Conference of the 6 m telescope users October 14, 1997, SAO RAS

SCHEDULE

1. *Yu. Yu. Balega (SAO RAS)*
BTA in 1997, I half year

2. *E.R. Rudtskaya (RFBR)*
On the main principles of activity of the Russian Foundation of Basic Researches

3. **Reports of applicants for observing time**

O.K. Sil'chenko (SAI MSU)
Decoupled galactic nuclei

D.I. Makarov (SAO RAS)
Rotation amplitudes of flat edge–on galaxies

V.V. Sokolov (SAO RAS)
Optical observations of GRB970508 from May to October, 1997

4. **Scientific reports**

Yu.N. Gnedin (MAO RAS)
Astronomical Observatons of the Hale-Bopp comet: new, unexpected results

H. Zinnecker (Potsdam, Germany)
Young multiple systems in the regions of star formation

W. Dushl (Heidelberg, Germany)
The nucleus of the Seyfert galaxy NGC 1068 at 2.2 μm

M. Schoeller (ESO, Garching, Germany)
Current VLT project state

J. Krelowski (Torun, Poland)
Diffuse interstellar bands – the 75th anniversary of studies

V.E. Panchuk (SAO RAS)
Key programmes and spectroscopy of stars at large telescopes

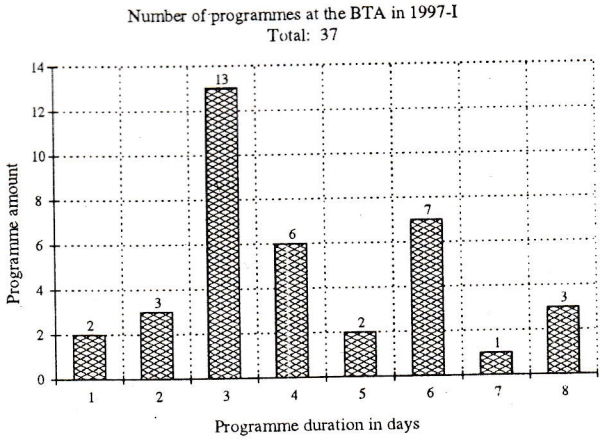

Figure 2:

Yu. Yu. Balega

BTA in 1997, I half year

In the first half year of 1997 68 time requests were accepted by the Programme Committee 37 of which were granted. The programmes "Interferometry of Mira variables and nebulae" (G. Weigelt, Germany), "Magnetic fields of Ae/Be Herbig stars" (Yu.V. Glagolevskij, SAO), "Magnetic fields of white dwarfs" (S.N. Fabrika, SAO) were allotted 8 nights each. Seven nights were assigned for the programme of G. Courtes (France) "Continuum of primeval galaxies". The programmes of G. Wade (Canada), V.G. Klochkova (SAO), N.A. Tikhonov (SAO), D.I. Makarov (SAO), A.M. Fridman (IA RAS), Yu.N. Parijskij (SAO), D.A. Varshalovich (FTI) were given 6 nights each. One night was allotted for each of the programmes of V.O. Chavushian "New gravilens" and A.G. Gorshkov "Unique radio sources". The amount of programmes with respect to the number of nights allotted is shown in Fig. 2.

The time allotted for the programmes of

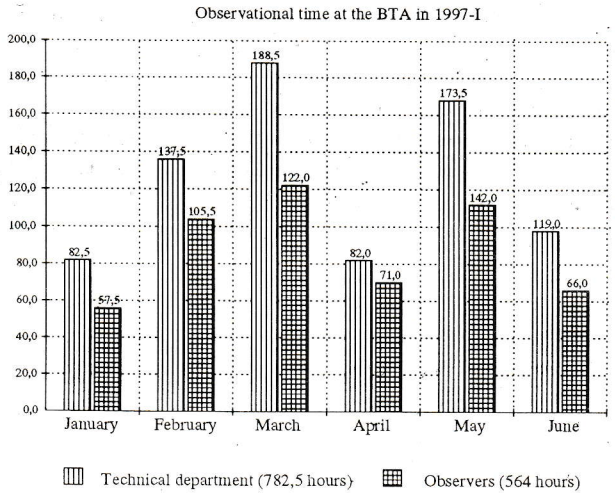

Figure 3:

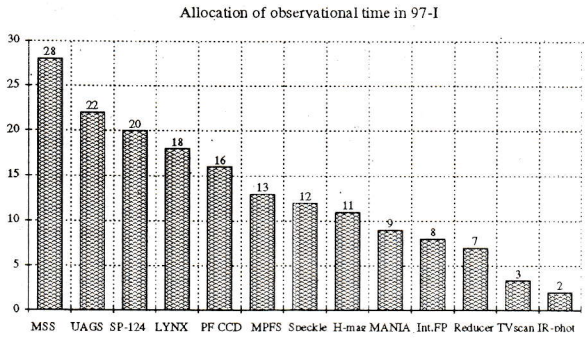

Figure 4:

T. Kipper, O.K. Sil'chenko, T.Yu. Magakian, V.O. Chavushian, V.E. Panchuk, D.I. Makarov, G. Richter, M. Barstow, V.A. Gagen-Torn, A.G. Gorshkov was utilized to the best advantage. The programmes of G. Wade, A.S. Miroshnichenko, V.G. Klochkova, G. Weigelt, G.M. Beskin, A. Richichi, N.N. Somov, V.V. Neustroev, A. Shearer, G. Hasinger, S.N. Fabrika and A.S. Amirkhanian were not fulfilled because of the bad weather conditions.

The total time of observations was 783 hours from the data of the Technical Department of BTA or 559 hours from the records of astronomers. The ratio of the time indicated by astronomers to that of the Technical Department, 0.7, has remained uchanged.

The monthly number of observational hours is given in Fig. 3. Comparing this distribution with that of the previous years, the amount of observational time of the BTA site had been noticed to monotonically decrease earlier between January and June, in 1997 no regular alternating of clear and overcast nights was observed. The distribution of the time in the techniques used is presented in Fig 4. It should be mentioned once again that the 6 m telescope is a spectral instrument. The spectrographs created more than 20 years ago have mostly been used.

The technical nights were basically taken for the work connected with the updating of the BTA automatic control system: testing of precision characteristics, testing algorithms of dynamic control, adjustment of the control computers of the telescope. Besides, the problems of the BTA optics, posed by the astronomers, were solved: adjustment of the Main stellar spectrograph, examination of the main mirror coating. The technical time was also used to assimilate new observational methods and for getting ready to receive observing teams from abroad with their own equipment.

Obsolescence of the scanner, one of the major devices of the 6 m telescope, called for its maintenance in proper condition. After the introduction in the process of observations of CCD detectors, whose quantum efficiency, dynamic range and geometric stability are much better than in an image converter with the TV tube of a scanner, the number of requests for the scanner has dramatically decreased. That is why in 1999 the scanner is supposed to be struck off the list of the issued systems of the telescope.

The low-efficient spectrograph SP–124 at the N1 focus is also to be either updated or replaced.

The staff of SAO have continued examining the state of the BTA main mirror reflecting coating. The partial impairment of reflectance is caused by multiple aluminizing. Proposals have been prepared for the plant of optical glass in Lytkarino to perform investigation of the mirror for the purpose of reclaiming the polished layer.

Among the most remarkable results of the observations performed at the 6 m telescope in the first half year rank the obtaining of multicolour blue images of 20 galaxies in the direction of the Virgo cluster. 15 galaxies resolve into stars, which allows the distances to be redetermined (N.A. Tikhonov).

D.I. Makarov and I.D. Karachentsev conducted successful observations on the programme "Amplitudes of rotation of flat edge–on galaxies". The aim of the programme is to study coherent motions on scales of 100 Mpc in the Universe.

V.G. Klochkova and V.E. Panchuk obtained optical spectra of four faint ($V > 13^m$) infrared sources RAFGL 2688, IRAF 04296+3429, IRAS 2223+4327 and IRAS 23304+6147 with the echelle spectrometer in the prime focus of the telescope. Emission bands of the molecule C2 were discovered for all this sources.

E.R. Rudtskaya

On the main principles of activity of the Russian Foundation of Basic Researches

Elena Robertovna Rudtskaya spoke about the principles of activity of the RFBR in the area of support through individual grants, recommendations to the applicants were given. It was noted in the presentation that due to lack of budget, the RFBR had to restrict itself to supporting minor research groups, having ruled out funding complex engineering developments and Centres of joint use.

O.K. Sil'chenko

Decoupled galactic nuclei

By two-dimensional spectroscopy search is carried out for galaxies whose nucleus is distinct in metallicity with respect to the bulge surrounding it (there exists a jump in equivalent widths of metal absorption lines along the radius). In the same galaxies the rotation of the central region itself is investigated for the purpose of clarifying if chemically decoupled nuclei are decoupled dynamically as well. For the last three years this programme has received 20 nights at BTA. Using the multipupil field spectrograph, observations of the central regions of 21 galaxies have been obtained (the observations were supervised by V.L. Afanasiev, V.V. Vlasyuk and S.N. Dodonov). Chemically decoupled nuclei have been found in the 16 galaxies for which dependences of indices of magnesium and iron absorption lines on radius have been obtained.

D.I. Makarov

Rotation amplitudes of flat edge–on galaxies

Since anisotropic flows of galaxies beyond the Local supercluster have been revealed (1985), the insight into this phenomenon has been ambiguous till now.

Initial contradictions between observations and basic models of large–scale structure formation have been eliminated by now. However new observations of independent samples of galaxies are needed because of inconsistence of different observational data available. A catalogue of thin edge–on spiral galaxies (FGC), which cover both the northern and southern hemispheres, has been compiled by joint efforts of the Laboratory of large scale structure investigation of SAO RAS and Astronomical Observatory of Kiev State University (Ukraine). For northern hemisphere galaxies optical study appears to be the most realistic, and the 6 m telescope is the most suitable for mass investigation of rotation curves.

The programme of measurements of rotation curves and radial velocities of edge–on galaxies is aimed at investigation of large scale flows of galaxies on 100 Mpc scale. The observations have been carried out since 1995 with the prime focus fast spectrograph of the 6 m telescope of SAO RAS. FGC galaxies of the northern polar zone ($D > +38°$) having angular diameters $a < 2.5'$ and axial ratios $a/b > 8$ are embraced by the survey. For two years of the observations redshifts, rotation curves and spin directions for 183 galaxies have been determined. The typical rotation curve covers up to 84% of the standard optical diameter of a galaxy. An amplitude of the optical rotation curve is in close correlation with the width of the 21 cm radio line, so it is promising to use flat galaxies for distance determination by the Tully–Fisher method, independently of their redshifts. The median value of the radial velocity for galaxies of our sample is 7352 km/s. The galaxies investigated are, as a rule, massive spirals, with a median value of rotation curve maximum of 148 km/s. Up to now the programme has been fulfilled by $\approx 70\%$.

V.V. Sokolov

Optical observations of GRB970508 from May to October, 1997

The most detailed light curve of the optical star-like source corresponding to the γ–burst of May 8, 1997 in 4 photometric bands simultaneously and also its broad-band spectrum during the burst and after it were obtained.

The spectral variations were traced up to the 200th day after the gamma event. The rate of brightness decrease changed. It was found to drop in the IR rays (8000Å) 36 days after the burst. These new facts may essentially affect the present-day insight into physycal nature and distances to the source of γ–bursts. The deceleration of brightness decrease may be caused by the internal properties of the source itself, and we observe the formation of a nebula resulting from the outburst on the surface of the compact source.

Yu. N. Gnedin, T.M. Natsvlishvili

Astronomical Observations of the Hale-Bopp comet: new, unexpected results

Results are reported of observations of the Hale-Bopp comet named "the comet of the century" or "the grand comet", including data of observations carried out in a a number of observatories of Russia and of the CIS. A distinguishing feature of the comet is its remarkable activity. Since the moment it was discovered, gaseous and dust jets continuously errupted from its nucleus, spherical and conical outbursts and

envelopes, arched and other structures constituted by gas molecules and dust particles have been found. A great number of new molecules, undetected previously in other comets, have been found to be present in the head of the comet. Here are represented nearly all the compounds found in huge molecular clouds of our Galaxy, where, to our current knowledge, intensive star formation occurs.

Another distinction of the comet is an unusually large number of molecules evaporating from the nucleus surface per second. It can be stated that over the past 20 years, when the intensive photometric and spectroscopic observations were initiated, the number of basic cometary molecules (H_2O, OH, CH_4, CO_2, NH_3, CN, C_2) at the gaseous phase was much greater even at large distances from the Sun (>7 a.u.) than in any other comet at any distance from the Sun.

The most important clue to comprehension of the nature and origin of celestial objects is the isotopic composition of atoms and molecules they contain. Using the radio astronomy methods deuterium cyanides, DCN, have been first found in the Hale–Bopp comet.

The ratio of different nitrogen isotops — $^{14}N/^{15}N$, has also been determined for the first time. The isotopic composition of the Hale-Bopp comet has turned out to be the same as that of the Earth. The nucleus of the comet has been revealed to rotate with a period approximately equal to 12 hours. The most unexpected result consists in the detection of sudden reversal of rotation of the comet nucleus. In 1997 February it was rotating clockwise, while in March the direction reversed. A rapid variability was also found. The observations of one of the authors (T.M. Natsvlishvily) in collaboration with astronomers of SAO RAS shows very fast (on a scale of several minutes) variations of polarized comet radiation, the degree of polarization reaching a value over 20%. Large fluxes of polarized light reflected from the comet head and tail were recorded by N.N. Kiselev and by the researchers of AO KhSU. In CrAO (Ukraine) N.M. Shakhovskoj and V.V. Rozenbush have recently reliably measured circular polarization of the comet radiation. Quite a new fact in the area of physics of comets is the discovery of X–ray radiation from some of them, including a powerful flux of soft X–ray radiation from the Hale–Bopp comet.

Occultation of bright stars as well as three compact sources having maser OH lines at frequencies 1667 and 1665 MHz were observed. The noticeable absorption of light indicates that the inner part of the head is optically thick.

More detailed information about the observations of the Hale-Bopp "comet of the century" will be given in publications on the subject.

H. Zinnecker

Young multiple systems in regions of star formation

The short talk of Prof. Hans Zinnecker from the Astrophysical Institute in Potsdam was devoted to the pre-main-sequence binary stars, as a source of our knowledge of star origin. They generally carry a closer memory of star formation and of binary formation mechanism in particular. Young stellar systems that can be resolved by direct imaging or speckle interferometry enable us to place the components separately on the H-R diagram. On the other hand, unresolved young binaries can cause errors in the determination of the initial stellar mass function and also in the reconstruction of the star formation history. Unresolved binaries lead to underestimation of the age of the T Tauri star population. In order to achieve a higher spatial resolution more sophisticated observing techniques such as speckle imaging need to be employed. Prof. H. Zinnecker described the expected results that could be obtained using the speckle techniques with the 6-m telescope in the infrared region of the spectrum. These include the estimate of binary frequency among pre-main-sequence stars, study of their brightness ratio and semi-major axis distribution, search for weak infrared companions, etc. Up to now, mass estimates for pre-main-sequence stars, based primarily on comparison with the theoretical evolutionary tracks, have been scanty. The most common question is whether there exists a single mechanism of binary formation, which can explain the full range of component separations, or there are two mechanisms – one for wide binaries (filament fragmentation) and the other for close binary systems (disk fragmentation).

W. Dushl

The nucleus of the Seyfert galaxy NGC 1068 at 2.2 μm

The source of continuous radiation in the nuclear region of the Seyfert 2 galaxy NGC 1068 is obscured from us by a dense dust torus. The absorption of radiation in the infrared range of the spectrum is much lower than in the visible range, which allows one to investigate the circumnuclear zone structure. The latest radio observations of the central structure with the interferometer MERLIN at frequencies from 5 to 22 GHz have shown it to consist of 5 components with a minimum separation of 0.1″. Most of the components have a negative spectral index $dF_\nu/d\nu$ between -0.33 and -0.88, while one of them shows an index of $+0.31$. It is this component that is identified with the actual NGC 1068 centre. We observed the galaxy nucleus in the K filter (2119/411 nm). In this band the

diffraction limit of resolution of BTA equals 0.076″. The image has been reconstructed from 778 200 ms snapshots with the application of speckle masking. Under the assumption of Gauss profile, the nucleus diameter is 35 ± 7 mas (1 mas = 0.001″), while for the model of a uniform disk it is 57 ± 12 mas. These diameters correspond to 2.5 ± 0.5 pc and 4.2 ± 0.8 pc at a distance of 15 Mpc. The flux from the nucleus in the K band is estimated to be 650 mJy. The spectral index value between 5 GHz and K band, which follows from our measurements equals 0.39. This estimate is very close to the spectral indices of nuclei for other galaxies such as Sgr A*, M 81 and M 104.

If the flux maximum is reached at 2 μm and the synchrotron selfabsorption becomes significant at frequencies below 5 GHz, the radiation region may then be represented as a uniform sphere with a radius of $2 \cdot 10^{15}$ cm (≈ 0.7 Mpc, ≈ 133 a.u., ≈ 0.01 mas) and a magnetic field of ≈ 11 Gs. The energy of relativistic electrons is ≈ 2.7 GeV.

Since the size of the central source is much smaller than that of the observed compact region (35 mas), then the object we resolve can not be the synchrotron source itself, but rather it is material in the immediate vicinity of the actual nucleus. However, the high resolution permits us to see that the flux in the K band is observed only from one of the radio sources at the centre of the galaxy, most likely from the nucleus itself.

M. Schoeller

Current VLTI project state

The VLT Interferometer (VLTI) at the ESO Cerro Paranal site is focused on the use of the coherent combination of the array of four 8 meter main telescopes together with a number of smaller auxiliary telescopes. The simultaneous use of all 8 m telescopes for interferometry will be possible probably for only a small fraction of observing time. In the talk the opto-mechanical aspects of the VLTI project were discussed, including the factors which affect fringe contrast transfer, polarization effects in interferometers, pupil configurations and orientations, effects of seeing. The need for and ways of precise position metrology were discussed. The computer modelling plays an important role in the definition and future use of VLTI. The first light will be detected by the first 8 m telescope already in the spring of 1998, but the first array observations will be probably carried out only after 2002.

J. Krelowski

Diffuse interstellar bands – the 75th anniversary of studies

Diffuse interstellar bands (DIBs) are the puzzling features which appear in the spectral range from the near UV to near IR in spectra of reddened stars. They apparently form absorption spectra of dark HI clouds, together with other spectroscopic features such as atomic and molecular lines or continuous extinction and polarization. DIB intensity ratios vary evidently from cloud to cloud in the interstellar matter (ISM), strongly suggesting that several carriers must be identified to account for the whole DIB spectrum. The recent surveys have discovered hundreds of very weak interstellar features; the pattern of them is clearly related to the well-known, strong DIBs and thus they may facilitate the identification of the DIB carriers. These unidentified species are most likely big molecules or tiny dust grains which can produce only one strong and several very weak features each. In the case of single clouds, the DIB intensity ratios clearly split into several groups, most probably characterizing different cloud environments. In the report different types of HI interstellar clouds have been discusssed and the suggestion of how to classify them and put into an evolutionary sequence has been given.

V.E. Panchuk

Key programmes and spectroscopy of stars at large telescopes

The principal trends in the studies of stellar spectra on large telescopes are briefly stated. Along with this, potentialities (concerning the techniques) of BTA in these studies as well as the investigation that has already been carried out at the 6 m telescope are discussed.

The following directions of research in the category "Stellar populations" form the basis of the key programmes:

- Study of low–mass stars in the vicinity of the Sun. This is basically the problem concerned with brown dwarfs, which is of independent significance for the theory of star formation and is also related to the problem of primeval lithium (at the centre of a star with a mass of 0.06 of solar lithium does not deplete).
- Study of the galactic anticentre. Both the attempts to specify the chemical composition in the disk of the Galaxy and the attempts to investigate distant open clusters, which are characterized by different metallicities typical of the subsystem of globular clusters, dominate this class of problems.
- Early nucleosynthesis. When working in the range of metallicities between -1 and -2.5 we are

faced with striking uniformity of abundance ratios "element/iron" and it is from metallicities less than -3, that one can see the consequences of spatial inhomogeneities in the processes of early galactic nucleosynthesis. A separate problem in the investigation of the pair of lines "thorium/neodium" which is a stand–alone indicator of the age of the Galaxy.

- Light elements in the early Universe. The combinations of isotopic abundances of lithium, beryllium and boron are observational tests of models of nucleosynthesis in the process of Big Bang. Active search for the beryllium plateau, which is an analog of the lithium plateau discovered in 1982 (M. Spite and F. Spite), is under way on the 10 m telescope. Another important trend is study of the ratios of light element isotopes in the atmospheres of the oldest stars of the Galaxy and in the ISM, which permits the contribution of fission reactions into isotopic ratio to be evaluated.
- Kinematics of stellar populations. From low signal/noise spectra obtained for a lot of stars radial velocity dispersion inside open and globular clusters is investigated.
- Spectroscopic studies of AGB stars in the Magellanic Clouds and inside nearby globular clusters of the southern sky. The problem of self–enrichment of globular clusters with heavy elements synthesized at the asymptotic giant branch phase.

At the basis of the key programmes in the category "Physics of stars" lie the following directions:

- Spectroscopy of A stars with high spectral resolution and high signal-to-noise ratio. Examination of matters concerned with diffusion and separation of chemical elements, the problem of excess of rare earth elements.
- Astroseismology. Determination of mass and evolutionary status of stars near the MS. In principle, this is the most accurate (to date) way of measuring distances. Telescopes distributed in longitude are needed.
- Test of mixing. The nuclei of lithium, beryllium and boron decay at temperatures 2.5, 4 and $4.8 \cdot 10^6$ K, respectively, therefore abundances of these elements are a good indicator of depth of convective zone location.
- Search for low–mass star companions. Alongside the rush in hunting for planets, which is comprehensible to all, there are more specific problems: if the theory of formation of stars holds true (companions of great masses and orbit eccentricities have been found), whether the observed Doppler shifts reflect the baricentric motion or they are caused by magnetic variability modulated by rotation and/or photometric variability (pulsations).
- Estimation of distances to nearby galaxies from LBV spectra. The study of lines formed in the stellar wind allows the LBV luminosity to be reliably determined.

It is emphasized that in the optical department some stock is available in a number of the directions enumerated: developed spectroscopic technology, uniform observing programmes, highly trained specialists, interesting results.