IX Russian-Finnish Symposium on Radio Astronomy

"Multi-Wavelength Investigations of Solar and Stellar Activity and Active Galactic Nuclei"

Program and abstracts

15–20 October 2006, Nizhnij Arkhyz

RUSSIAN ACADEMY OF SCIENCES

IX Russian-Finnish Symposium on Radio Astronomy

"Multi-Wavelength Investigations of Solar and Stellar Activity and Active Galactic Nuclei"

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Nizhnij Arkhyz
2006

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Special Astrophysical Observatory RAS,
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Program of the IX Russian-Finnish Symposium on Radio Astronomy, Nizhnij Arkhyz, 15-20 October 2006

October 15, Sunday

09:00-24:00	Day of arrival
19:00-20:00	DINNER
18:00-21:00	Registration of participants

October 16, Monday

08:00-09:00	BREAKFAST
08:30-09:30	Registration of participants
09:30-09:45	Opening ceremony
	Session 1. AGNs
	Chair: Marat Mingaliev
09:45-10:15	**Valtaoja E.** The problem of high-energy emission from AGN
10:15-10:45	**Tornikoski M.** Metshovi AGN projects contributing to the Planck foreground science
10:45-11:05	COFFEE BREAK
11:05-11:35	**Hovatta T.** Long-term radio time scales of Active Galactic Nuclei
11:35-12:05	**Kovalev Yu.** Nature of Active Galactic Nuclei from Massive Instantaneous Radio Spectra Study with RATAN-600 in 1997-2006 supplemented by VLBA experiments
12:05-12:35	**Gorshkov A.** Extragalactic source variability studies of complete samples with RATAN-600
12:35-13:00	**Volvach A.** The combined radio and optical investigations of the intraday variability of active galactic nuclei
13-00-14:30	LUNCH

	Session 2. Extragalactic Sources
	Chair: Esko Valtaoja
14:30-15:00	**Lahteenmki A.** Planck – unlocking the secrets of the Universe
15:00-15:30	**Parijskij Yu.** Very deep SKY surveys with RATAN-600
15:30-15:50	**Bursov N.** RZF Survey
15:50-16:10	**Khabibullina M.** Mean spectral index of the faintest NVSS objects from RZF data
16:10-16:40	**Larionov M.** Radio spectra properties of a complete sample of sources near the North Celestial Pole
16:40-17:00	COFFEE BREAK
17:00-17:25	**Torniainen I.** Radio spectra of GPS galaxies
17:25-17:50	**Temirova A.** New objects from the "Cold" survey
17:50-18:15	**Nieppola E.** Spectral energy distributions and 37 GHz monitoring of BL Lacertae objects
19:00-20:00	DINNER
	October 17, Tuesday
08:00-09:00	BREAKFAST
	Session 3. Extragalactic Sources
	Chair: Merja Tornikoski
09:00-09:25	**Shapovalova A.** A link between variable optical continuum and radio emission of a compact jet in the radio-loud Seyfert galaxy 3C390.3
09:25-09:50	**Burenkov A.** Spectral monitoring of NGC 5548 in 1996-2004
09:50-10:15	**Trushkin S.** New WMAP catalog sources or how many bright sources are on the sky
10:15-10:40	**Doroshenko V.** Continuum and broad emission line variability of Seyfert galaxy

10:40-11:00	COFFEE BREAK
11:05-11:30	**Efimov Yu.** Study of a magnetic field structure in blazar jets from optical photopolarimetric data
11:30-11:55	**Verkhodanov O.** Open WEB-resources of SAO RAS for extragalactic research
	<u>*Session 4. Sun*</u>
	Chair: Aleksander Stepanov
12:00-12:30	**Riehokainen A.** Multi-frequency observations of the polar radio structures
12:30-13:00	**Bogod V.** RATAN-600 microwave spectral solar observations – today and future
13-00-14:30	LUNCH
14:30-14:55	**Borovik V.** Multiwave RATAN-600 observations of post-eruptive processes on the Sun
14:55-15:20	**Golubchina O.** Results of the prominence observations at microwaves during the maximal phase of the total solar eclipse of March 2006
15:20-15:45	**Korzhavin A.** RATAN-600 observations of microwave structure of the quiet Sun
15:45-16:15	**Gelfreikh G.** Peculiarities of QPOs of microwave emission of the flaring solar active regions
16:15-16:40	**Korzhavin A.** Estimations of effective height, size and brightness temperature of the solar cyclotron sources
16:40-17:00	COFFEE BREAK
17:00-17:25	**Modin E.** On the theory of resonant transitive radiation of decimetric radiation of flares
17:25-17:50	**Kotelnikov V.** About a double inversion sign of polarization microwave emission flare-productive active region
19:00-20:00	DINNER

October 18, Wednesday

08:00-09:00	BREAKFAST
	Session 5. Sun
	Chair: Georgy Gelfreikh
09:00-09:25	**Tlatov A.** Reversal background magnetic field in the solar polarized radio emission at 17GHz
09:25-09:50	**Tlatov A.** Oscillation of the polarized radio emission "The Sun as a star"
10:00-13:00	Visit to RATAN-600
13-00-14:30	LUNCH
	Session 6. Galactic Sources
	Chair: Yury Parijskij
14:30-15:00	**Lehto H.** Polarization observations of mCVs
15:00-15:25	**Trushkin S.** Recent data of the multi-frequency monitoring of microquasars
15:25-15:50	**Stepanov A.** Radio pulsations from the AD Leo flare and electric current diagnostics
15:50-16:15	**Fabrika S.** The supercritical accretion disk in SS433 and ultraluminous X-ray sources
16:15-16:35	**Zinchenko I.** Physical and chemical structure of high mass star forming regions
16:35-16:55	COFFEE BREAK
16:55-17:15	**Vdovin V.** Developments of low-noise mm receivers for radio astronomy
17:15-17:55	**1. Gosachinskij I.** On the sky spectroscopy with RATAN-600 **2. Gosachinskij I.** The investigation of interaction between supernova remnants and the interstellar medium
19:00-20:00	DINNER

	October 19, Thursday
08:00-09:00	BREAKFAST
09:00-12:00	Visit to the Optical telescopes site
12:00-18:00	Excursion to the Mountains area, Barbecue
	October 20, Friday
08:00-09:00	BREAKFAST
09:00-24:00	Day of Departure

ABSTRACTS
(alphabetically ordered)

PECULIARITIES OF QPOS OF MICROWAVE EMISSION OF THE FLARING SOLAR ACTIVE REGIONS

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Quasi-periodic oscillations of solar coronal structures are effectively registered in particular at microwave waves. The physical nature of periodical processes in the corona is clearly connected with plasma structures of the solar atmosphere.

On the other hand, the modern conception is that processes leading to eruption of energy in solar flares are results of energy accumulation in the corona or chromosphere produced by some reconstruction of plasma structures.

In spite of developments of the modern observations predominantly using cosmic techniques, we are still far from a satisfactory observational understanding of the above processes. The QPOs of solar active regions were found decades ago and their connections with the flares were detected. Nevertheless, the physical nature and possible forecasting applications are still far from a reasonable level of knowledge. New development of microwave instruments with a high spatial resolution and regular observations (NoRH, RATAN–600, SSRT at Badary) opened a new era in such studies. Oscillations with periods from few minutes to hours were investigated and their time variations were specially analysed. So, we may conclude that investigations of these parameters for ARs with different levels of flare activity, time variations including, may lead to a better understanding of the physics of the problem. Some preliminary results of such studies are presented in this report, based on an analysis of the Nobeyama radio maps of the Sun with the 10 sec averaging and covering periods of hours of observations (dates 11 Sep 2001, 07 Oct 2002, including), and comparing these with spectral parameters of the regions obtained with RATAN–600.
This study was partially supported by the Program of the Presidium or the Russian Academy of Sciences.

A LINK BETWEEN VARIABLE OPTICAL CONTINUUM AND RADIO EMISSION OF A COMPACT JET IN THE RADIO-LOUD SEYFERT GALAXY 3C390.3

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We present an observational evidence for a relation between variability of radio emission of the compact jet, nucleus optical continuum emission and ejections of new jet components in the radio galaxy 3C390.3. We combine results from the monitoring of 3C390.3 in the optical region (Shapovalova et al. 2001; Sergeev at al. 2002) with ten very long baseline interferometry (VLBI) observations of its radio emission at 15 GHz carried out from 1992 to 2002 using the VLBA (Kellermann et al. 2004). For ten VLBA images, we identified five moving components (C4-C8) and two stationary components (D,S1). Proper motions of the moving components correspond to apparent velocities from 0.8c to 1.5c. No significant correlation exists for the moving features between optical continuum and radio emission. However the variations of optical continuum are correlated with radio emission from a stationary feature (S1) in the jet. The optical emission follows radio flares with the mean delays t(S1-opt)$\approx$0.4 year. Most probably the optical continuum is produced near the location of radio emission of the S1 stationary component. The localization of the source of optical continuum with the innermost part of the jet near S1 implies that the broad line emission originates in a conical region (dimension $\approx$ 100 light days) at a distance of $\geq$ 0.4 pc from the central engine. For the components C4-C7, the epochs t(S1) of separation from the stationary feature S1 are coincident, within the errors, with maxima in optical continuum. This suggests that radio ejection events of the jet components are coupled with the long-term variability of optical continuum.

We suppose that the broad emission lines having a double-peaked structure originate in two kinematically and physically different regions of 3C390.3:

1. BLR1 – the traditional BLR (Accretion Disk (AD) and the surrounding gas). It is at the distance $\approx$ 30 light days from the nuclei (Shapovalova et al. 2001).

2. BLR2 – in a subrelativistic outflow surrounding the jet in the cone within $\approx$ 100 light days at a distance of $\geq$ 0.4 pc from the central engine.

During the nucleus maximal brightness periods most of the continuum variable radiation is emitted from the jet and ionizes the surrounding gas, creating a BLR2 that mainly determines the broad line emission. During the brightness minima the jet contribution to the ionizing continuum is decreasing and the main broad line emission comes from the "classical" BLR1 (AD), ionized by nuclei continuum related with the acctretion at BH. Such a scenario explains two maxima ($\approx$ 30d and $\approx$100d) found in the cross-correlation function describing the time-lag of broad line variations relatively to continuum on the base of the results of 3C390.3 optical monitoring in 1996-2000 (Shapovalova et al. 2001).

Acknowledgements. This work was supported by grants: CONACYT 39560F (Mexico), INTAS (N96-0328) and RFBR (00-02-16272; 03-02-17123 and 06-02-16843, Russia).

References

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Sergeev et al.: *ApJ*, 2002, **576**, 660;
Kellermann et al.: *ApJ*, 2004, **609**, 539.

RATAN-600 MICROWAVE SPECTRAL OBSERVATIONS OF THE SUN – TODAY AND FUTURE

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Problems of solar radio emission study with the help of the RATAN-600 radio telescope are considered. It is shown that the main scientific results were attained due to the continual improvement of instrumental parameters. In the case of solar investigations many new features of active solar plasma were detected, in particular:

- A small-scale radio emission structure of the Quiet Sun (a so-called "radio granulation");
- Neutral line associated sources in solar active regions;
- Non-thermal radio emission above sunspots groups, so named "the decimetre halo";
- Cyclotron lines in the active regions;
- Multiple polarization inversions in flare-productive active regions;
- Relations between the double polarization inversions effect at microwaves and Noise Storms activity at meter waves;
- The short-wave increasing of polarization flux before big flares;
- The "darkening" radio emission effect in flare-productive active regions;
- An evolution of polarization flux spectrum before big flares;
- Discovery of micro-bursts and their relation with Noise Storms;
- Detection of a frequency boundary between S- and B-components and others.

Examples of the features listed above are described. A possible future development of solar investigations with RATAN-600 is discussed.

MULTIWAVE RATAN-600 OBSERVATIONS OF POST-ERUPTIVE PROCESSES ON THE SUN

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During two last decades, authors of some studies of post-eruptive arcades repeatedly came to the following unexpected conclusions. Microwave emission of arcades was excessively polarized, presumably due to contribution of non-thermal electrons. Their lifetime was much longer than the estimated cooling times, presumably due to the post-eruptive energy release. Finally, the plasma pressure exceeded the magnetic pressure ($\beta \geq 1$) in their hot top parts. CORONAS-F/SPIRIT observations in the high-temperature (~10 MK) line MgXII and multi-wave RATAN-600 observations along with data from other spectral domains provided important information to verify these conclusions and assumptions. All above facts were confirmed in analyses of this data set. They were explained in terms of the standard flare model ("CSHKP") elaborated by Yokoyama & Shibata (1998) to qualitative account for the chromospheric evaporation, but applied to late post-eruptive phase. In this case, high β conditions indicate magnetic reconnection processes responsible for the prolonged heating and particle acceleration. This approach allows to reconcile the listed facts with known estimates of parameters of the coronal plasma in post-eruptive arcades, and to remove seeming contradictions with habitual conceptions. We consider long-lived post-eruptive arcades observed on 22 October 2001, 2 November 1992, and 28–30 December 2001 and demonstrate that these conclusions are valid, because high-density hot regions in their top parts (thus, high β regions) existed for a long time, and their radio emission contained non-thermal component, which is indicative of the presence of accelerated particles.

References

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SPECTRAL MONITORING OF NGC 5548 IN 1996 – 2004

A.N. Burenkov[1], *A.I. Shapovalova*[1], *N.G. Bochkarev*[2], *V.H. Chavushyan*[3], *S. Collin*[4], *V.T. Doroshenko*[2], *L. Popović*[5], *N. Borisov*[1], *L. Carrasco*[3], *D. Ilić*[6], *J.R. Valdes*[3], *V.V. Vlasuyk*[1], *V.E. Zhdanova*[2]

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We present results of a spectral monitoring program of the Seyfert galaxy NGC 5548 with the 6m and 1m telescopes of SAO (Russia) and with the 2.1m telescope of Guillermo Haro Observatory at Cananea, México. Spectra were obtained with long-slit spectrograph, covering the spectral range ~(4000–7500) Å with a (4.5–15) Å resolution. We found that:

– Both the flux in the lines and continuum gradually decreased, reaching minimum values during May-June 2002. In the minimum state, the wings of Hβ and Hα became extremely weak, corresponding to a Sy1.8 type, not to a Sy1, as observed previously when the nucleus was brighter.

– When the line profiles were decomposed into variable and constant components, the variable broad component is well correlated with the continuum variation. It consists of a double peaked structure with radial velocities of $\sim \pm 1000$ km/s relative to the narrow component. A constant component, whose presence is independent of the continuum flux variations, shows only narrow emission lines. The mean, rms, and the averaged over years, observed and difference line profiles of Hβ and Hα reveal the same double peaked structure at the same velocities. The relative intensity of these peaks changes with time. During 1996, the red peak was the brightest, while in 1998–2002, the blue peak became the brighter one. Their radial velocities vary in the range ∼500–1200 km/s.

– In 2000–2002 a distinct third peak appeared in the red wing of Hα and Hβ line profiles. The radial velocity of this feature decreased between 2000 and 2002: by the observed profiles, from $\sim +(2500–2600)$ km/s to $\sim +2000$ km/s and it is clearly seen on the difference profiles.

– The fluxes of various parts of the line profiles are well correlated with each other and also with the continuum flux. The blue and red parts of the line profiles at the same radial velocities vary in an almost identical manner.

– Our results favor the formation of the broad Balmer lines in a turbulent accretion disc with large and moving "optically thick" inhomogeneities, capable of reprocessing the central source continuum.

We made an attempt to investigate the variability of physical parameters in the **BLR** of NGC 5548 using the Boltzmann plot method given by Popović (2003). We applied the method on the broad Balmer lines, and found that variability seen in lines is also present in the electron temperature (**T**). We found that the average **T** for the considered period was ≈ 10000K, and that it varies from 6000K (in 2002) till 15000K (in 1998). This variation correlates with the optical continuum flux ($r = 0.85$) and may indicate existence of an accretion disk in the **BLR** of NGC 5548. We found that Partial Local Thermodynamical Equilibrium approximation is valid for at least one part of the BLR of NGC 5548.

The detailed discussion of these results is done in our papers (Shapovalova at al. 2004; Popović et al. 2005).

Acknowledgements. This work was supported by grants from CONACYT 39560-F (Mexico), RFBR 06-02-16843 (Russia) and the Ministry of Science and Environment Protection of Serbia.

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MEAN SPECTRAL INDEX OF THE FAINTEST NVSS OBJECTS FROM RZF DATA

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A spectral index of a 'mean' radio source from NVSS catalog was estimated by summarizing of the drift scans of the RZF survey. In the area of RZF servey (RA2000:0-24; DEC2000:40.5-42.5) there are 28000 NVSS sources with a total flux density from 2 to 400 mJy at 1.4 GHz. These NVSS sources are considered as point ones. We have divided this flux range to 12 bins: 2–4, 4–6, 6–8, 8–10, 10–13, 13–17, 17–24, 24–35, 35–60, 60–110, 110–220, 220–400 mJy. We summarized 7500 intercepts of one-hour records at 4 GHz of RZF survey by a number of NVSS sources in each bin. Indeed we 'detected' a 'avarage' source in each bin of NVSS sample and obtained 'average' flux densities at 4 GHz for each flux bin: 0.9, 1.7, 2.6, 3.7, 4.3, 6.9, 7.6, 10.5, 17.2, 27.5, 60.0, 177 mJy respectively.

The data give a rough estimate of the 'average' spectral indices (1.4–4 GHz) for each NVSS sources bin. We found that an 'average' spectral index is a function of NVSS flux densities. A comparison with expected mean spectral indices and the reliability of such a estimate are discussed.

However, in the bin of 3–8 mJy the spectra have spectral index equal to –0.8, i.e. the relative fraction of the steep spectrum sources decreased probably because a number of FRII radio sources decreases just in this flux range (Jarvis & Rawlings, 2004).

References

Jarvis M.J., Rawlings S.: *New Astron.Rev.*, 2004, **48**, 1173.

RZF SURVEY

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The completed second version of the RZF catalog at 7.6 cm wavelength is presented. A reality of faint and new objects of the catalog is evaluated. Radio spectra of NVSS objects are plotted and a new distribution of spectral indices is found.

New information about a contribution of background of the faint radio sources with inverted spectrum and about a “sub-mJy” population of the background radio sources in the cm range is found. It is shown that an average spectral index of radio sources at the mJy level is flatter, a percentage of classical radio galaxies FRII type drops, but the population of objects with inversion spectra is negligible.

Candidates of the most distant radio galaxies ($z > 4 - 5$) catalog are selected by colors from the SDSS counterparts.

A decrease of white noise of radiometers is achieved by a large integration time at pixel that is below the level of WMAP experiment.

The synchrotron component of the foreground Galaxy emission with high accuracy at earlier unstudied angular scales was removed.

CONTINUUM AND BROAD EMISSION LINE VARIABILITY OF SEYFERT GALAXIES

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We focused on the observed properties of some Seyfert galaxies without detailed discussion of underlying physical mechanisms. Our purpose was to show a diversity of observed effects due to variability in spectra of six galaxies (NGC 4151, NGC 5548, Mrk 6, Ark 120, 3C 390.3, Arp 120B), optical spectral and photometric monitoring of which was carried out in the Crimean Astrophysical Observatory and Crimean Laboratory of the Sternberg Astronomical Institute over many years. This monitoring shows that

- All light curves demonstrate a variability on different time scales from days to years.
- Amplitude of variations increases with increasing of the time interval of observations.
- The flux in emission lines changes in response to the flux variation of the ionizing continuum source with some time delay. Thus, the emission lines "echo" or "reverberate" the continuum changes. This time delay is due to light-travel time effects within the BLR.
- The time delay of the broad Hβ emission line flux relative to optical continuum in the vicinity of the Hβ line lies in an interval from 9.2 days for Arp 102B to 80 days for 3C 390.3. This means that a region of the most effective emission in the Hβ and Hα lines is fairly small, and it is located at a distance of about 9 – 80 light days from the continuum source.
- We found one very strange and inexplicable case (3C 390.3) when a lag calculated from the broad Hα line significantly exceeds that of the Hβ. In all other cases, the Hα and Hβ lines have a similar lag.
- We revealed a slightly different lag for two time intervals for NGC 5548: $\sim$26 days in 1972–1988 and $\sim$ 18 days in 1989–2001.
- Analysis of the lag as a function of the radial velocity does not show any reliable evidence of the pure radial dominated outflow, possibly, except for NGC 4151. A weak evidence of radial inflow was found in Mrk 6 and Ark 120. Predominantly, we found that there is no pure radial inflow or outflow in the BLR of the considered galaxies. In all cases, the kinematics mainly looks like a chaotic or rotational motion.
- We also found that the lag for the central part of the broad Hβ emission line is slightly larger than for wings (NGC 5548).

- The lag slightly increases with increasing of the continuum flux (Ark 120). This fact is consistent with a virial relation between the velocity field and the distance of the emitting region: the velocity field diminishes with increasing distance from the central continuum source. This implies that the velocity field is dominated by a central massive object.

- Not only the flux of broad emission line but also the line profiles appreciably changed with time. The emission-line profile changes usually occur on a time scale that is much longer than the light-travel time scale.

- In all cases, the excess between the normalized Balmer profiles and the mean normalized profile shows a very complicated behavior both over time and wavelength, and it can hardly be related to the expected reverberation signal from the simple disk model. The profile evolution for some galaxies (NGC 4151, Mrk 6, 3C 390.3) can be reproduced to larger or smaller extent with the two-component model in which profile changes are due to changes in the relative strength of two variable components with a fixed shape. The double peaked profile was often observed among the discussed objects. Profile decomposition gives one component that dominates in the central part of the profile, while the double peaked component dominates in the profile wings. However, the moving features of the profile shapes observed, e.g., in 3C 390.3, NGC 4151, and Arp 102B can be a result of rotating redistribution of matter in the Keplerian disk.

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THE STUDY OF A MAGNETIC FIELD STRUCTURE IN BLAZAR JETS BY OPTICAL PHOTOPOLARIMETRIC DATA

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There are no direct methods to measure magnetic field intensity in sources of synchrotron radiation. Usually estimations of magnetic field intensity are obtained from the Faraday rotation measure in radio region with additional data about a path length and an electron density. Besides the Faraday rotation of polarization plane there are observational parameters which are connected directly with the intensity of magnetic field and its structure: a polarization degree and a spectral index. Both these parameters can be obtained from optical observations. On the other hand, various theoretical models connect magnetic field intensity with polarization degree.
From two polarimetric modes observed in blazars: circular and linear, the last one is rather

large (from 1% to 40%) and can be detected easily in contrast to the circular polarization which is very small (fraction of percentage). In its turn, the linear polarization is directly connected with spectral index. So, the comparison of theoretical predictions from various models of magnetic field with observed dependencies between polarization degrees and spectral indices allows to significantly confine an uncertainty of the magnetic field intensity estimations. The first such attempt had been made about 30 years ago by Nordsieck (1976). Moreover, such a comparison allows to follow the variations of the magnetic field intensity from observed variations of polarization degree and spectral index.

In this report we present a result of such comparison for two well-known blazars 3C 66A and OJ 287. It was shown that in both sources the decrease of polarization and spectral index indicate: an increasing disorder of magnetic fields of relativistic jets.

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THE SUPERCRITICAL ACCRETION DISK IN SS433 AND ULTRALUMINOUS X-RAY SOURCES

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SS433 is the only known persistent supercritical accretor, it may be very important for understanding ultraluminous X-ray sources (ULXs) located in external galaxies. We describe main properties of the SS433 supercritical accretion disk, jets and its radio nebula W50. Basing on observational data of SS433 and published 2D simulations of supercritical accretion disks we estimate parameters of a funnel in the disk/wind of SS433 and discuss formation of jets and a nebula. Critical observations which may throw light upon nature of ULXs come from nebulae observations around ULXs. We present results of 3D-spectroscopy of nebulae around several ULXs located in galaxies at distances of 3-6 Mpc. We found that nebulae are powered by their central black holes. The nebulae are shocked and dynamically perturbed probably by jets.

RESULTS OF THE PROMINENCE OBSERVATIONS AT MICROWAVES DURING THE MAXIMAL PHASE OF THE TOTAL SOLAR ECLIPSE OF MARCH 2006

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Results of the prominence radio emission study according to observations of the solar eclipse on 2006 March 29 with the Northern sector and with the Southern sector with the Flat mirror of RATAN-600 are discussed. Investigation of the prominence located in the NE solar limb is executed in the (1.03-5.0) cm wavelength range. These observations are unique because the solar eclipse was observed with one telescope simultaneously by two different methods. This enables to supplement mutually the data received by observations with two different sectors and gives an opportunity to control some obtained results. The angular resolution of the antenna in the horizontal direction is from 17.5 arcsec up to 47 arcsec in the (1.88-5.0) cm wavelength range with the Southern sector and the Flat mirror and from 0.44 arcmin to 1.68 arcmin in the (1.03-3.9) cm range with the Northern sector of the RATAN-600. An average angular size of the prominence source in the specified wavelength range is about 30 arcsec. From observations with the Northern and Southern sectors, the position of maximum of the prominence radio source have been found to coincide with the prominence top of the solar image in the He II 304 line (SOHO, ϕ=45^o, NE limb of the Sun). The radio fluxes of the prominence were obtained in the wavelength range from 1.03 to 5.0 cm. The fluxes in the range λ = 1.38 - 4.0(cm) are equal to F(λ)=0.8-0.01(s.f.u.). These values coincide for observations with both sectors of RATAN-600, meanwhile the methods of the observations and the techniques of data processing of the observations with two sectors were different.

The obtained spectrum of the prominence defined a thermal mechanism of the prominence radio emission in the (1.03-5.0) cm range. There is a sharp decrease of the prominence radio flux down to value F = 0.02 s.f.u. in comparison with expected value for the 1.03 cm wavelength, according to received dependence F (λ). Possibly it is caused by the Moon closing the prominence at the moment of observation. A relative position of the Moon and the Sun at the moment of the solar eclipse maximum phase allowed to estimate the height of the prominence above the photosphere. The derived brightness temperatures of the prominence are equal to $T_b = (5450 - 17900)^o$ K in the (1.84-4.21) cm wavelength range. It was registered a bipolar structure of the radio source associated with the prominence. The degree of circular polarization of the source is: $p = (5 - 10)\%$ for the (1.84-5.0) cm wavelengths.

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EXTRAGALACTIC SOURCE VARIABILITY STUDIES OF COMPLETE SAMPLES WITH RATAN-600

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We present preliminary results of the study and analysis of complete and limited in flux density source samples from the Zelenchuk and MGB surveys carried out with the RATAN-600 radio telescope.

This work pursues two the main aims:

- Investigation of general statistical characteristics of a discrete source sample;
- Investigation of variability processes in discrete sources in a wide range of wavelengths. That assumes a study of the amplitude and frequency characteristics of variability on all time scales from several years to several days.

The following results of this investigation have been revealed (or confirmed):

1. The long-term variability with a time-scale more than several years. Our observations have allowed to trace a complete evolution cycle of the isolated flare in a number of sources from its occurrence before decay and to specify its amplitude and frequency characteristics. There is no plateau at the maximum of a flare, a flare increase and decay are well described by a exponential temporal law. Such a form of flare is not described by any model.
2. The variability with a time-scale about tens of days. We consider the variability with a week time scale as an important result of our investigation. It is a new type of the variability and, as it was found out, it is widespread enough. Approximately 10% of sources with flat spectra have a similar variability. The variability often has a cyclic nature and, basically, is exposed at frequencies below 10 GHz.
3. The existence of variability with a time-scale about four days for all compact radio sources. We are sure that the given type of variability is not a property of a radio source, but a result of radiation propagation in inhomogeneous interstellar medium.

ON THE SKY SPECTROSCOPY WITH RATAN-600

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Observations of radio lines with the RATAN-600 radio telescope are being carried out during 30 years in the domain of

– systematical investigations of a cloudy structure of the Galactic interstellar medium in the lines of HI at 21 cm, OH at 18 cm, H_2CO at 6.2 cm and H_2O at 1.35 cm with the aim of understanding its structure, dynamics, evolution and interaction with other Galactic populations;

– investigation of physical and evolutionary status of large structures of interstellar gas;

– a search of gas clouds at cosmological distances with the help of their probable line emission.

The most interesting results were obtained in the investigation of HI gas around SNR's and HII regions, recombination line H110α in the Orion nebula, HI Super Shells, a formaldehyde cloud in the source Sgr B2, statistical characteristics, "scale relations" and internal motions of the HI clouds and properties of interstellar gas at high Galactic latitudes.

INVESTIGATION OF INTERACTION BETWEEN SUPERNOVA REMNANTS AND INTERSTELLAR MEDIUM

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During 1999-2006 the second stage of investigation of HI distribution around supernova remnants (SNRs) was carried out with the RATAN-600 radio telescope. In contrast to a previous stage during 1985-87 now SNR of large angular dimension (greater than $10'$) and specific type – S (shell) were selected, independently from their radio brightness. It is obvious that namely such objects have sufficiently large ages for demonstrating a evidence of interaction between their shock waves and surrounding neutral gas. Such a evidence could be detected in the "Right Ascension – Velocity" $(\alpha - V)$ maps as ring like structures, whose parameters may bring information about sizes, ages and energy of supernova explosion.

Now we have observed about 130 SNRs and 105 $\alpha - V$ maps are plotted. Some interesting objects (such as S147, Cygnus Loop, HB3) were studied in detail and results were published separately. Soon all $\alpha - V$ maps will be available at our web-site.

LONG-TERM RADIO TIME SCALES OF ACTIVE GALACTIC NUCLEI

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We have studied long-term variability time scales of a large sample of Active Galactic Nuclei at several frequencies between 4.8 and 230 GHz. The sample consists of 80 sources from different classes of AGN. In our sample we have quasars, BL Lacertae objects and Radio Galaxies. Our sample consists of sources from the Metsähovi monitoring programme where a sample of compact extragalactic radio sources has been monitored for over 25 years. In addition we use lower frequency data from the University of Michigan monitoring programme and data obtained from the SEST-telescope between 1986 and 2003.

We used the first order structure function, the discrete auto-correlation function and the Lomb-Scargle periodogram to study the characteristic time scales of variability. We were interested in finding differences and similarities between classes and frequencies. Also the methods were compared in order to find the most efficient one for different purposes.

We have also compared the results of this study with earlier structure function analysis by Lainela & Valtaoja (1993). In the earlier analysis the structure function was used to study 42 sources from the Metsähovi monitoring sample at 22 and 37 GHz frequencies. We wanted to find out how the time scales have changed after the amount of monitoring data has more than tripled.

The main conclusion of our study is that in these sources smaller variations happen also in short time scales but larger outbursts only in time scales of many years. Therefore in order to study how often sources are in active state and how long these flares typically last the long-term monitoring is needed.

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RADIO VARIABLE SOURCES WITH THE RT32 RADIO TELESCOPE

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We discussed first results of radio observations of AGNs and microquasars with the RT32 radio telescope (Zelenchuk) during 2004-2006. We carried out more than 20 sets of observations of the microquasars: SS433, Cyg X-3 and LSI+61d303 at frequencies 2.3 and

8.45 GHz. Usually during 1-3 days these sources were observed in a multi-scanning mode, when the antenna elevation or the antenna azimuth were changed following a cosmic source. Thus, for 3-5 daily observations with a duration of 30-60 minutes we integrated up to 100 single scans, which could be used to study a fast intra-day variability. The flux sensitivity of about 10-20 mJy was reached at both frequencies. From November 2004 to August 2006 in twelve two-day sets of observations the sample of 50 bright variable extragalactic sources from 3 and WMAP catalogs and from the sources list selected for the Russian-Finnish program of AGNs was studied. It is important for such programs that from March 2005 the RT32 observations were regularly carried out simultaneously at both frequencies 2.3 and 8.5 GHz in two circular polarizations. A good agreement of the RATAN and RT32 flux measurements of microquasars and AGNs was obtained.

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ESTIMATIONS OF EFFECTIVE HEIGHT, SIZE AND BRIGHTNESS TEMPERATURE OF SOLAR CYCLOTRON SOURCES

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The modeling of microwave emission from a spot-associated cyclotron source was done to refine the method of estimations of effective brightness temperature, size and height above photosphere in the processing of RATAN-600 observations. The simple model of a source with a dipole distribution of magnetic field and with a two-step transition region between the cold dense chromosphere and the hot corona was used.

When a source approaches the limb the decrease of a source visible size in E-W direction takes place due to the projection effect, which causes the decrease of its effective size in processing of a one-dimensional scan of RATAN-600. The subsequent Gauss-analysis would overestimate values of brightness temperatures if necessary corrections were not done.

The same projection effect leads to the fact, that the size of source observed in polarized emission (Stokes parameter V) exceeds the size of the source in full intensity emission (Stokes parameter I) due to non circular distribution of polarized emission.

The method of estimates of the effective height of emission above photosphere level by measurements of an emission centre of weight declination from a source geometrical centre at approaching to the limb was modeled and presented.

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RATAN-600 OBSERVATIONS OF MICROWAVE STRUCTURE OF THE QUIET SUN

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To investigate microwave emission of the quiet Sun the observations with RATAN-600 from September, 2005 to March, 2006 in the range 6-16.4 GHz with the 1% frequency resolution were used.

We present an analysis of observational data for several days with different positional angles. A small-scaled structure with the size of 20-40 arc sec is regularly observed with RATAN-600 one-dimensional observations. A high degree of correlation for separate elements of the structure in the different frequencies channels at all band of the observations exists. Our estimates of an average life time are several hours. There is a direct dependence between the sizes and life of time for separate elements.

The spectra of brightness temperatures grow with wavelength. The emission polarization is very likely negligible. The characteristics of presented observed structure are very close to ones of a super granulation (chromosphere network) which is not sufficiently investigated in microwaves. The separated bright sources are identified with bright X-ray points or bipolar magnetic structure.

Our modeling demonstrates that the structure of the chromosphere network can exist in a wide spatial range, but really only the sources with the sizes of 20-40 sec of arc can be detected at microwaves. Possible mechanisms of such radio emission are discussed.

The daily monitoring with RATAN-600 observations provides possibilities to regularly estimate a state of the quiet Sun by emission characteristics of microwave small-scaled structure and to trace rises of new centers of activities.

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ABOUT A DOUBLE INVERSION SIGN OF POLARIZATION MICROWAVE EMISSION FROM FLARE-PRODUCTIVE ACTIVE REGION

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Polarization inversions have been detected in some microwave sources by Piddington et al. (1951) and by Peterova at al. (1974). Tokhchukova et al. (2002) have shown that a more complex phenomenon is observed in the flare-active regions: before a powerful flare the sign of circular polarization changed twice within a narrow frequency range. Here we discuss observations of flare-productive active regions. These observations were carried out with the RATAN-600 radio telescope in a broad radio range for a period from 2000 to 2004.

The double inversion has been observed in several events before powerful proton flares. We propose two alternative models for explanation of this phenomenon. The first model is the existence of the magnetic “hole” in active the region and the second model is the propagation of radio waves through a layer with zero magnetic field.

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RADIO PULSATIONS FROM THE AD LEO FLARE AND ELECTRIC CURRENT DIAGNOSTICS

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Using pulsations characteristics of AD Leo radio flares observed by Bastian et al. (1990) with the Arecibo 300m and by Stepanov et al. (2001) with the Effelsberg 100m radio telescopes the values of electric currents (7–40) $\times$ 10^{11} A and plasma parameters in stellar flares are determined. It was shown that radio pulsations can be due to both “sausage” oscillations as well as current RLC-oscillations in a flare loop (Zaitsev et al. 1988, 2004). Explanation of very intense radio bursts ($T_b \approx 10^{15}$ K) in terms of coherent plasma emission gives the magnetic field value (100–300 G) and the electron number density (10^{10}–10^{11} cm^{-3}) in the flares. The energy of electric current stored in the flares was estimated as (1–50) $\times$ 10^{25} J. It is shown that $< \sim$10% of stored energy was released in the flares.

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NATURE OF ACTIVE GALACTIC NUCLEI FROM MASSIVE INSTANTANEOUS RADIO SPECTRA STUDY WITH RATAN–600 IN 1997–2006 SUPPLEMENTED BY VLBA EXPERIMENTS

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We present results of observations of 1–22 GHz instantaneous continuum spectra of about 3000 active galactic nuclei performed in 1997–2006 with the 600 meter ring transit radio telescope RATAN–600. An analysis of types and structure of the measured instantaneous spectra has lead us to a conclusion that almost all spectra could be modeled as a sum of two main spectral components: LF-component (decreasing with frequency) and HF-component (with a maximum in cm-mm band). In the framework of a model with longitudinal magnetic field, the HF-component is explained by synchrotron radiation of a continuous compact relativistic jet emerging from the nucleus, the LF-component — by radiation of optically thin extended peripheral structures which accumulate jet particles. Long term variability is studied in about 600 AGNs. It is dominated in the same model by the variable emission of a compact jet (HF-component) and is explained by variable flow of relativistic particles injected in the jet base. We also apply another model, a standard homogeneous blob of relativistic particles with synchrotron self-absorption, for sources with simple parsec scale structure and peaked spectral shape. On the basis of our combined RATAN and VLBA measurements, we estimate the magnetic field in jet regions of these sources and compare it with estimations provided by the model with longitudinal magnetic field.

PLANCK — UNLOCKING THE SECRETS OF THE UNIVERSE

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The Planck satellite is a European Space Agency ESA's mission capable of mapping the whole sky at several radio wavelengths. The ultimate purpose of the satellite is to measure, with a high resolution, the cosmic microwave background (CMB) anisotropy pattern, and thus define the geometry and content of our Universe. At the same time all foreground radio sources in the sky, including extragalactic radio sources, will be measured, too. The by-products of the CMB map cleaning process, the foreground source maps, will become useful

scientific results in themselves. Hence the task is two-fold. First, to provide the cosmologists with tools for cleaning the CMB maps, and second, to extract scientific information out of the high radio frequency all-sky foreground source catalogs.

One of the most important goals of our Planck project is the acquisition of complete sky surveys at several high radio frequencies —an unprecedented event that should solve at least some of the open questions regarding active galactic nuclei (AGNs). Even though we do have a general idea of the basic structure and nature of AGNs, the detailed structure and precise physical processes at work are not yet well understood. AGNs emit at all electromagnetic frequencies from the radio to the gamma-ray region, and all these frequencies are connected, each frequency adding to the complete picture. The future of the AGN research is in multi-frequency studies performed with sophisticated ground-based and space-borne instruments or instrument networks, and Planck will be a significant contributor to this work.

The Metsähovi and Tuorla Planck team has developed a special software called the Quick Detection System (QDS), that will be used for detecting strong, possibly flaring, radio sources in the time-ordered data stream of the Planck satellite within one week from the time of observation. This is essential for follow-up observations since the actual data product of the satellite will not be available until after two years after the mission has started, and even the Early Release Compact Source Catalog (ERCSC) will be available only approximately nine months after the first full sky observation cycle has been completed. The QDS will give us a unique opportunity to get our hands on the Planck foreground data months before anybody else, to trigger virtually simultaneous follow-up observations of interesting events, and also help monitor the quality of the satellite data at an early stage. QDS will be operated in the Planck Low Frequency Instrument (LFI) Data Processing Centre (DPC) in Trieste, Italy, by our team. The launch date of the Planck satellite is currently set for early 2008, and the operation of the QDS will start as soon as the test period of the satellite has been completed.

In this paper we describe the Planck mission; the instruments and the science it has been designed to study. A special emphasis will be made on the Finnish participation in the project. This includes, for example, the 70 GHz receivers that were designed and build in Finland, and many aspects of the science we are currently involved in.

POLARIZATION OBSERVATIONS OF mCVs

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We have observed magnetic variable stars in polarized light in UBVRI with the NOT. We will discuss some of our recent results.

RADIO SPECTRA PROPERTIES OF A COMPLETE SAMPLE OF SOURCES NEAR THE NORTH CELESTIAL POLE

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The RATAN-600 radio telescope was used to study spectral properties for a complete sample of 504 sources from the NVSS catalogue near the North Celestial Pole. The main task of the work was to determine instantaneous spectra of radio sources with the purpose to select objects with inverted spectra near the 22 GHz frequency for subsequent investigation under the space VLBI Project "RadioAstron". The high angular resolution of the project "RadioAstron" which is to be achieved 10^{-6} arcsec imposes strict demands to angular dimension of sources. These must be super-compact objects with a high value of the correlated flux. Such objects form a considerable part of objects just with inverse and flat spectra. At present there are no complete high-frequency catalogues of such objects up to low flux density levels (0.2 Jy at 22 GHz). The only available data on the North Celestial Pole are the VLA survey (NVSS) at 1.4 GHz. It is important to obtain spectral characteristics up to the highest frequency of 22 GHz planned in the work of the space interferometer. The following criteria were used in selection of sources from the catalogue NVSS:

1. $00^{\mathrm{h}} \leq RA2000 \leq 24^{\mathrm{h}}$
2. $+75^{o} \leq DEC2000 \leq +88^{o}$
3. Flux density: $S_{\nu}[1.4\mathrm{GHz}] \geq 200$ mJy from the NVSS catalog

The total number of sources is 504. After data reduction we obtained flux densities of sources and their spectral characteristics. The sources spectral types were determined: 65% – normal, 24% – steep, 7.3% – flat, 2.3% – inverted, and 1.4% – spectra with a maximum at centimeter wavelengths (GPS). Eleven sources with inverted spectra were detected. The statistics of the sources spectra from our sample contrasts with spectral characteristics of the sample of objects with the same initial parameters but carried out at the frequency 20 GHz by Sadler et al. (2006). We obtained that there is a 25% deficit of sources with the inverted spectra in our sample. This can be explained by the spectral properties of the "subliminal" sources, which did not fall into the initial sample at the frequency of 1.4 GHz.

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ON THE THEORY OF RESONANT TRANSITIVE RADIATION OF DECIMETRIC RADIATION OF FLARES

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In this work a mechanism of resonant transitive radiation (RTR) with reference to its possible application for interpretation of decimetric radio emission of solar flares is analyzed. Such radiation depends on a number of parameters of the radiating media. In particular, on the parameter of spectrum of small-scale inhomogeneity of electronic density, ν. Platonov & Fleishman (2002) derived the formulas for factors RTR in dependence on the frequency of radiation for $\nu = 2$. On the whole these formulas describe the behavior of RTR precisely, however in narrow frequency intervals they can give either negative or infinite values. In this work, using the approaches similar to those developed by Platonov & Fleishman (2002), factors of RTR for an arbitrary parameter have been obtained. These factors, in particular, did not give negative and infinite values. On their basis the RTR factors integrated on frequency have been obtained. These factors were used for the analysis of decimetric radiation of the flare on December 24, 1991. It has been shown, that the RTR of this flare could originate in plasma with small-scale inhomogeneities with $\dfrac{\langle \Delta N^2 \rangle}{N^2} = 2.5 \cdot 10^{-5}$.

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SPECTRAL ENERGY DISTRIBUTIONS AND 37 GHz MONITORING OF BL LACERTAE OBJECTS

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BL Lacertae objects (BL Lacs) are a group of active galactic nuclei (AGN) characterized by strong and rapid variability, strong optical polarization and a lack of prominent emission lines in their spectra. We have determined spectral energy distributions (SED) for over 300 of these objects using archival multi-frequency data and fitted a parabolic function to the synchrotron component of the SED (Nieppola et al. 2006). The peak frequencies of the synchrotron components range between $\log \nu_{peak}$= 12.67–21.46. We divided the sample into low-energy (LBLs), intermediate energy (IBLs) and high-energy (HBLs) BL Lacs according to their $\log \nu_{peak}$. The correlation between $\log \nu_{peak}$ and the luminosity at ν_{peak} was not significant, in contradiction with the "blazar sequence" scenario (Fossati et al. 1998). We also report a summary of the first 3.5 years of observations with the extensive BL Lac

sample at 37 GHz. The BL Lac source list contains 398 sources, all of which were observed at least once. Roughly 34% of the sample was detected at $S/N > 4$. Most of the detected sources were LBLs, being intrinsically more luminous at radio wavelengths than HBLs.

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DEEP SKY SURVEYS WITH RATAN-600

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Blind Sky surveys with RATAN-600 were suggested by the general PROJECT of AVP (1968). A Flat mirror was included into the main CIRCLE structure to carry out quick all-sky survey, as successfully was made with the Kraus telescope of Ohio University. In 1960th the Sky seemed to be filled by first generation young objects with inverted and SSA spectra, which were missing in the meters wavelengths catalogs. The Sternberg Astronomical Institute of the Moscow State University group have surveyed the sky zone DEC:0-14deg with sub-Jy sensitivity at the 2-8 cm wavelength and the first big (8500) list of objects detected at 4 GHz objects was published just before the famous 87GB catalog appeared (see the Zelenchuk survey catalog in CATS data base). The CMB anisotropy studies were early on included in the high priority scientific targets. The first deep blind sky survey was done at 4 cm wavelength in the winter 1975-1976 with sub-mK sensitivity, but only results interesting for CMB people were published, and they reject all available in 70-th variants of the theories of galaxies formation. The second epoch of deep blind surveys started after installation of the world best cryo-receiver at 7.6 cm (with $\sim$2mK/s$^{1/2}$ sensitivity). The first 17 Feb. 1980 24h- drift scan demonstrated that about 200 details may be found on this record and may be classified as radio sources, and we integrated point sources (PS) and CMB anisotropy tasks in the experiment. Several regions were selected for deep surveys, including the celestial Pole, the Declination of SS433 strip, and the Declination of 3C84 (near the RATAN zenith) strip. Weakness of the CMB anisotropy requires a great averaging (hundreds daily scans) and we observed some regions during many years. At all frequencies lower 10 GHz we see a confusion limit, and we proposed ways to suppress this noise using specific shape of the RATAN-600 beam. It helps us to reach the few mJy level at cm wavelengths and much below by P(D) analysis. The multi-frequency mode of observations, important for SCREENS (foregrounds) cleaning in the CMB experiments, turned out to be useful for a spectral classification of the PS appearing on the scans. Now it is clear for all CMB groups, that the depth of the CLEANING from PS is the real limit of CMB dedicated experiments, including the PLANCK mission. The problem with PS objects at CMB frequencies connects with an absolutely unknown Source Population (between IRAS and NVSS, or GB). At RATAN-600 we try to use SELF CLEANING mode, using much higher resolution than required by CMB physics (sub-degree scales). A huge amount of data collected during the CMB experiments should be used by PS people. I shall present the positive and negative experience, connected with the international BIG TRIO program, and problems with detection of a new population at cm wavelengths. The present state of RATAN-600 "Cold" and RATAN-600 Zenith Field (RZF) blind surveys will be mentioned, as well as the present-day situation with High Frequencies Sky Surveys. This presentation describes results of several groups in SAO and in SPb-branch of SAO, and now is partially supported by the RFBR grant 05-02-17521, OF RAS, SPb Center of RAS.

MULTI-FREQUENCY OBSERVATIONS OF THE POLAR RADIO STRUCTURES

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In this work we present a comparison of the enhanced temperature regions (ETRs) in the radio emission of the Sun with other manifestations of solar polar structures over some days in 2003-2005. The radio observations at 37 GHz were made with the Metsahovi Radio Telescope (Finland). We compared our radio data with different SOHO/EIT and SOHO/MDI images for the same periods. We also superposed the intensity contours of the full-radio maps obtained in Metsahovi on the Meudon Spectroheliograph CaII(k3) and H(alpha) images. We tried to find difference between ETRs inside and outside of coronal holes. We find that the ETRs are clearly connected to brightness structures seen in the CaII(k3)/Hα and magnetic field sources seen in SOHO/MDI. Thus we can conclude that ETRs have chromospheric origin.

NEW OBJECTS FROM THE "COLD" SURVEY

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Results of deep surveys of a $\pm 10'$ strip of the sky centered on the declination of SS433 carried out on the Northern sector of the RATAN-600 telescope at 2.7 and 7.6 cm wavelength in 1987-2000 are discussed. About 600 objects at the 7.6 cm wavelength were identified with NVSS sources. Eighteen sources detected at 2.7 cm were not detected at 7.6 cm but could be identified with NVSS objects. It cannot be ruled out that some of these are sources with inverted spectra. At both wavelengths there is a fairly large number of Gaussian profiles

which are not identified with NVSS objects (106 at 2.7 cm and 43 at 7.6 cm); it is quite possible that not all of these cases are false.

The survey objects are cross-identified with sources in the NVSS catalog and the corresponding two-frequency spectral indices determined. We find a decrease in the mean spectral index in the transition from objects with flux densities $S_{21} \geq 30$ mJy to those with $15 < S_{21} < 30$mJy. The constructed $\log N - \log S$ relation at 2.7 cm has a slope of 3/2 at flux densities ≥ 300 mJy and flattens at weaker flux densities. The 1.4 GHz (NVSS), 3.94 GHz (RATAN-600), and 11.11 GHz (RATAN-600) data are used to estimate the number of objects per square degree at a wavelength of 1 cm.

REVERSAL BACKGROUND MAGNETIC FIELD IN THE SOLAR POLARIZED RADIO EMISSION AT 17 GHz

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Polarization of radio emission on the solar disk was studied with the Nobeyama radio heliograph observations during 1992-2006. The latitude-time diagrams of polarization circular radio emission were constructed. To decrease the noises we used several solar images for a day. We found drifts of radio emission polarization in the high-latitudes activity and in the latitude band of sunspots. Process of the magnetic field reversal of the large-scale magnetic field in polarization of radio emission of the Sun was found during 22-23 cycles. An analysis of polarization for structures of various brightness temperatures has been carried out.

OSCILLATION OF THE POLARIZED RADIO EMISSION "THE SUN AS A STAR"

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We investigated variations of the radio emission of the whole Sun at 1.76 cm wavelength obtained and archived at the Nobeyama radio heliograph in 1992-2006. For this purpose the daily data of the intensity and also right/left circular polarization of the radio emission with one-second average were processed. It was found that 3 minutes oscillations are present at the different phases of solar activity, including the minimum of activity. Especially conspicuous these oscillations present in a difference between the right and the left circular polarization. Intensity of the oscillations changes with a level of the solar activity. Spectral analysis of the presence of 3-minute oscillations in polarization of the solar radio emission shows that there exist a modulation with the periods of 27 and 157 days. During the

minimum activity the main periods of the 3 minutes oscillations are slightly shorter than during the maximum activity.

RADIO SPECTRA OF GPS GALAXIES

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Gigahertz-peaked spectrum (GPS) sources are active galactic nuclei which are characterized by a convex radio continuum spectrum peaking at the GHz-frequencies. Their nature is still unclear, but currently the strongest scenario suggests that at least some of them are newborn radio sources in which the activity has been triggered on only 100 – 1000 years ago. There are both quasar and galaxy type GPS sources, which have a similar shape of spectrum but the nature and the physics of sources are thought to be different. Our earlier study (Torniainen et al. 2005) showed that a considerable proportion of quasar-type GPS sources are more likely misidentified flat-spectrum quasars – not GPS sources at all.

We have collected 96 GPS galaxies from the literature, observed them and collected all possible radio data for them to study how pure the galaxy type GPS samples are. Our sample includes both frequently monitored sources and sources with only a few detections. The spectra of the sample show that less than a third of our sample were definitely or highly probably GPS sources whereas less than a third did not have enough data for any solid classification. Five sources had a convex spectrum but high variability and the rest had steep or flat spectrum. These results show that the GPS galaxy samples have more genuine GPS sources than the quasar samples but yet a remarkable share of them cannot be classified as GPS sources.

Difference between the quasar and galaxy samples can partly be explained by selection effects: the quasar sample was selected from the Metsähovi monitoring sample which has been monitored over 25 years whereas the galaxy sample was gathered from the GPS literature and included both weak or rarely observed sources and more frequently monitored sources.

Acknowledgements. The authors made use of the database CATS (Verkhodanov et al. 1997) of the Special Astrophysical Observatory.

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METSÄHOVI AGN PROJECTS CONTRIBUTING TO THE PLANCK FOREGROUND SCIENCE

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During recent years we have had a special focus in our Metsähovi observing projects. We have put an emphasis on the understanding of AGNs that could contribute to the extragalactic foreground that will be detectable by the Planck satellite.

First of all, we have observed completely new source samples. Many AGN samples have been excluded from high-frequency radio observations earlier simply because they were assumed to be too faint or "uninteresting". One of our largest new source samples was the complete BL Lacertae Object (BLO) sample.

In addition to the few-epoch observations of large source samples we have been interested in the long-term variability behaviour of a densely monitored set of sources. We have analysed these data in order to improve our understanding of the variability behaviour of these sources: how often do flares typically occur in a certain source, and how likely is e.g. the Planck satellite to detect a source in a flaring state at a random observing epoch?

We are also working our way towards predicting, or at least making "educated guesses" about, the activity behaviour of radio-bright AGNs.

In this presentation we will discuss our source samples and show some recent results.

NEW WMAP CATALOG SOURCES OR HOW MANY BRIGHT SOURCES ARE ON THE SKY

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We continued studies of the WMAP-sources after publishing results of three years (Hinshaw et al.; Jarosik et al.; Page et al.; Spergel et al. 2006). Trushkin (2003) presented compiled radio spectra of 205 extragalactic sources from the catalog, compiled from the WMAP survey data at 23-94 GHz in the first year of its operation.

We have shown that 205 WMAP-sources are reliably identified with radio sources from known catalogs (FIRST, NVSS and so on). ∼50% of the sources have flat or inverted spectra, ∼15% – spectra with the peaks at 5-20 GHz (GPS-sources), ∼10% – power-law spectra and ∼10% – show the composite spectra (as 3C84).

We discussed recent results of the radio observations of the AGNs from the WMAP catalog with the RATAN-600 and RT32 telescopes.

Now the final 3-year catalog contains 323 sources, while four identified sources from the former version were not included in the new one. Using again the search *select and match* and spectra plotting procedures in our CATS data base (Verkhodanov et al. 1997) we have found optical and radio identifications for the most of new 120 WMAP-sources from the radio and optical catalogs in the CATS data base. Now we discuss results for new 120 sources, their spectra and features. The statistics for types of the sources did not generally changed. We have found that 313 WMAP-sources have optical counterparts: 220 – quasars, 30 – galaxies, 32 – AGNs, 30 – BL Lac objects and one – the planetary nebula IC418. We have observed some of the new WMAP-sources with RT32 (IAA) at 2.3 and 8.5 GHz. Comparison fluxes from the first version catalog and second one allows us to estimate of the variability of the sample. As was expected, the index of the variability at 63 GHz is higher than at 23 GHz. There are the sources with 100% changes of the fluxes on the effective time scale about one year, (3yr-1yr)/2 in the WMAP3-catalog.

Using an analogous method of the source selection from the CATS data base we have found that a probable number of the sources brighter 400 mJy at 23 GHz is equal to 1300-1500 on the sky. Thus there is a strong effect of confusion dramatically decreasing the number (323) of detected sources in the WMAP survey.

We hope that such studies will help in the future PLANCK CMB-experiment data-precessing.

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RECENT DATA OF THE MULTI-FREQUENCY MONITORING OF MICROQUASARS

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We discuss results of recent radio observations of the microquasars SS433, GRS1915+105 and Cyg X-3 with the RATAN-600 and RT32 (IAA) radio telescopes.

We have carried out long monitoring programs of daily observations sets for microquasars with the RATAN radio telescope at frequencies of 1, 2.3, 4.8, 7.7, 11, 21.7 and 30 GHz. Flaring events were detected when the fluxes increased by a factor of 2-200. The flaring synchrotron emission indicates the jets formation, coupling with accretion disk activity in the Galactic microquasars and in the active galactic nuclei (AGN). The multi-frequency light curves are compared with the XTE ASM data at 2-12 keV to study correlations during the flares. Indeed in many cases such correlations were detected.

Radio flaring events of SS433, Cyg X-3, LSI+61d303 were often optically thin at $\nu >5$ GHz, and follow to general predictions of the relativistic outflows of mass or fast electrons from binaries. On the other hand, we have often measured the inverted (optically thick) spectra of flaring events in the active states of GRS1915+105, Cyg X-3 and V4641 Sgr with the spectral indices $\alpha >+1$ at $\nu >1$ GHz.

We have detected a clear X-ray/radio association in light curves of GRS 1915+105 during October-November 2005, when it was very active (0.5-3 Crabs at 2-12 keV).

After 18 days of the quenched state ($\sim$10 mJy) Cyg X-3 exhibited the 1Jy- radio flare on 1 Feb 2006. Such a remarkable property – before a flare the radio emission fall down in deep (local) minimum of fluxes – is probably a general feature of the radio/X-ray binaries.

The flare of 1 Feb was also detected with the Nobeyama 45m and NMA telescopes (Tsuboi et al. 2006), and for the first time a flat radio spectrum of the flaring event from Cyg X-3 was directly measured in the quasi-simultaneous observations from 2 to 110 GHz. Then two following flaring events (5 and 17 Jy) were detected later during $\sim$100 days. Their durations were 50 and 30 days respectively. The very fast rising flare, from 1 to 2 Jy during 3 hours, was detected with the RT32 telescope (Trushkin et al. 2006) on 05 June. At last on 25 July we have detected a very powerful flare (15 Jy) from Cyg X-3 again. All these flares happened during a long period (Feb 1 – Aug 1) when X-ray emission was relatively high ($\geq$0.3 crabs), variable and hard.

We studied evolution of the powerful flares from the optically thick state to the optically thin one at the lower frequencies. We have to draw an unexpected conclusion: during the stage of initial rising (ejection stage) the density of thermal electrons is also rising resulting in the higher optical depths at frequencies lower than 1 GHz just near maximum of the flare.

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THE PROBLEM OF HIGH-ENERGY EMISSION FROM AGN

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The basic framework for radio-bright AGNs, which are also the only types of extragalactic sources known to emit a significant amount of high-energy radiation, is a relativistic jet with shocks embedded in it. Presumably, the most significant intrinsic properties of the source are then the absolute luminosity of the jet/shocks, the flow speed (the Lorentz factor) and the angle which the jet makes to the line of sight. The more detailed nature of the flow (accelerating/decelerating flow, turbulence, particle acceleration/reacceleration, magnetic field configuration, jet opening angle and curvature, duty cycle of the shock activity, etc.) as well as the jet surroundings (in particular, density of the ambient photon field) must also play a role.
The spectral energy distributions of radio-bright AGN, often called blazars, can be approximated by two parabolas. The first one is caused by synchrotron radiation from the jet

and from the shocks, the second one by an inverse Compton radiation from the relativistic electrons in the jet, upscattering ambient photons into X-to-TeV energies.
Both theoretically and observationally, our understanding of the blazar emission remains rather poor. I discuss some new attempts to model the spectral energy distributions of blazars, focusing on correlations between various observed and intrinsic properties, and on the problems of the proposed theoretical models for the high-energy emission.

OPEN WEB-RESOURCES OF SAO RAS FOR EXTRAGALACTIC RESEARCH

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The sky survey at various wavelength bands is one of the most important branches of the modern observational astrophysics. To the present moment, several data bases unify resulting data of such surveys. We consider here Web-resources designed for radio astronomical and extragalactic study and operating in the Special Astrophysical Observatory. We describe structure, operation, standard tasks and the current status of the largest data bases in respective astrophysics fields. They are the data base of radio astronomical and astrophysical catalogs CATS (`http://cats.sao.ru`) (Verkhodanov et al. 1997, 2005) and the SED (Verkhodanov et al. 2000) which is an analysis system of spectral energy distribution (`http://sed.sao.ru`). These servers were unified in a one cluster and are used both for separate source and statistical studies in astrophysics and cosmology. A new site (`cmb.sao.ru`) is prepared for cosmology. It was worked out with the same approach as the above mentioned. It bases on the GLESP (Doroshkevich et al. 2005) package and allows a user to transform spherical harmonics to full sky maps. It contains the WMAP CMB and foreground maps and corresponding files with $a_{\ell m}$ coefficients of spherical harmonics. We plan to unify all three servers into one cluster for acceleration of investigation in the field of cosmology and astrophysics.

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PHASE ANALYSIS IN STUDY OF COSMIC MICROWAVE BACKGROUND

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Phase analysis based on the complex values of spherical harmonics of the CMB fluctuation expansion is an extremely important method of observational cosmology. We consider several aspects of phase analysis in the CMB study. They concern the problems of signal restoration (Naselsky et al. 2005), search for non-Gaussianity (Chiang et al. 2003) and study of the foreground contamination of this separated CMB signal (Naseslky et al. 2003, 2004, 2005). Using the GLESP (Gauss-LEgendre Sky Pixelization) package (Doroshkevich et al. 2005) for CMB analysis we produce phase data for spherical harmonics in the form of $a_{\ell m} = |\delta_{\ell m}| \exp(i\Psi_{\ell m})$, where $a_{\ell m}$-s are coefficients of spherical harmonics of the ℓ–multipole in the m–mode, $|\delta_{\ell m}|$ is their amplitude, $\Psi_{\ell m}$ is a phase, and i is the imaginary unit. Considering the minimum in correlation of phases of CMB and foregrounds we can separate the signal corresponding to these properties at low ℓ ($\ell \leq 100$) where the point source influence is minimal. Another important moment is the study of the Gaussianity problem in the CMB observational data. To check statistical properties of the data we produce phase diagrams. These diagrams demonstrate the strong non-Gaussianity for all accessible maps of CMB. The high phase correlations between CMB and foregrounds hint us about problems of signal separation. Similar approaches are developed for the Planck mission.

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THE COMBINED RADIO AND OPTICAL INVESTIGATIONS OF THE INTRADAY VARIABILITY OF ACTIVE GALACTIC NUCLEI

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The combined radio and optical observations of the active galactic nuclei 0133+476, 1633+382, 2145+067, 2251+158 were performed in 2004-2006. The aim of analysis was to detect an intraday flux variability and to search for its possible correlation in radio and optical wavelengths. Observations were conducted with the use of the RT-22 radio telescope (SRI CrAO) at 22 and 36 GHz and the 1-m Zeiss-1000 reflector of SAO RAS with CCD camera.

During observations we found no significant fluctuations of fluxes at both ranges. At the level of 10% from the average amplitude more high activity of the object 1633+382 was detected at 36 GHz in May 2004 then the one in May 2005. The reason of it may be a passive phase of the object after the burst in 2002. The observable flux variation in 0133+476 at the time scale of one hour were noticed in October 2005 but not optical range. Such flux behaviour may indicate to absence of the identical area for radio and optical emission after matter collimation in the black hole polar region.

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PHYSICAL AND CHEMICAL STRUCTURE OF HIGH MASS STAR FORMING REGIONS

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In recent years we surveyed several tens of high mass star forming regions in various molecular lines and in millimeter wave continuum. Basic physical properties of detected clumps and molecular abundances were derived. One of the problems is a selection of the best tracer of mass distribution. In particular, we found that in regions of high mass star formation the CS emission correlates well with the dust continuum emission and is therefore a good tracer of the total mass while the N_2H^+ distribution is frequently very different. This is opposite to their typical behavior in low-mass cores where a freeze-out plays a crucial role in the chemistry. The behavior of other high density tracers varies from source to source but most of them are closer to CS. Radial density profiles in massive cores are fitted by power laws with indices about -1.6, as derived from the dust continuum emission. The radial temperature dependence on intermediate scales is close to the theoretically expected one for a centrally heated optically thin cloud. The velocity dispersion either remains constant or decreases from the core center to the edge. Several cores including those without known embedded IR sources show signs of infall motions. They can represent the earliest phases of massive protostars. There are implicit arguments in favor of small-scale clumpiness in the cores.

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