

MS6: NEW TRENDS, RESEARCH DIRECTIONS AND PERSPECTIVE PROGRAMS  
 IN FIELD OF ASTRONOMY AND ASTROPHYSICS  
 Saturday, July 17, 2004

**Oral Session 1**

12:00 – 13:30  
 Guest House Hall  
 Convener: Dr. Iryna Vavilova (Kiev, Ukraine)

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IN FIELD OF ASTRONOMY AND ASTROPHYSICS  
Saturday, July 17, 2004**

**Poster Session**

**17:00 – 18:30**

**Guest House Hall**

**Convener: Dr. Sergei G. Kravchuk (Kiev, Ukraine)**

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MINI SYMPOSIUM 6:

NEW TRENDS, RESEARCH DIRECTIONS  
AND PERSPECTIVE PROGRAMS IN FIELD  
OF ASTRONOMY AND ASTROPHYSICS

## The Astronomical Equipments at the Terskol Observatory: Capabilities and Results

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We provide the review of IC AMER Observatory equipment for astronomical observations at the Terskol Observatory.

## Very High Resolution Spectroscopy on the 2-m Telescope of the Terskol Observatory

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## Observations of the Mutual Events in Jovian Satellite System during 2003 at the Terskol Observatory

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Observations of the mutual events in Galelian satellite system of Jupiter are very interest for celestial mechanics. Its allow to make more precise orbit elements of satellites and to improve motion satellite theory. Observation procedural of such events was elaborated at the Terskol Observatory (ICAMER, Nothern Caucasus). One allow to obtain good-quality row for photometry curves of some mutual events and for Galelian satellite coverings. Observations were realized in period from January to June 2003 with help the Zeiss-600 telescope using a CCD-camera ST-6 and time service. Work was conducted in the framework of international program coordinating by the French Institute of Celestial Mechanics. The procedure and results of observations are presented in this work.

## Modern Astrometry in Different Ranges of Electromagnetic Waves

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The term “Modern Astrometry” was introduced by Prof. J. Kovalevsky (Kovalevsky J., *Modern Astrometry*, Springer-Verlag Berlin Heidelberg 1994, 2002). It means that some new more effective astrometry instruments and methods have appeared in the last 3–4 decades. New technologies made a revolution in the all divisions of astrometry and replaced the old methods based on visual observations. Modern Astrometry methods were considered by Kovalevsky for optical and radioastronomy only. But these ones are rapidly developing now over all other spectral ranges besides the optics and radio and we try here to analyze contemporary situations. First of all we are concerned in Infrared and Gamma-ray ranges where modern astrometry methods are introducing actively too.

This work has been partly supported by the Ukrainian Foundation of the Fundamental Research Grant 02.07/00017.

## Astrometry at the RTT150 Telescope within the International Framework of KSU (Russia), TUG (Turkey) and NAO (Ukraine)

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Contemporary astrometric projects expect for accurate position measurements for objects up to 20–22 magnitude. For ground-based observations it is possible to do with astrographs of 1 metre and more apertures with the accurate tracking at lengthy exposures and accurate timing. Much functional astronomical complex RTT150 implemented on the base of AZT-22 telescope (LOMO, 1995) is appropriate for such purposes. Special properties of the RTT150 computer control which ensure the necessary astrometric characteristics are presented in the paper. A possibility for the accurate tracking is recognized for telescope motion along the given trajectory which is successfully used for corrections of irregularities of the general gear and for compensation of the influence of differential refraction at great zenith distances. The computer control software have a comfortable user interface which allows to control the telescope both in interactive and automatic modes for a given list of objects. Astrometric properties of the RTT150 are confirmed by the results which have been obtained at the project for improvement of the link between optical and radio reference frames. Description of the observation programmes and methods is presented for new astrometric projects. In particular, such problems concerning the research of minor bodies of the Solar System are picked out, as determination and improvement of the orbit elements of the near-Earth objects, determination of the dynamical properties, including masses of the selected asteroids, both from the positional observations and observations of occultations of stars by the asteroids, and improvement of the orbit elements of the faint great planet satellites.

## Astrophysical Tasks for Polarimetric Researches with Small Telescopes

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A number of important astrophysical tasks (study of structure of the interstellar medium, of shadowing-variable stars, of vertical structure of cloudy layers of planetary atmospheres, etc.), which may be solved by using of the polarimetric data, are listed. Such observational results it is possible to obtain on telescopes with mirrors diameters up to 1 meter.

## High Performance Computing for Scientific Research in Ukraine

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The paper considers the creation of a solution for low cost high performance computing. A kind of a solution can be used for scientific research in Ukraine. It describes the main principles of a software and a hardware cluster systems architectures. It also describes the testing of a sample system used for evaluation of a technologies of HPC. We will point the key features that affect a performance of a cluster system used for HPC. Equipment structure of the basic version of a solution is considered and some characteristics are discussed.

## What Limits the Precision of Ground-Based Stellar Photometry and Positional Measurements?

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Nobody has reached the photometric precision better than 0.001 of a magnitude with ground-based telescopes. At the same time, we should detect barely a million photons from any bright star to achieve a Poisson noise of one millimagnitude. The instrumental accuracy of coordinate determination with the ground-based telescopes equipped with the CCD camera is also no better of 0.1–0.2 arcsec. Many factors limiting the precision of stellar photometry and astrometry on the ground are superimposed and occur simultaneously. We show, however, that image motion, recently discovered by the authors, may be a barrier both to millimagnitude photometry and milliarcsecond astrometry with ground-based instruments. Stellar image motions (SIM) have a chance of being detectable only using the observations with several telescopes synchronously. The measurements of SIM were carried out with the help of registration of a star image near to diaphragm edge, playing a role of an optical knife. The spectra of SIM show periodic variations on the scale from a few seconds to minutes typically having amplitudes a few tenths of arc seconds. Clearly, image motions during the integration time can cause photometric errors and frustrate exact coordinate determinations. The nature of SIM remains obscure. It is significant that image displacements measured synchronously in different telescope reference frames show significant correlations. Emphasis is given to problems of the detecting of SIM and estimating their amplitude-frequency characteristics with the Synchronous Network of Telescopes.

## Interferometric Method for Image Formation: the Basic Ideas and Computer Simulation

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As it is known, the key resolution limit of an astronomical instrument is determined by diffraction of a received wave on the instrument aperture. However, at observation from the Earth surface in a short-wave side of a wave band, it is seldom possible to achieve this limit because of the phase contortions arising at propagation of a wave in the Earth atmosphere from the fluctuations of the refraction index. There is a series of ideas how to form an astronomical image decreasing or excluding influence of phase distortions during observation. One of such methods is the interferometric imaging method. In the present paper the technique of is described and results of simulated observations of various objects and their images reconstructed are adduced at different levels of atmospheric contortions. Advantage of a multi-beam interferometer, both on the instantaneous images and at time accumulation is well-visible.

## Rating of a Potential Opportunity of Space Objects Observations by Optic-Electronic Systems in Daylight Conditions

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Now objects of astronomical researches are the big variety of space objects of a natural and artificial origin. A wide range of parameters change characterizes orbits of the objects. However, restrictions on optic-electronic systems using connected with high level of sky brightness in daytime do not allow to ensure the high-quality coordinate and not coordinate information about the space objects taking place on Sun-synchronous orbits. But observation of such objects is possible during daylight time only. It is obvious that adaptation of optic-electronic systems for work in conditions of day light time demands the decision of some problems dealt with space objects supervisions conditions features analysis, revealing of factors interfering such supervision and development new (optimization known) methods of astronomical optic-electronic systems signals processing. The important stage at carrying out of such researches is the rating of a potential opportunity of space objects observation by optic-electronic systems in the daylight. It results to draw a conclusion on expediency of carrying out of the further works in the marked direction. In the report the signal-noise characteristic of daytime conditions of space objects supervision by optic-electronic systems is considered. The technique and the basic results of a potential opportunity rating of space objects observation by optic-electronic systems in day light time are discussed. Conclusions about expediency and possible further researches directions on adaptation of optic-electronic systems in conditions of daylight time are made.

## Atmospheric Limitations to Astrometric Detection of Extra-Solar Planets with Very Large Telescopes

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The report describes a new effective technique of atmospheric image motion suppression for observations with large ground-based one-aperture telescopes. The method is based on use of enhanced symmetrization of star reference fields. Another (optional) element of the technique is a special apodization of a telescope entrance pupil especially effective for extremely large  $D > 30$  m apertures. Numerical simulations made for a 10-m telescope shows that both atmospheric image motion and photon noise in the star images can be reduced to better than 10 microarcseconds at 10 min exposure. Estimates refer to  $C_n^2$  vertical profile typical to Chilean astronomical sites, moderate  $FWHM = 0.4''$  and star densities at galactic coordinates  $l = 0^\circ$ ,  $b = 20^\circ$ . For a 100-m telescope, the precision is 0.2 microarcsec/10 min at high star density and drops to 1 microarcsec/10 min at the Galactic pole. For a 10-m telescope that measures astrometric reflex motion of stars to 10 microarcsec accuracy, a detection limit for Saturn–Jupiter sized planets is about 5–10 kpc. Application of very high precision astrometry is especially useful for searching extrasolar planets around Pre-main-sequence, early Main-sequence and low-mass stars which are difficult to study with a radial velocity technique.

## Robotic Telescope of the Terskol Observatory

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We present the project of remotely operated telescope for the Terskol Observatory. This project has been designed to observe celestial objects by accessing Terskol Web server and downloading images in real time.

## Project of the Network of Television Observations of the Occultation Phenomena

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Occultations of celestial objects are the most ancient phenomena, observable from the Earth. Owing to simplicity these observations are the most popular and regular. In spite of development of new observation technologies the interest to them does not die away. The range of problems solved by means of occultation observations are extended. The Astronomical Observatory of the Kiev National University during 40 years of coordination of occultation observations has created and kept the network of observational stations on the territory of the former USSR. Increasing accuracy of modern lunar ephemeris and star catalogues demand improvement of the observation methods. The project of equipment of existing network of observational stations by new of the same television installations is proposed. Possibilities of new observation program with method of occultations are considered in order to study kinematics of multiple star systems, small bodies of Solar System, as well as figure of marginal zone of the Moon. Accumulation of such precision observations carried out from different points of the Earth without a personal errors of the observers will also allow to receive the reliable information on irregularity of the Earth's rotation and secular changes in movement of the Moon.

## Processing of CCD Frames of Images of Star Fields without the Frame of a Flat Field Using New Software in Program Shell of MIDAS/ROMAFOT

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Results of processing of CCD frames of star fields obtained by two ways are analyzed. In the first case (a traditional method), the frame of flat field are used. In the second one, the own large-scale flat field it is obtained directly from the processable frames of image. That is we suggest to find the frame of a flat field individually for each frame of the image. Photometric researches of regular errors are carried out for a wide interval of expositions (up to 100 times) for the same celestial objects in zones of overplanning of displaced frames (up to half of the frame size). Comparison of an instrumental photometric scale with a scale of photometric standards shows the absence of photometric field errors and brightness errors. Software procedure of cyclic processing of any quantity of CCD frames of star fields is realized in program shell of MIDAS/ROMAFOT.

## Realization of Vilnius UPXYZVS Photometric System for CCD Camera AltaU42 in the MAO of the NAS of Ukraine

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The description of two-inch glass filters of the Vilnius UPXYZVS photometric system, which are made at the Main Astronomical Observatory of the NAS of Ukraine for CCD camera AltaU42 with format  $2048 \times 2048$  pixels, is presented in the paper. Reaction curves of instrumental system are shown. Estimations of minimal stars magnitudes for each filters band in comparison with the visual  $V$  one are obtained. New software for automation of processing of CCD frames is developed in program shell of LINUX/MIDAS/ROMAFOT. It is planned to carry out observations with the purpose to create the catalogue of primary UPXYZVS CCD standards in selected fields of the sky for some radio-sources, globular and open clusters, etc. Numerical estimations of astrometric and photometric accuracy are obtained.

## Technical Opportunities of Optical Telescopes on Angular Support GEO

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Expansion of a circle of tasks of the space control, increase in quantity of artificial space objects (SO) in circumterrestrial space show new requirements to volume, efficiency of the received information, and, accordingly, to a firmware of systems of supervision SO. Now in publications and in Internet the information on results of supervision GEO has appeared by means of modern telescopes with registration of results on CCD-matrixes. In the given sources the results, testifying that accuracy of definition of parameters of movement GEO makes units of angular seconds are declared. It is represented interesting to investigate influence of various factors on accuracy of angular support GEO. First of all it concerns necessary speeds and accuracy support GEO. In the second, this time of supervision GEO in sight the reception optical device. And, at last, time of an exposition of CCD-matrixes. At carrying out of processing of the received data the essential role is played with binding of measurements to labels of time. Proceeding from stated in the report technical restrictions on accuracy of angular definitions GEO have been investigated by optical telescopes. It is shown that accuracy of measurements is limited to technical opportunities and conditions of supervision. The analysis of making mistakes of angular definitions has been also carried out. At carrying out of researches it was necessary that binding of measurements be carried out by means of second labels of navigating GPS-signals. The conclusion about an opportunity of carrying out of calibration measuring channels of radio-technique tracking systems.

## Feasibilities of Photo Clinometric a Method of Definition of a Relief at Radio-Locating Research of a Planet

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Previously, a method of determination of the relief of a planet surface by a series of its images was described. It is based on the fact that at given directions of illumination and observation the brightness of a surface element depends on its orientation. The present paper describes the case when the initial images are obtained using a side-looking radar, focusing on the amount of information about the relief containing in the obtained set of images.

## Influence of the Phase of the Spherical Planet on Determination of the Coordinates of Details of an Albedo on the Planet's Surface from Ground-Based Telescopic Observations

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The new method of determination of planetocentric coordinates of details of an albedo on the visible disk of a spherical planet is offered under various conditions of its illumination. The method is intended for processing of the images of planets received on ground-based telescopic observations. The position of a detail on the image of a planet is determined not concerning center of a geometric planetary disk, and concerning center of the illuminated part of its visible disk that allows excluding influence of a phase of a planet. The auxiliary coordinate system connected to equator of intensity is applied for determination of a position of points on the illuminated part of a visible planetary disk. The formulas for transition from auxiliary coordinate system to planetocentric coordinate system are received. The particular cases of determination of planetocentric coordinates of basic points of the illuminated part of the visible disk of a spherical planet lying on equator of intensity, under the formulas which are not requiring of attraction of auxiliary coordinate system are considered. The method is checked up on an example of processing of the images of a Mercury and Mars.

## Dynamical Properties and the Origin of Planetary Satellites

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The classification of satellites by their gravitational interaction with planets, the Sun, other satellites, and ring self-gravitating formations is discussed. The determining parameters are the distance between a satellite and a planet, and planet-satellite or ring-satellite mass ratio. Some peculiarities of orbits of external and internal satellites are ascertained. Scenario of the satellite origin is discussed. An accretion of protoplanetary cloud is more probably for the formation of internal satellites. External satellites have formed seemingly as a result of a capture of asteroids and comets in consequence of their complex interaction with other satellites.

## Influence of the Variable Magnetic Field of the Sun on Formation Protoplanet Disk

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Influence of a variable magnetic field of the Solar cycle on formation of planets of Solar System is considered. As against a constant magnetic field which influence on dust plasma is reduced, basically, to pushing out of substance from circumsolar space, the variable magnetic field creates the allocated orbits. Thus, in separate regions there can be an amplification of a magnetic field and pushing out of substance, in others, on the contrary, accumulation of substance, and in a consequence and formation of planets. Comparison of the periods of rotation of planets with the periods formed by a solar magnetic cycle is carried out. It is shown that orbits of the basic planets can be expressed as the periods multiple duration of a magnetic cycle with the period of  $\sim 23.7$  years.

## Physics of Stars and Galaxies – without Proton to Proton Fusion and without Dark Matter and Black Holes

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Recent observations indicate the abundant presence of neutron stars near the galactic centers; also a possible decay of superheavy nuclei into the elements of periodic table (Proton 21 experiments). The theoretical evaluation of ancient atoms' collision systems results in an understanding of these new observations, and a coherent representation of physical reality. The galactic centers are systems of neutron stars and the General Relativity predicted gravitational effect makes the hypothetical black holes and dark matter unnecessary.

## Investigation of Atmospheric Instability for Communication Experiments with ESA's Geostationary Satellite ARTEMIS

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Free-space laser communication systems have some advantages in comparison with radio communication systems, especially on far distances in the space. Since February 2003 ESA's ARTEMIS satellite with laser communication payload on board is successfully working at the 21.5 degrees East point of the geostationary orbit. ARTEMIS is successfully performing laser communication links with optical communication terminal at low orbital satellite SPOT-4 and is performing laser communication link experiments with the Optical Ground Station of ESA at Canary Islands. During the optical communication experiments from ground station to geostationary satellite the laser beam passes across the atmosphere, which influences its propagation. After the agreement with ESA managers during visit to the observatory two years ago we are preparing a laser communication link with the ARTEMIS satellite from the Main Astronomical Observatory in Kyiv. This will enable us to compare the results of investigations of propagation of laser communication beam across the atmosphere in different regions in particular Atlantic region – Canary Islands and continental region – Ukraine. The investigations of atmospheric instability in particular the atmosphere attenuation and turbulence are very important for ground to satellite propagation of laser beam for determine the necessary divergence of laser beam and power of laser. For investigations of atmosphere instability was performed the observations of different stars at different fields of sky and periods of observations. It was used the short expositions (40 ms) of stars at CCD camera in focal plane of objective with a filters. It was performed the calculations of middle positions of images of stars and determined the deviation of positions of images of stars from middle position. It was performed calculations of atmosphere attenuation and FWHM (Full Width Half Maximum) faction also. The calculations were performed using the MIDAS/ROMAFOT program packet. The results of atmosphere instability and estimations of necessary laser beam characteristics for ground-space communication experiments are presented in paper.