Slovak Academy of Sciences

Astronomical Institute

ANNUAL REPORT 2006

Astronomical Institute, Tatranská Lomnica, Slovakia

Contents

1 Foreword

The present form of the report of the activities of the Astronomical Institute of the Slovak Academy of Sciences (AI SAS) does not differ significantly from the last year report. Its structure and layout are, however, considerably different from those in the corresponding Slovak version (also available at our web page). The English version is focused almost uniquely on the scientific activities of the AI SAS and it omits a number of important 'non-scientific' issues, like, e.g., financial matters of the institute, teaching commitments at universities, etc.; these can only be found in the Slovak version. The report for 2006 is the fourth in the English language that I have the pleasure to present, and I hope you will find it of interest.

Our staff in High Tatras and Bratislava was unchanged in 2006, except that Ladislav Scheirich retired after 39 years as an observer of the Department of Solar Physics and Lubomir Hambalek started his PhD study in the Stellar Department.

It is useless to attempt to summarize content of the following many pages in a few rows here. Nevertheless, some important issues should be pointed out. The amount of scientific production is expressed by 53 papers in internationally distinguished refereed journals and 13 articles in referred conference proceedings. A number of interesting results have been obtained, some of them being highlighted in what follows. Our institute plays a very important role in 16 well-established international projects and a number of informal collaborations.

AI SAS organized a workshop "Solar Flares and Initalization of CMEs", held at Tatranska Lomnica on September 13-15, 2006. Solar physicists involved in observations, theory, and instrumentation have discussed recent results and fostered collaborations in the following fields of solar physics: recent advances in investigation of flare coronal hard X-ray sources, in theoretical and observational physics of coronal mass ejections. Special section was devoted to numerical magnetohydrodynamic modeling of active region evolution. Also solar flares and their impact on the Earth's atmosphere was included to the programs of the workshop. It was a very successful professional forum for 37 participants from 7 (USA and Central European) countries.

In 2006, AI SAS has been very successful at applying for observational time at the world-class solar telescopes, located at the Canary Islands, through the Opticon Trans-national Access Program of the 6FP EU. All financial expenses related to the operation of these telescopes during our campaigns have been covered by this program (totally 144 000 Euros). Our research group studying the origin of the reservoirs of small bodies of the Solar System uses the huge European computational capacity, so-called GRID computing, which belongs to the most powerful computational tools in the world at present. An important support of an efficient usage of the GRID is provided by the experts from the collaborating Institute of Informatics of the Slovak Academy of Sciences within the project Enabling Grids for E-science II.

The last volume of our journal Contributions of the Astronomical Observatory Skalnate Pleso (number 36) appeared in three regular issues. The journal is covered by the ISI and is electronically available from our web page (http://www.ta3.sk) and the ADS database as well.

We have also succeeded to improve substantially our observational facilities and infrastructure. A new ST-10XME CCD camera, produced by SBIG, Santa Barbara, USA, was purchased - it enables photometry of bright Centaurs and comets at large heliocentric distances. A new powerful internet server was put into operation. In 2006 IP telephony was installed at all the working places of AI SAS. We completely redesigned the WWW homepage of AI SAS. We required a higher level of lucidity and simple way of managing. This goal was made good using the latest tools in developing the websites. Instead of HTML 4.0 we used XHTML 1.0 language, Cascading Style Sheets (CSS2) for creating a new layout and PHP5 language as a functional base of our WWW homepage, as well.

The head of the Stellar Department D. Chochol was established as a single point of contact (national coordinator in the Slovak Republic) for the activities of the International Year of Astronomy 2009.

Ján Svoreň
director of AI SAS

2 Research

2.1 Interplanetary matter

Observational facilities:
Skalnaté Pleso Observatory - a 61 cm reflector with a CCD camera, an all sky fireball fish-eye camera; Modra Observatory - a receiver of a forward scatter meteor radar.

Research activities:

- theoretical investigation of transfer orbits among different populations of small bodies in the Solar System regarding near-Earth objects
- photometry and astrometry of asteroids and comets,
- investigation of the activity of selected cometary nuclei and its influence on the physical and dynamical evolution of these bodies,
- a search for meteoroid streams of an asteroidal origin,
- investigation of the meteoroid population in the vicinity of the Earth's orbit,
- interrelations among the populations of small bodies in the Solar System and their evolution,
- description of the distribution of meteoroid particles in the inner Solar System,
- study of the structure of selected meteor showers,
- identification of the meteor sporadic background activity by a forward scatter radio system,
- detection of ozone in the upper mesosphere with ground based radio observations,
- operation of fireball fish-eye cameras within the framework of the European Fireball Network,
- investigation of the light scattering of dust particles in the Solar System and Earth atmosphere,
- search for hyperbolic and interstellar meteoroids using data from IAU Meteor Data Center and other sources,
- study of meteorite properties.

2.2 Solar physics

Observational facilities:
Stará Lesná Observatory - a horizontal solar telescope with spectrograph, Lomnický Peak Coronal Station - a double 20 cm coronagraph with a spectrograph.

Research activities:

- study of rotational characteristics of sunspots and surrounding photospheric plasma based on own measurements,
- spectral analysis of the quiet and active solar photosphere and chromosphere using spectra from Tenerife VTT observations,

- study of the dynamics and energy transfer in the quiet upper solar atmosphere from SOHO (SUMER, CDS, EIT) and TRACE satellites data,
- investigation of the coupling of a cosmic ray modulation and solar LDE flares and also coronal mass ejections,
- derivation of magnetic fields in specific coronal structures using own eclipse observations,
- analysis of coronal holes and their relation to the background and local magnetic fields and a relationship between polarization and intensity of the green line in different coronal structures,
- study of a time-latitudinal distribution and large-scale development of solar prominences,
- observations of both the 530.3 nm and 637.4 nm emission coronal lines as well as the white-light corona to study solar cycles,
- preparation of the homogeneous coronal data set for the 530.3 nm coronal line,
- computation of the coronal index of solar activity.

2.3 Stellar astrophysics

Observational facilities:
Skalnaté Pleso Observatory and Stará Lesná Observatory - two 60 cm photometric reflectors, a 50 cm reflector with a CCD camera.

Research activities:

- investigation of interacting binary and multiple systems, symbiotic stars, novae and nova-like objects focused on physical processes during phases of their activity, studies of their origin, structure, evolution and physical conditions in the circumstellar environment,
- photometric detection of various manifestations of both regular and semi-regular stellar variability, models' construction explaining the behaviour of the systems,
- use of the IUE as well as HST databases for the spectroscopy of interacting binaries and direct HST images to study expanding envelopes of novae and symbiotic stars,
- spectroscopic investigation of chemically peculiar star phenomena based on spectra from ESO, Mt. Stromlo, Nauchnyj, Ondřejov, Rozhen and Zelenchuk observatories,
- study of the chemical composition and properties of the atmospheres of CP stars, and the role of radiative diffusion of some species,
- search for possible relations between the orbital parameters of binaries with Am components.

3 Personnel

3.1 Executives

Director : J. Svoreň, deputy director : J. Žižňovský, scientific secretary : J. Rybák

3.2 Scientific Council

A. Bobák, E. Dzifčáková, K. Kudela, A. Kučera (chairman), L. Neslušan, E. Pittich, V. Porubčan, T. Pribulla (vice-chairman), V. Rušin, J. Rybák, A. Skopal, J. Žižňovský.

3.3 Department of Interplanetary Matter

Head: J. Svoreň
Staff in Bratislava: J. Farkašová, M. Hajduková, Jr., I. Kapišinský, M. Kocifaj, J. Pittichová (currently a post-doctoral scientist at the Institute for Astronomy, University of Hawaii, USA), E. Pittich, T. Paulech, V. Porubčan, N.A. Solovaya
Staff in the High Tatras: G. Červák (technician), M. Husárik (postgraduate student), M. Jakubík, Z. Kaňuchová (postgraduate student), L. Neslušan, M. Pikler (technician), J. Svoreň, M. Tirpák (postgraduate student).

3.4 Department of Solar Physics

Head: A. Kučera
Staff: P. Bendík (technician), P. Gömöry, P. Havrilla (technician, since 1/7), Ľ. Klocok, J. Koza (MC fellowship at the Utrecht University, the Netherlands), R. Mačura (technician), K. Maník (technician), M. Minarovjech, V. Rušin, J. Rybák, M. Saniga, L. Scheirich (technician, till 30/6), J. Sýkora, O. Štrbák (since 1/5), F. Tomasz (postgraduate student, till 30/9).

3.5 Stellar Department

Head: D. Chochol
Staff: D. Božík (technician), J. Budaj (currently a post-doctoral scientist, University of Arizona, USA), Ľubomír Hambálek (postgraduate student, since 1/9), L. Hric, V. Kollár, R. Komžík, E. Kundra (postgraduate student), K. Kuziel (technician), T. Pribulla, P. Schalling (technician), A. Skopal, J. Tremko, M. Vaňko, M. Zboril, J. Zverko, J. Žižňovský.

3.6 Administration and Maintenance

Head: M. Alman
Staff: J. Ambróz, R. Bekeš, F. Budzák, T. Drzewiecka, M. Dufalová, T. Griešová, Ľ. Hanigovský, K. Krempaská, D. Novocký, A. Sanigová, M. Šoltýsová, P. Zimmermann.

4 Guests

In 2006, the following guests visited our institute: P. Ambrož (Astronomical Institute, Ondřejov, Czech Republic), M. Bárta (Astronomical Institute, Ondřejov, Czech Republic), P. Bellaire (NSF, North Arlington, Virginia, USA), G. Cevolani (ISAC (FISBAT) CNR, Bologna, Italy), H. Coffey (NOAA NGDC, USA), J. Chen (Naval Research Laboratory, Washington, DC, USA), L. Errico (ISAC (FISBAT) CNR, Bologna, Italy), D.A. Falconer (NASA MSFC, Huntsville, AL, USA), A. Grandpierre (Konkoly Observatory of the Hungarian Academy of Sciences, Budapest, Hungary), A. Hanslmeier (Institute of physics/IGAM, University of Graz, Graz, Austria), J. Janík (Institute of Theoretical Physics and Astrophysics, Masaryk University, Brno, Czech Republic), M. Jankovič (Central European University, Budapest, Hungary), M. Karlický (Astronomical Institute, Ondřejov, Czech Republic), J.M. Kreiner (Mt. Suhora Observatory, Cracow Pedagogical University, Krakow, Poland), D. Kudryavtsev (SAO RAN, Russia), Z. Mikulášek (Institute of Theoretical Physics and Astrophysics, Masaryk University, Brno, Czech Republic), M.I. Nouh (National Research Institute of Astronomy and Geophysics

(NRIAG), Helwan, Cairo, Egypt), J. Pap (GEST/University of Maryland, Greenbelt, USA), I. Pustilnik (Tartu Observatory, Estonia), M. Planat (FEMTO-ST, LPMO/CNRS, Besancon, France), J.I. Romanjuk (SAO RAN, Russia), A.N. Saad (National Research Institute of Astronomy and Geophysics (NRIAG), Helwan, Cairo, Egypt), S. Shugarov (Sternberg Astronomical Institute, Moscow State University, Moscow, Russia), S. Stoiser (Institute of physics/IGAM, University of Graz, Graz, Austria), A. Veronig (Institute of physics/IGAM, University of Graz, Graz, Austria), A. Vittone (ISAC (FISBAT) CNR, Bologna, Italy), S.T. Wu (CSPAR, University of Alabama in Huntsville, Huntsville, USA) V. Yurchyshyn (Big Bear Solar Observatory, CA, USA).

5 Results

The main results acquired and published by the research personnel of the Astronomical Institute in the year 2006 are briefly described below. Information about the reference to the published paper in the list of publications is given in brackets.

1/ The most significant result of the year 2006 – result 1: A gravitational origin of the fine structure of the Perseid meteoroid stream.

An analysis of the precise photographic orbits using the method of indices has shown that 560 meteors of 875 Perseids taken into account were sorted out to 17 filaments which form higher structures, called the branches of the stream. We compared the semi-major axes of the mean orbits of 17 discovered filaments with the theoretical positions of planetary resonances of Jupiter and Saturn. By this comparing, the Jupiter and Saturn branches of the Perseid stream were identified. Consequently, numerical integrations of 245 700 test meteoroid particles over 6250 years were done. Our integrations of the test cloud lead to an interesting fact. The gaps located in the positions of resonances with Jupiter and Saturn have been formed soon after the first revolution of the stream. The mean orbits of the found filaments are located in a close proximity of strong resonances. They represent, with a high probability, increased numbers of particles gravitationally expelled from a resonant gap and temporary settled down in its close proximity. The presented results could be considered as a strong indication of a gravitational origin of the fine structure of the Perseid meteoroid stream (paper No. 49).

2/ The most significant result of the year 2006 – result 2: Origin of the broad H-alpha wings in symbiotic binaries.

The extreme broad emission wings of the hydrogen H-alpha line in the spectra of interacting binaries represents a pivotal problem of their astrophysics. To date models considering rotating discs, scattering on free electrons and/or radiative damping in lines were elaborated. Recently a theory of the Raman scattering Ly-beta photons on neutral atoms of hydrogen was developed. The aim of the current study was to suggest a rivaling alternative to explain the significant broadening of the H-alpha line during outbursts that is consistent with the structure of the active object. In the model I assumed that the broad H-alpha wings are produced by ionized hydrogen. I found that the broad wings can be formed in the high-velocity stellar wind from the hot star. By this way the active star loses a fraction of its mass at rates of approximatelly 1x10E-6 solar masses per year. The radiation produced by the H-alpha line is consistent with the radio observatoins. The suggested model has implications for investigation of the mass-loss from other astrophysical objects, as AGB stars, planetary nebulae or the active galactic nuclei. In the symbiotic star research this study represents an important ingredient of the structure of active objects (paper No. 45).

3/ The most significant result of the year 2006 – result 3: Temperature influenced dynamics of small dust particles.

We analysed the motion of spherical dust particles under the action of gravity, electromagnetic radiation force and Lorentz force for materials with temperature-dependent dielectric functions in the visible spectral range. It was shown that even a weak variation of the optical constants with heliocentric distance may influence predominately a long-term dynamical behaviour of submicron-sized and small micron-sized dust grains. The lifetime of carbonaceous or Si particles may change by several tens of per cent because of the temperature dependence of particle refractive indices. The orbital inclination is the most evident difference between the evolution of a dust particle with temperature-dependent optical properties and one without. While carbonaceous $2\,\mu$m-sized particles with optical constants independent of temperature may evolve in orbits with inclinations greater than an initial value, grains of the same size with variable refractive indices will be spread along orbits characterized with inclinations lower than the initial one. The temperature-dependent dielectric function thus may be responsible for the complex distribution of dust material along Keplerian orbital planes. Here the temperature works as a separation factor for particles having slightly different temperature dependences of the optical constants (paper No. 30).

4/ The most significant result of the year 2006 – result 4: The eclipsing model of the symbiotic binary YY Her.

The eclipsing model of the symbiotic star YY Her From 2000, we coordinated specifically pointed international photometric campaign to symbiotic star YY Her with the aim of detail covering of light curve in four colours. On the base of analysis of obtained data, the secondary minimum on the light curve was discovered and the orbital period of the system was improved to the value 587.54 of day. We draw conclusion by comparison and testing of models of binary involving the ellipsoidal effect, effect of reflection and sinusoidal variations of nebular emissions, with hot component embedded in envelope with temperature 4000 K. We compared the calculated and observed brightness of envelope and found out that envelope has the disc-like structure. We computed the thickness of the envelope with value of 27 diameters of the Sun by method of envelope asymmetry estimation (paper No. 18).

5/ The most significant results obtained within frame of international collaboration – result 1: Multiple stellar systems.

All available archive and new observations enabling detection of multiple components to contact binary stars. Firstly, spectroscopic observations from David Dunlap Observatory (Canada) lead to the direct detection of six multiple systems. New adaptive optics observations on 3.6m CFHT disclosed a companion to 9 contact binaries. Presence of a third body was indicated in the Hipparcos astrometric observations by showing either stochastic astrometric motion or acceleration. Times of the minimum light were used as an indirect indicator in systems showing period changes of the orbital period. In 20 systems stable orbit was found. Several systems manifest large ratio of the X-ray and bolometric flux indicating presence of an active late-type dwarf companion. All above-mentioned techniques showed that sample of 151 contact binary stars brighter than V=10 in maximum was found to contain 64 multiple systems. In case of better-observed Northern hemisphere we have 52 multiple systems among 88 objects. This supports a hypothesis that interaction with third body is crucial for the formation of close binary stars (paper No. 40).

6/ The most significant results obtained within frame of international collaboration – result 2: Structure of the active object in the symbiotic star Z And.

The key problem in investigation of symbiotic stars is the nature of their outburst. Observations show an increase of the active object luminosity to 10 000 Suns, a dramatical decrease of its temperature from 200 000 to only 20 000 K, whereas the spectrum indicates the presence of a hot body capable of ionizing hydrogen and helium. Understanding the geometrical structure of the active object, which is currently not well known, can significantly contribute to our understanding the nature of outbursts. The aim of our study was to reconstruct structure of the active object in Z And. Analysing the high-resolution spectroscopy, obtained within a wide international collaboration (Italy, Japan, Czech republic, Russia), multi-colour photometry (from observatories of AI SAS) and the ultraviolet spectroscopy as measured by the satellite Far Ultraviolet Spectroscopic Explorer, we inferred the structure of its active object. We found that the hot object consisted of an optically thick, slowly-expanding (100-200 km/s) disk-like material encompassing the accretor at the orbital plane and a fast (2 500 km/s) optically thin stellar wind over the remainder of the accretor. The result contributes to our understnding the physical processes resposible for the outbursts (paper No. 46).

7/ It was found that a small inhomogenity in the orbital distribution of dynamically new comets cannot account for so-called "fading problem". Within the study, some earlier results of other authors were refined: while the planetary perturbations does practically not change the comet perihelia (a typical change is ± 0.05 AU, a maximum change up to ± 0.15 AU), the comet semi-major axes are significantly modified. In the case of Jupiter-Saturn pertubations, the change of the axes is Gaussian-like with the dispersion equal to 0.00052 ± 0.00012 AU^{-1} (paper No. 33).

8/ We demonstrated that no alien star passing the solar system with a relative velocity equal to or larger than 5 km/s could cause the observed abrupt decrease of the number density of bodies in the classical Kuiper belt beyond the heliocentric distance 50 AU (paper No. 35).

9/ In the scope of the photometry of the interplanetary matter objects at Skalnate Pleso Observatory there were obtained photometric data for 45 asteroids and the fragments of periodic comet 73/P Schwassmann-Wachmann 3. The photometry program was oriented to asteroid shapes modelling, near-Earth objects and Hungaria family asteroids. The 38 astrometric observations of 7 asteroids were published (papers Nos. 34, 57, 58, 62, 63).

10/ Geminid meteoroid stream members were selected from the newest version of the IAU MDC database of photographic orbits. The selection was made by a method of indices developed by us. Subsequently, the mean orbit and radiant ephemeris of selected Geminids were determined. The list of all 387 selected Geminids is available in digital form at webserver of AI SAS (paper No. 24).

11/ The international cooperation among Skalnate Pleso Observatory and observatories from Czech Republic, USA, Canada, Italy, Portugal and Ukraine discovered the binary character of two asteroids - (1717) Arlon and (2754) Efimov (papers Nos. 90, 92).

12/ The capture of ideally spherical dust particles in orbital resonances with planets is already well-known. However, the stability of realistically shaped particles in the resonances is notoriously unknown and definitely questionable. In addition, numerical modeling for such particles was impossible until now (because of lack of satisfactory theories as well as the computational resources). Our present simulations have shown that nonspherical particles are characterized by small change of semimajor axis of the orbit, and thus these particles are never in "stable resonances"with planets (contrary to spherical bodies) (paper No. 26).

13/ The trajectories of irregularly shaped particles ejected from comet Encke were simulated numerically. Orbital evolution of these particles show 1/ the motion in perihelion and 2/ also an evident spread of the particles into various directions (including directions perpendicular to the orbital plane of the parent body). These facts can explain presence of realistically shaped particles in regions in which the spherical particles cannot survive (paper No. 27).

14/ The special case of the general three-body problem, in which the distance between the two bodies with similar masses is much longer than between the primary body and its small satellite, was solved. The theory allowed to determine conditions at which a high-eccentricity orbit of a satellite will change to the near-circular one within finite time (paper No. 47).

15/ Infrared images and spectra of comets 2P/Encke, 67P/Churyumov-Gerasimenko, and c/2001 HT50 (LINEAR-NEAT) we received by the Spitzer Space Telescope. A heliocentric distance of observed comet was less than 5 AU. Comet Encke exhibited a smooth continuum, best modeled by carbonaceous grains with a small peak grain size of 0.4 mikcometer. The thermal model depends on the phase angle of the comet. Comet HT50 displayed a significant silicate mineralogy with a silicate-to-carbon submicron mass ratio of 0.6 (paper No. 25).

16/ The proportion of possible interstellar particles to interplanetary ones, observed with different techniques, was found to be much higher for small particles obtained from high power radars and cosmic dust detectors in comparison with results of photographic observations from the IAU Meteor Data Center in the range of large meteoroid particles. This contradiction may be explained by different mass distributions of interstellar and interplanetary particles (paper No. 17).

17/ The activity and structure of the Taurid meteor complex summer streams (Zeta Perseids and Beta Taurids), based on forward scatter radio observation along the baseline Lecce-Bologna-Modra and from the Ondrejov backscatter meteor radar observations in 1997-2004, are analysed and studied. The observed maxima are consistent with the previous analyses. A filamentary structure of the stream is observed and confirmed by a variation of the mass exponent (paper No. 42).

18/ The forward scatter radio observations of the Lyrid meteor stream along the Lecce-Bologna-Modra baseline in 1997-2004, for echoes of duration greater than 8 seconds, indicate a complex structure of the stream. The peak of activity appeared at solar longitude of 32.3 degrees and the Earth passes through the central zone, with the half strength of the maximum, for only two days. The variation of the mass exponent indicates on a relatively stable population of meteoroids (paper No. 39).

19/ The analysis of CCD photometry of cataclysmic variable V 1493 Aql (Nova Aql 1999) showed that photometric data are strongly modulated with period of 0.156 ± 0.001 day, while the brightness variations show the significant sinusoidal shape. Such behaviour is interpreted within the meaning of orbital moving what is in agreement with behaviour of cataclysmic variables above period gap (paper No. 13).

20/ The orbital period changes of 13 eclipsing binaries were discussed. Period changes of GO Cyg and GW Cep were explained by the light-time effect for the first time. It was shown, that the quadratic ephemeris combined with the light-time effect can explain the period change of V505 Sgr (papers Nos. 22, 32).

21/ CCD photometry of the outburst of a young eruptive star V1647 Ori, obtained in the years 2003-5, and comparison of the spectroscopy with FU Ori and EX Lupi type objects showed that V1647 Ori is the prototype of a new class of objects in an early stage of stellar evolution (paper No. 21).

22/ Sixteen spectra of six Am binaries were obtained and analysed. The purpose is to study the influence of the companion on the chemical composition of the Am star. Temperatures, masses, ages, rotation and abundances of several chemical elements were determined. We concluded that HD 861, 29479 and 108651 are typical Am stars. HD 20320 and 96528 are mild Am stars and HD18778 is not Am star (paper No. 23).

23/ Paper presents radial velocities and spectroscopic elements for ten close binary stars. The radial velocities were determined by double rotational fitting to extracted broadening functions. Three systems - ET Boo, VW LMi and TV UMi are spectroscopic quadruple systems while AG Vir is spectroscopic triple. Of special interest is system VW LMi where two binaries revolve in 355 days orbit (paper No. 40).

24/ CCD photometric monitoring of the open cluster NGC 6231 performed over several years lead to the first Stromgren photometry of the hot eclipsing binary V1034 Sco. Simultaneous analysis of the new photometric observations and published radial-velocity curves resulted in determination of masses of the components and independent determination of the distance modulus of the host open cluster as V_0 - M_V = 10.73±0.02 (paper No. 55).

25/ The distributions of geometrical and physical parameters from the catalogue of contact binary stars (Pribulla et. al., 2003) and ASAS-3 (The All Sky Automated Survey) were compared and discussed. To distinguish the W UMa systems from other binaries in ASAS-3 dataset, the Fourier decomposition was used (paper No. 52).

26/ In order to monitor magnetic activity of solar active stars, we studied photometrically two eclipse systems SV Cam, RZ Tau and SB1 system II Peg during the season winter 2004/2005. The objects SV Cam and II Peg were found to have activity complexes - spots - in higher stellar latitudes (paper No. 53).

27/ We improved a new method of mathematical procedures to the processing of 2-dimensional coronal images. By using of the digital camera and the correct number of shots and exposures, there is possible to obtain the processed images with almost theoretical resolution of the used objective. This method was employed also for processing of the older white corona pictures taken during the past total solar eclipses (paper No. 14).

28/ We find out the important similarity between the EUV coronal and white-light coronal structures. In the case of common relevance of those similarity the missing LASCO C2 white-light corona structures from 1 to 1.5 solar radii is possible to refill by the EUV corona structures. A high dynamics for the some prominences, when comparing the EUV and white-light coronae evolution, was find out for the first time. A borders of the helmet stremers were identified as the outer boundaries of the coronal holes, where the lines of the magnetic fields are open (paper No. 37).

29/ Spectral variation analysis and wavelet analysis applied on three solar activity indices (the coronal green-line brightness, the mumber and summary area of sunspots, the total magnetic flux) have revealed similar time variations in the N-S asymmetry of these indices on both the short (1.5 - 3.0 years) and long (∼18 years) time scales. It is argued that the N-S asymmetry parameter represents probably a certain fundamental property of the sun's body, indicating relationships and a measure of correlations between the magnetic field generations at both the solar hemispheres (paper No. 82).

30/ Time variations in rotation of the solar corona have been quantitatively determined in dependence on heliographic latitude and phase of the 11-year solar activity cycle during period 1939-2001 (our own database of the coronal green-line intensities has been analyzed). Comparisons of the found results with the latest achievements of seismology show that the velocity field in the sun's convective (optically invisible) layer displays similar features to those found in the upper solar atmosphere, including discontinuities in differential rotation of the sun (papers Nos. 12, 54, 81).

31/ The search for substructures in latitude/time distribution of the long-lived isolated coronal holes revealed that they are organized into two populations: (1) coronal holes occurring around the maximum phase of 11-year solar activity cycle and living for 2-4 years and, (2) long-lived holes (surviving for 18 years) which are magnetically unipolar and described here in relation to the regular polarity changes of the global magnetic field within 22-year Hale solar magnetic cycle (paper No. 59).

32/ We confirmed the existence of the compressive magneto-acoustic waves which propagate downward from the transition region to the chromosphere in the chromospheric network under study. We showed that the propagation of these waves is closely related with the chromospheric and transition region oscillations with periodicity of around 300s. Our results could be used as an indirect evidence for the heating of the solar corona above chromospheric network through magnetic reconnection (paper No. 16).

33/ Height stratification of temperature, velocity and their rms fluctuations were determined in non-magnetic solar photosphere and a small area of increased magnetic activity by SIR inversion code applied on 15-min sequence of spectrograms. The mean temperature stratifications in the non-magnetic region agree well with the classical 1D models and the 3D simulations. However, the observed rms temperature is much lower than in the simulations, the observed mean velocities indicate more upflows (paper No. 31).

34/ Investigation of temporal variations of the flare index, sunspot number, as well as area of sunspots in comparison to solar irradiance showed that oscillations of the irradiance are of a lower importance as oscillations of other indicies. Oscillations of individual indicies of solar activity are not simultaneous in the epoch 3 years long around maximum of the solar activity for the solar cycle 23 (paper No. 11).

35/ Using observations of two observatories – Kanzelhoehe Solar Observatory and Observatory Skalnate Pleso – a homogeneous catalogue of the hemispheric sunsport numbers have been constructed fro the epoch 1945–2004. Preliminary results have revealed that asymmetry of the sunspot number is the most pronounced during maxima of the solar activity what is is contradiction to the previously derived results. The catalogue is accessable in an electronic form (paper No. 51).

36/ Time series of spectral measurements used for investigation of the influence of the 5-min oscillations on intesity and velocity field in the solar atmoshere allowed to determine: influence is dominating especially in the upper photoshere, granular structures diminish quickly with increasing altitude over the solar surface, these structures are more stable as in the lower photosphere (paper No. 36).

6 Grants/Projects

6.1 International grants

- 2006-2009, Project DFG - temporal evolution of the photosphere and chromosphere in a quiet and active regions (project No. DFG 436 SLK113/7/0-1) - principal investigators: H. Wöhl, A. Kučera, J. Rybák
- 2004-2006, Project CNR-SAV - Physical and dynamical aspects of the evolution of short-period comets - principal investigator: E. Pittich
- 2004-2006, Project CNR-SAV - Interplanetary bodies and atmospheric phenomena - principal investigator: V. Porubčan
- 2004-2006, Project CNR-SAV - Physical processes in active stars and search for their star and planetary companions - principal investigators: D. Chochol, T. Pribulla
- 2002-2006, Project EU HPRN-CT - European solar magnetism network - principal investigators: R. Rutten, A. Kučera
- 2006, OPTICON – Trans-national access programme project (6FP EU): Spectroscopy and imaging tomography of the solar fibrils: photospheric drivers and coronal consequences – Swedish Solar Telescope - principal investigator: J. Ryák
- 2006, OPTICON – Trans-national access programme project (6FP EU): Spectroscopy and imaging tomography of the solar fibrils: photospheric drivers and coronal consequences – Dutch Open Telescope - principal investigator: J. Ryák
- 2006, OPTICON – Trans-national access programme project (6FP EU): Spectroscopy of the quiet solar photosphere: properties of the shocks and location of the acoustic flux - principal investigator: A. Kučera

- 2005-2007, Project FP6-2002-Mobility-5 No. 011379-MULTIDOT - Marie Curie Host Fellowship programme - principal investigator: J. Koza
- 2006-2007, collaborative inter-government project (Slovakia - Czech republic - project No. 01506) The variability of chemically peculiar stars of the Main Sequence - principal investigator: J. Zverko
- 2004-2006, USA-SK NSF project 'Space weather: numerical MHD study of CMEs: inicialization and propagation' - principal investigator: J. Rybák
- 2005-2006, collaborative inter-government project (Greece - Slovakia) - International Greek-Slovak On-line Network of Selected Astronomical Observatories - principal investigator: L. Hric
- 2006-2007, collaborative inter-government project (France - Slovakia) ECO-NET No. 12651 NJ - Geometries over finite rings and the properties of mutually unbiased bases - principal investigator: M. Saniga
- 2006-2007, collaborative inter-government project (Austria - Slovakia) - Solar flares: trigerring mechanism and consequences for space weather - principal investigator: J. Rybák
- 2003-2006, collaborative inter-institute (Slovakia - Croatia) - Solar active phenomena - principal investigator: A. Kučera
- 2005-2007, collaborative inter-institute project (Slovakia - Poland) - Photometric investigation of contact binaries and short-period eclipsing binaries - principal investigator: T. Pribulla
- 2005-2008, collaborative inter-institute project (Slovakia - Bulgary) - Abundance anomalies in single and binary stars - principal investigator: M. Žižňovský

6.2 Grants of the Slovak Grant Agencies VEGA and APVT

- 2006-2009 - Complexes of small bodies of the Solar System - principal investigator: M. Hajduková
- 2006-2009 - Dynamics of small bodies in cosmic space, physico-chemical properties of the bodies - principal investigator: M. Kocifaj
- 2004-2006 - Dynamics and evolution of comets and asteroids from the point of their migration into regions of planetary orbits - principal investigator: E. Pittich
- 2004-2006 - Solar activity in the corona and prominences - principal investigator: V. Rušin
- 2004-2006 - The dynamical evolution and activity of the interplanetary bodies - principal investigator: J. Svoreň
- 2004-2006 - Zonal pecularities in the evolutionary processes on the Sun - principal investigator: J. Sýkora
- 2004-2006 - Study of the activity in the interacting binaries - principal investigator: A. Skopal
- 2004-2006 - The structure of the transmission regions of the cataclysmic and related binaries - principal investigator: L. Hric
- 2006-2008 - Multispectral analysis and modeling of development of active and quiet solar atmosphere atmosphere - principal investigator: A. Kučera

- 2006-2008 - Investigation of properties of chemically peculiar (CP) stars - principal investigator: J. Zverko
- 2005-2007 - Emission corona and prominences: indicators of solar activity and space weather - principal investigator: V. Rušin
- 2006-2010 - Olympiad for astronomy for scholars - principal investigator: L. Hric

6.3 Institute projects

- Structure of meteor streams - principal investigator: V. Porubčan
- Cosmic dust - principal investigator: I. Kapišinský
- Dynamics of comets and asteroids and investigation of cometary dust - principal investigator: E. Pittich
- The astrometry of asteroids and the mutual interaction of interplanetary matter - principal investigator: L. Neslušan
- Photometry of comets and asteroids and cometary astrometry - principal investigator: J. Svoreň
- Study of variable phenomena of early spectral type stars and automatization of their observations - principal investigator: J. Žižňovský
- Chemically peculiar stars - principal investigator: J. Zverko
- Close binaries - principal investigator: D. Chochol
- Cataclismic variable stars - principal investigator: L. Hric
- Symbiotic stars - principal investigator: A. Skopal
- Solar eclipses - principal investigator: V. Rušin
- Solar protuberances and automatization of solar observations - principal investigator: M. Minarovjech
- Dynamics of solar photosphere and chromosphere - principal investigator: A. Kučera
- Solar cycle and Solar-terrestrial relations - principal investigator: J. Sýkora
- Outer layers of the solar atmosphere - principal investigator: J. Rybák

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11. BADALYAN, O.G. - OBRIDKO, V.N. - SÝKORA, Július: Cikliceskie variacii differencialnogo vrascenia solnecnoj korony In: Astronomiceskij zurnal, vol. 83, 2006, p. 352-367. Also as: BADALYAN, O.G.- OBRIDKO, V.N. - SÝKORA, Július: Cyclic variations in the differential rotation of the solar corona In: Astronomy Reports, vol. 50, 2006, p. 312-324.

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