CHALLENGES IN MODERN ASTROPHYSICS
OPTICON Awareness Conference
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Research projects and scientific highlights in Bulgaria

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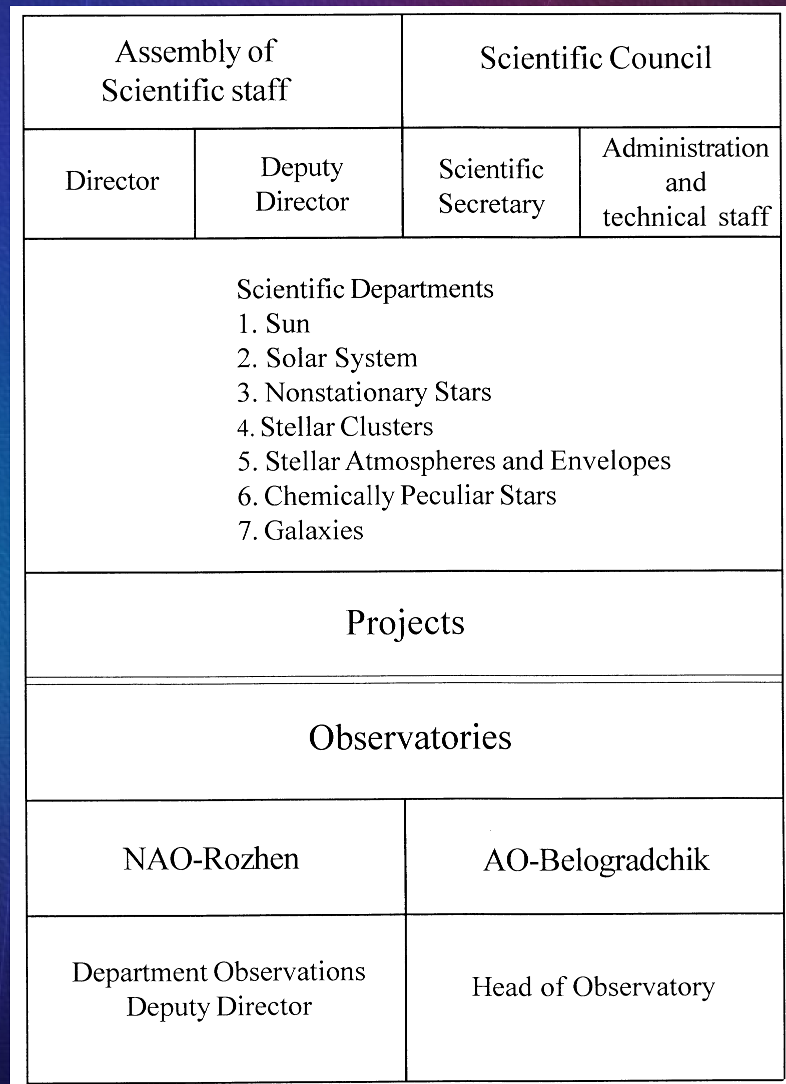
Astronomical organization in Bulgaria

- Institute of Astronomy and National Astronomical Observatory - Rozhen, Astronomical Observatory – Belogradchik, Bulgarian Academy of Sciences
- Department of Astronomy, Sofia University “St. Kliment Ohridski”
- Astronomical Center at Shumen University “Episkop Konstantin Preslavski”
- People's astronomical observatories and planetariums: Varna, Smolyan, Yambol, Dimitrovgrad, Stara Zagora, Gabrovo, Kardzali, Haskovo, Sliven and Silistra.

A short history of astronomy in the Bulgarian Academy of Sciences

- 1952 - A Department of Astronomy (DA) at the Physical Institute of BAS was created.
- 1957 - The first satellite tracking station in Bulgaria was created in DA.
- 1967 - The Bulgarian government took a decision for the construction of National Astronomical Observatory (NAO).
- 1970 - A contract for the supply of a 2-meter universal reflector in the optical system Ritchey-Chrétien-Coudé was concluded with VEB Carl Zeiss, Jena.
- 1976 - The Astronomical Observatory Belogradchik became an observational base of DA BAS.
- 1980 - The regular observations with the 2 m telescope of NAO - Rozhen started.
- 1981 - Official opening of NAO - Rozhen.
- 1995 - The Institute of Astronomy (IA) was created as a

Organization chart of IA

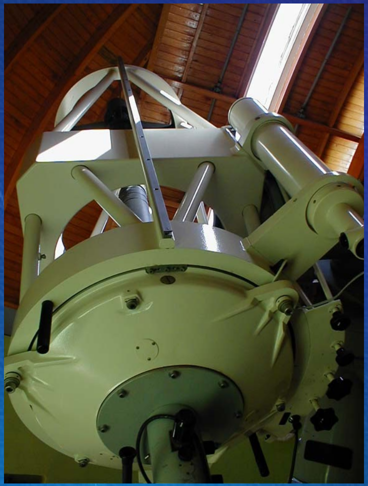


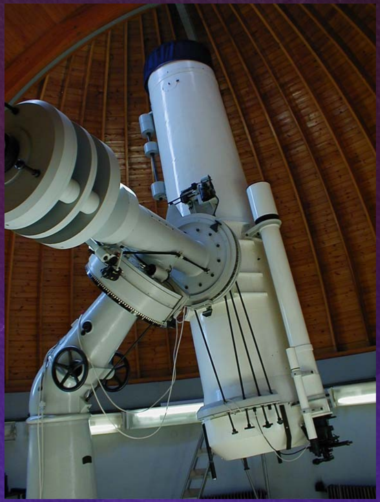
National Astronomical Observatory Rozhen

The NAO - Rozhen is an astronomical complex with four optical telescopes situated in the Rhodope Mountains at altitude of 1750 m with coordinates: longitude $1^{h}\ 38^{m}\ 58^{s}$ and latitude $41^{o}\ 41'\ 48''$.

The 2-m telescope of Rozhen observatory is equipped with a Coudé-spectrograph, two modern CCD cameras - VersArray and Photometrics, a two-channel focal reducer, broad band and interference set of filters.

NAO Rozhen





The 60 cm and the 50/70 cm Schmidt telescopes of NAO

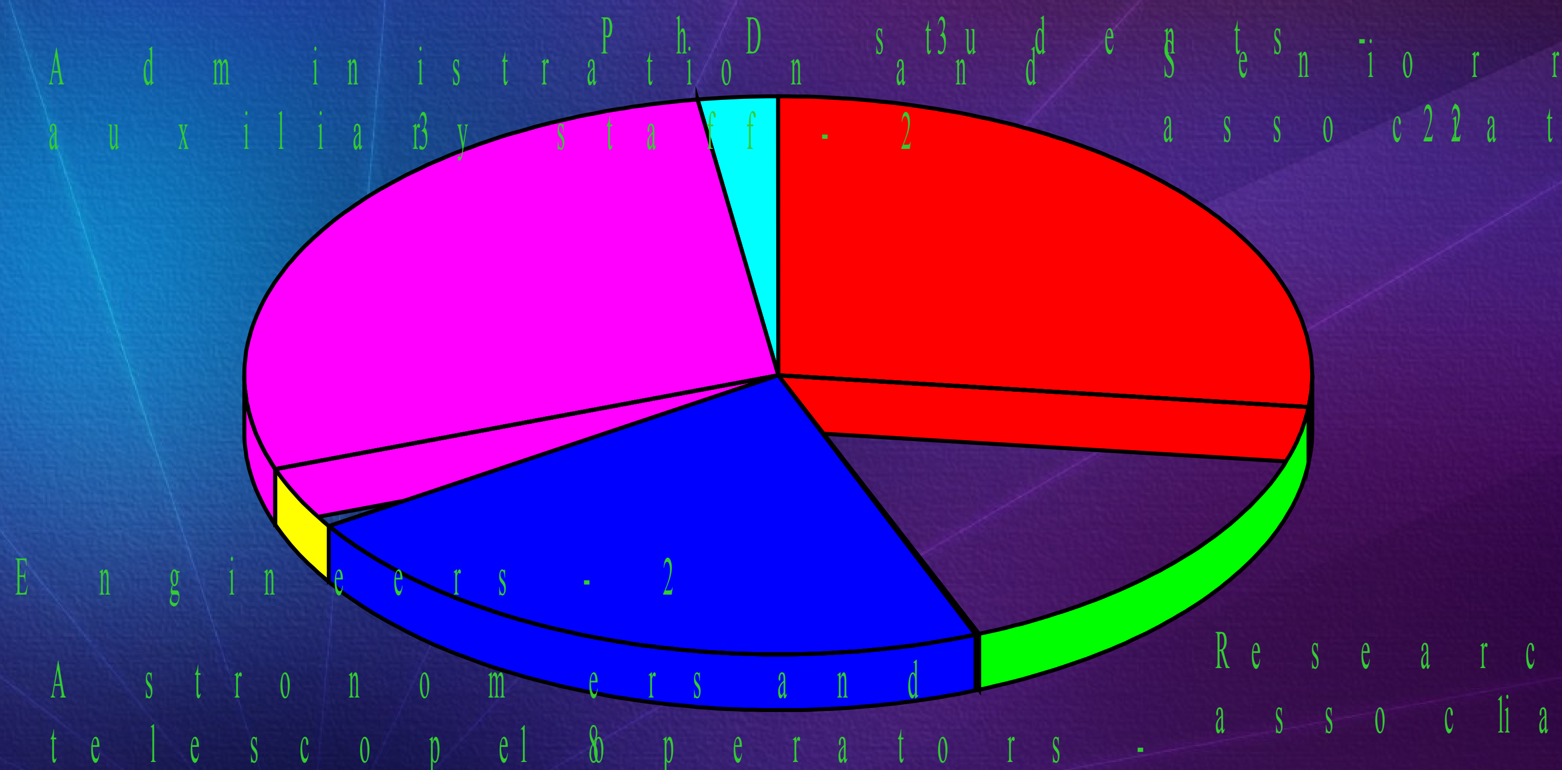
The Solar dome built in 1994 and the 15 cm Lyot-coronagraph, constructed in IA.

Astronomical Observatory Belogradchik

The construction of the Astronomical Observatory Belogradchik (AOB) began in 1961. AOB was built near the Belogradchik citadel at 610 m altitude and coordinates: longitude 1h 30m 41s, latitude 43° 37′ 22″. In 1965 a 60 cm Cassegrain telescope for professional research in astrophysics was ordered in Carl Zeiss Jena. Two main modes of astronomical observations are carried out at observatory: electrophotometric observations with a single

Researchers and other collaborators in IA

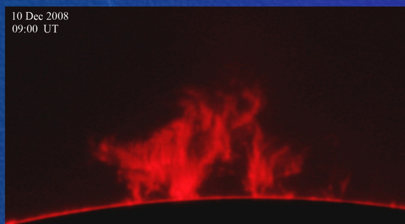
The staff of IA is 79 persons, including scientific, technical, auxiliary and administration staff, and 3 PhD students.

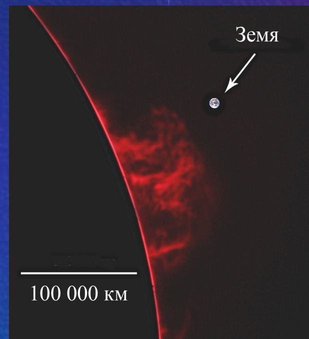


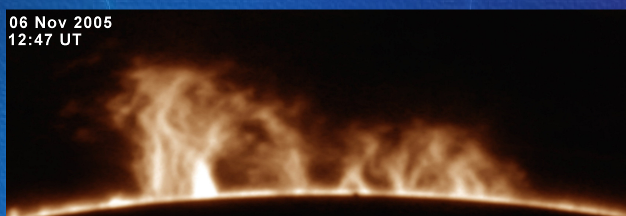
International relations, projects and publications of IA

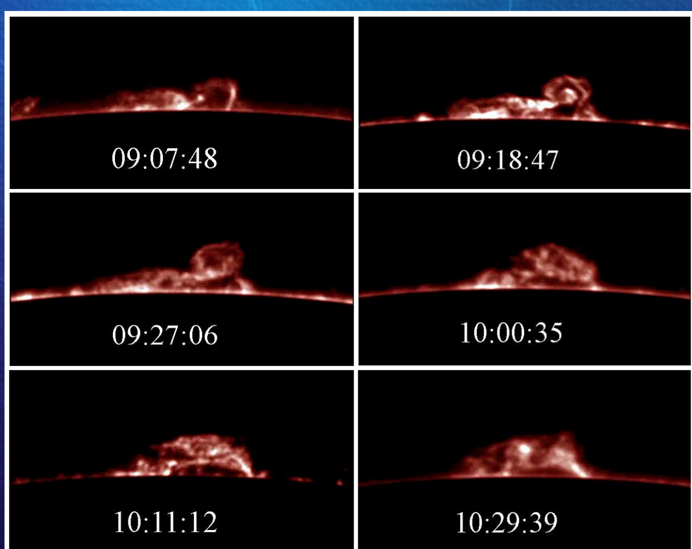
- IA has scientific relations and cooperation on scientific projects with many astronomical institutes and observatories from European countries like: Germany, France, Poland, Romania, Ukraine, Russia, Slovakia, Austria, Finland, Czech Republic, Greece, Hungary, Great Britain, Belgium, Macedonia, and with USA, India and Canada.
- 60 scientific projects were developed in the IA, in the period 2004-2008. These include 18 projects of the institute, 6 projects with the National Scientific Foundation, 3 projects sponsored by UNESCO-BRESCE , 1 project sponsored by NATO and 32 bilateral inter academies projects.
- The publishing of a scientific journal of IA was restored in 2007. Five new volumes of Bulgarian Astronomical Journal have been already published.

Sun







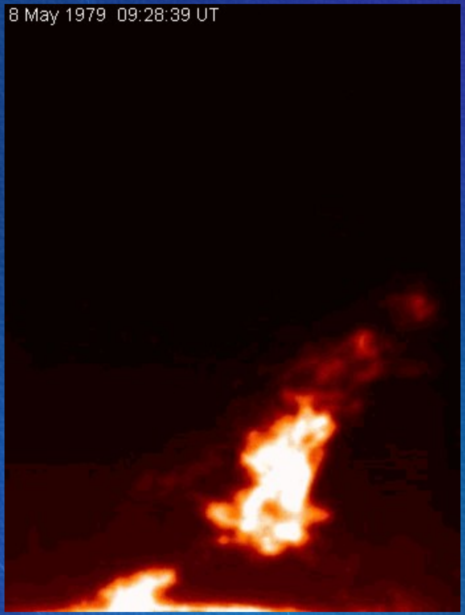


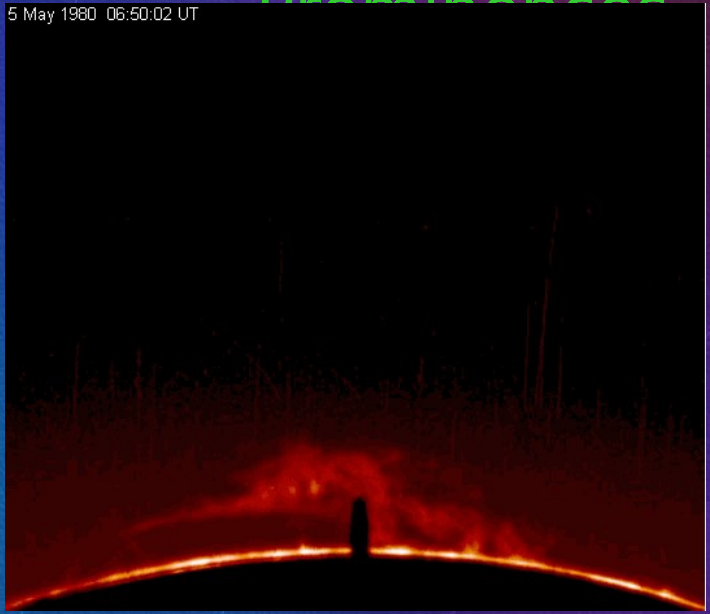
The solar activity (sunspots, promi-nences, flares, etc.) is a basic topic of solar researches in IA. The quiescent and eruptive prominences are a natu-ral laboratory for the physics of non-totally ionized plasma and its intera-ction with magnetic fields. The studies of the structure and dynamics of the quiescent prominences allowed the determination of oscillations in some of them, as well as the possible mecha-nisms leading to such reorganizations of the prominence configuration occurred in the result of magnetic field

The prominence activation observed on 25 Nov. 2005. A destabilization.

Sun

Structure and Dynamics of Eruptive Prominences



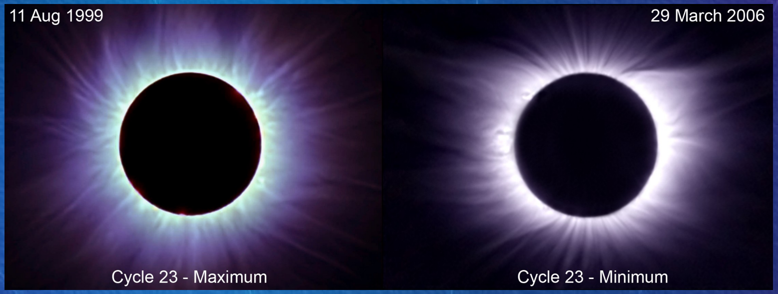


Eruptive prominen-ces on 22 Aug. 2006 observed with the 15-cm coronagraph in Solar tower at NAO - Rozhen

The dynamic patterns, horizontal expansions, and evolution of two eruptive prominences (EPs), closely associated with coronal mass ejections, were determined. The EPs were observed on 8 May 1979 (left) and 5 May 1980 (right) in Astr. Ins. of

Sun

Observations of the Solar Corona during Total Solar Eclipses



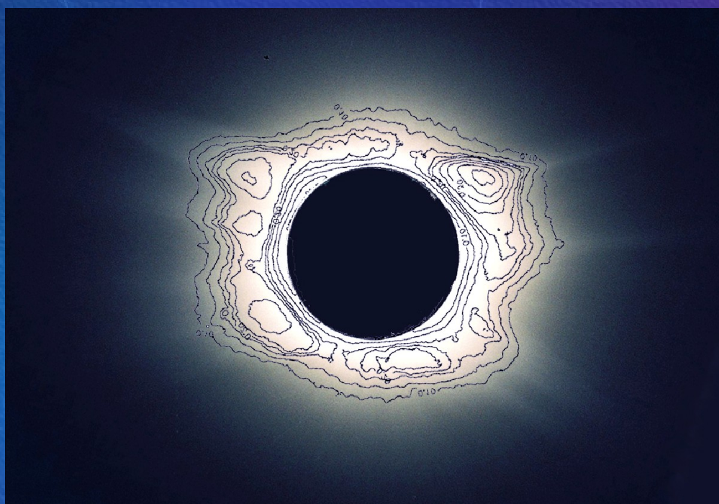
The basic structural elements and the distributions of the polarized solar white-light corona were obtained in two basic epoch of the 11-year solar

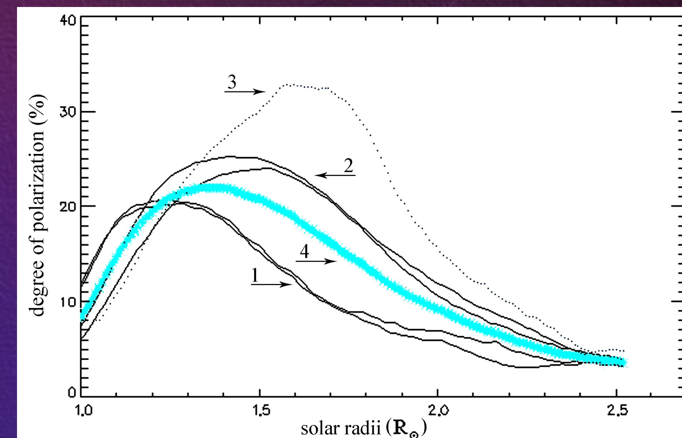
Two campaigns for observa-tions of the TSEs on 11 August 1999 and 29 March 2006 were carried out. Basic tasks:

- Registration and investiga-tion of the solar corona polari-zation at a distance up to 5 solar radii
- Registration and investiga-tion of the white-light corona and prominences
- Registration and

Sun

Total Solar Eclipse on 29 March 2006





Isophote map of the polarized corona superimposed on its white-light image

(1) degree of the polarization in the polar areas

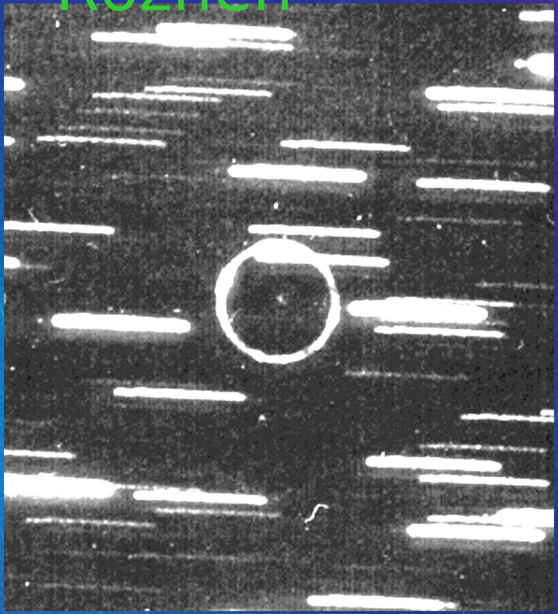
(2) equatorial plane of the polarization

(3) polarization in the coronal streamers

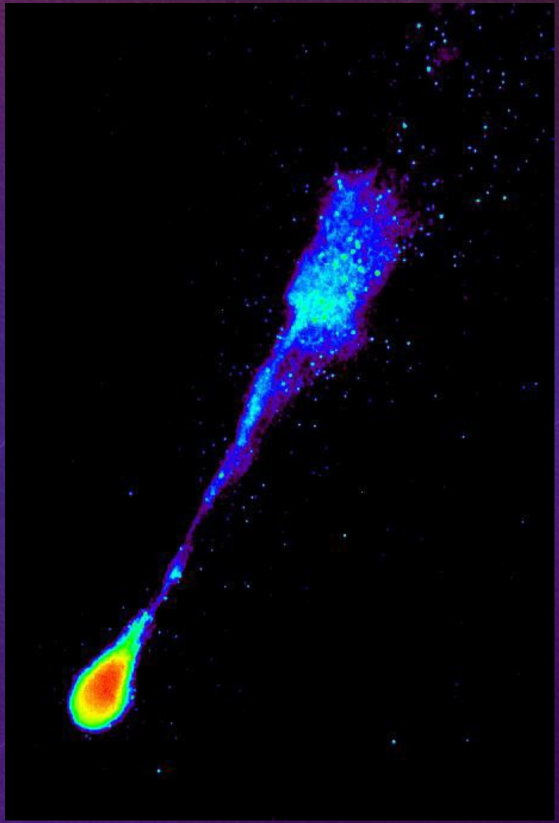
(4) total distribution of the

Solar System

Pictures of Haley comet obtained in NAO – Rozhen



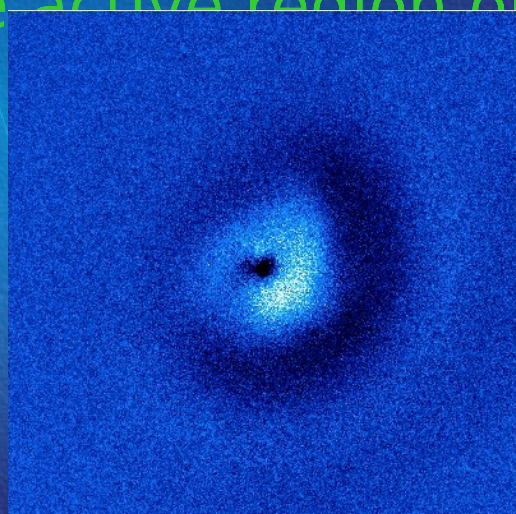
2m RCC telescope, 25 November 1984



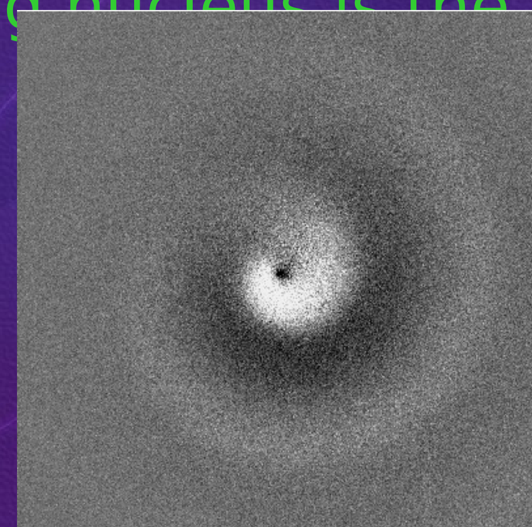
January 1986, Schmidt telescope, Illustration of the strong interaction between the comet plasma and the interplanetary magnetic field

Solar System

Results from the narrow-band CN observations of comet 8P/Tuttle (January 2008). The mean-image subtraction method revealed low-contrast CN envelopes. A toy Monte Carlo model was implemented to reproduce the time-series of the CN images. The emission of HCN into a relatively wide cone by a single active region on a rotating nucleus is the most proba



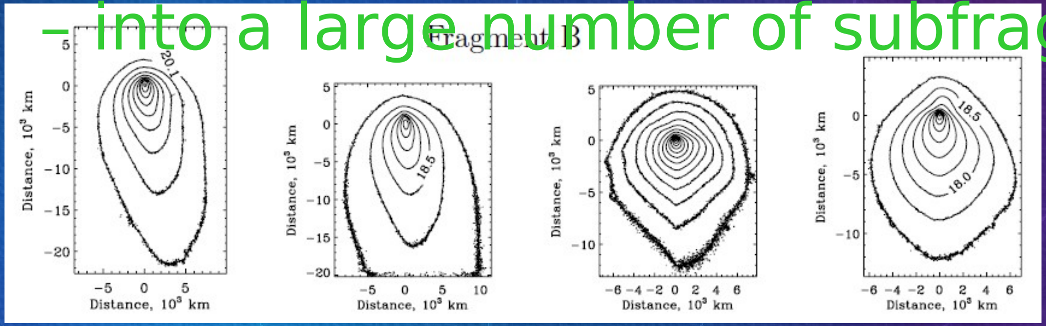
Series of the CN images for January 9 obtained after subtraction of the



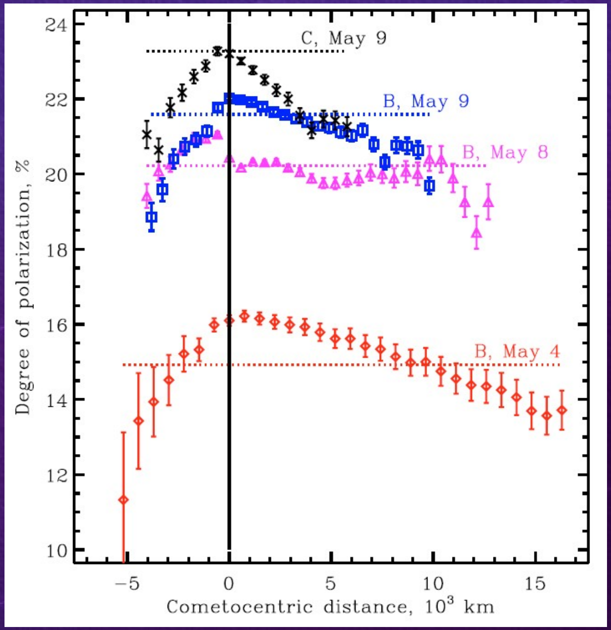
Model differential images of the CN coma for January 9.

Solar System

The Jupiter family comet 73P/Schwassmann-Wachmann 3 (SW3) split into several pieces in 1995. The last return of the comet in 2005−2006 was accompanied by tremendous further splitting of some SW3 components – in particular component B – into a large number of subfragments.

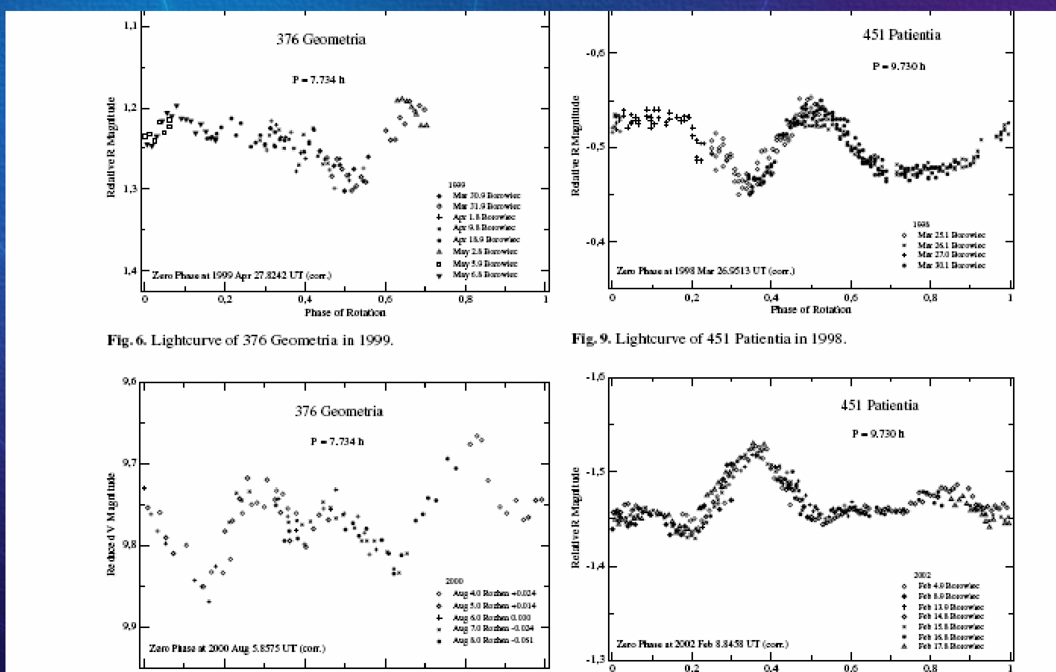


Fragment B was found in outburst on May 8. The brightness outburst was accompanied by changes in the shape of the coma. During the outburst, the spatial distribution of the linear polarization showed some



Photometric observations of asteroids

Studies of the rotational parameters of small bodies



Light curves taken in much opposition en-able to model and determine the position of the rotation axis in the space and sense of rotation. The know-ledge of these para-meters contributes to the understanding the evolution and structu-re of the asteroid belt.

Shape and model of 376 Geometria

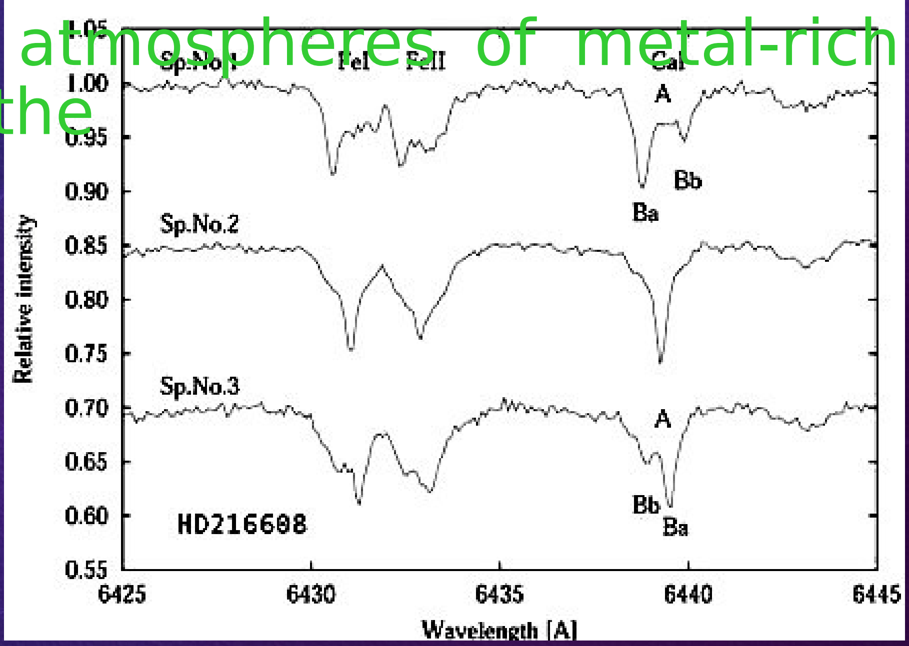
Chemically Peculiar Stars

Chemically peculiar stars of spectral types from B to F have unique role for understanding the longest stages of stellar evolution. Moreover, they proffer extraordinary possibilities to extend our knowledge about many important physical processes and phenomena such as radiation and particle transport in stellar interiors, stellar magnetism, stellar rotation, and tidal interactions.

Finding more than forty new chemically peculiar stars in open stellar clusters in our Galaxy, and ascertaining the fact that such kind of stars exists in Large Magellanic Cloud as well.

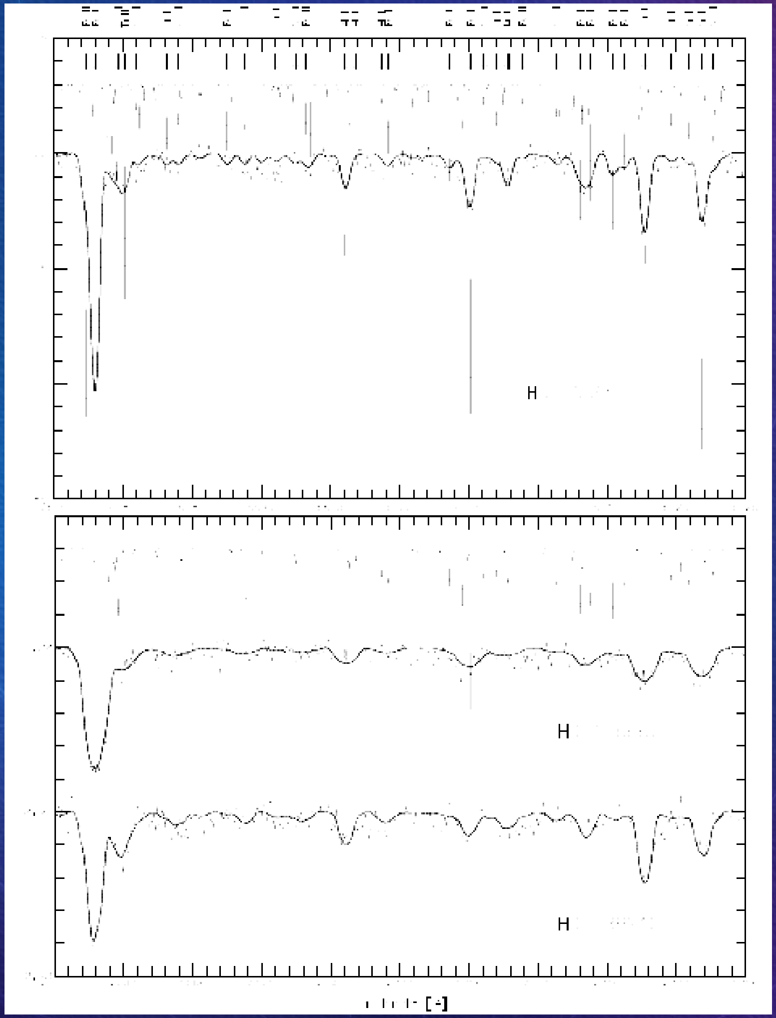
Chemically Peculiar Stars

Metallic-line stars (Am-stars) are the most numerous sub-group of chemically peculiar stars. In the atmospheres of stars in binary systems we observe tides similar to those we have in the oceans. As a result of spectroscopic observations carried out at NAO - Rozhen, for the first time we reached the conclusion that stars with higher tides in the atmospheres exhibit smaller excess of heavy elements. The chemical composition of the stellar atmospheres of metal-rich stars was derived by using the spectral synthesis method . Half a dozen new spectroscopic binary stars wit metal-enriched atmospheres have been discovered.



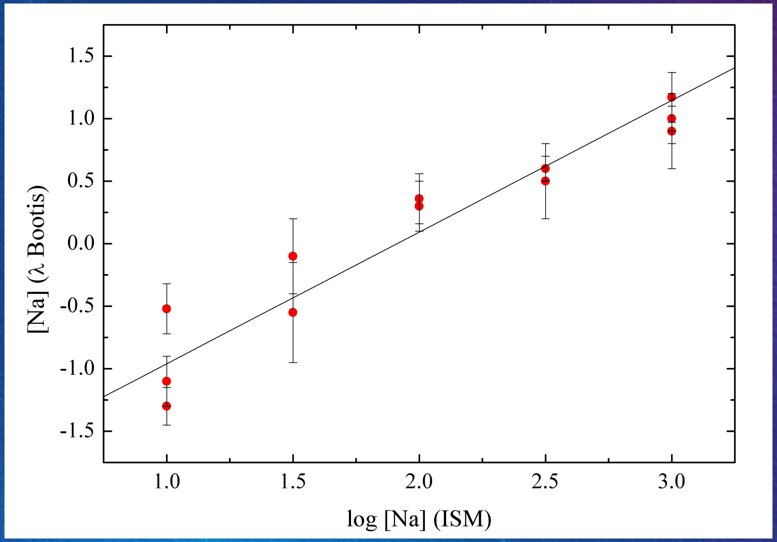
Spectra of HD216508, newly found triple star

Chemically Peculiar Stars

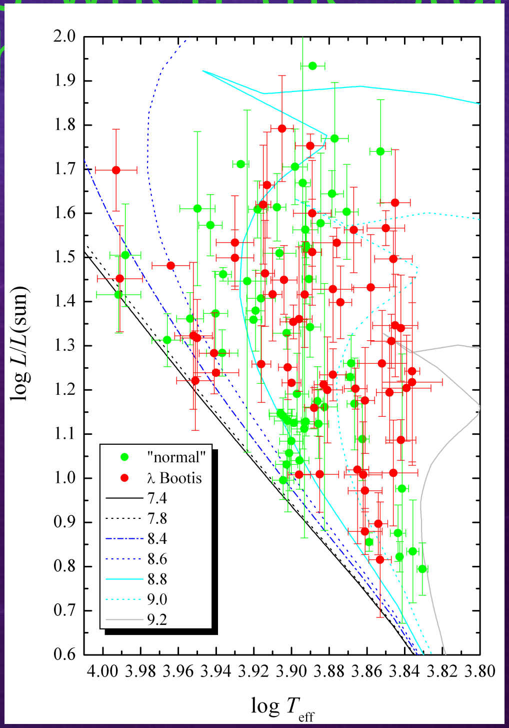


Establishing the connection between abundance anomalies found in the atmospheres of double stars components and orbital elements of the binary systems – the systems with larger eccentricities and longer periods exhibit more pronounced abundance anomalies

Chemically Peculiar Stars

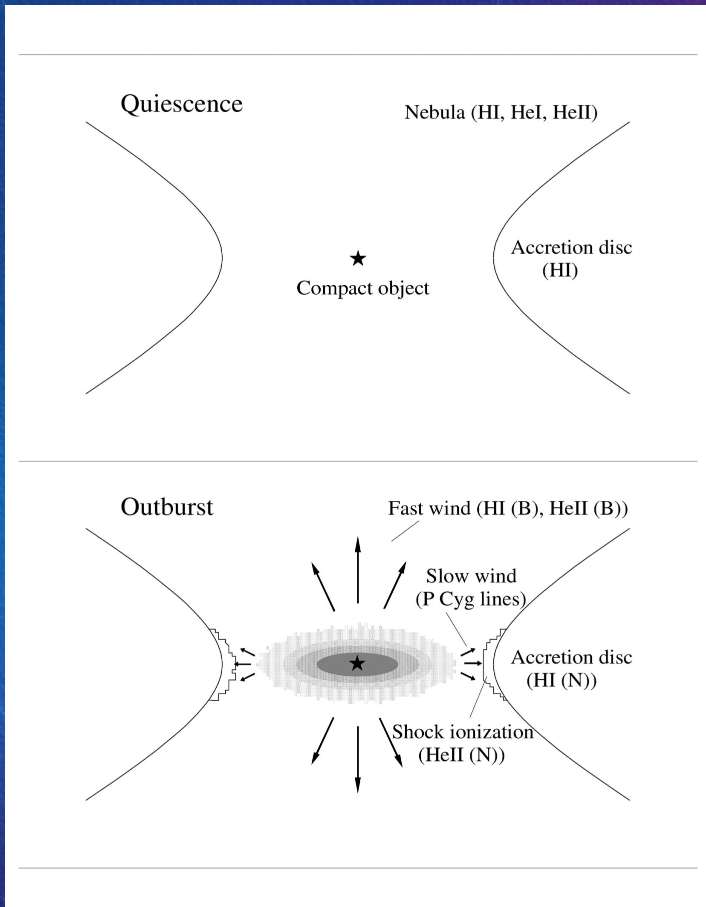


Metal-weak atmospheres of other type of stars named Lambda Bootis are thought to be resulting in an interaction between stars and interstellar clouds of dust and gas when the stars fly through th



Orbital parameters of two new spectroscopic binaries of type Lambda Bootis have been determined for the first time. Our data strongly support the idea that those stars belong to the young Galactic disk population and their basic astrophysical characteristics are not very much different from those of ”normal”

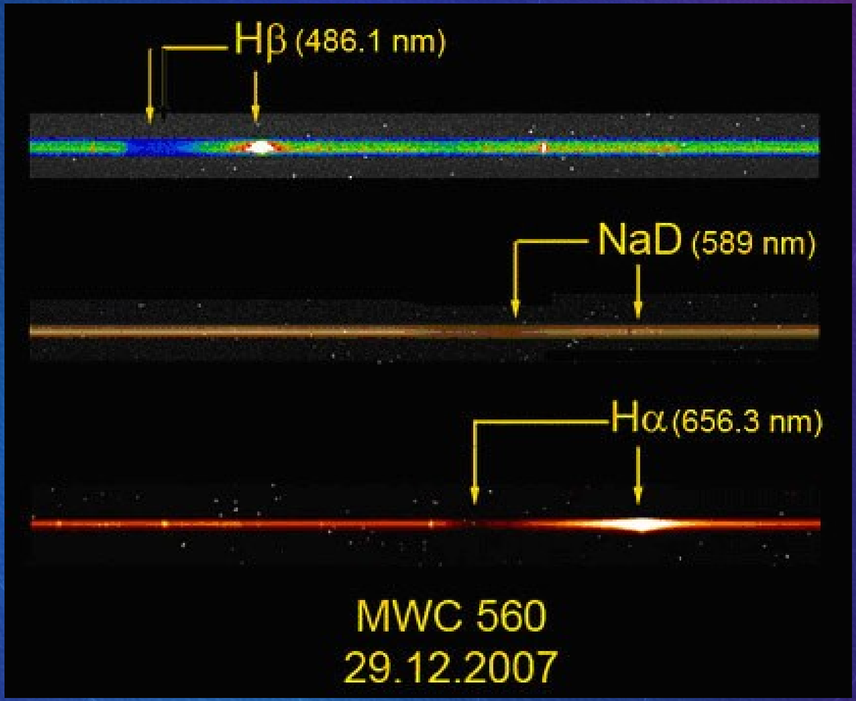
Stellar atmospheres and envelopes



Model of the hot component in the symbiotic binary Z And

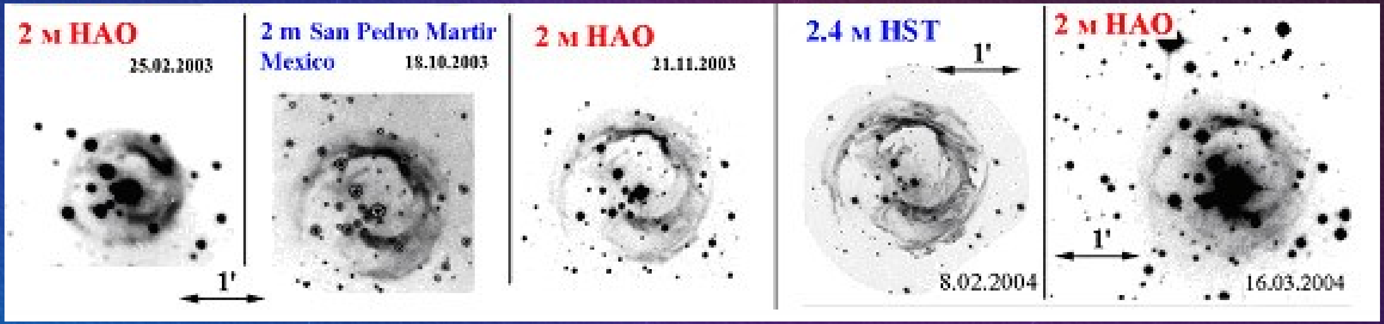
The symbiotic stars are interacting double systems, consisting of a red cool giant and a compact object (white dwarf), which accretes mass from the stellar wind of the giant and undergoes episodic outbursts. An ejection of an optically thick shell exceeding by a factor of 40 the size of the compact object, as well as two velocity mass outflow regimes, including outflow with a high velocity of 500 km/s and another one with

Stellar atmospheres and envelopes



In 1990 an ejection with an enormous velocity of up to 7000 km/s from the symbiotic star MWC 560 was observed in NAO-Rozhen. Nowadays, almost two decades after the observation of that impressive phenomenon, the mass outflow with a high velocity of up to 2000 km/s from the accretion disk, surrounding the white dwarf in this binary system, continues.

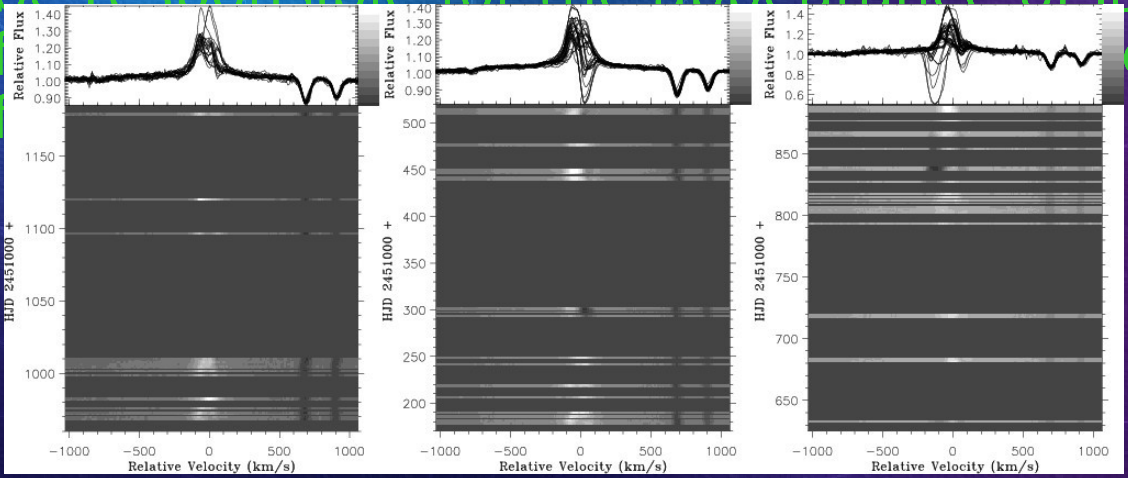
Stellar atmospheres and envelopes



As a result of the unique outburst of the object V838 Mon an expanding light echo appeared, which was observed for several years. The light echo is a very luminous source in the space and an exceptionally rare natural phenomenon. The distance, from its side, provides a possibility to obtain the luminosity, which is of fundamental importance to understand the nature of the phenomenon. The data show that very probably the distance to V838 Mon is 10 kpc. In this case it should be the most luminous source in our Galaxy, observed up to the present time,

Stellar atmospheres and envelopes

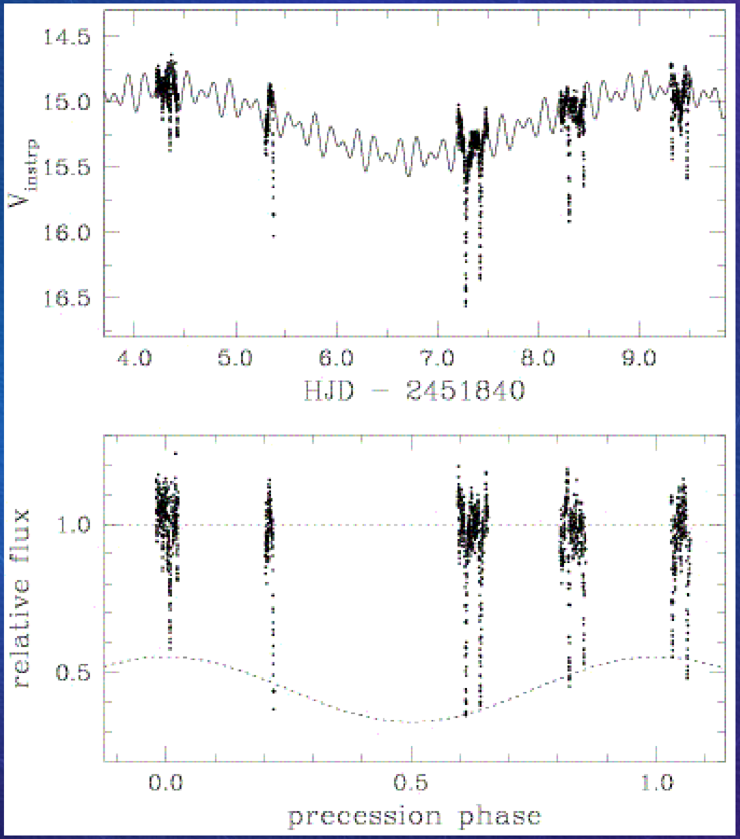
The key limiting assumptions incorporated within current OB stars model atmospheres include a globally stationary and spherically symmetric stellar wind with a smooth density stratification. Recent observational results indicate that hot stars winds are certainly not smooth and stationary. In particular, long-term monitoring campaign of OB stars performed at NAO Rozhen revealed the presence of large-scale wind structures, such as high density spirals, disks etc. Evidence of small-scale structures (clumps/blobs) are also found. Stellar pulsations and magnetic fields might equally be responsible for the appearance of large-scale wind f es might lead to the f



Spectral observations of HD199478 obtained in 1998 (left), 1999 (middle) and 2000 (right) around Hα. One (up) and two dimension (down)

Nonstationary stars

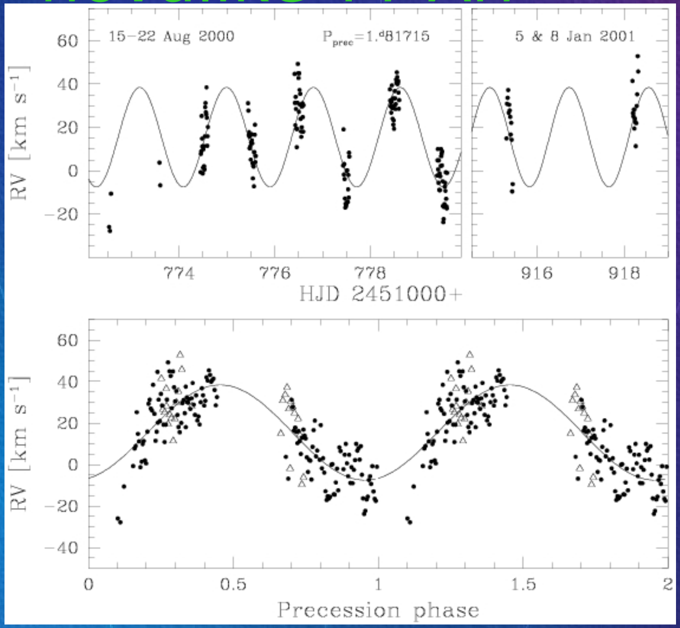
Photometric and spectral observations of cataclysmic variables



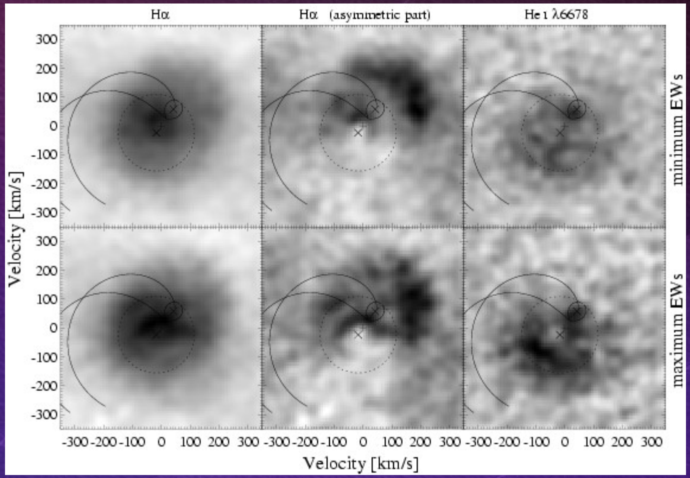
PX And light curves showing the modulation of the out-of-eclipse magnitude and eclipse depths with the detected periods. The periodogram analysis of the light reveals the presence of “negative superhumps” and the correspon-ding retrograde precession period of the accretion disk. The analysis suggests that the eclipse depth is modulated with the precession period.

Nonstationary stars

Spectral and photometric observations of the novalike TT Ari

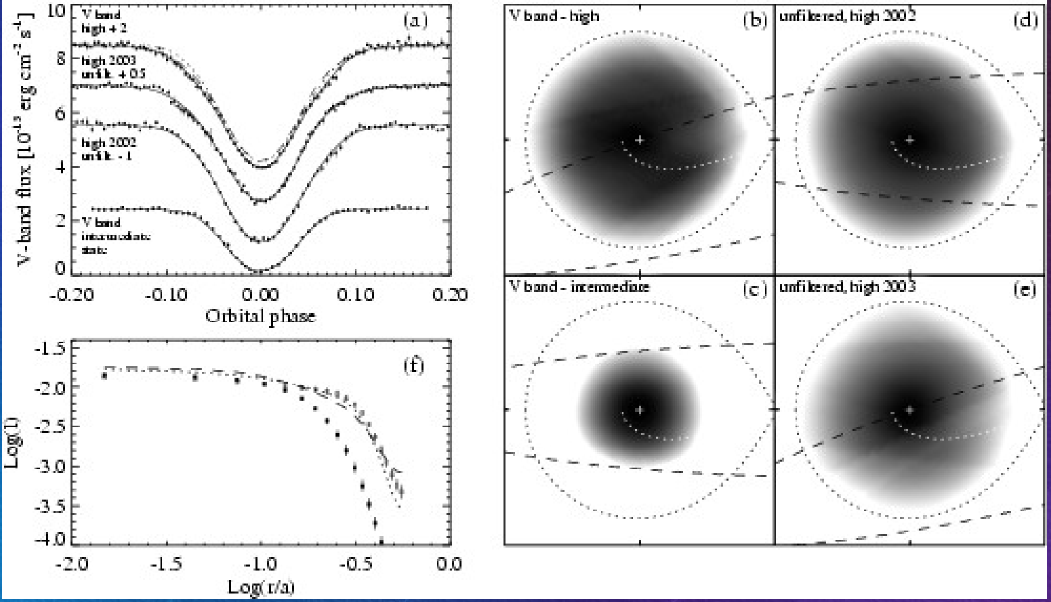


Upper panel: the *RV* s corresponding to the wavelengths separating Hα in two parts of equal flux. The best fit with the expected precession period of 1.^{d}81715 is also shown. *Lower panel*: the same data



Doppler Tomography of the emission lines Hα and He I 6678 in the spectra of TT Ari in the times of minimums or maximums of the period superhumps. The asymme-tric structure of the disk is

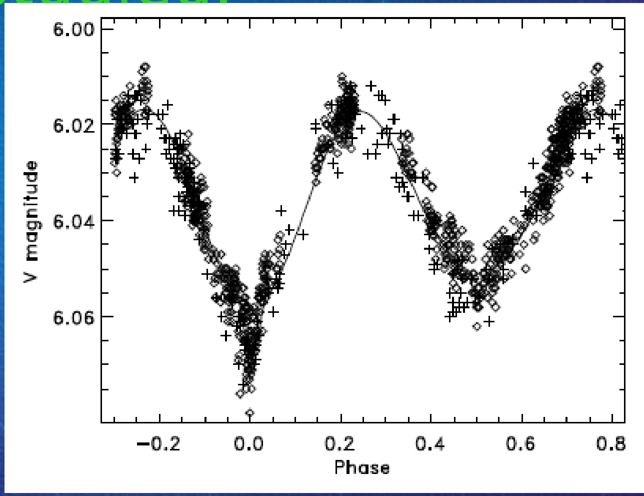
Nonstationary stars

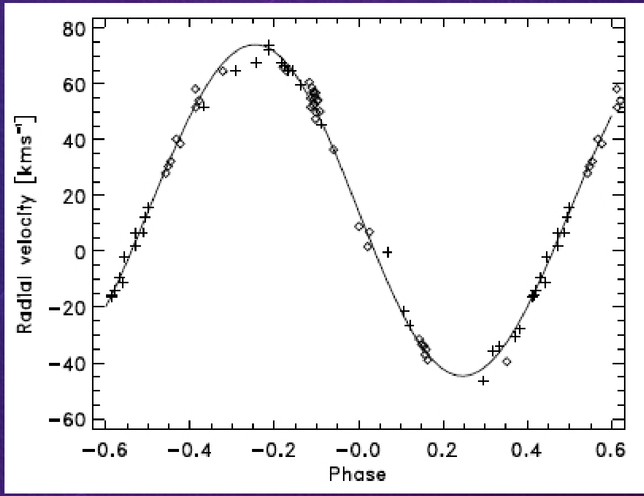


The CCD photometric observations of the eclipsing novalike cataclysmic variable DW UMa reveal that the star presents eclipses with very different depth: ~3.2 mag in intermediate state and ~1.2 mag in the high state. Eclipse mapping reveals that this difference is almost entirely due to the appreciable changes in the accretion disc radius in the different states. The phenomenon is observed for the first

Nonstationary stars

Active processes in stars of late spectral class. Modulation of brightness in presence of spots is being studied, rotation periods and parameters of spots are determined, models of light curves are built and long term cycles of activity are being studied.

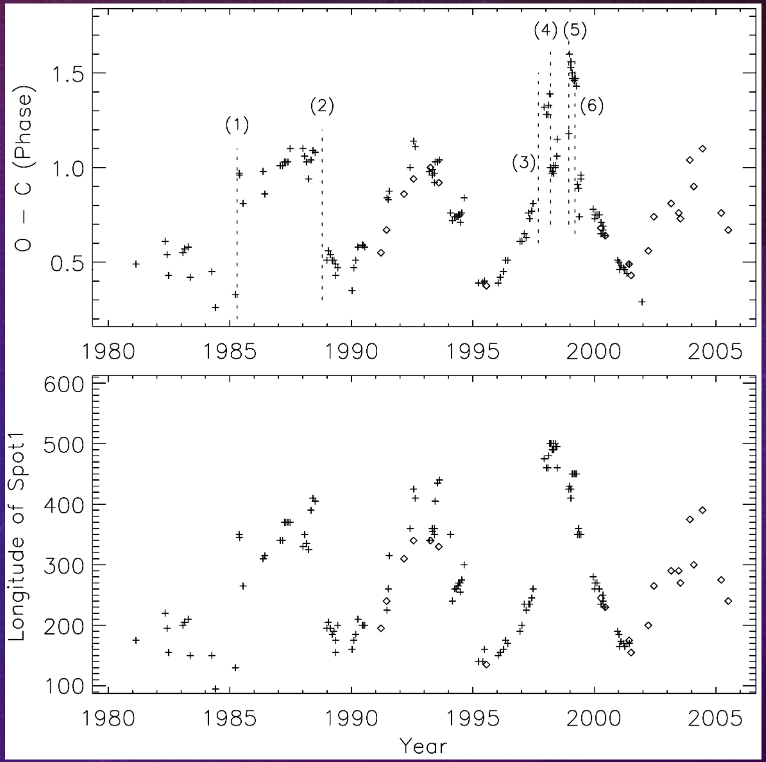




light- curve and radial velocities curve of 33 Tau

Nonstationary stars

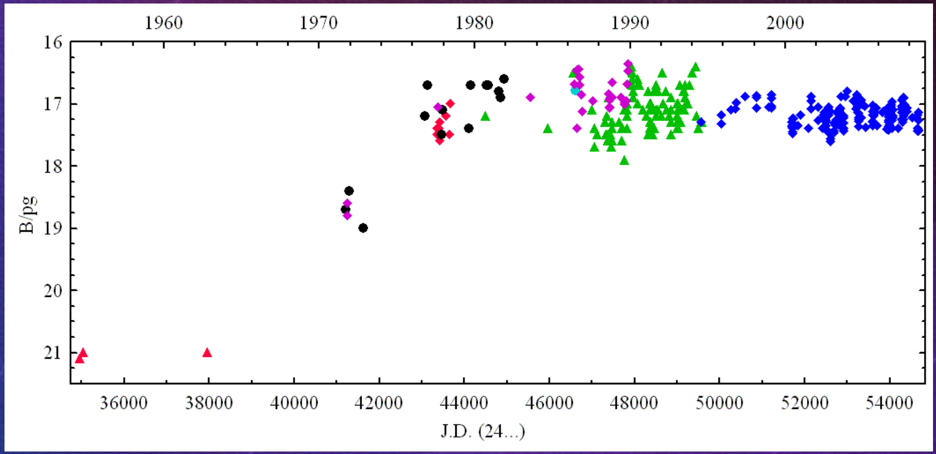
Photometric study of the active giant FK Com disproved the presence of flip-flop events (alternative switch over of stellar activity between two opposite longitudes on the star). An oscillating process with 5.8 years period has been found overlaid with sudden phase jumps. The main process of oscillation – cycle of activity – is due to migration of the main stable spot around the pole



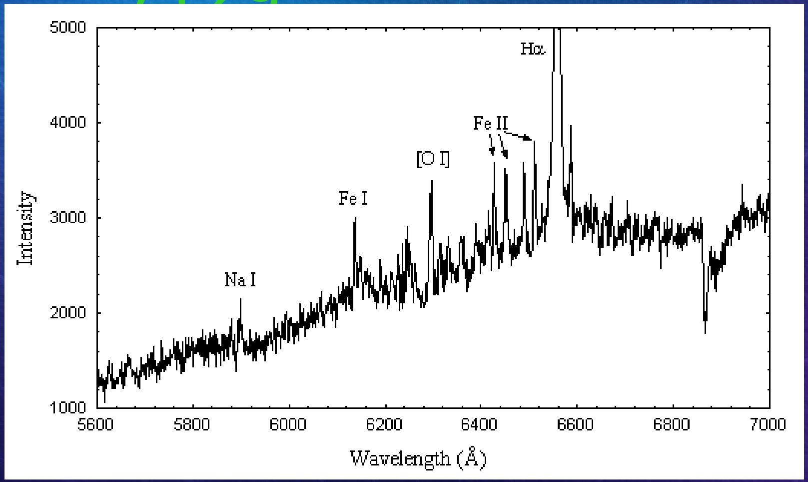
Nonstationary stars

The T Tauri star V 350 Cep

The field of NGC 7129



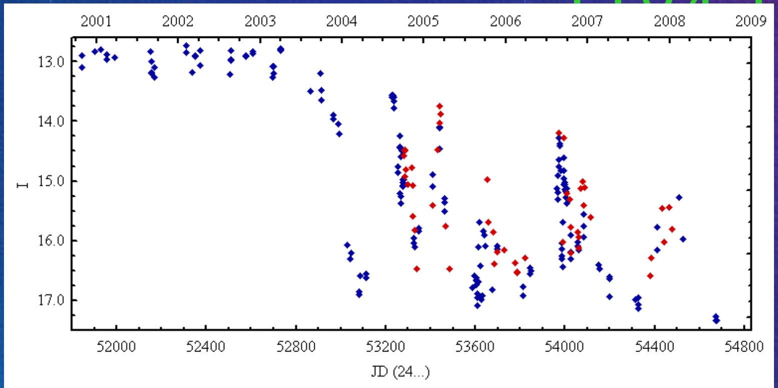
The long time light curve of V 350 Cep

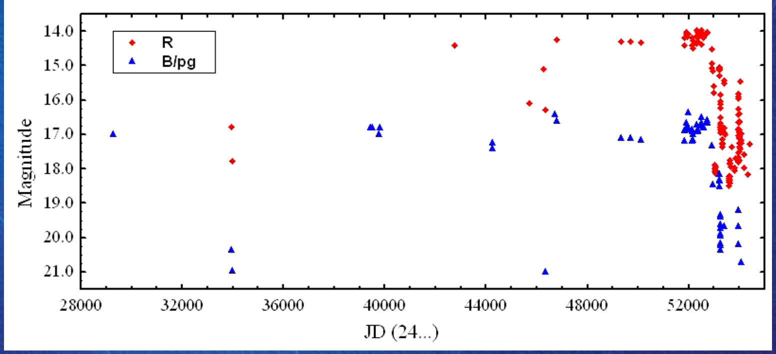


Spectrum of V 350 Cep obtained with the 2-m RCC telescope and the focal reduser FORERO1

Nonstationary stars

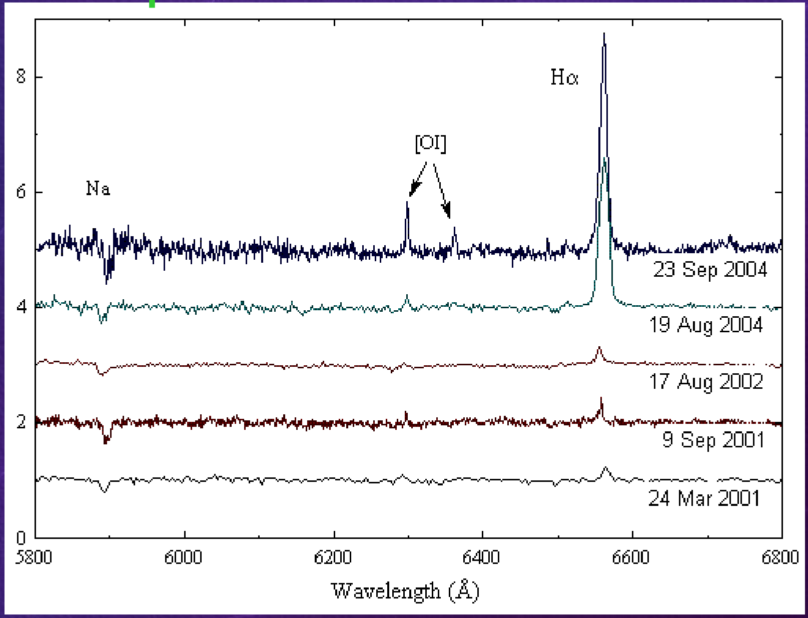
The UX Ori type star V 1184 Tau





The long time light curve of V 1184 Tau

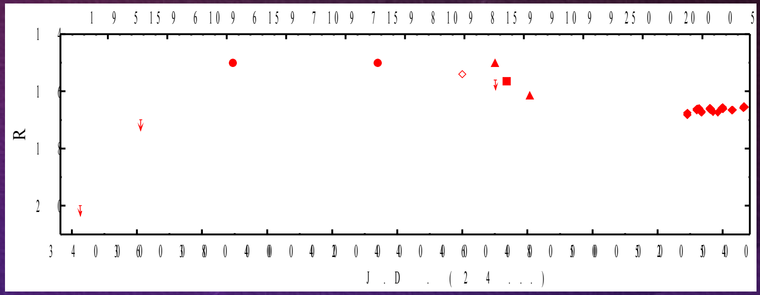
A series of spectra of V 1184 Tau obtained in maximum and in the deep minimum.

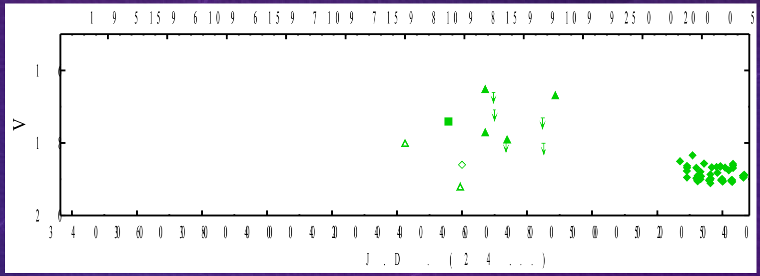


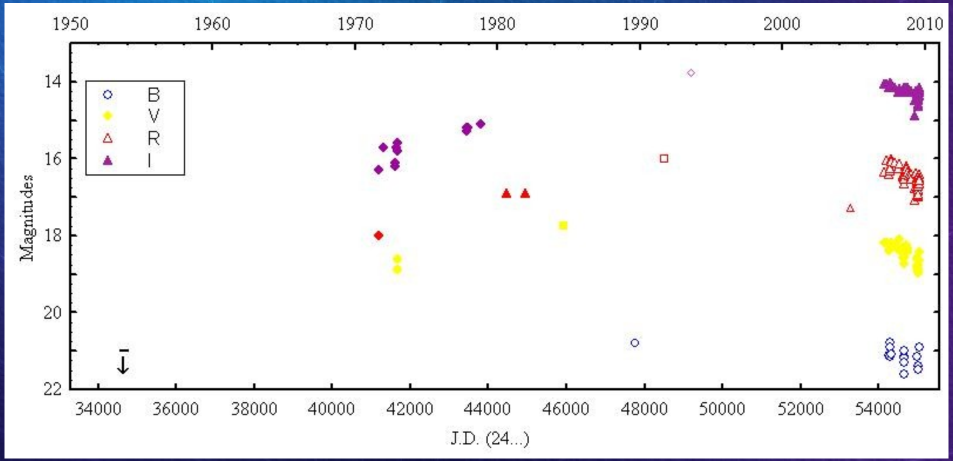
Nonstationary stars

FU Ori type stars

R and V light curves of V 1735 Cyg in the period 1952 -- 2009



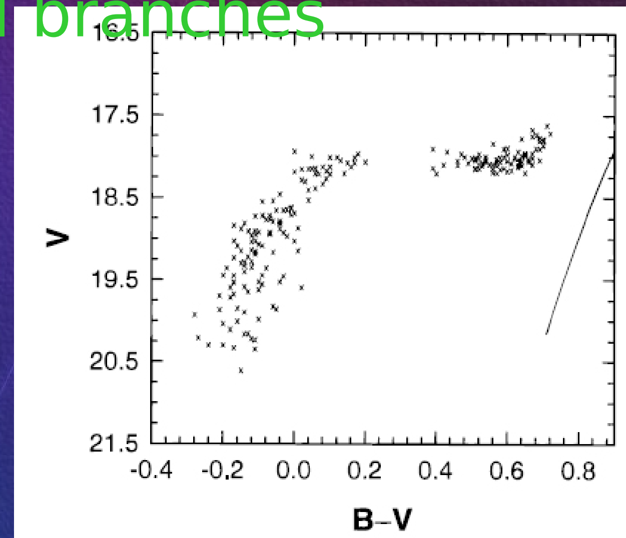


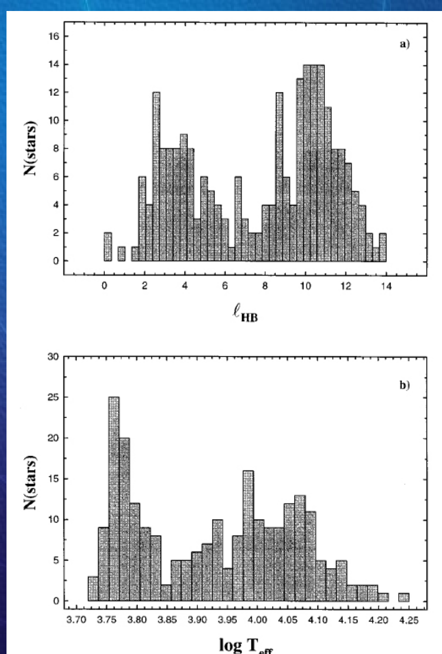


BVRI light curves of V 733 Cep in the period 1950 -- 2009

Stellar clusters

Bimodality and gaps GAPS on globular cluster NGC 6229 horizontal branches





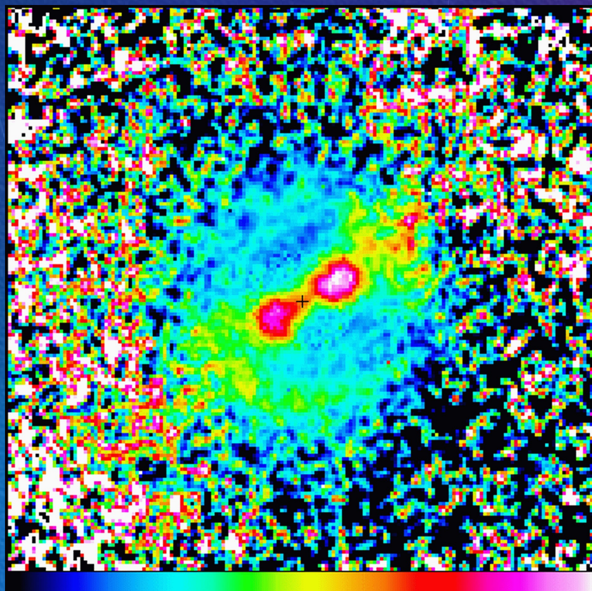
The outer halo globular cluster NGC 6229 has a peculiar horizontal-branch (HB) morphology, with clear indications of a bimodal HB and a gap on the blue HB. HB bimodality may be caused by a unimodal distribution in mass, provided the mass dispersion on the HB is

Galaxies

Basic fields of interest are Physical processes and chemical abundance in galaxies, systems of galaxies and the Universe. Photometry and Surface photometry of normal and active galaxies and galaxies in voids are carried out. Disk profiles and star formation in galaxies, irregular galaxies, and the movement of ionized gas are

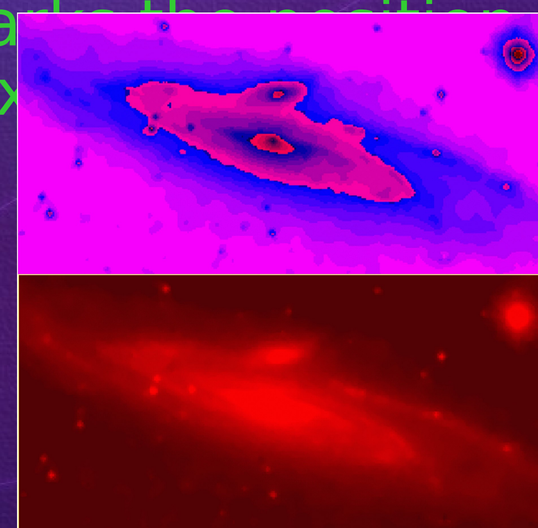
A panorama of the giant spiral galaxy NGC 891, visible edge-on. The gas-dust flat component of the galaxy is visible as a dark band. The bluish spots in this band are unresolved associations of young hot stars, giving evidences of undergoing high-rate global star

Galaxies



A V-I colour index image of the Sy2 galaxy Mrk 573, observed with the 2-m telescope of NAO. There could be seen the ionization cones (coded white-red) and the extended [OIII] emission (coded yellow-green); the cross ma… of the galax…

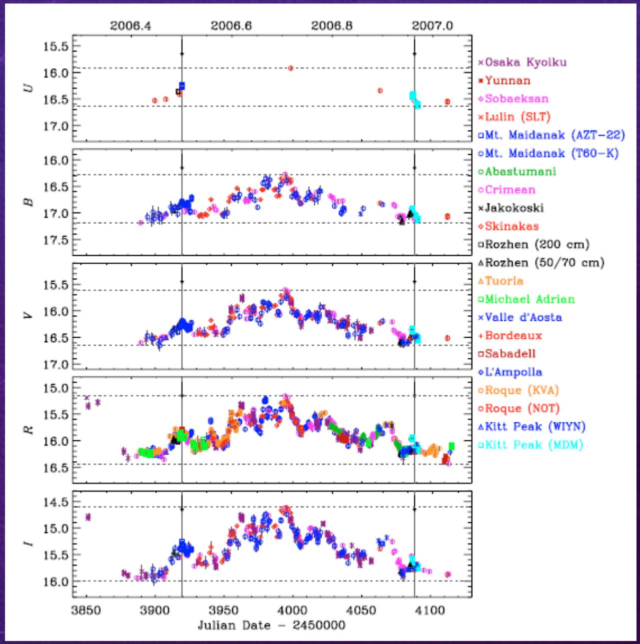
A CCD frame in R-band of Mrk 1040 – a Sy1 galaxy with a satellite from the 2-m RCC telescope. The pseudo-colours are specially chosen to stress on the faint filaments and bridges in the disk of the galaxy. The top picture shows the isophotes of



Galaxies

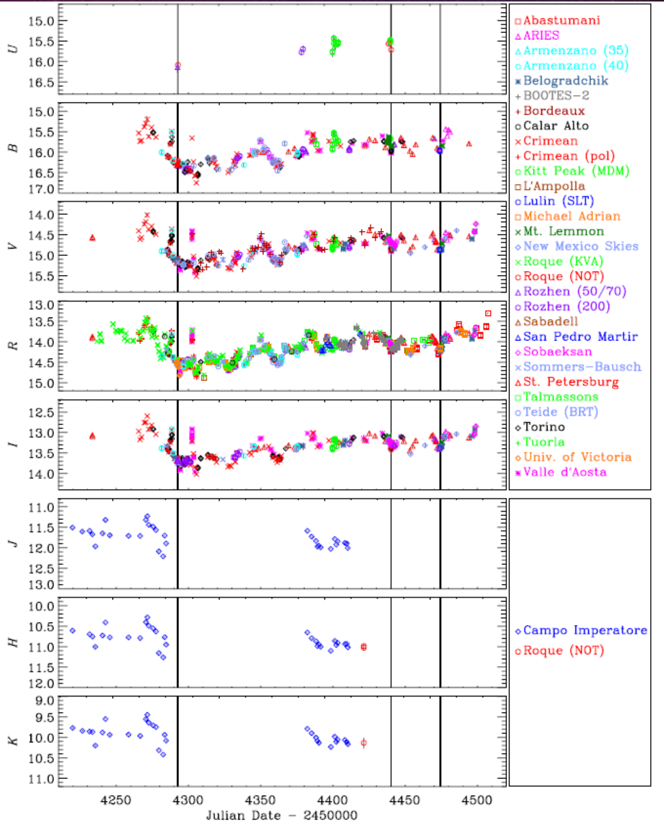
The both observatories take a part in the Whole Earth Blazar Telescope - a network of optical, near-infrared, and radio observers who in concert have the capability to obtain continuous, high-temporal-density onitoring of blazars.

Johnson-Cousins *UBVRI* light curves of 3C 454.3 from May 2006 to January 2007. The vertical lines and arrows indicate the times of the XMM-Newton pointings of July and December 2006.



Galaxies

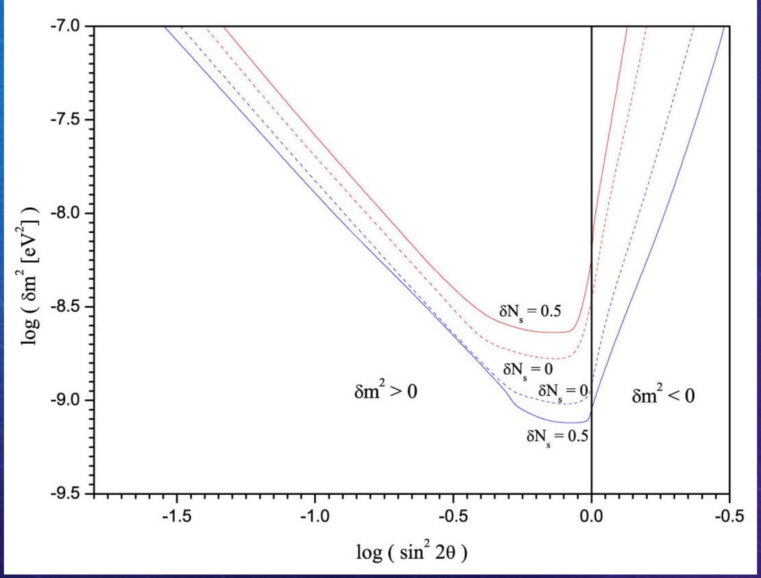
The radio-to-optical light curves obtained by the WEBT are usually studied in conjunction with observations at higher frequencies (ultraviolet, X- and gamma-rays), by satellites as XMM-



Optical *UBVRI* and near-IR *JHK* light curves of BL Lacertae in the 2007–2008 obser-ving season. Vertical lines indicate the three XMM-Newton pointings of July 10–11 and Dec. 5, 2007, and Jan. 8,

Cosmology

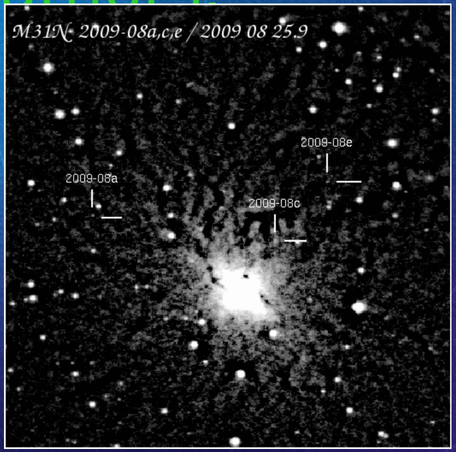
Large scale structure in the Universe is studied. Primordial nucleosynthesis And chemical evolution of the light elements in the presence of neutrino scillations is analysed. Cosmological constraints on oscillation parameters are obtained. Different baryogenesis scenarios are investigated. Possibilities of antimatter in the Universe are studied.

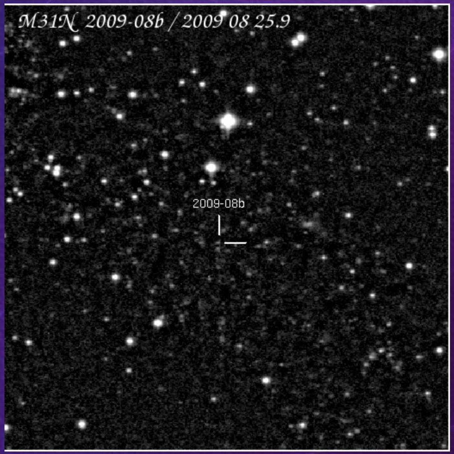


Cosmological constraints on neutrino oscillations parame-ters, which are by an order of magnitude more precise than the available previously in literature. The lower two curves correspond to 3% He-4 uncertainty, the upper – to 5% He-4 uncertainty.

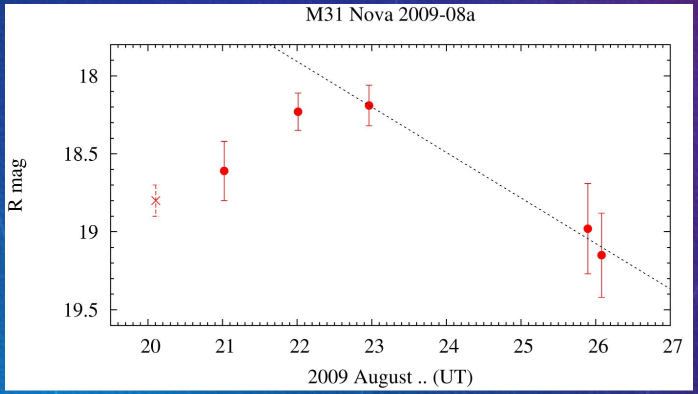
Monitoring of nova outbursts in Adromeda galaxy

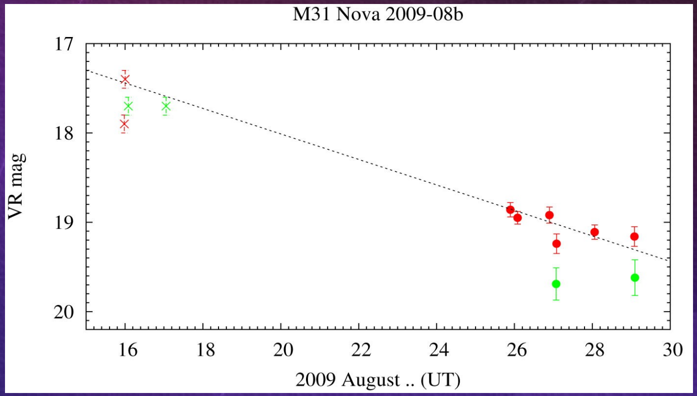
The 2 m and the 50 cm telescopes of the NAO Rozhen and the 60 cm telescope of AO Belogradchik, are used for nova outbursts monitoring in the nearby giant galaxy Andromeda. In the last 4 years 16 nova outbursts were discovered. About a half of our novae were confirmed by spectroscopic observation from other authors.

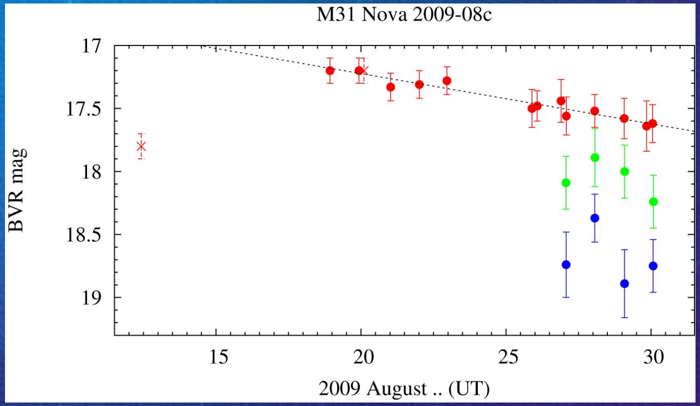


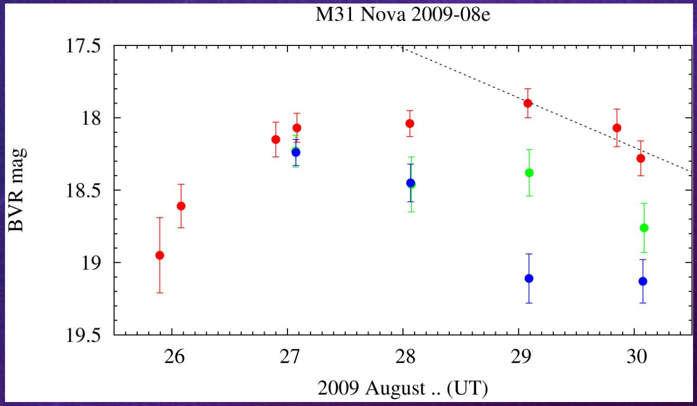


Monitoring of nova outbursts in Adromeda galaxy







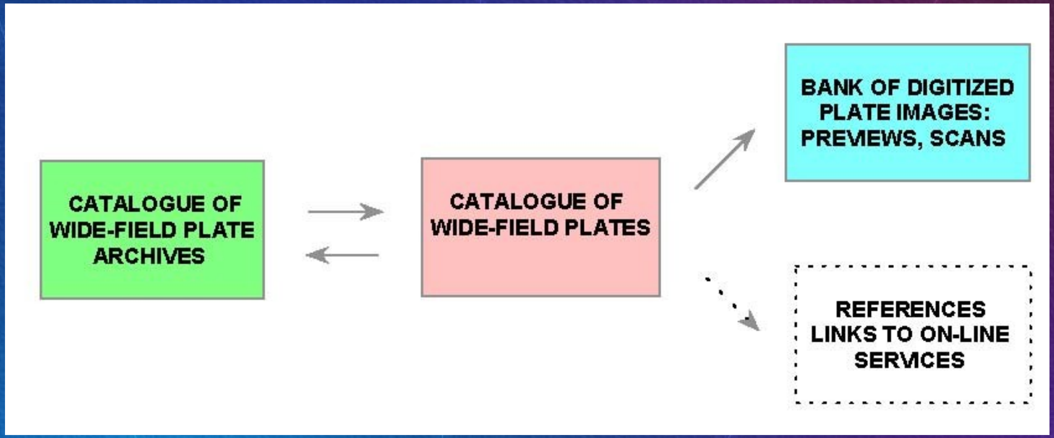


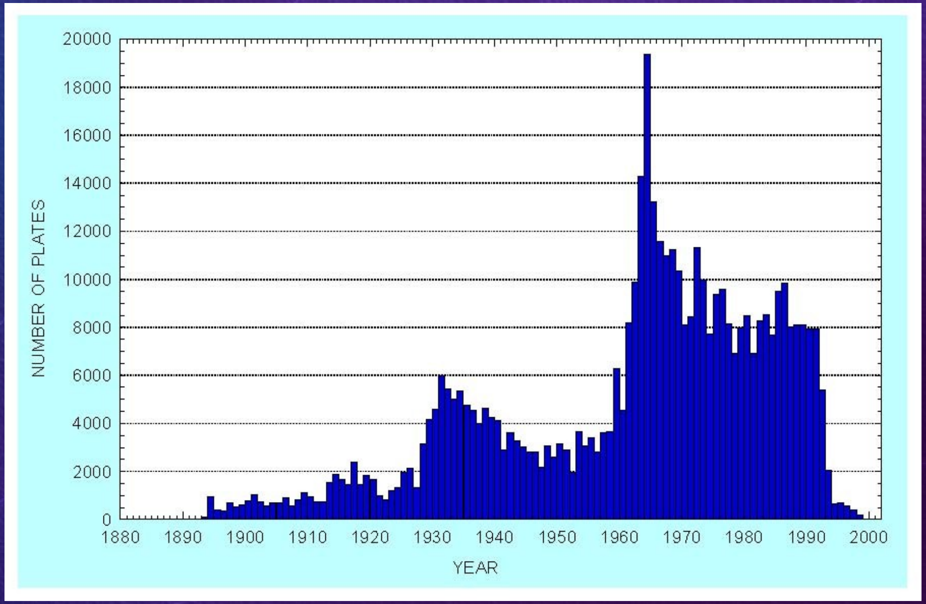
Photometric behaviour of the outbursts according our and other observations

Wide-Field Plate Database (WFPDB)

WFPDB is the basic source of information for the photographic wide-field astronomical observations, stored in the archives of 125 observatories worldwide. WFPDB is online accessible at http://www.skyarchive.org/, as well as through the VizieR system of the Strasbourg Data Centre at http://webviz.ustrasbg.fr/viz-bin/VizieR?-source=VI/90. The new development of WFPDB is connected with the forthcoming creation of a Bulgarian Virtual Observatory as a part of the global international net of virtual observatories.

Wide-Field Plate Database





Wide-Field Plate Database

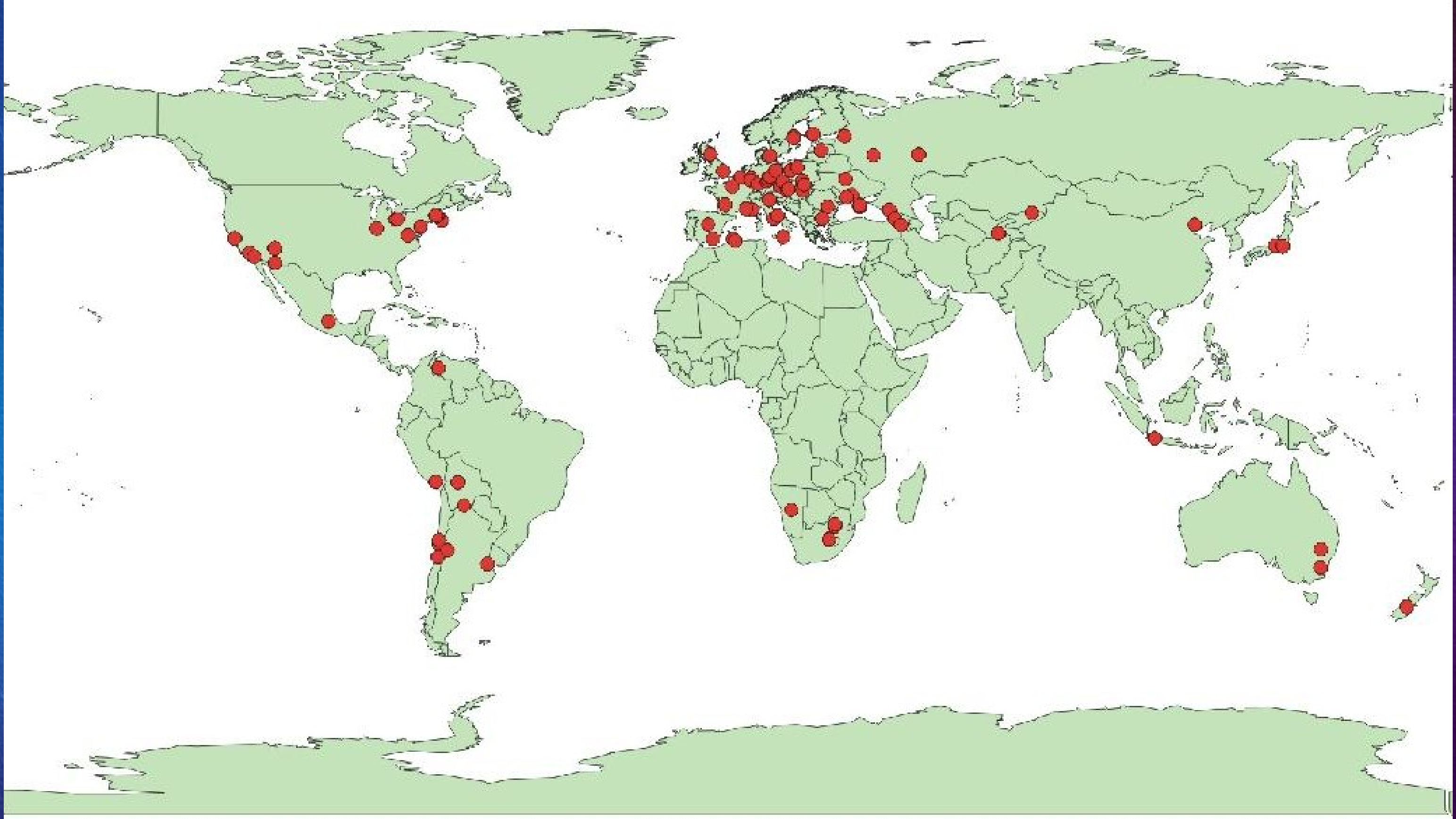
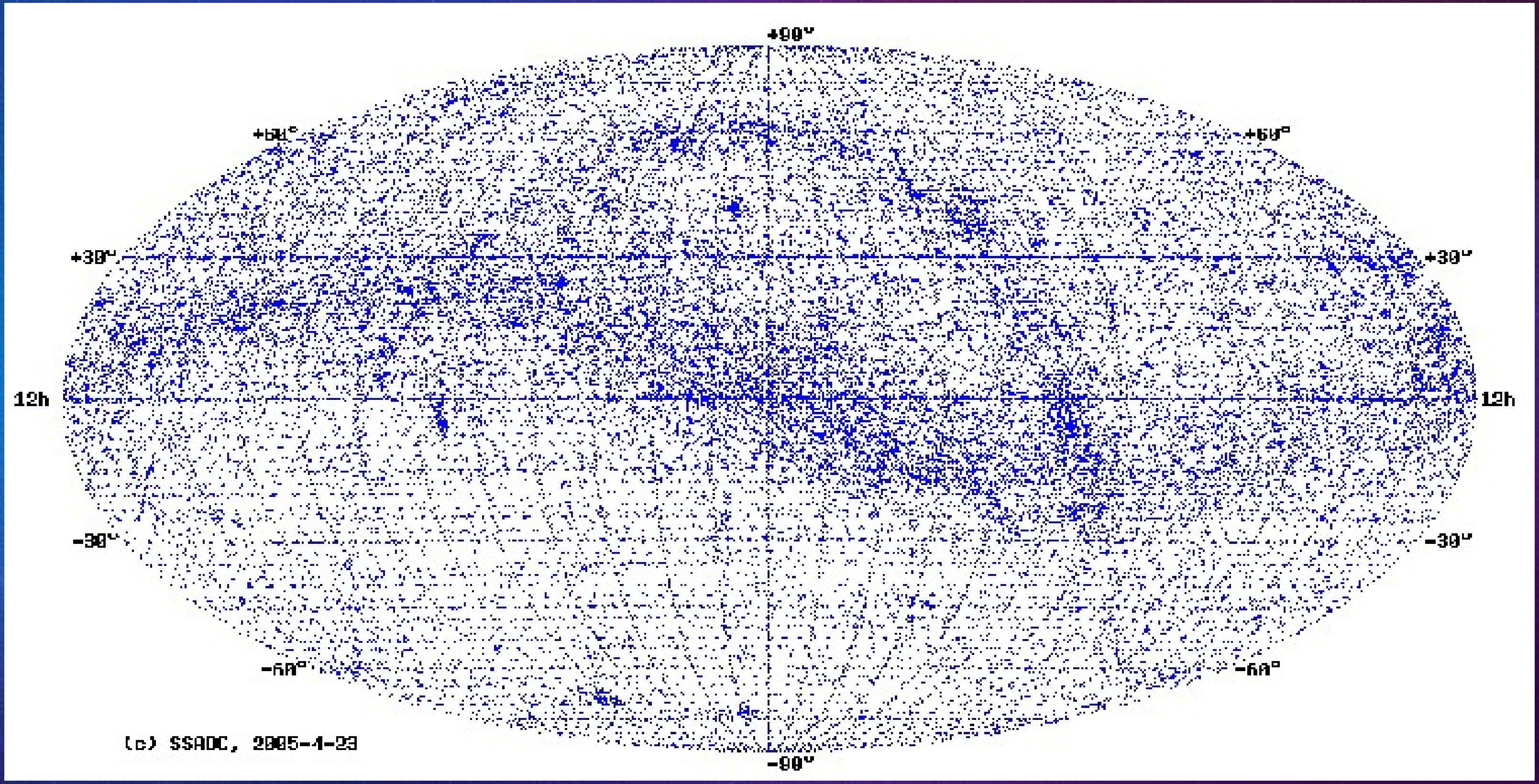
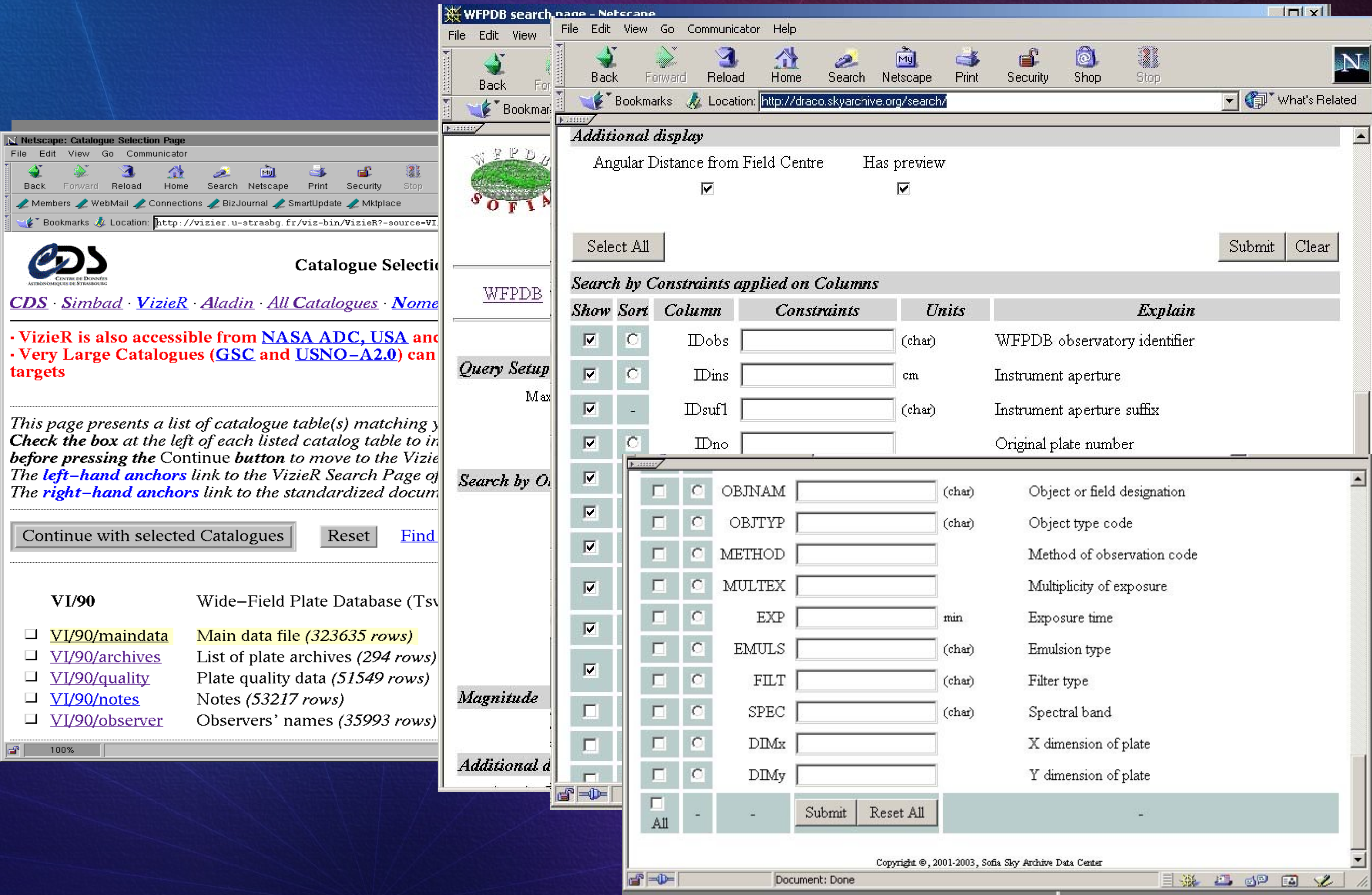


Fig. 1. World-wide distribution of wide-field telescopes

Wide-Field Plate Database



Database SEARCH engines



Most cited publications according to ADS

- *MWC560 - A unique astrophysical object,* Tomov, T.; Kolev, D.; Zamanov, R.; Georgiev, L.; Antov, A. 1990, *Nature*, 346, 637 - 37 citations
- *Deep Impact: Observations from a Worldwide Earth-Based Campaign,* Meech, K. J., Ageorges, N., A'Hearn, M. F., ... , Bonev, T**,** et al., 2005, *Science,* 310, 265-269 – 98 citations
- *Bimodality and Gaps on Globular Cluster Horizontal Branches. II. The Cases of NGC 6229, NGC 1851, and NGC 2808*, Catelan, M.; Borissova, J.; Sweigart, A. V.; Spassova, N., 1998, *ApJ*, 494, 265 - 79 citations
- *An Optical Spectroscopic Atlas of Low-Redshift Active Galactic Nuclei,* Marziani, P.; Sulentic, J. W.; Zamanov, R.; Calvani, M.; Dultzin-Hacyan, D.;

Most cited publications according to ADS

- *Bright OB stars in the Galaxy. I. Mass-loss and wind-momentum rates of O-type stars: A pure Halpha analysis accounting for line-blanketing,* Markova, N., Puls, J., Repolust, T., Markov. H., 2004, *A&A*, 413, 693-709 – 54 citations
- *Bright OB stars in the Galaxy. III. Constraints on the radial stratification of the clumping factor in hot star winds from a combined H alpha, IR and radio analysis*, Puls, J., Markova, N., Scuderi, S., Stanghellini, C., Taranova, O. G., Burnley, A. W., Howarth, I. D., 2006, *A&A*, 454, 625-651 – 65 citations
- *Shapes and rotational properties of thirty asteroids from photometric data*, Torppa, J., Kaasalainen, M., Michalowski, T., Kwiatkowski, T., Kryszczyńska, A., Denchev, P., Kowalski, R., 2003, *Icarus*, 164, 346 –

Most cited publications according to ADS

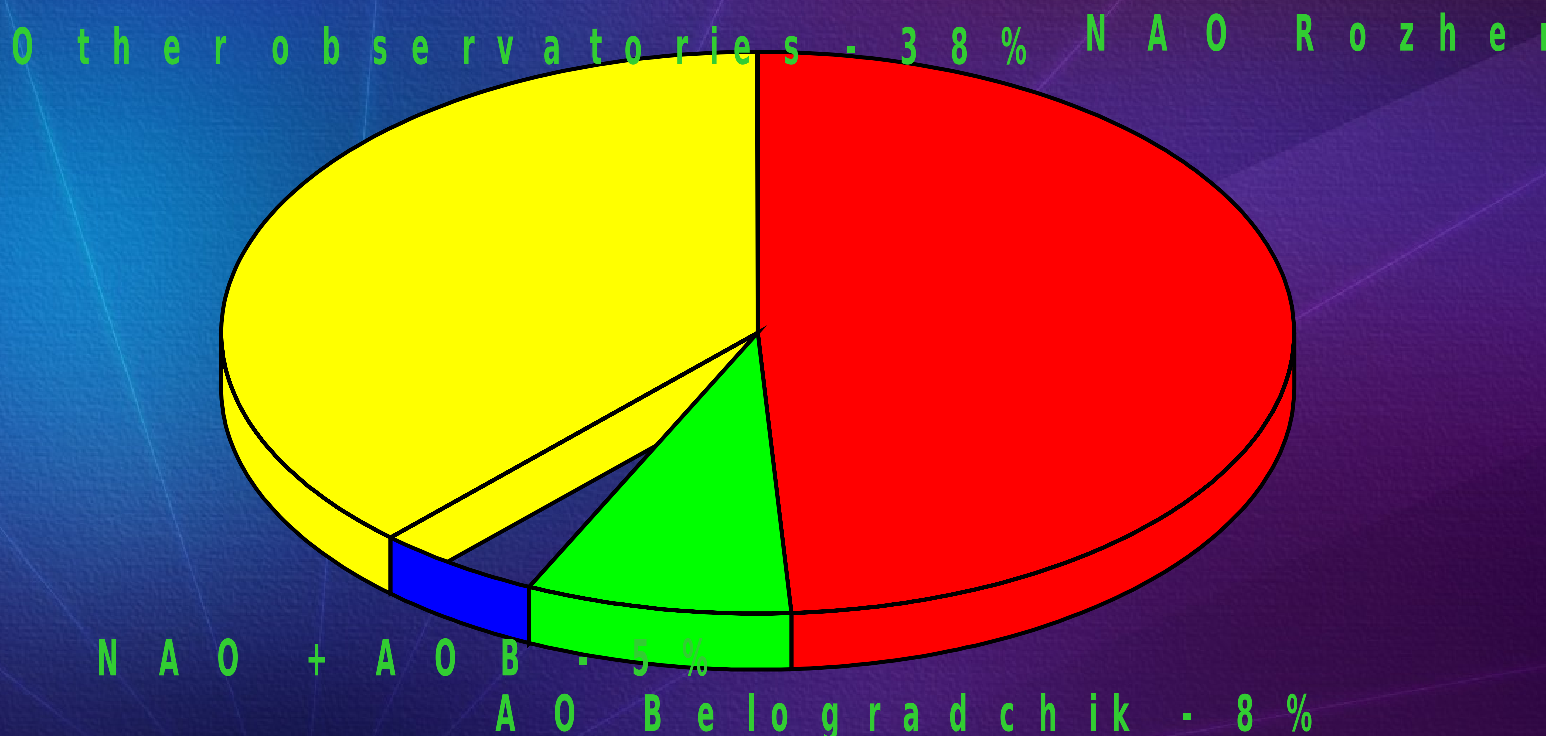
- *The photosphere and chromosphere of the RS Canum Venaticorum star, II Pegasi I. Spots and chromospheric emission in 1991*. Byrne, P. B.; Panagi, P. M.; Lanzafame, A. C.; Avgoloupis, S.; Huenemoerder, D. P.; Kilkenny, D.; Marang, F.; Panov, K. P.; Roberts, G.; Seiradakis, J. H.; van Wyk, F.
  1995, *A&A*, 299, 115 – 32 citations
- *The Unusual 2001 Periastron Passage in the "clockwork" Colliding – Wind Binary WR 140,* Marchenko, S. V., Moffat, A. F.J., Ballereau, D., Chauville, J., Zorec, J., Hill, G. M., Annuk, K., Corral, L. J., Demers, H., Eenens, P. R. J., Panov, K. P., Seggewiss, W., Thomson, J. R., Villar-Sbaffi, A., 2003, *ApJ,* 596, 1295 – 29 citations
- *Light element non-LTE abundances of λ Bootis*

Most cited publications according to ADS

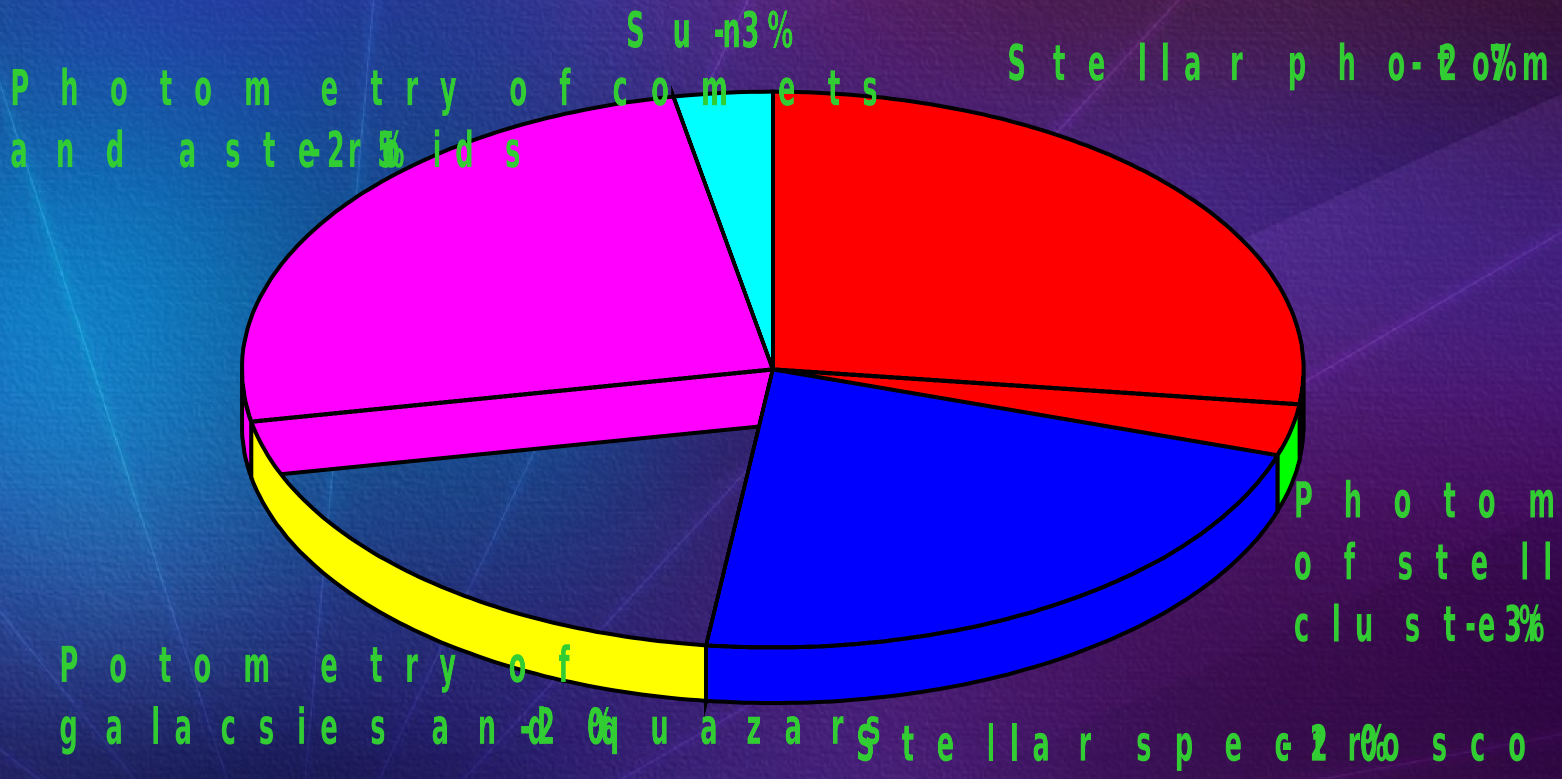
- *Mass and age determination for 21 λ Bootis-type stars,* Iliev, I. K.; Barzova, I. S. ,1995, *A&A*, 302, 735 – 24 citations
- *A photometric campaign on the Be stars Omicron And, KX And, KY And, LQ And and EW Lac,* Stagg, C. R.; Bozic, H.; Fullerton, A. W.; Gao, W. S.; Guo, Z. H.; Harmanec, P.; Horn, J.; Huang, L.; Iliev, L. H.; Koubsky, P.; Kovachev, B. Z.; Pavlovski, K.; Percy, J. R.; Schmidt, F.; Stefl, S.; Tomov, N. A.; Ziznovsky, J., 1988, *MNRAS*, 234, 1021 – 25 citations
- *Cosmological nucleosynthesis and active-sterile neutrino oscillations with small mass differences: The nonresonant case* Kirilova, D. P.; Chizhov, M. V., 1998, *PhRvD*, 58, 3004 – 40 citations
- *Nonequilibrium neutrino oscillations and primordial production of ^{4}He*, Kirilova, D. P.; Chizhov, M. V. 1997, *PhLB*, 393, 375 – 38 citations

Distribution of published papers

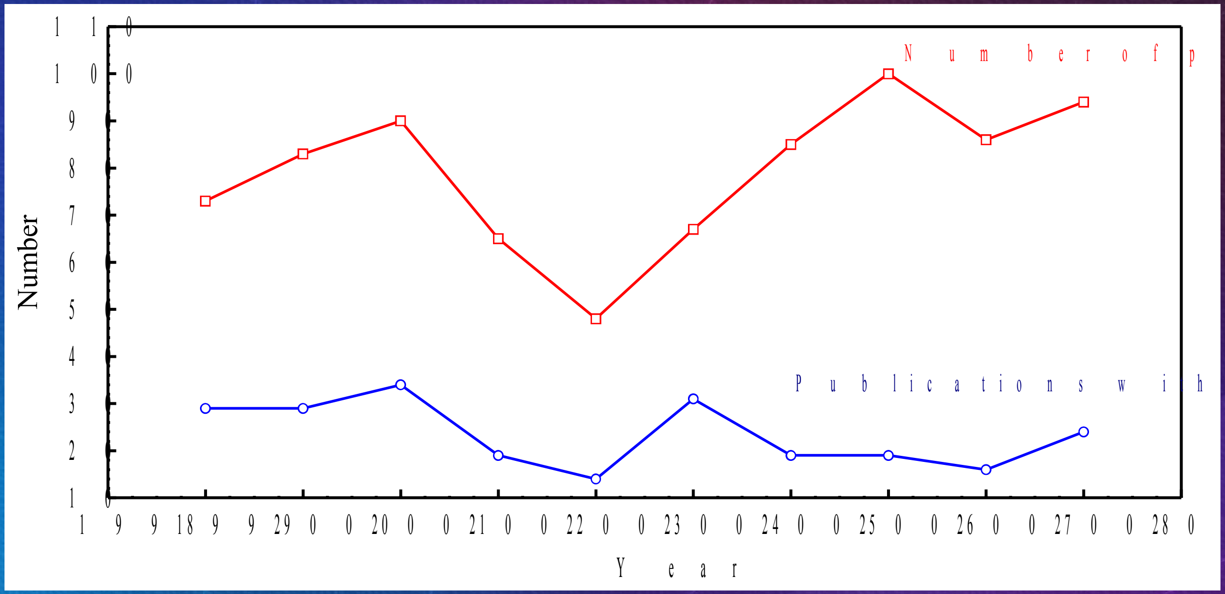
About 70% from the papers of the Institute have observational astronomy topic



Distribution of published papers by topics



Distribution of publications by years



772 publications in the period 1999-2008, 214 in the journals with an impact factor: 86 in A&A, 21 in IAU Sym, 20 in MNRAS, 13 in Astron. Nachrichten, 8 in AJ, 7 in Ap&SS, 6 in ApJ, 6 in RMxAA, 5 in Icarus, 5 in P&SS, 4 in Sol. Phys., 2 in PASP