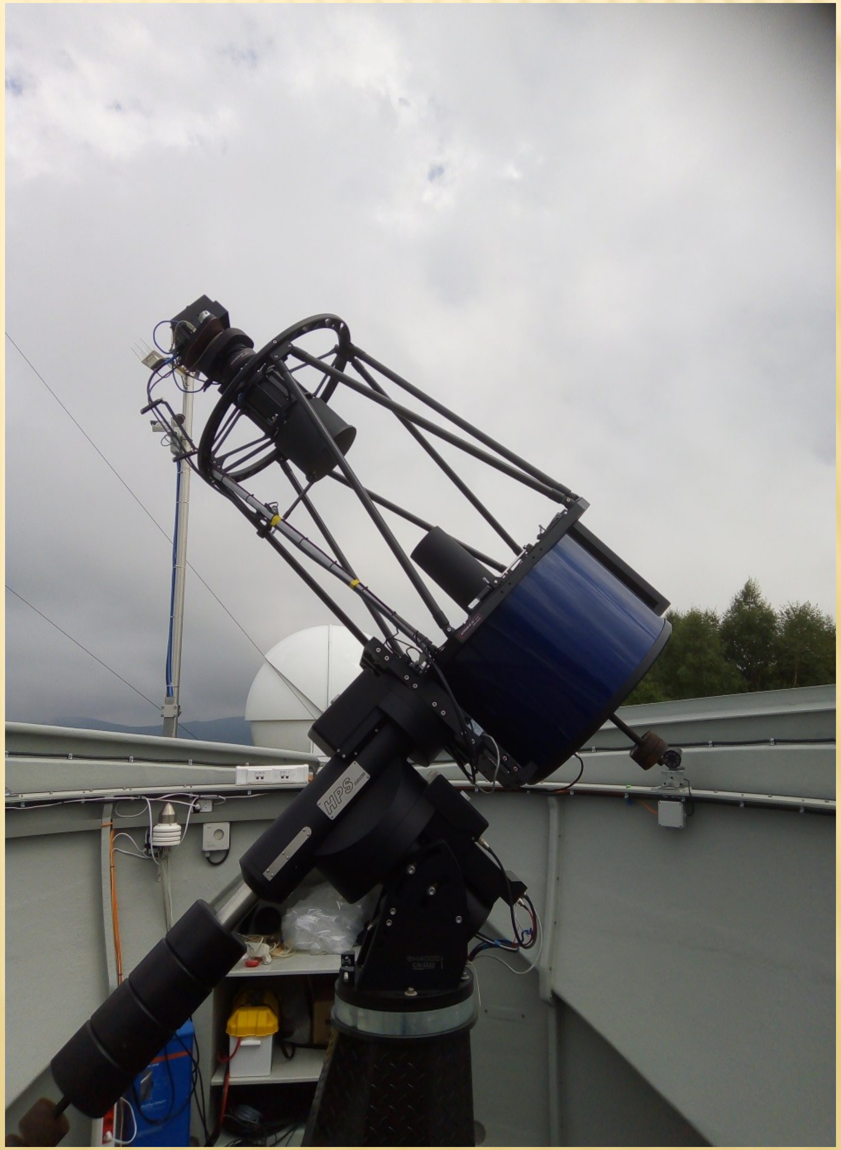
t’s light curve Nov 2017-Feb2018



Deep image of TXS0917+624 under 1” seeing

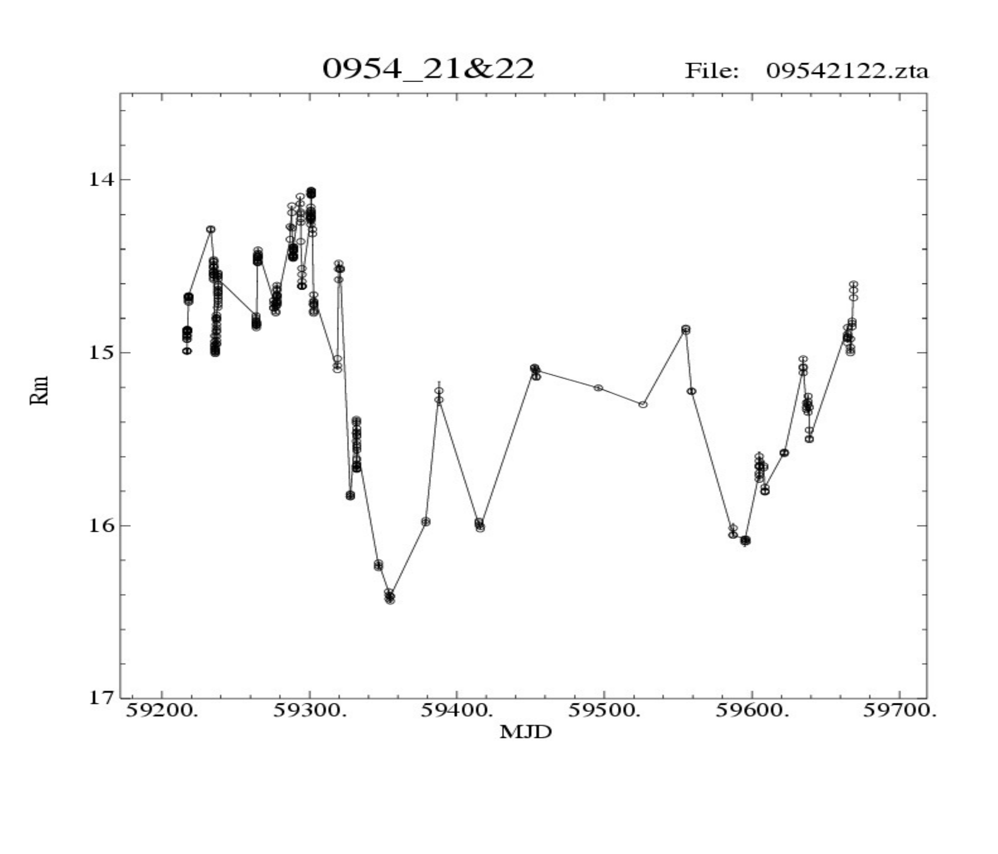


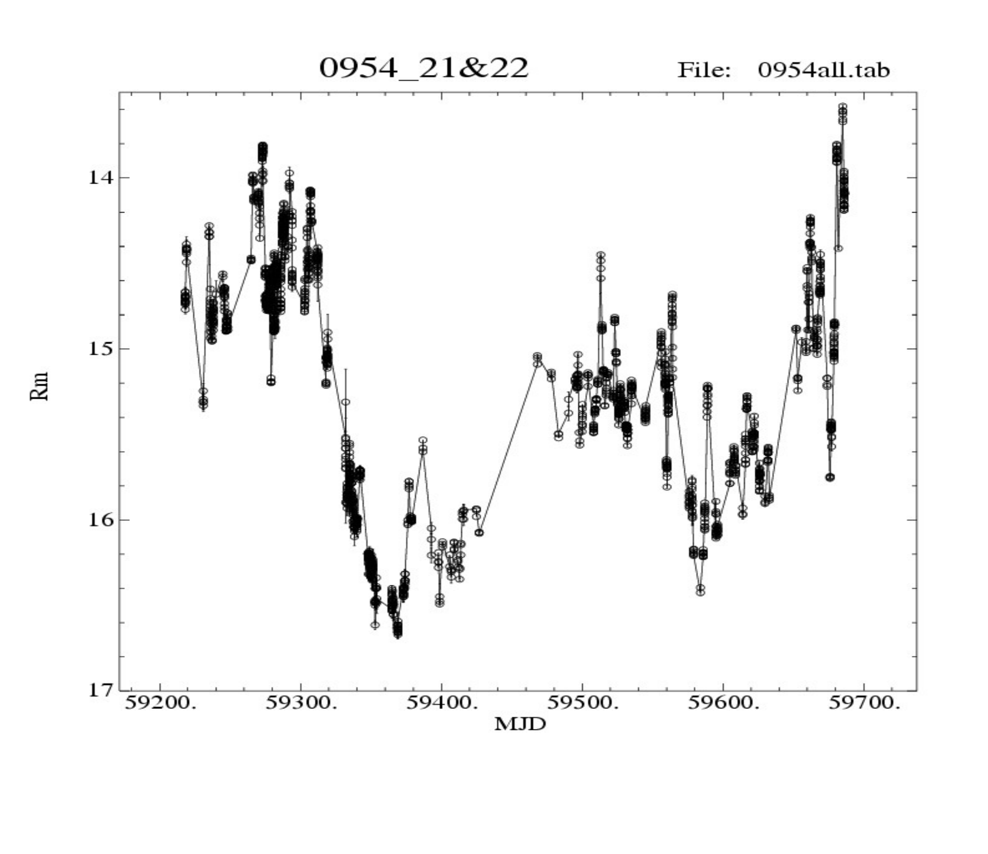
THE SMALL 0.5-M RC TELESCOPES
(MANUFACTURED BY ASTROSIB, NOVOSIBIRSK)



WHAT CAN BE DONE WITH SMALL 0.5-M TELESCOPE ?

The example – our studies of blazar 0954+658 in R band through 2021-2022

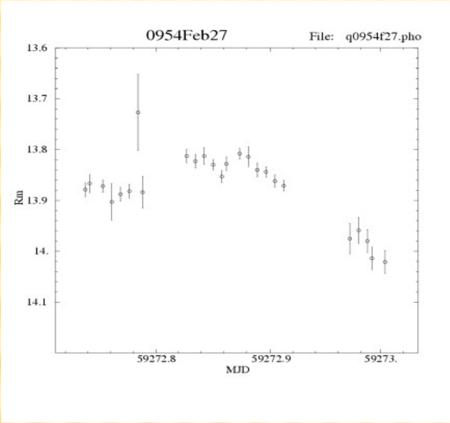


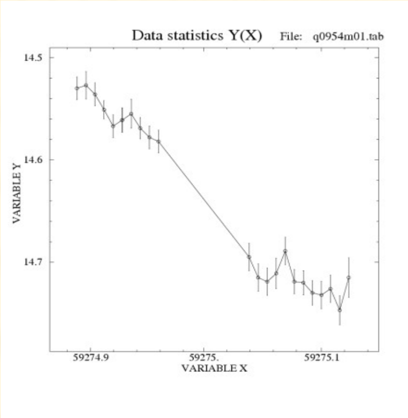


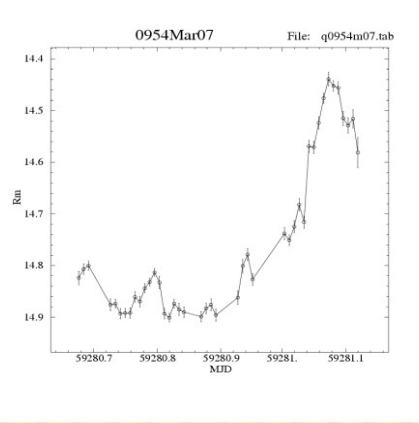
Zeiss-1000 (according to official schedule)
Photometrical accuracy – better 0.01 mag.

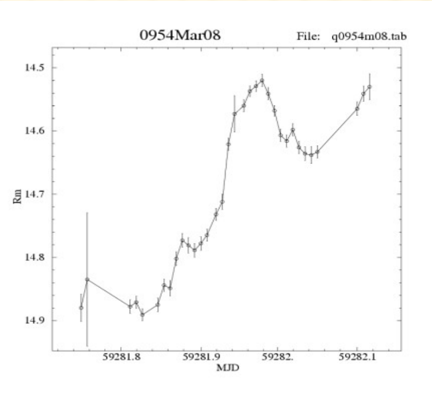
AS-500(on regular basis)
Photometrical accuracy – 0.01-0.03 mag, but more der
time coverage.

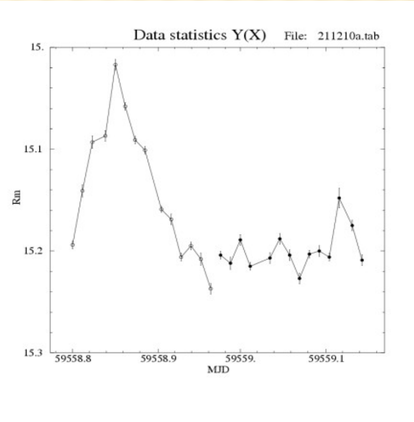
S4 0954+658 «ZOO» INTRADAY VARIABLITY WITH 0.5-M TELESCOPE

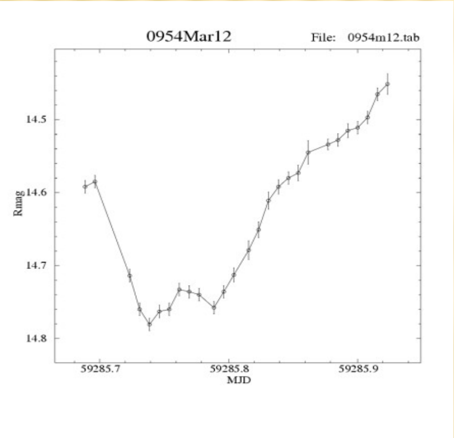


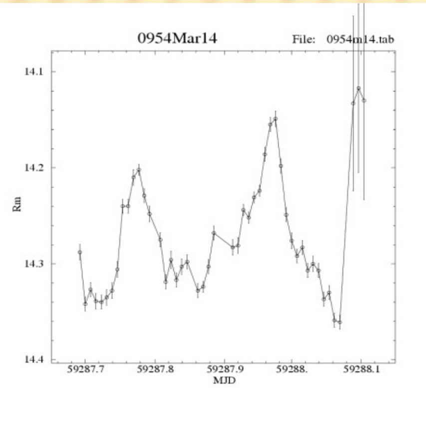


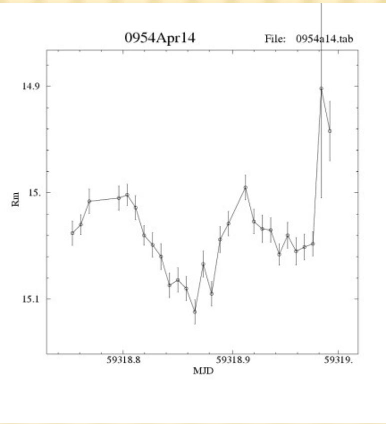


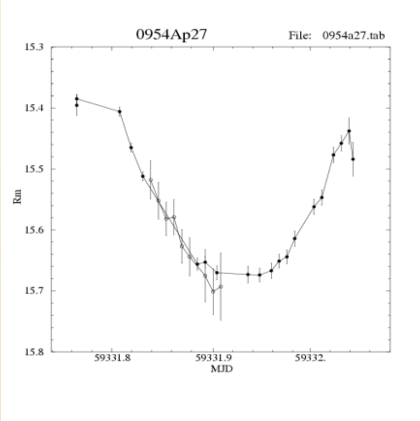


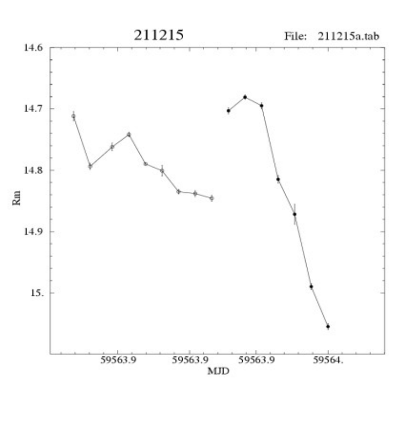








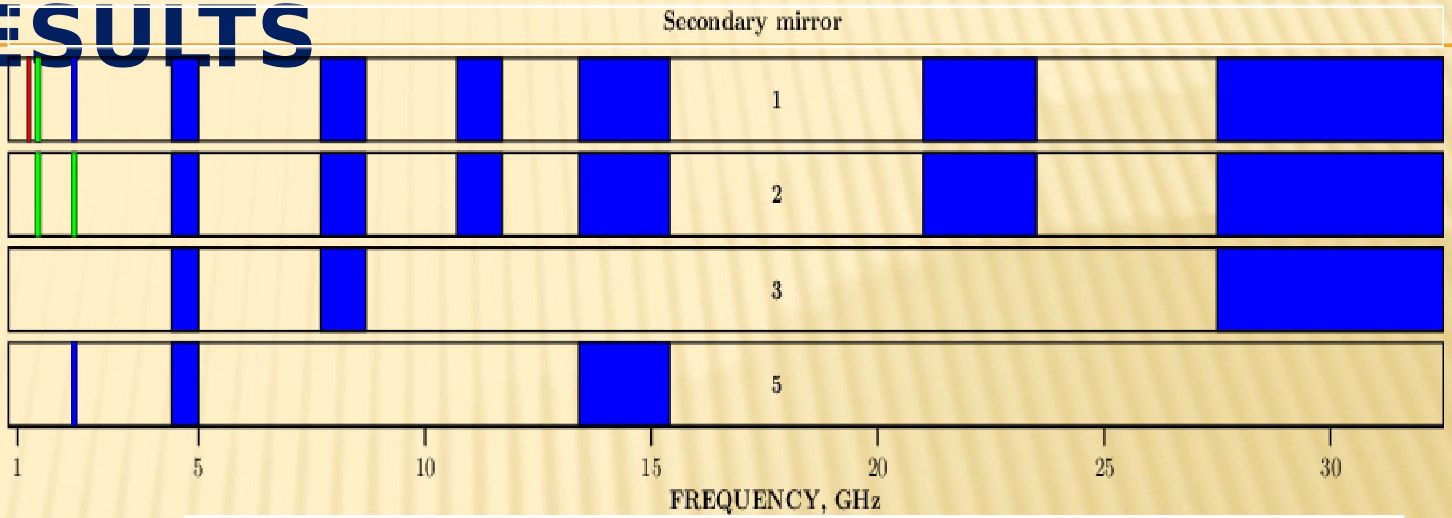


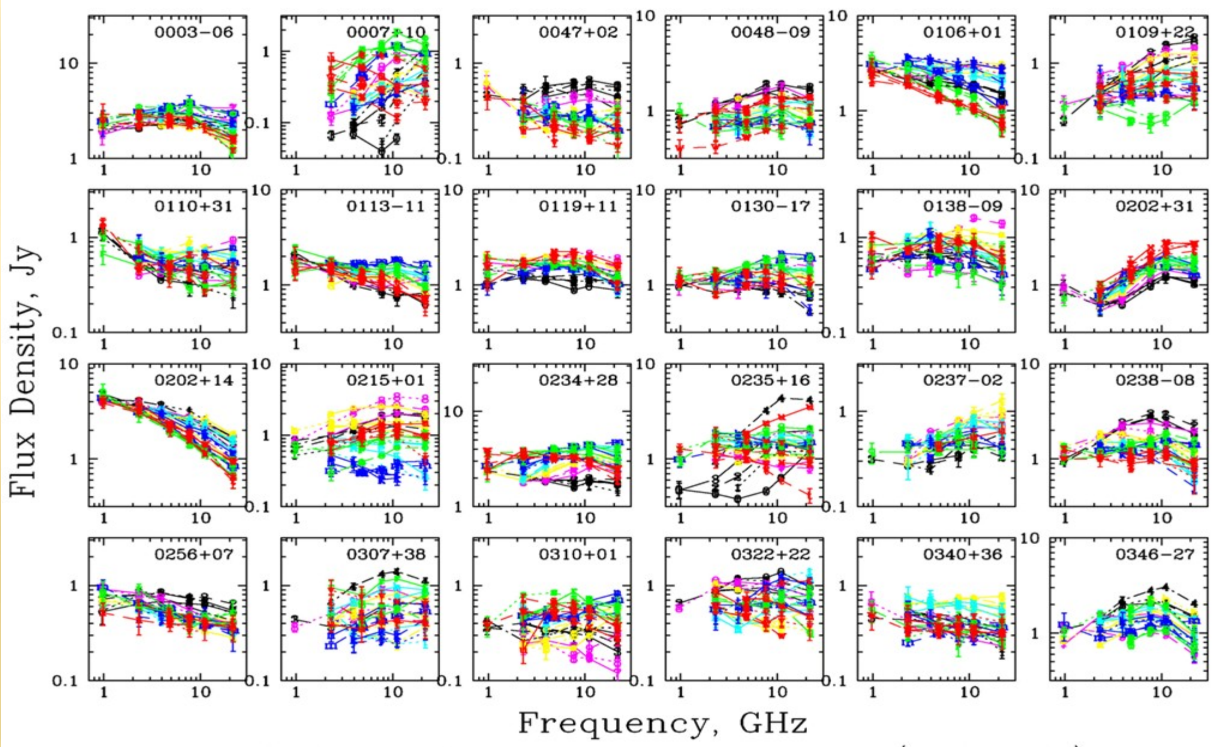


RATAN-600: PARAMETERS AND RESULTS

f_0 (GHz)	Δf_0 (GHz)	ΔF (mJy/beam)	$HPBW_x$ sec	AR arcsec
22.3	2.5	50	1.0	11
14.4	2.0	25	1.1	13
11.2	1.0	15	1.4	16
8.2	1.0	10	2.0	22
4.7	0.6	5	3.2	35
2.25	0.08	40	7.2	80
1.28	0.06	200	10	110

f_0 (GHz)	Δf_0 (GHz)	ΔF (mJy/beam)	$HPBW_x$ sec	AR arcsec
22.3	2.5	95	1.5	16.5
14.4	2.0	50	1.6	18
11.2	1.0	30	2.1	23
8.2	1.0	20	2.7	30
4.7	0.6	10	4.8	53
2.25*	0.08	80	11	121



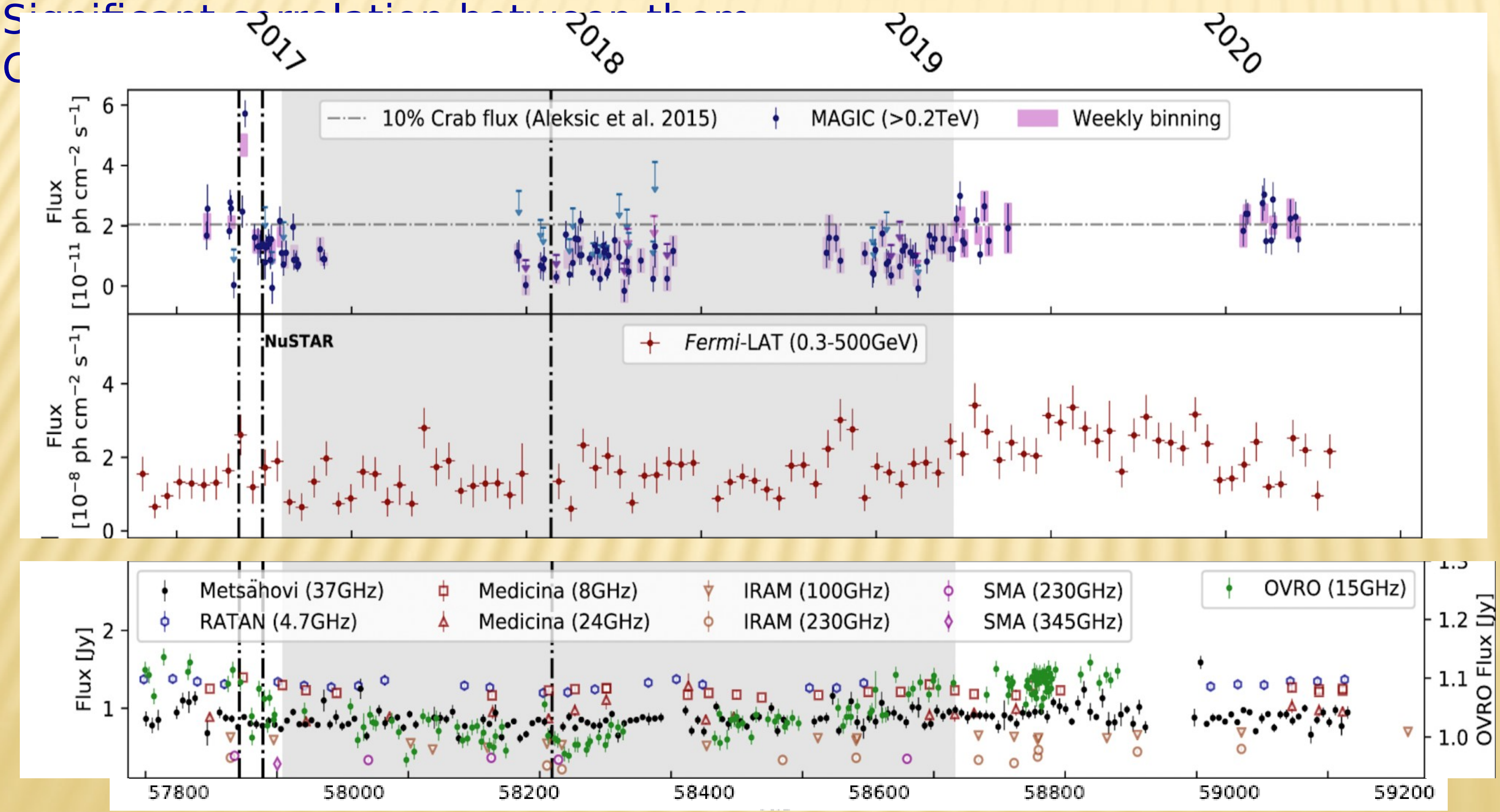


Kovalev et al. 1999,

Multi-messenger characterization of Mrk501 during historically low X-ray and gamma-ray activity

Multi-band study of blazar Mrk 501 within low activity period in 2017-2020.

Variable non-thermal emission over the all energy ranges, mainly – in X- & γ-ray.
Significant correlation between them.

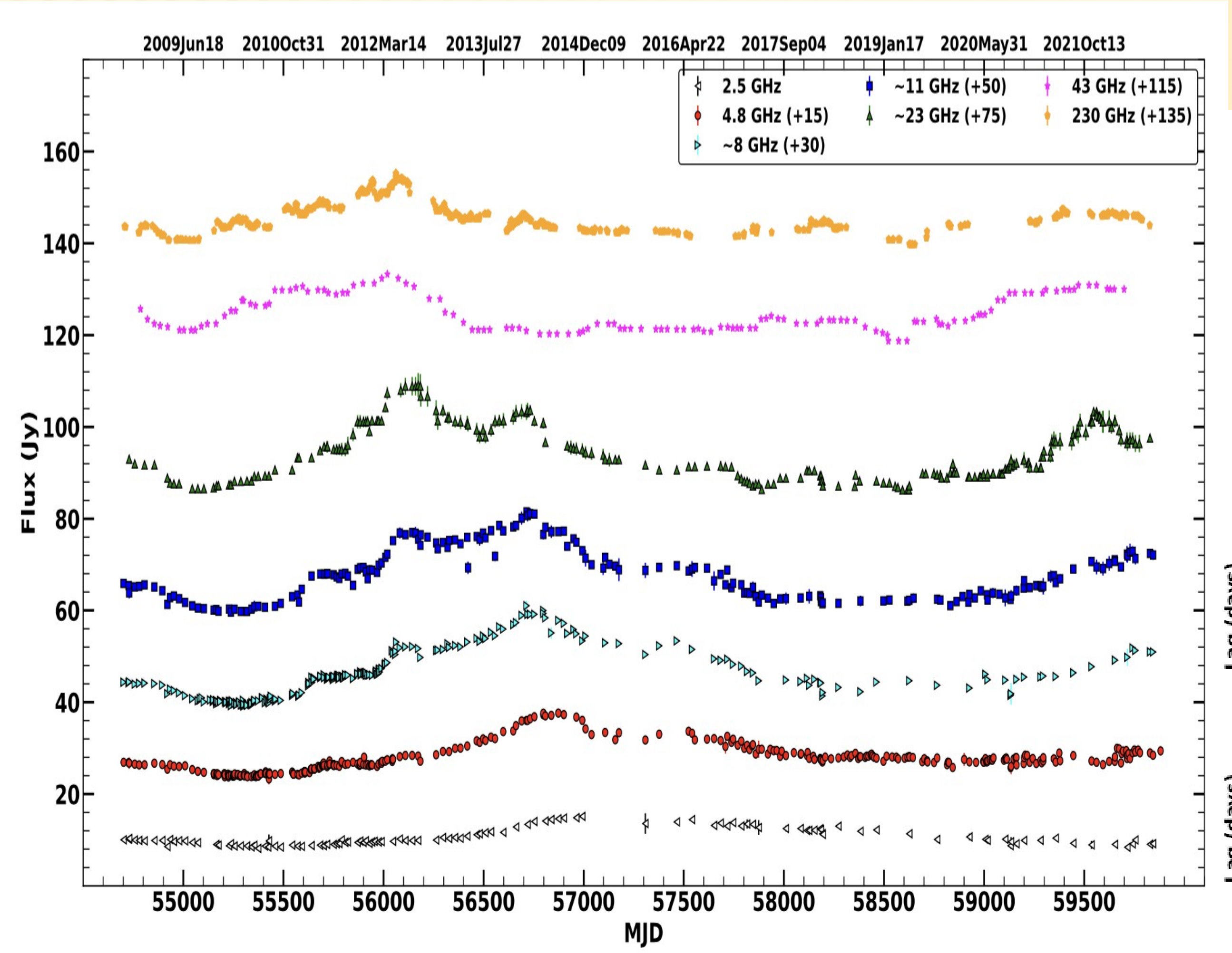


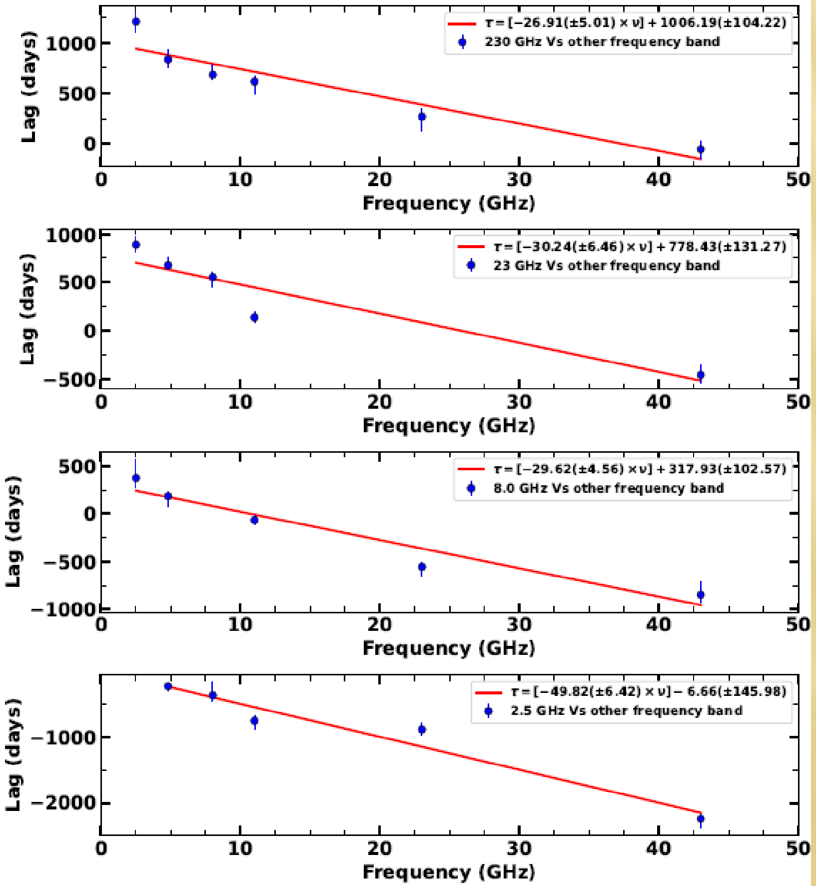
Radio, single-dish	Freq, GHz
OVRO	15
Medicina	8, 24
RATAN-600	4.7, 11.2, 22
Metsähovi	37
IRAM	100, 230
Radio, interferometry	
VLBA	43
SMA	230, 345
X-ray	
Swift-XRT	0.3-2; 2-10 keV
NuSTAR	3-7; 7-30 keV
γ-ray	
Fermi-LAT	0.3-500 GeV
MAGIC	> 0.2 TeV

MW VARIABILITY OF 3C279

Variations of flux spectral density are explaining by a model of shock waves and changes of doppler-factor in curved relativistic jet.

Observatory	Data coverage time	Bands (GHz)
RATAN-600	04-08-2008 to 31-10-2022	2.25, 4.7, 8.2
	04-08-2008 to 31-10-2022	11.2, 22.3
F-GAMMA	04-08-2008 to 01-01-2015	2.64, 4.8, 8.35
	04-08-2008 to 01-01-2015	10.45, 21.7
XAO-NSRT	29-03-2017 to 29-10-2022	4.8
	24-08-2018 to 17-10-2022	23.6
UMRAO	18-11-2009 to 28-04-2012	4.8
	07-09-2009 to 16-05-2012	8.0
VLBA	04-08-2008 to 24-06-2022	43
SMA	04-08-2008 to 09-09-2022	230





- MNRAS, submitted Aug 2023, MN-23-3301-MJ

MULTI-MESSENGER ASTRONOMY LEAGUE FOR BRICS 2022-2025

PI: Prof. Lili Yang, Sun Yat-sen University, China:
Study data reconstruction of LHAASO,
observations and catalogues of high-energy transients;

PI: Dr.Sotnikova Yu., SAO RAS, Russia:
Studies of blazars, GRB, HEN, optical and radio observations;

PI: Prof. Soebur Razzaque, University of Johannesburg, South Africa:
GRB, AGN (SALT, SAAO, MeerKAT);

PI: Dr. Nayantara Gupta, Raman Research Institute, India:
association of UHE cosmic ray, gamma-ray or GW event;
identify the sources associated with IceCube events;
ToO observations (Astrosat, HCT) MW data analysis, MM and MW modeling.

RATAN-600, BTA, ZEISS-1000 PROPOSALS

PROPOSAL 1 (regular observations of blazars, PI – SAO RAS)

MALBRICS collaboration: multi-frequency monitoring of blazars

MALBRICS collaboration: optical monitoring of blazars

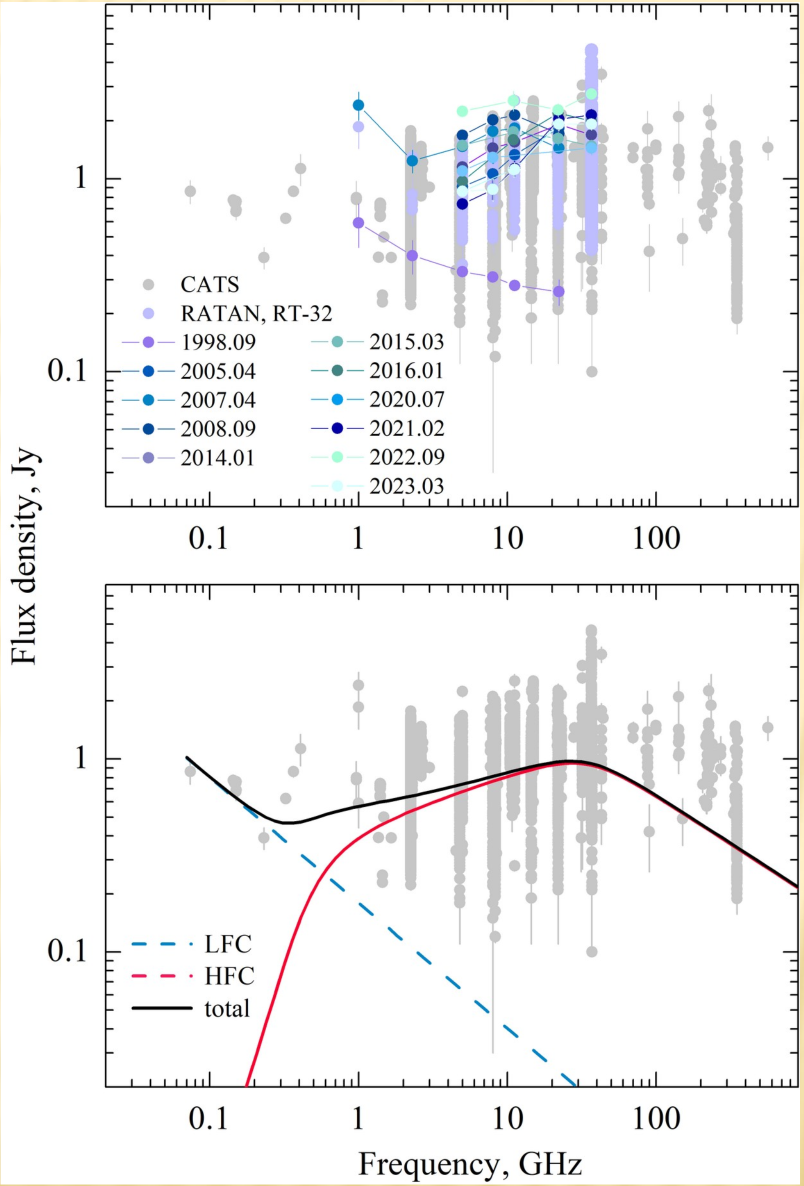
PROPOSAL 2 (ToO, PI – external, project member)

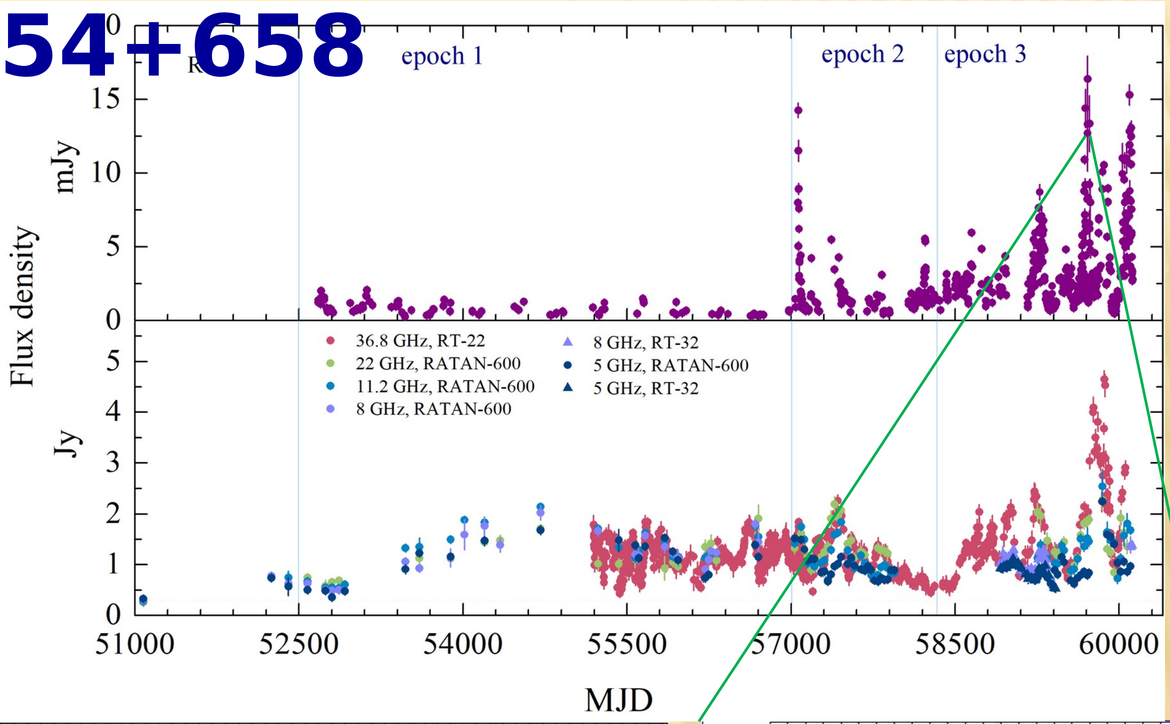
MALBRICS trigger: radio properties of transient events

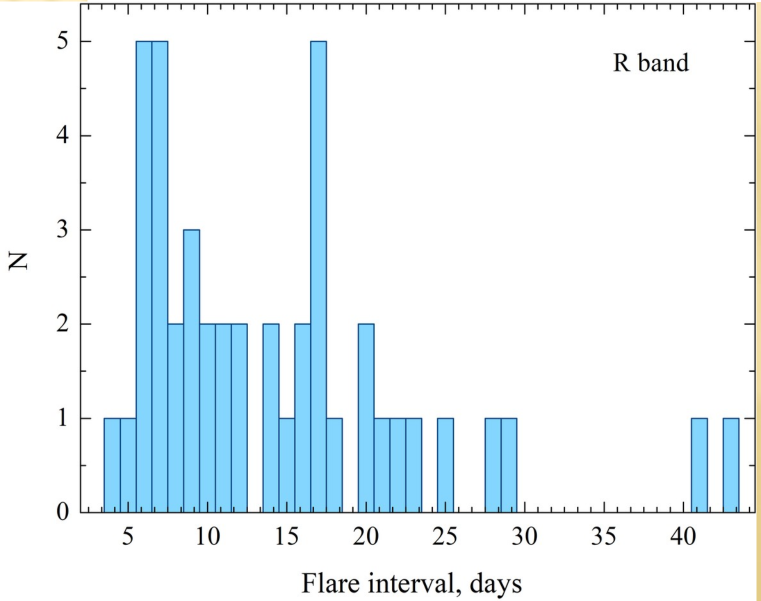
MALBRICS trigger: optical properties of transient events

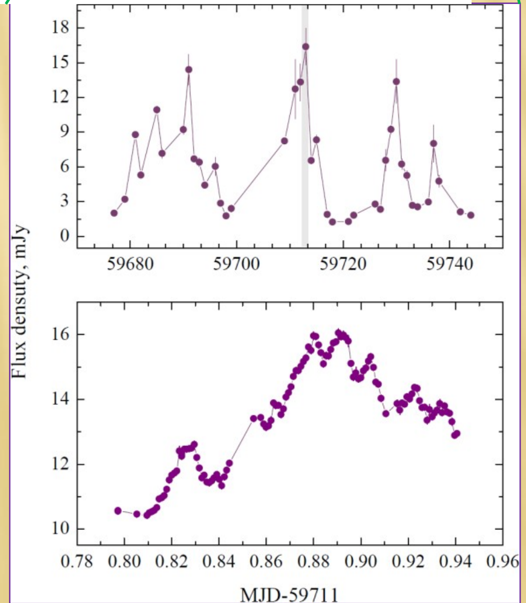
GRB, flaring blazars, high-energy neutrino candidates HEN, TDE.

Optical and radio variability of the blazar S4 0954+658



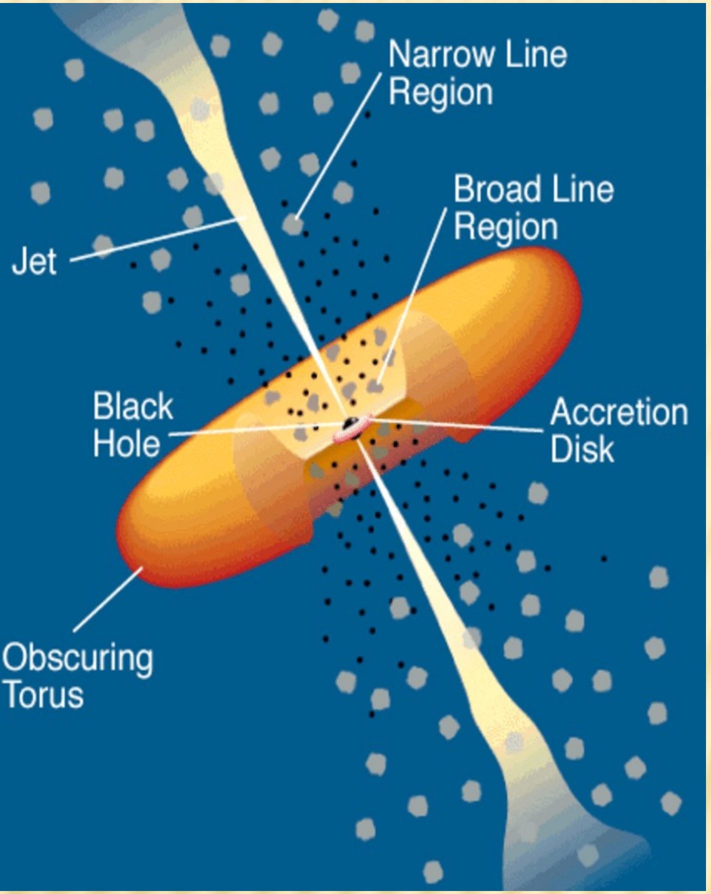


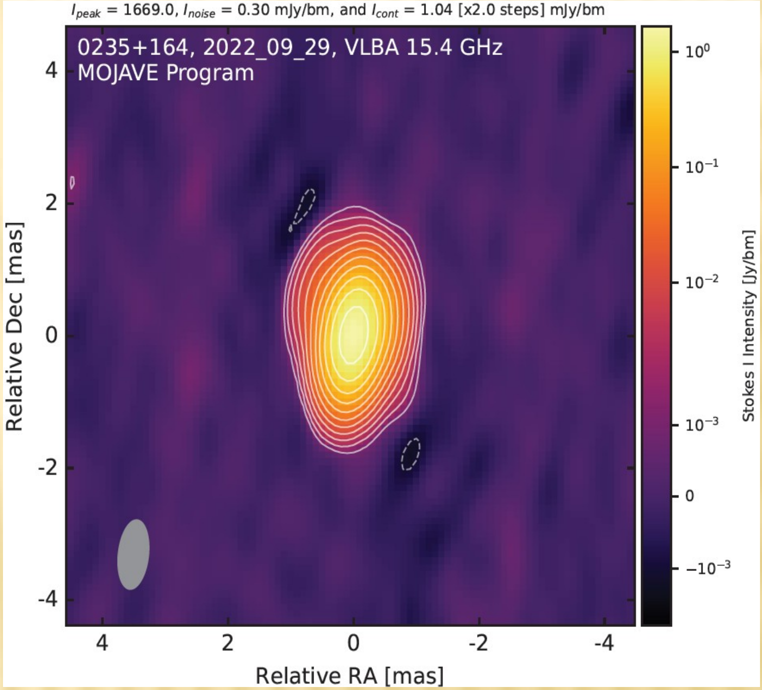




Vlasyuk et al., 2023AstBu..78..464V

AO 0235+164 – MULTI-BAND STUDIES





SED – spectral energy distribution (https://tools.ssdc.asi.it/SED/)

Radio map at 15 GHz, MOJAVE (https://www.cv.nrao.edu/MOJAVE/index.html)

The schematic image of adopted AGN model according to Urry & Padovani 1995.

AO 0235+164

Target object for many observing proigrams
High variablity level across all EM range
Among first AGNs with confirmed correlation between gamma- and optical flares
Jet orientation angle ~2.4° (Hovatta et al., 2009)
Compacntess: $\theta \lesssim 0.5$ mas (RadioAstron data)
Quasi-periodicity in optical and radio ranges ~8 yrs

RADIO & OPTICAL INSTRUMENTS USED

RATAN-600 – 1-22 GHz
RT-32 – 5, 8 GHz
RT-22 – 37 GHz

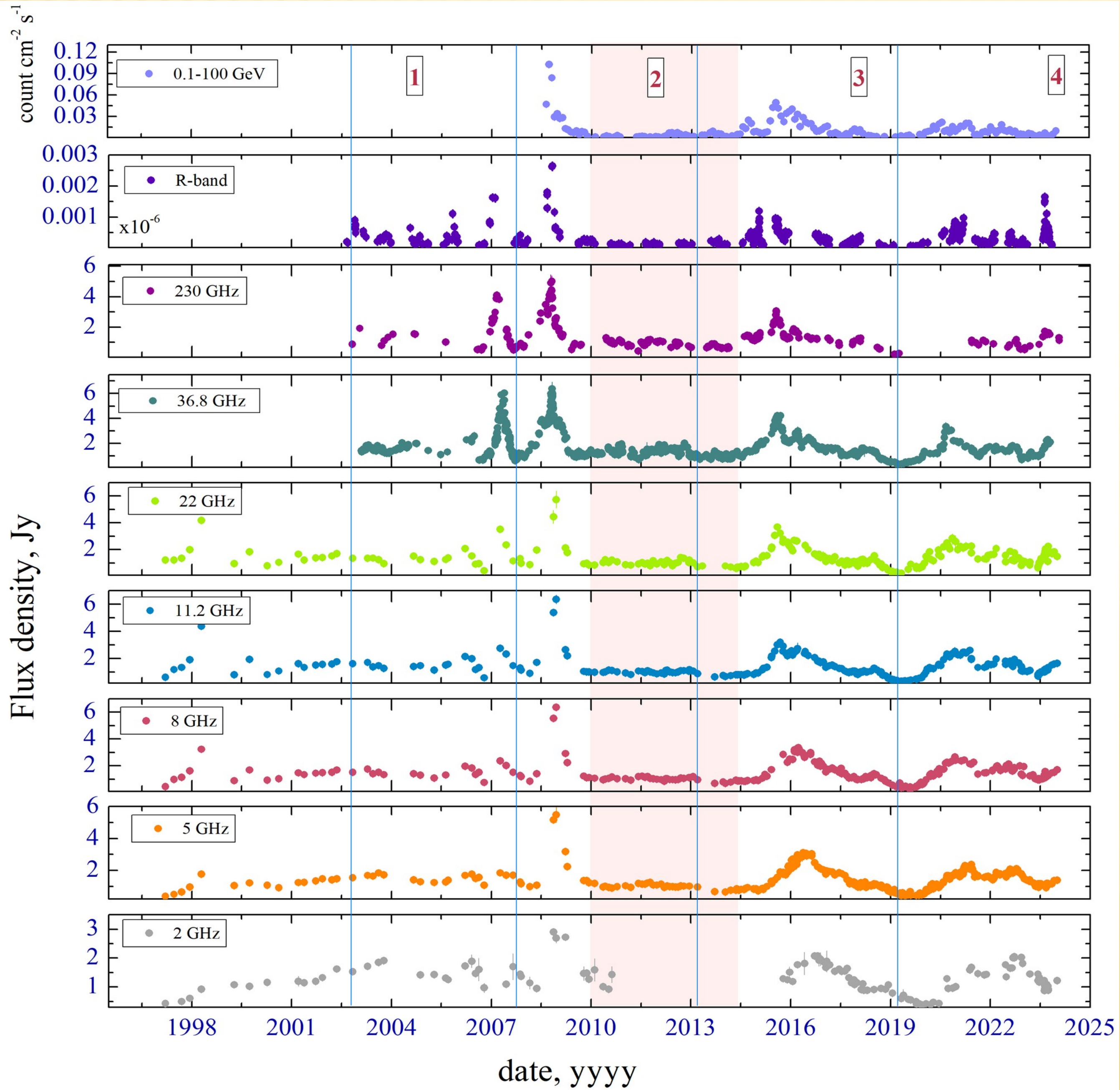
Zeiss-1000, AS-500/2 – R band

Sub-mm and gamma-rays facilities

230 GHz
SMA - Submillimeter Array

γ-rays

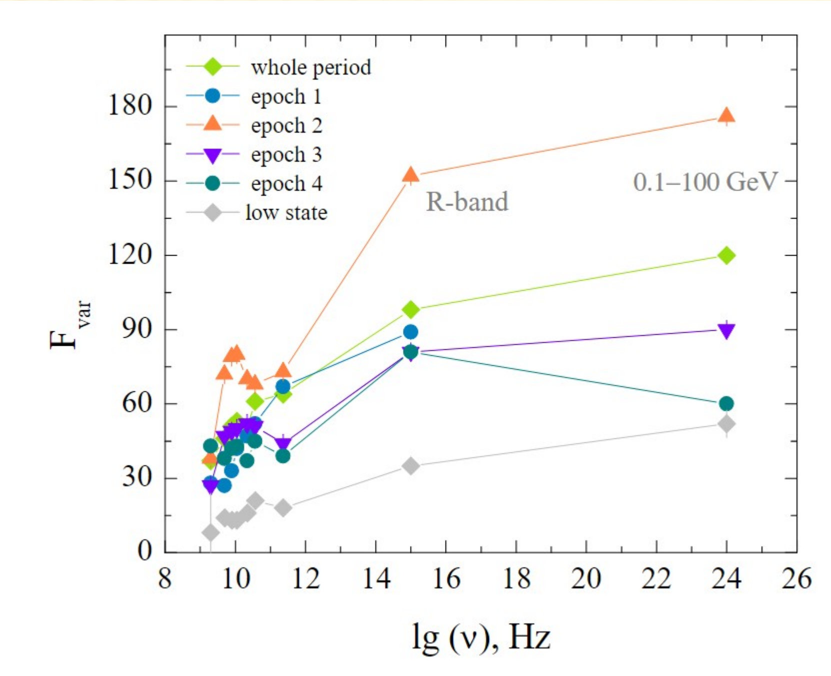
MW variability of AO 0235+164

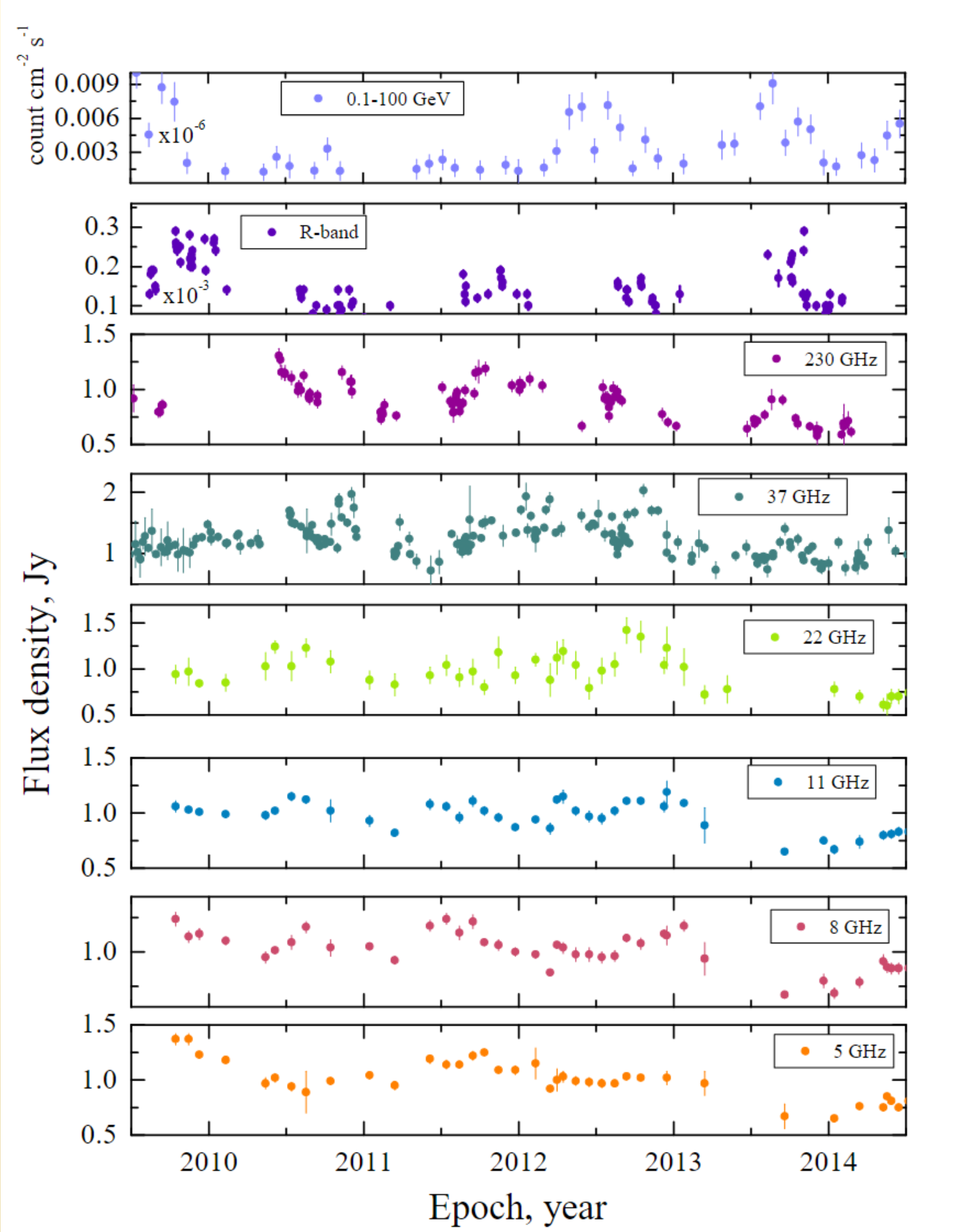


FACILITY	BAND	PERIOD	OBSERV.
RATAN-600	1.2, 2.3, 4.7, 8.2, 11.2, 22.3 GHz	1997-2024	SAO RAS
RT-32	4.84, 8.57 GHz	2020-2024	IAA RAS
RT-22	37 GHz	2002-2024	CrAO RAS
SMA	230 GHz	2002-2024	SMA
Fermi LAT	0.1-100 GeV	2008-2023	Fermi
Zeiss-1000	R-band	2002-2024	SAO RAS
AS-	R-band	2021-	SAO

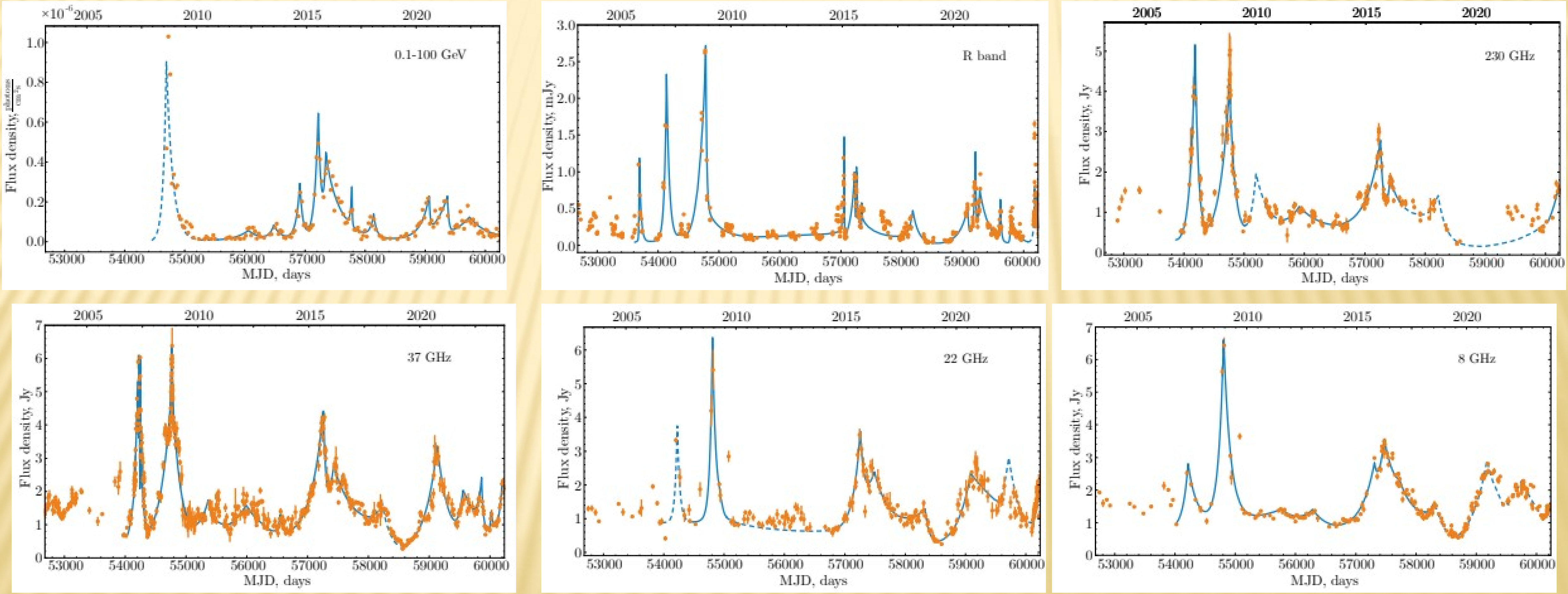
Article in preparation, Vlasyuk et al,2024

AO 0235+164: low state At 2009-2014





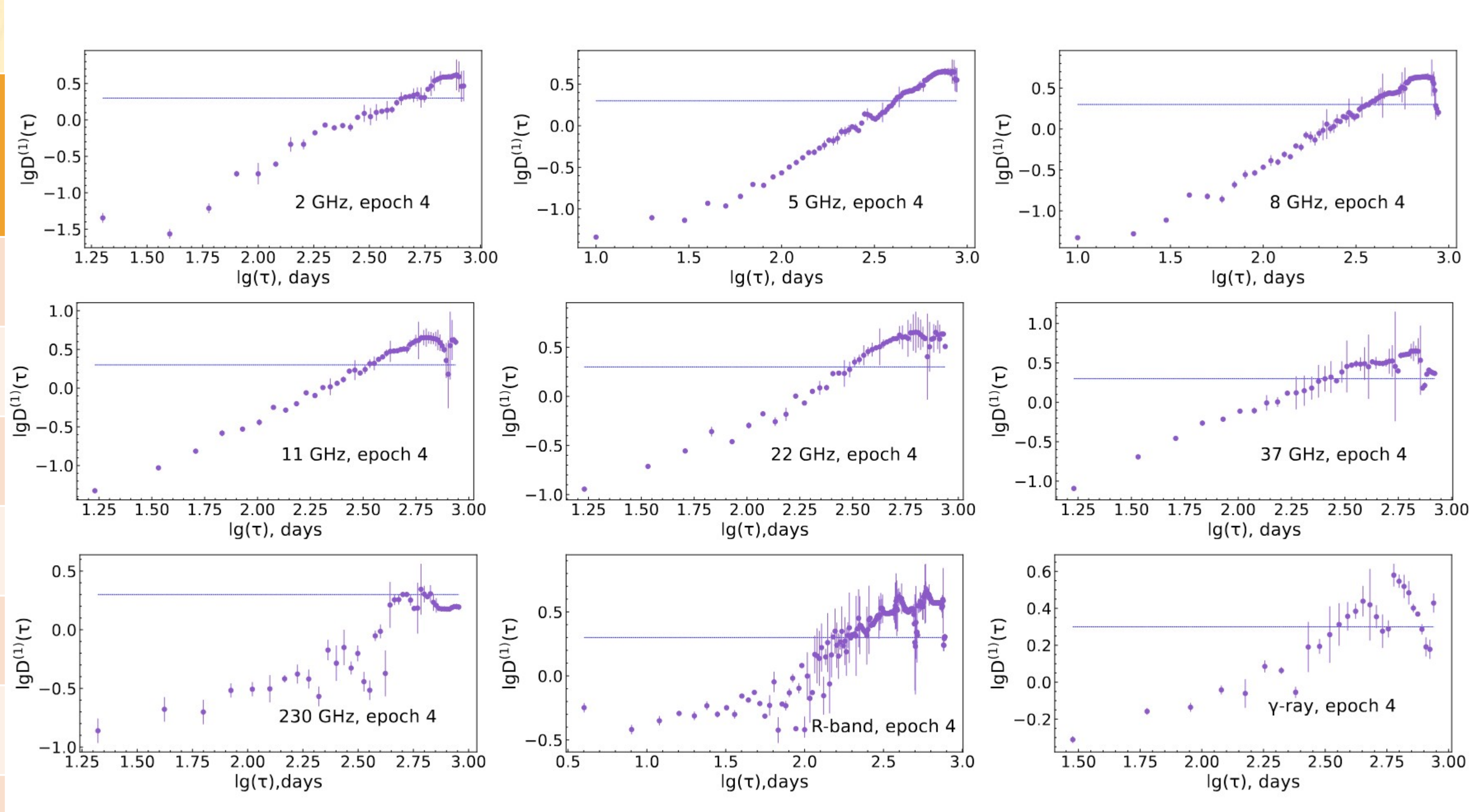
Flare activity of AO 0235+164 across 20 yrs period



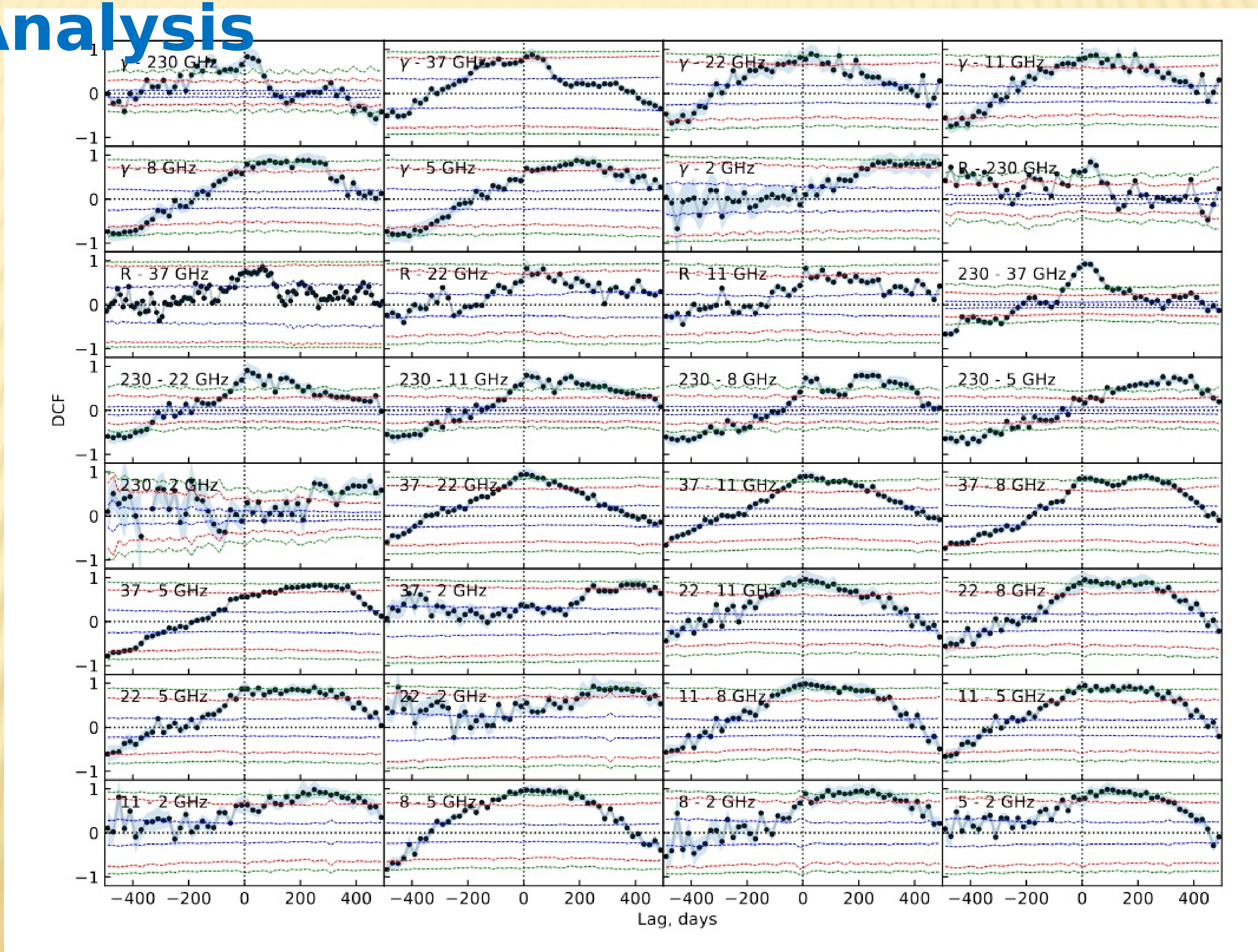
The structure function analysis

Analysis results

Spectr. range	τ_1	τ_2	τ_3	τ_4	τ_{low}
2 GHz	1.1	0.9	0.9	1.7	-
5 GHz	-	0.5	1.1	1.7	0.5
8 GHz	0.9	-	0.9	1.7	0.5
11GHz	0.9	-	1.1	1.4	0.5
22GHz	0.5	0.7	0.9	1.4	0.5
37GHz	0.4	0.7	≥0.9	0.9	≥0.5
230 GHz	0.3	0.7	1.7	1.1	0.5
Optic R	0.3	-	-	0.4	0.4



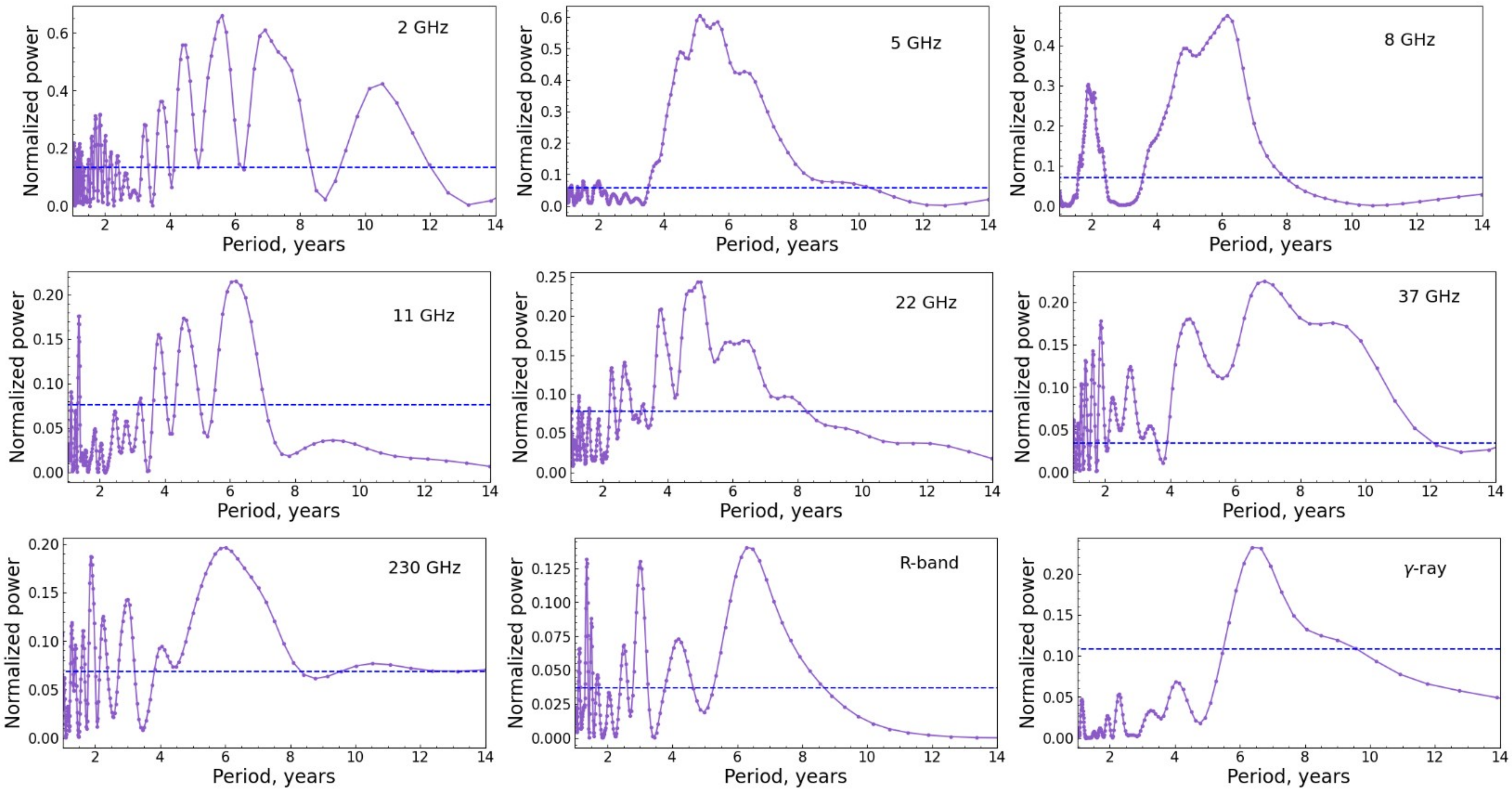
The Discrete Correlation Functions Analysis



AO 0235+164: quasi-reriods searches across

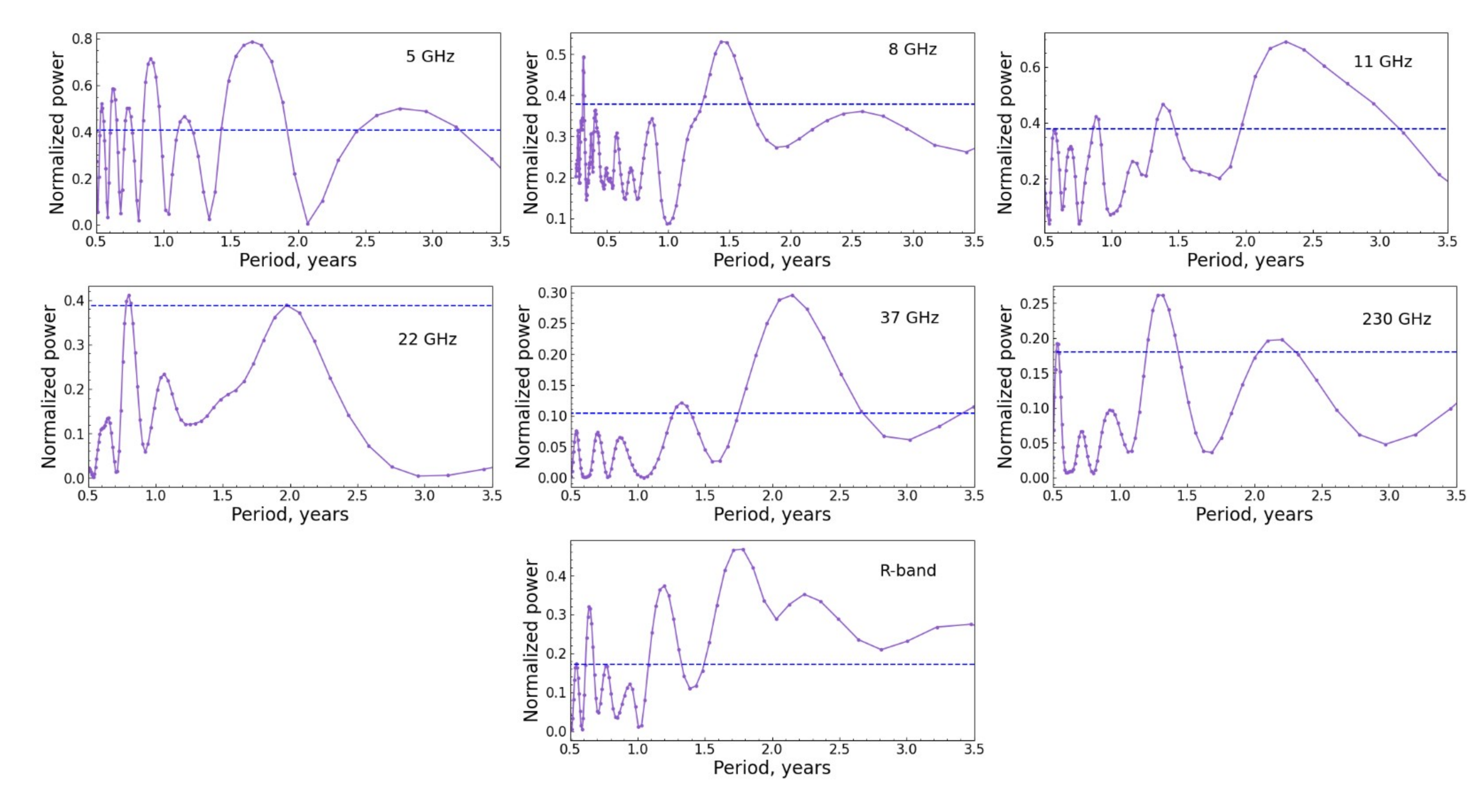
Range	Period, yrs
2 GHz	6.2±0.2
5 GHz	5.5±0.1
8 GHz	6.0±0.2
11GHz	5.8±0.2
22GHz	5.0±0.2
37GHz	6.9±0.2
230 GHz	6.0±0.3
Optic R	6.4±0.1
γ-rays	6.6±0.3

Peaks significance – From 5σ to 10σ



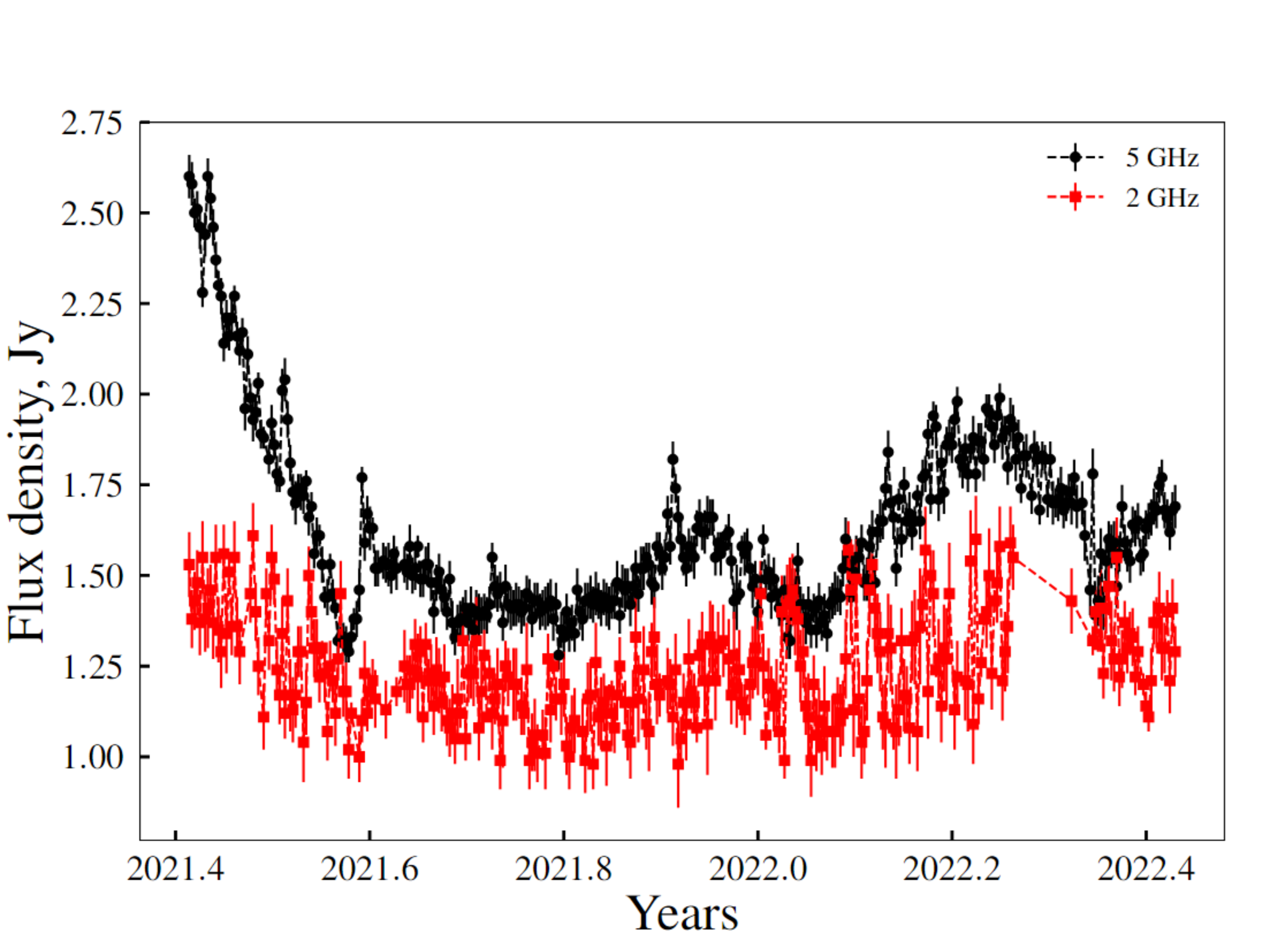
Quasi-periods across "low-state" period

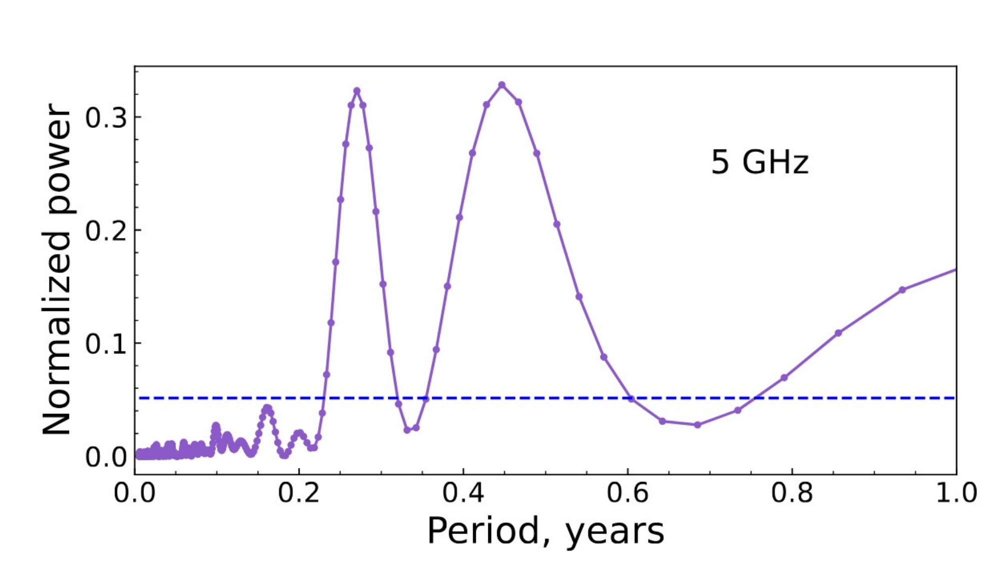
Range	Period, yrs
5 GHz	1.7±0.1
8 GHz	1.4±0.2
11GHz	2.3±0.1
22GHz	2.1±0.1
37GHz	2.3±0.1
230 GHz	1.4±0.1
Optical R	1.7±0.1

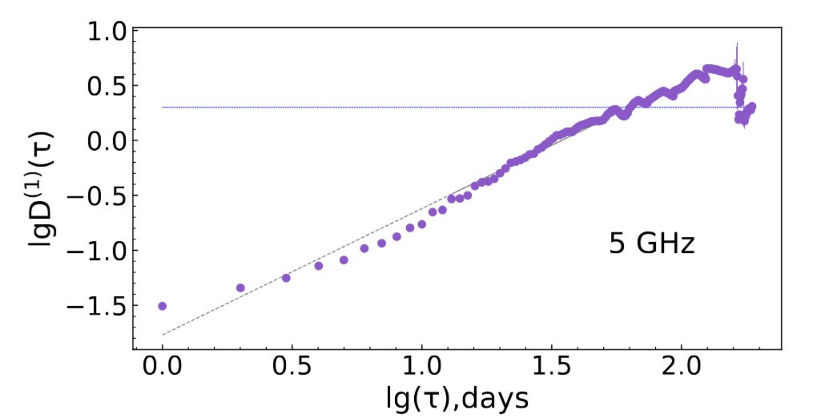


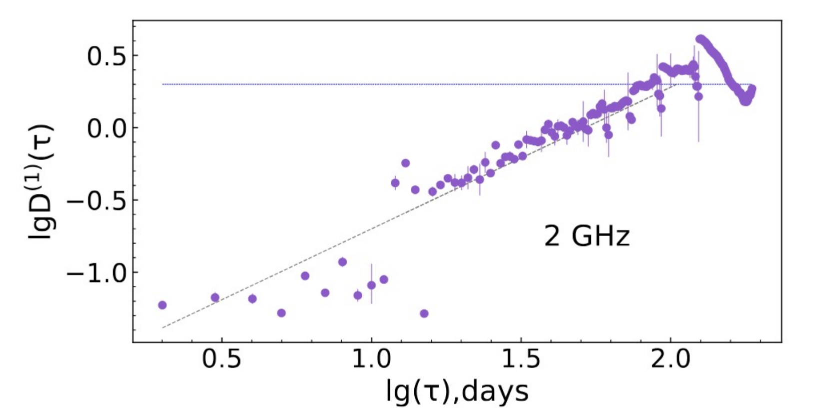
Peaks significance – from 3σ to 6σ

ay-by-day fluxe measurements with ATAN-600 in 2021-2022

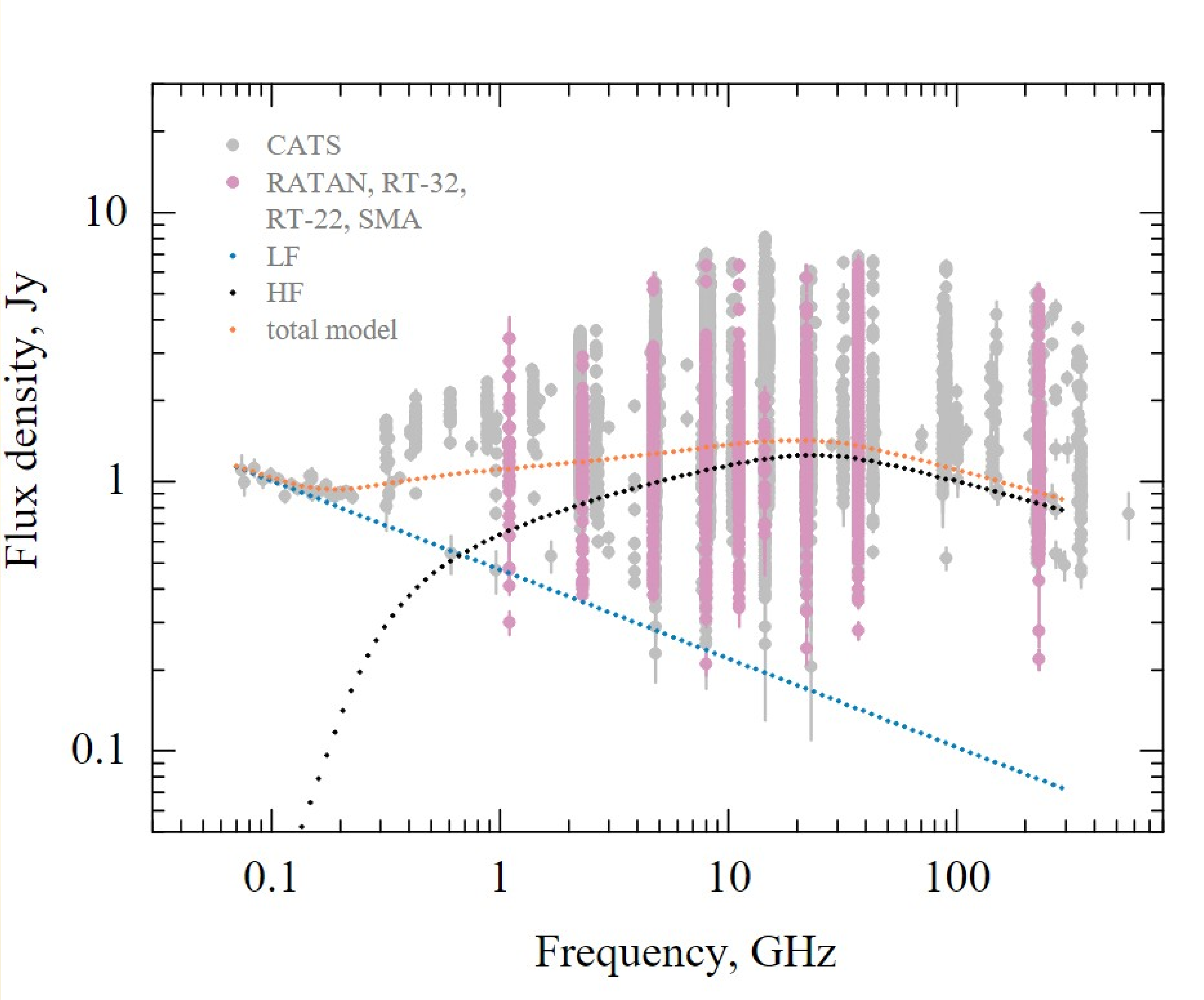






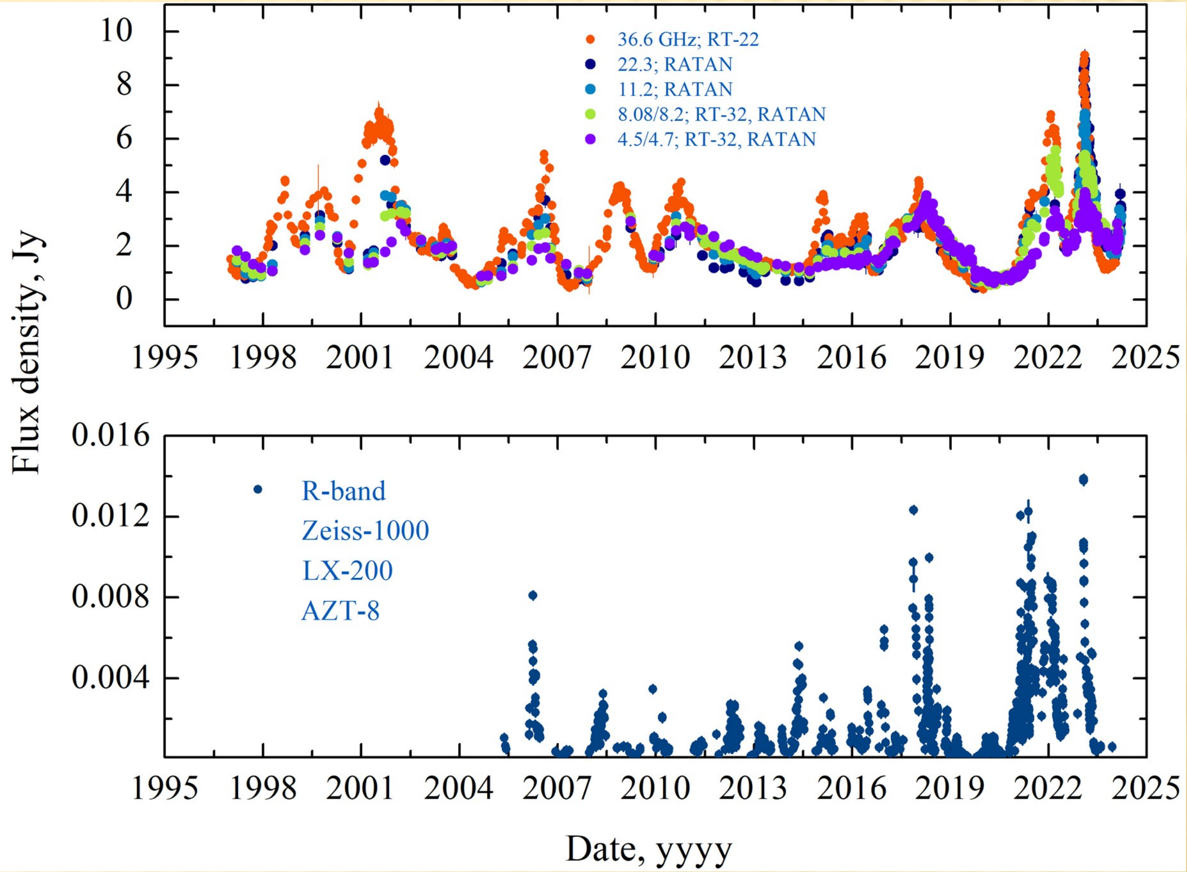


AO 0235+164 – TOTAL SPECTRUM IN RADIO RANGE APPROXIMAT



MW variability of Ton 599

telescope	band	epoch	Observatory
RATAN-600	1.2, 2.3, 4.7, 8.2, 11.2, 22.3 GHz	1997-2024	SAO RAS
RT-32	4.8, 8.6 GHz	2020-2024	IAA RAS
RT-22	37 GHz	2002-2024	CrAO RAS
Fermi LAT	0.1-100 GeV	2008-2023	Fermi
Zeiss-1000	R	2023-2024	SAO RAS
AS-500/2	R	2023-2024	SAO RAS
AZT-8	R	2005-2023	CrAO RAS
LX-200	R	2005-	AI SPbSU



1-37 GHz quasi-simultaneous spectrum of the blazar Ton 599 (4C +29.45) during its greatest radio flare

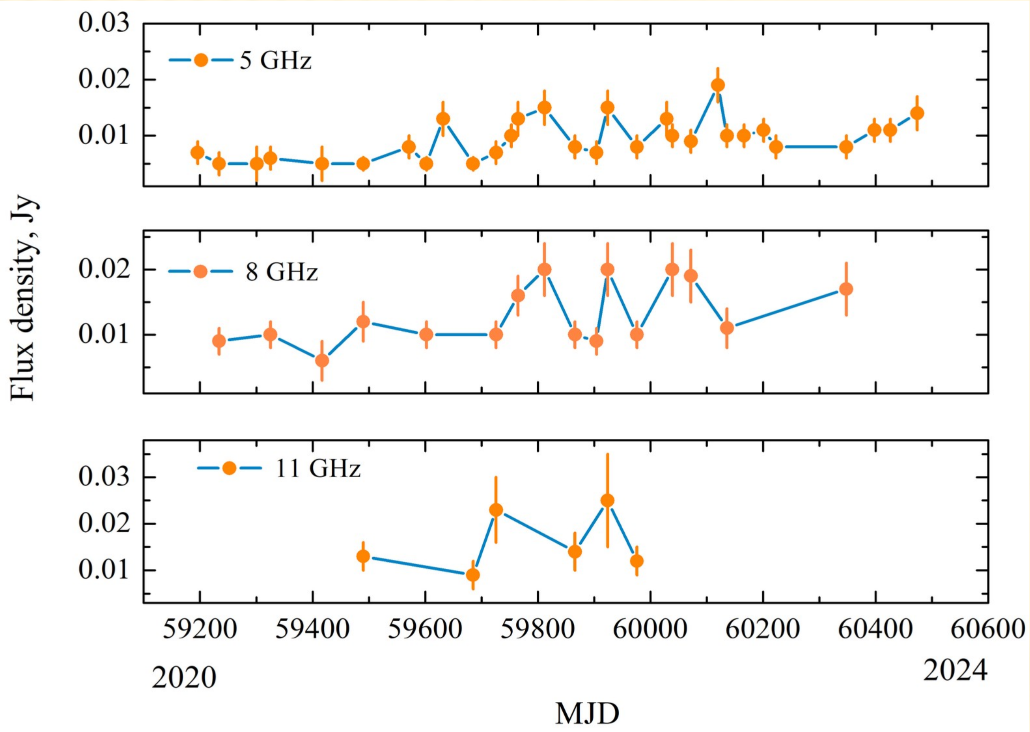
ATel #15894; *Mufakharov T. (SAO RAS), Mikhailov A. (SAO RAS), Kovalev Yu. (ASC Lebedev), Volvach A. (CrAO), Sotnikova Yu. (SAO RAS), Mingaliev M. (SAO RAS), Volvach L. (CrAO), Semenova T. (SAO RAS)*

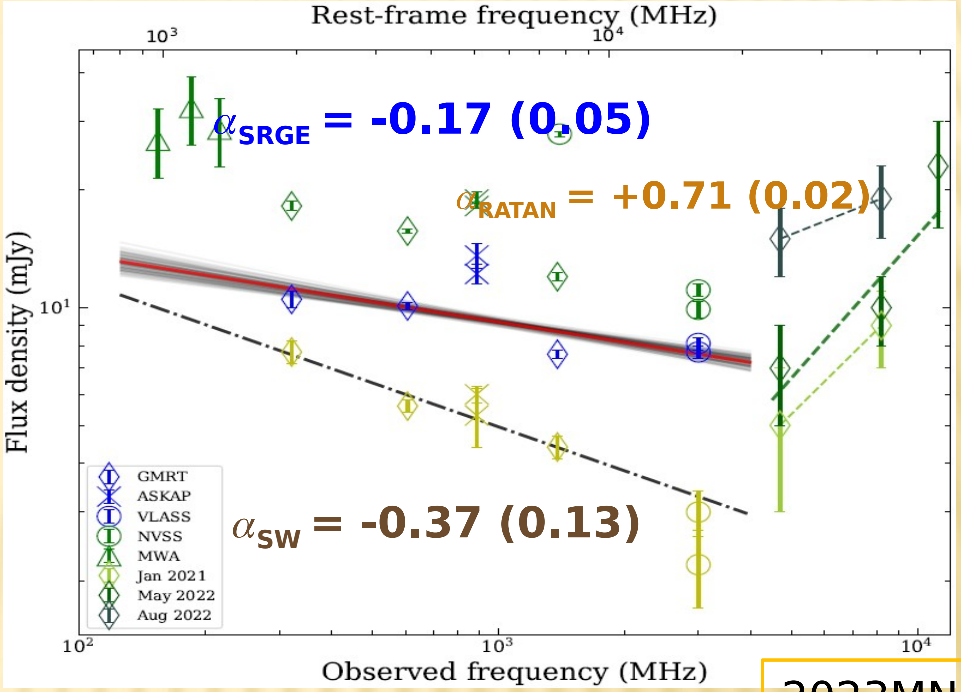
on 9 Feb 2023; 21:05 UT

The radio state of the blazar Ton 599 in the first quarter of 2024

ATel #16557; *Mikhailov A. G. (SAO RAS), Muhakharov T. V. (SAO RAS), Sotnikova Yu. V. (SAO RAS), Kovalev Yu. A. (ASC Lebedev), Kharinov M. A. (IAA RAS), Rahimov I. A. (IAA RAS), Semenova T. A. (SAO RAS), Andreeva T. S. (IAA RAS), Cherepkova Yu. V. (SAO RAS)*

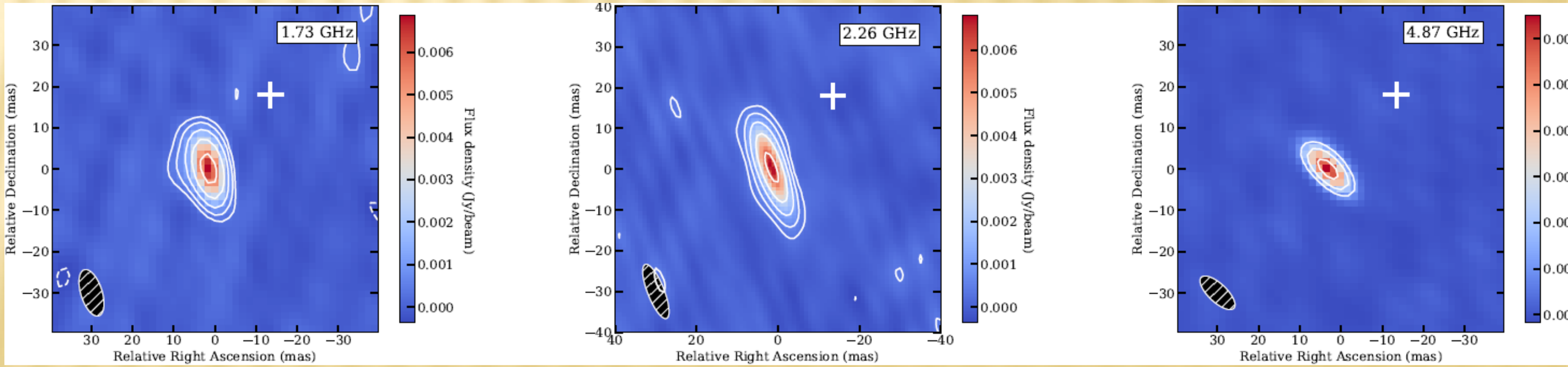
DISTANT BLAZAR SRGE J170245.3+130104 AT Z=5.5





2023MNRAS.519.4047A

MWA, GLEAM-X, GMRT, ASKAP RACS, VLA, NVSS and VLASS, and RATAN-600 (An et al. 2023, MNRAS)



Blazar was discovered at SRG survey

Z = 5.466±0.003 (BTA, SCORPIO)

$L_{X\text{-ray}}$ = 3.6×10^{46} erg/s (2-10 keV)

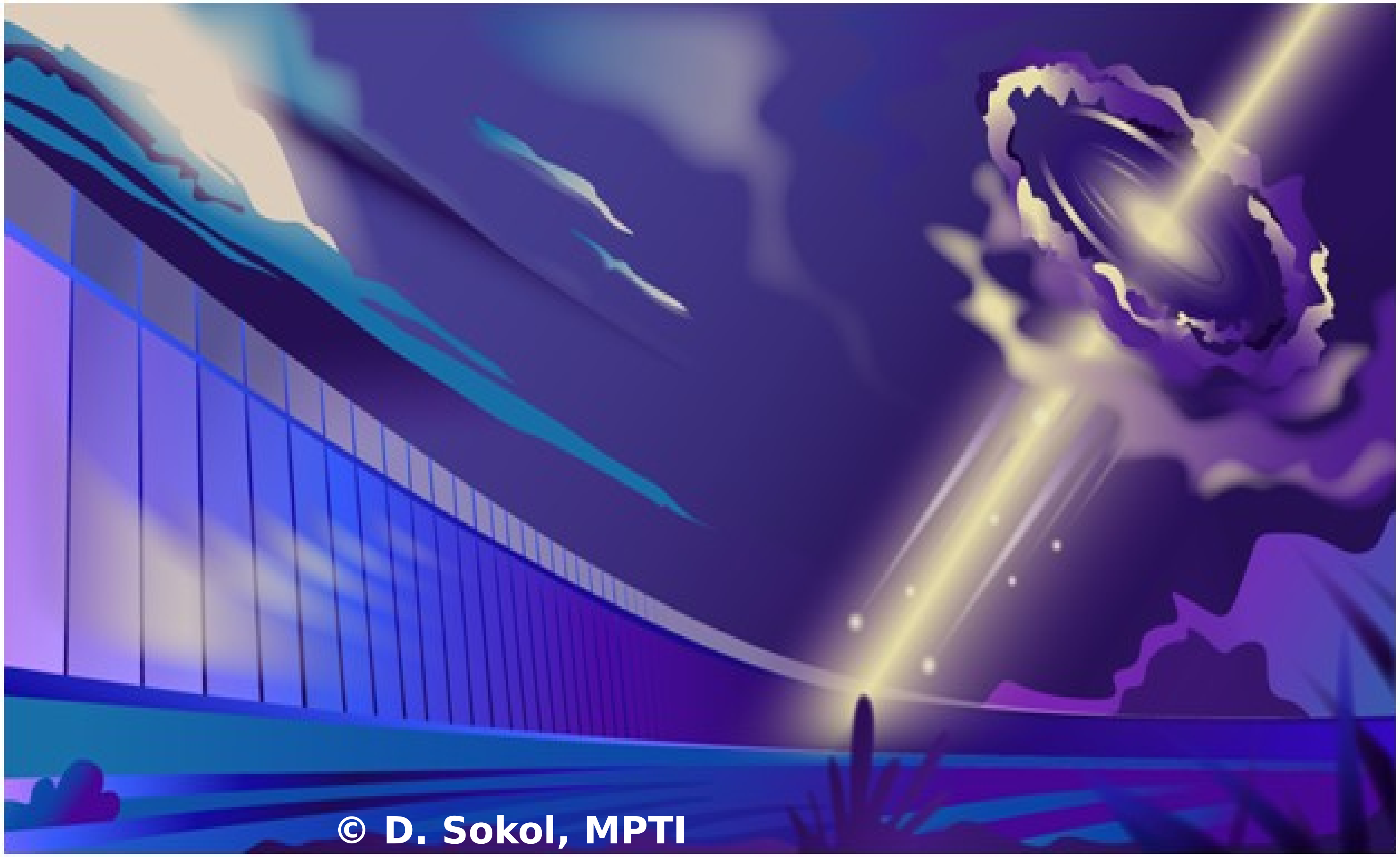
R > 1100

$\alpha_{4.7-8.2}$ = +0.71 (0.02), $S \sim \nu^{\alpha}$

S = 26±0.9 mJy

2024A&A...685A.111

MULTI-MESSENGER ASTRONOMY

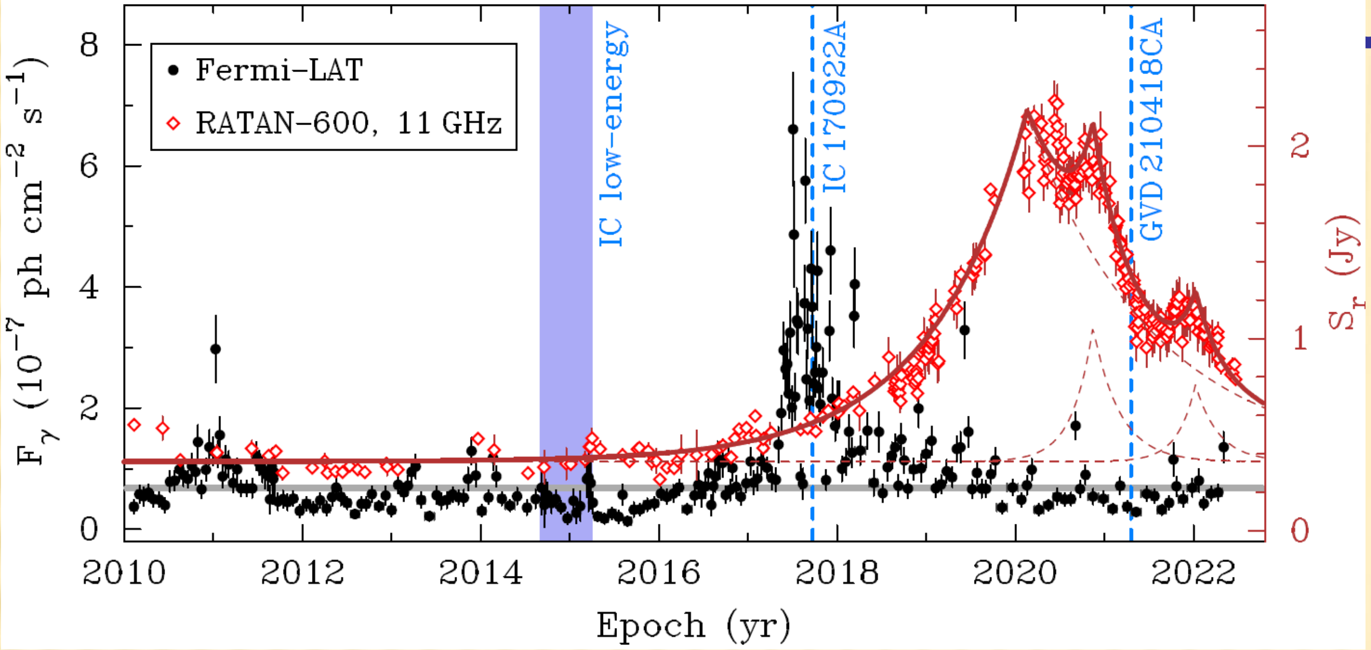


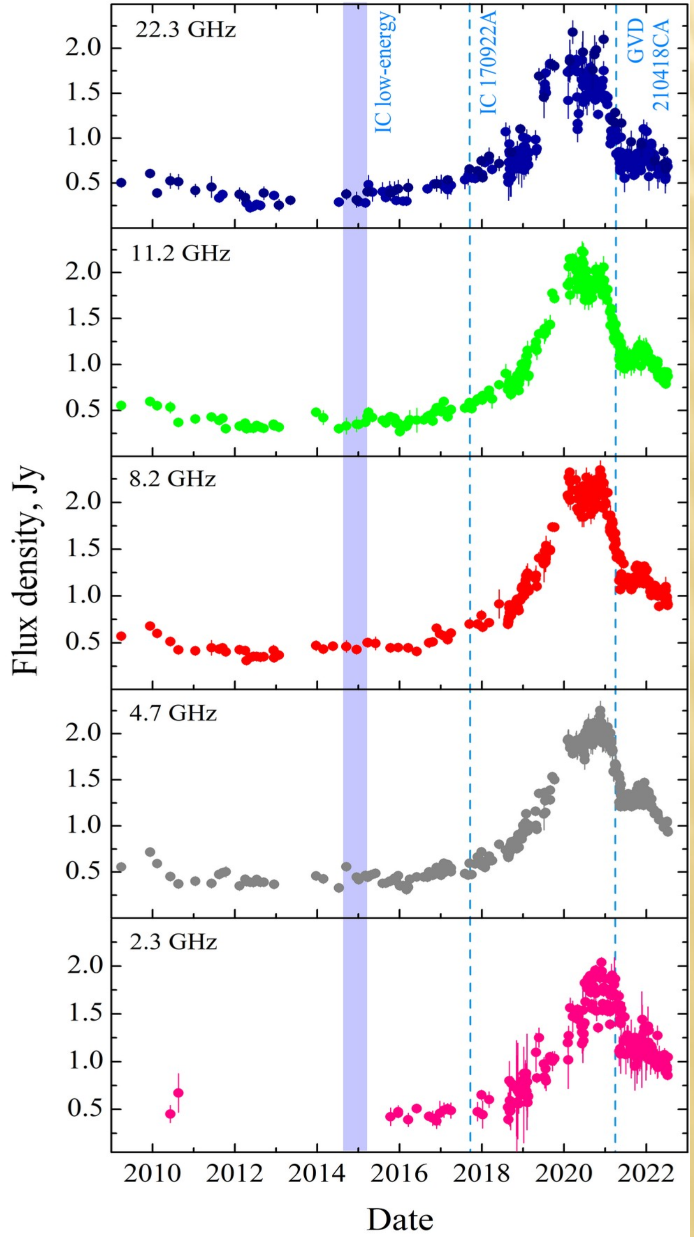
2020-2022: MSHE the project “Neutrinos and astrophysics of particle”

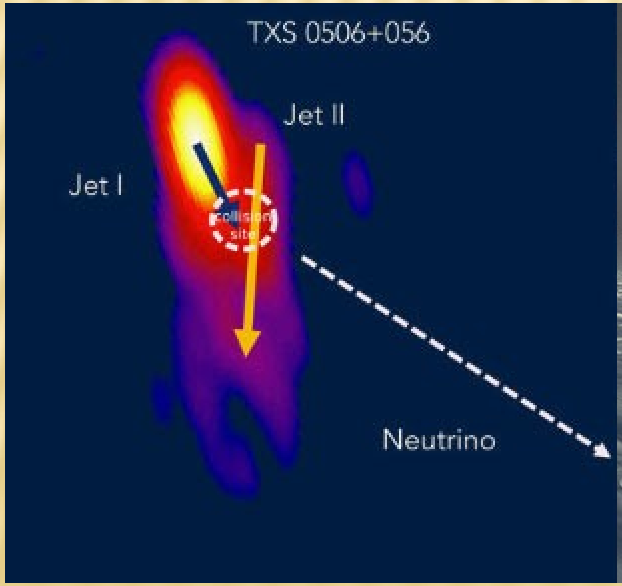
2024-2026: “Studying the origin, sources and properties of neutrinos at the Baikal Neutrino Telescope and other world-class facilities”

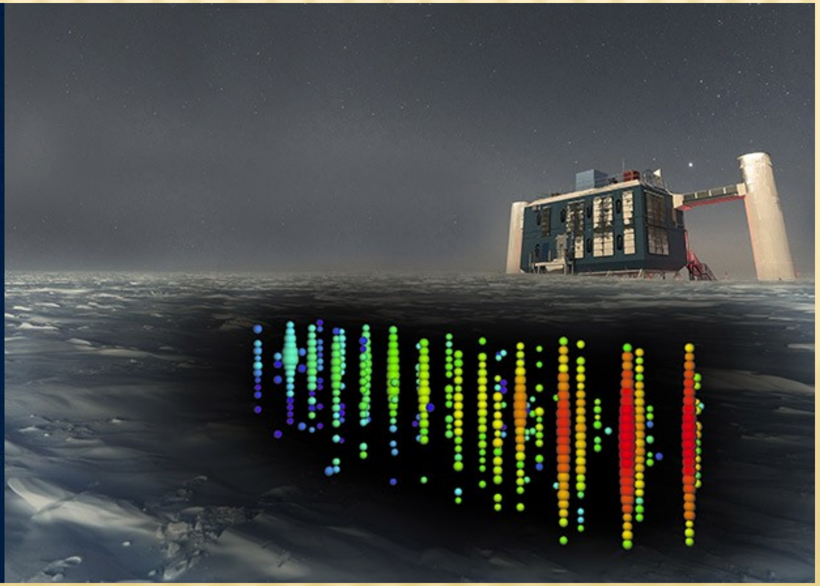
ASC; MPTI; INR RAS; SAO RAS

MULTI-MESSENGER ASTRONOMY: BLAZARS AS NEUTRINO SOURCES







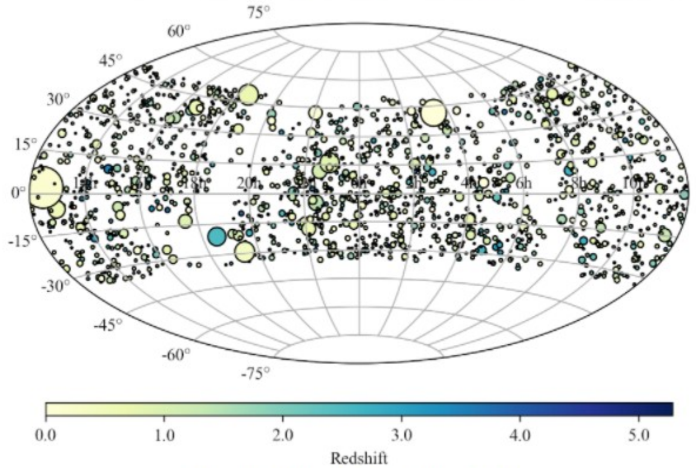


BLcat catalog

https://www.sao.ru/blcat

RATAN-600 multi-frequency catalogue of blazars

login
Data Usage Policy
Help
Export main Table and RATAN-600 data
Show/Hide columns



BLcat Edition 1.3, October 2021

M.G. Mingaliev, Yu.V. Sotnikova, R.Yu. Udovitskiy, T.V. Mufakharov, E.Nieppola, and A.K. Erkenov

Original 2014 edition: 2014A&A...572A..59M

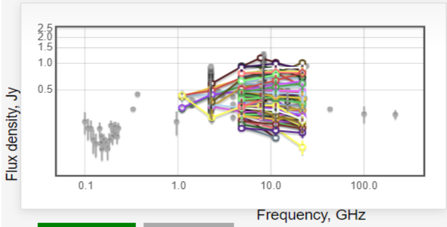
BL Lacs and cand. | FSRQs | Uncertain type | All

1 to 5 of 977 rows

check all	RATAN data	Epochs Stats	Source name	RA	Dec	Redshift Stats	Rmag Stats	Flux density at 4.7 GHz, [Jy] Stats	Radio luminosity at 4.7 GHz, W/Hz Stats	Blazar type Stats
				00 10						Select ty
9	Data explorer	1	5BZQJ0010+2047	00 10 28	20 47 50	0.6	19.3	0.14	1.15E+26	FSRQ
10	Data explorer	57	5BZQJ0010+1058	00 10 31	10 58 29	0.089	15.8	0.12	2.24E+24	FSRQ
11	Data explorer	10	5BZQJ0010+1724	00 10 33	17 24 19	1.601	16.7	0.58	4.14E+27	FSRQ

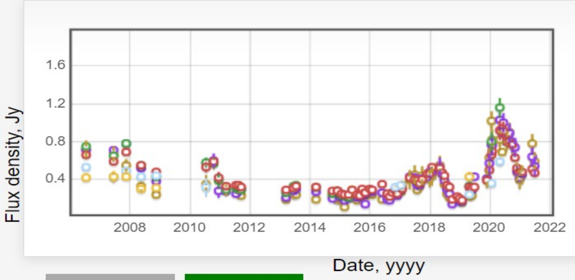
Radio spectra

Object: J002232+060804
R.A.(J2000.0) = 00 22 32 Dec (J2000.0) = 06 08 05



Radio spectra | Light curves
Show external data (1053)
export external data
<- prev 002206+452534 | next 002335+445635 ->

Date	21.7/22.3 GHz		11.2 GHz		7.7/8.2 GHz		4.8 GHz		2.3 GHz		1.1 GHz	
2006-07-15	0.72	0.09	0.71	0.02	0.75	0.02	0.66	0.02	0.53	0.03	0.42	0.02
2007-06-15	0.67	0.08	0.71	0.02	0.65	0.02	0.59	0.02	0.43	0.02	0.43	0.06
2007-11-15	0.55	0.06	0.78	0.02	0.78	0.02	0.69	0.02	0.49	0.02	0.43	0.02
2008-05-15	0.33	0.05	0.52	0.01	0.55	0.02	0.55	0.01	0.43	0.02	0.3	0.02
2008-11-15	0.24	0.03	0.38	0.01	0.43	0.01	0.48	0.01	0.44	0.02	0.31	0.03
2010-07-15	0.35	0.1	0.57	0.04	0.58	0.05	0.53	0.05	0.32	0.09	-	-
2010-10-15	0.58	0.07	0.6	0.07	0.57	0.03	0.59	0.03	-	-	-	-
2010-12-15	-	-	0.28	0.07	0.39	0.07	0.42	0.06	-	-	-	-
2011-03-15	0.29	0.06	0.28	0.02	0.29	0.02	0.33	0.01	-	-	-	-
2011-07-15	-	-	0.25	0.02	0.31	0.02	0.34	0.01	-	-	-	-
2011-08-15	0.3	0.04	0.29	0.01	0.3	0.01	0.34	0.01	-	-	-	-
2011-09-15	0.23	0.04	0.3	0.01	0.29	0.01	0.32	0.01	-	-	-	-
2013-03-15	0.19	0.03	0.21	0.03	0.26	0.03	0.29	0.03	-	-	-	-
2013-06-15	0.24	0.04	0.28	0.01	0.33	0.01	0.31	0.01	-	-	-	-
2013-07-15	0.24	0.04	0.3	0.01	0.34	0.01	0.33	0.01	-	-	-	-



Radio spectra | Light curves
Show external data (1053)
export external data
<- prev 002206+452534 | next 002335+445635 ->

2022AstBu..77..361S
2014A&A...572A..59M

MALTE: MULTIWAVELENGTH ASTRONOMICAL LEAGUE FOR TRANSIENT EVENTS

ABOUT

The MALTE is an international collaboration for exploring transient astronomical events. The aim of the project is a coordination of joint observations with optical and radio instruments which operate under control of MALTE members. The collaboration was initiated by groups within the BRICS project “Transient astronomical events and Deep Survey science” in 2022-2025.

Our universe is full of diverse populations of astrophysical objects that emit powerful radiation in extreme and unpredictable fashion over the whole EM spectrum and also in the form of neutrinos and GWs. Notable examples include gamma-ray bursts (GRBs), high-energy neutrino candidates, gravitational-wave bursts, AGN flares, and X/gamma-ray, optical and radio transients. Many of these are associated with catastrophic events involving relativistic compact objects such as black holes and neutron stars. However, their compact nature has hindered detailed observational characterization, thereby preventing a thorough physical understanding. Thanks to the recent advancements in facilities sensitive to neutrinos and GWs, the mysteries of many of these MM transient events might soon be unraveled.

SAO RAS

SUMMARY

MW astronomy: various properties
Blazars dominate at high z
Optics & Radio, Instruments
International cooperation


Thank you for attention !