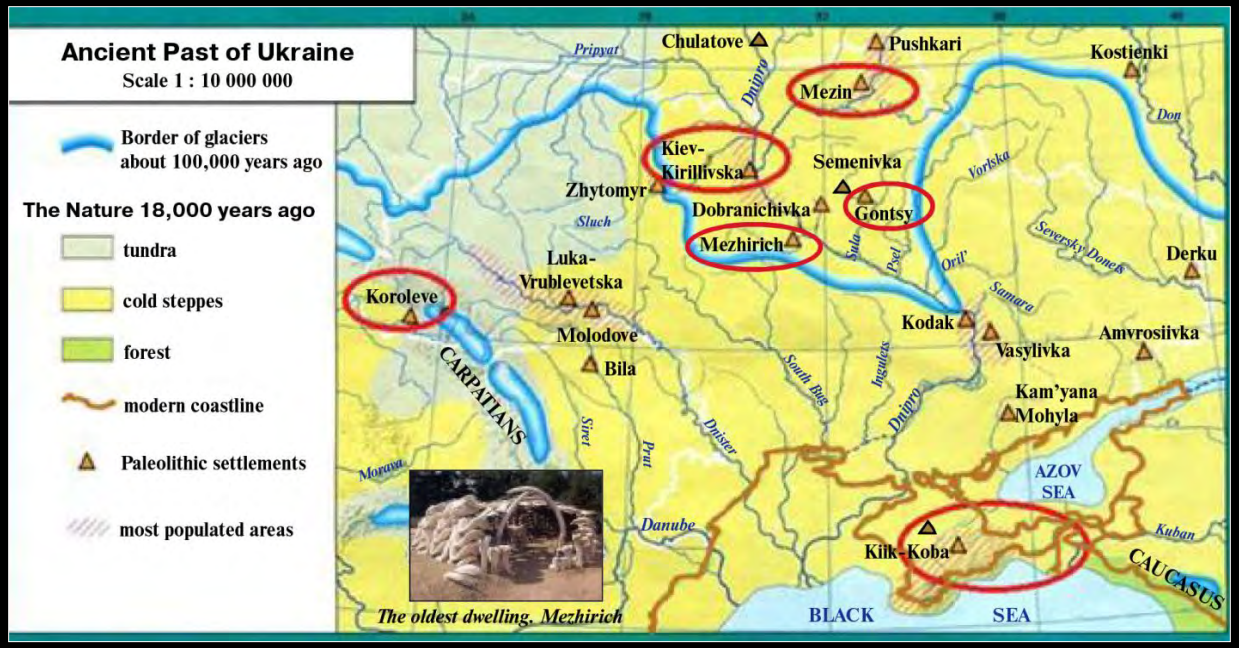
ASTRONOMY IN UKRAINE: GEO SPACE AND TIME SPANS

YAROSLAV YATSKIV

MAIN ASTRONOMICAL OBSERVATORY
OF NAS OF UKRAINE
27 AK. ZABOLOTNOGO ST.,
KYIV 03143 UKRAINE
IN COLLABORATION WITH IGOR LUK'YANYK AND IRYNA VAVILOVA

HISTORICAL NOTES

ARCHEOASTRONOMY FINDS AT THE SETTLEMENTS IN THE TERRITORY OF UKRAINE. PALEOLITHIC ERA



A map showing Paleolithic settlements in the territory of Ukraine, including Dobranichivka, Gontsy, Kiev-Kirilllovskaya, Kiik-Koba, Kodak, Mezhirich, Mezin, Molodove and others

A close-up of the right-hand end of the engraved mammoth tusk fragment from Kiev-Kirillovskaya (National Museum of History of Ukraine, Kyiv)

The Mezin composite (left) and wide (right) bracelets, which are considered as the paleo-astronomical calendars (National Science Museum of Natural History in Kyiv (left), National Museum of History of Ukraine in Kyiv (righr))

ARCHEOASTRONOMY FINDS AT THE SETTLEMENTS IN THE TERRITORY OF UKRAINE. FROM E-NEOLITHIC ERA TO THE V CENTURY

The ancient vessels (Trypillya culture, IV–II Millennium B.C.) with the astronomical symbolic

The first Slavic tribes have appeared during I Millenium B.C. At the Ukrainian territory there are two most studied *Slavic cultures: Zarubinetska culture* and *Chernyakhiv culture* (II - V centuries).

(left) Vessel-calendar from *Romashky* (Kyiv region).

(right) The pattern was correctly interpreted by Prof. B. Rybakov as an agriculture calendar from May 2 to August 7 (day of young shoots and holiday of harvesting), this period is just a season of maturing of wheat in Kyiv

ASTRONOMY IN UKRAINE. ORIGINS

Ostroh Academy, 1576

Lviv University Observatory, 1769

Kyiv-Mohyla Academy, 1783

ASTRONOMY AS THE NATURAL PHILOSOPHY AT THE FIRST UNIVERSITIES

- The first astronomical observations and their writing records are dated to the times of Kievan Rus' (X-XIII centuries). For example, the authors of the ***Lavrentievsky chronicle*** described the solar eclipses of 1064, 1091, 1115, and 1230 years and the lunar eclipses of 1161 year as well as the first authentic Comet Galley observation at the Kievan Rus' territory in 1066.
- In 1483 the first printed book on astronomy was written by physician and astronomer **Georgii Drohobich (1450-1494)**, who was a well-known author of Ukrainian origin.

G. Drogobich

- Systematic learning in astronomy is connected with the activity of the first Ukrainian universities in the XVII-XVIII centuries, namely the Ostroh Academy (A. Rymsha (1550-1595), astronomical cabinet in 1617-1630), the L'viv University (astronomical observatory in 1769) as well as the Kyiv-Mohyla Academy (astronomical cabinet in 1783).

Андрій Римша. "Хронологія"

Месяца сентебра, по-гебрейску єлюль, просто вресень,
Двадцать четвертого дня месяца сентебра
дороблен Єросолим, сталася реч добра.
Месяца октовріа, по-гебрейску тышри, просто паздерник,
Арха з Ноим на горе станула на суши,
другій потоп не будет, так нам писмо туши.
Октовріа 17 дня.
Месяца ноемврія, по-гебрейску маргеусам, просто грудень.
Жидом свято уставил тут царь Єровоам,
мы о свои не дбаєм, не велми ж добро нам.
Ноемврія 15 дня.
Месяца декавріа, по-гебрейску хашлеу, просто просинець 1.
В том месяцы Ісус Христос народился нам,

ASTRONOMY AS THE NATURAL PHILOSOPHY AT THE KYIV-MOHYLA ACADEMIA

- A graduate of the Kyiv-Mohyla Academy, **Ivan Kopievsky (1651-1714),** issued the first stellar map in the Slavic language in Amsterdam in 1699 and the basics of naval astronomy in 1701.
- The prominent Ukrainian-Russian philosopher, scientist and religious figure, **Pheophan Prokopovich (1681-1736)**, who worked at the Kyiv-Mohyla Academy in 1705 – 1716 (he was the rector of this academy in 1711 – 1716), lectured astronomical courses based on theories of Copernicus and Galileo. He also developed the philosophical foundation of the unity of matter and motion, which was generalized later on by Mikhail Lomonosov.
- The prominent Ukrainian philosopher, scientist and religious figure **Irynei (Ivan Falkovsky (1762-1823)**

Ph. Prokopovych

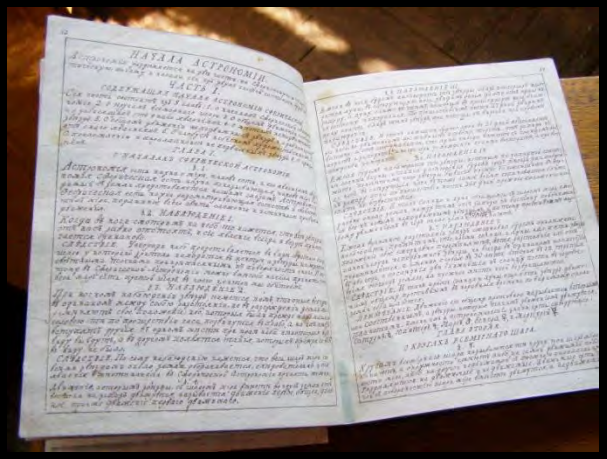
Світ… не є нескінченним, але замкненим та обмеженим певними границями…

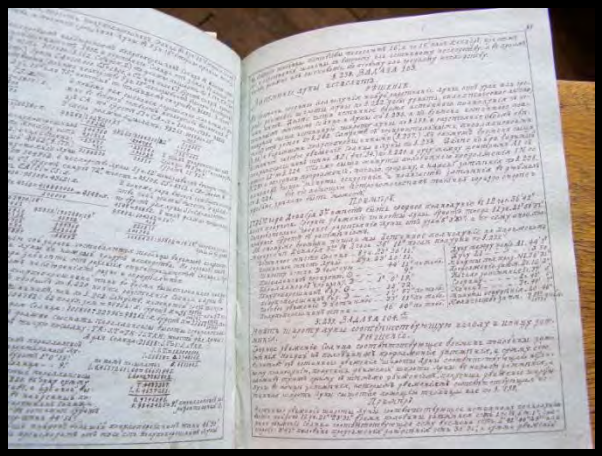
Передусім, треба знати, що рух із часом має дуже тісний зв'язок так, що ніщо не рухається інакше як у часі і ніщо не вимірюється часом, якщо не рухається…

Матерію не можна ніколи створити, ані зруйнувати, також ні збільшити, ні зменшити ту, яку створив Бог на початку світу, і якою і в якій кількості створена, такою залишається досі й буде залишатися завжди…

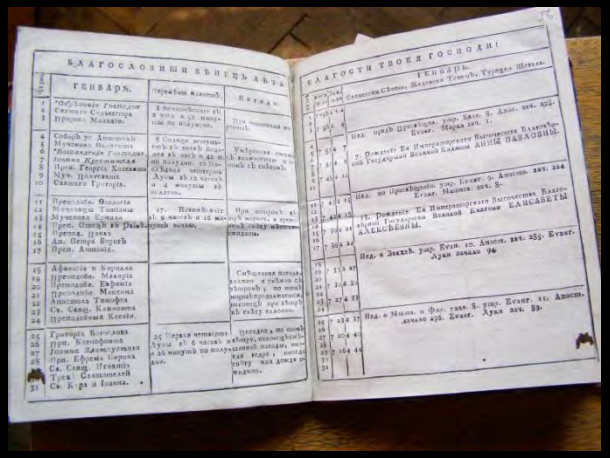
ASTRONOMY AS THE NATURAL PHILOSOPHY AT THE KYIV-MOHYLA ACADEMIA

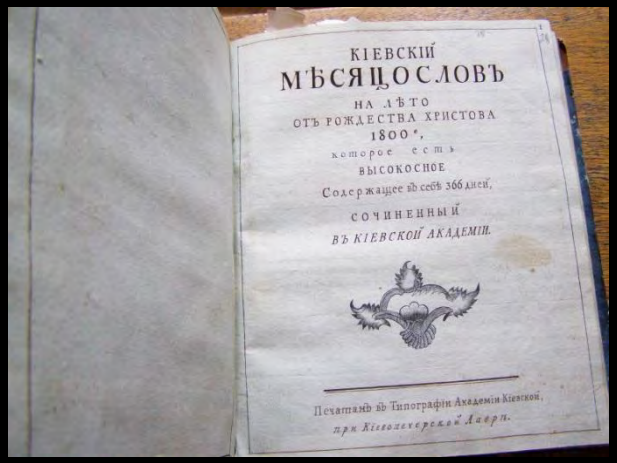
I. Falkovsky





“Скорочення змішаної математики” (ліворуч)
“Задача з обчислення затемнення Місяця” (праворуч)





Київський Місяцеслов на 1799 р. (ліворуч) і 1800 р. (праворуч)

ASTRONOMY IN UKRAINE XIX CENTURY

- Scientific research in astronomy was started in the XVIIIth century with establishment of *University astronomical observatories in L'viv, Odesa, Kyiv, Kharkiv*
- In 1821 the *Naval Observatory* was founded in *Mykolaiv* (later on as a department of the Pulkovo Observatory)
- New impetus for development of astronomical research were connected with the foundation of institutions of the Russian Academy of Sciences (later on the USSR Academy of Sciences) and the *All-Ukrainian Academy of Science* (later on the UkrSSR AS, and the NAS of Ukraine)

MYKOLAIV NAVAL OBSERVATORY, 1821

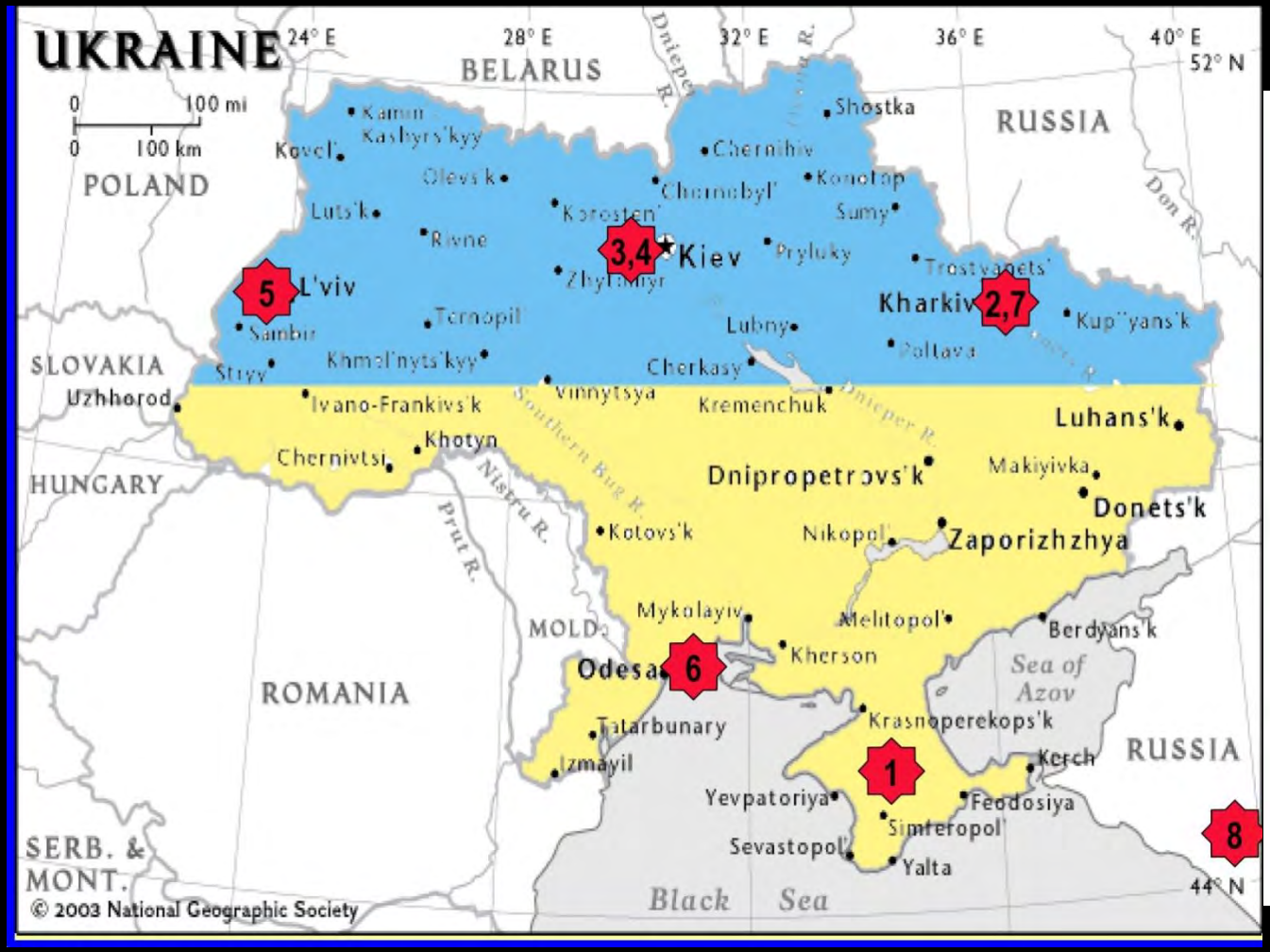
KHARKIV ASTRONOMICAL OBSERVATORY, 1824

KYIV ASTRONOMICAL OBSERVATORY, 1845

ODESA ASTRONOMICAL OBSERVATORY, 1871

ASTRONOMY IN UKRAINE XX CENTURY

Ukraine is a well-known astronomical country in Europe



- Main Astronomical Observatory (Kyiv 1944)
- Crimean Astrophysical Observatory (Simeiz 1908; Naukove 1945)
- Institute of Radio Astronomy (Kharkiv 1950-ies)
- Mykolaiv Astronomical Observatory (1821)
- Astronomical Observatory Kyiv Nat. University (1845)
- Astronomical Observatory L'viv Nat. University
- Astronomical Observatory Odesa Nat. University (1871)
-- Institute of Astronomy Kharkiv Nat. University
-- ICAMER (p. Terskol, North Caucasus, RF, 1970-ies)
- Space research Laboratory Uzhgorod Nat. Univ., 1957

POLTAVA GRAVIMETRICAL OBSERVATORY, 1926

MAIN ASTRONOMICAL OBSERVATORY, 1944

CRIMEAN ASTROPHYSICAL OBSERVATORY, 1944 (USSR), 1991 (UKRAINE)

RADIO-ASTRONOMICAL OBSERVATORY,1985

TERSKOL ASTRONOMICAL OBSERVATORY, 1977

STATUS OF ASTRONOMICAL RESEARCH AND EDUCATION ACTIVITY

Status of astronomical research institutions before 2014

Institutions	Number of Scientists	Number of Cand. Sci.	Number of Dr. Sci.
Institutions of the National Academy of Sciences of Ukraine (NASU)			
Main Astronomical Observatory of NASU www.mao.kiev.ua	102	52	20
Institute of Radio Astronomy of NASU www.ri.kharkov.ua	168	55	17
Laboratory of Astrophysics and Cosmology of Bogolyubov Institute of Theoretical Physics of NASU http://www.bitp.kiev.ua/en/aep/staff.html	6	4	1
International Center for Astronomical, Medical, and Ecological Research of NASU http://www.terskol.com/	20	8	1
Institutions of the Ministry for Education and Science of Ukraine			
SRI "Crimean Astrophysical Observatory" www.crao.crimea.ua	86	33	16
Astronomical Observatory of Taras Shevchenko National University of Kyiv www.univ.astro.kiev.ua	26	19	6
Astronomical Observatory of I.Franko National University of L'viv http://astro.franko.lviv.ua/	22	5	2
SRI “Astronomical Observatory” of I.I. Mechnikov National University of Odessa http://www.astro-observ.odessa.ua/	61	14	5

Status of astronomical research institutions before 2014

SR Institute of Astronomy of V.N. Karazin National University of Kharkiv http://ru.astron.kharkov.ua/	32	15	6
SRI "Nikolaev Astronomical Observatory" http://www.nao.nikolaev.ua/	15	8	1
Laboratiry of Space Researches of the Uzhgorod National University http://www.univ.uzhgorod.ua/static/ndi/pndl/	12	3	0
Department of High and Applied Mathematics,. Odessa National Maritime University http://www.osmu.odessa.ua/application/page?name=vpm	7	3	1
Department of Astronomy and Space Physics, Taras Shevchenko National University of Kyiv http://space.univ.kiev.ua/viewpage.php?page_id=1	21	9	2
Department of Astrophysics of I. Franko National University of L'viv http://www.physics.lnu.edu.ua/depts/KAF/index.htm	10	3	2
Department of Astronomy of I.I. Mechnikov National University of Odessa http://onu.edu.ua/uk/structure/faculty/phys/astronomy	8 (7)	4	2 (1)
Department of Astronomy of V.N. Karazin National University of Kharkiv http://www.univer.kharkov.ua/ua/departments/physics/	8 (3)	4 (1)	3 (0)
Astronomical Institutions of the NAS of Ukraine	296	119	39
Astronomical Institutions of the Ministry for Education and Science of Ukraine	302	117	42
Total	598	236	81

* Post-graduated students are not included in this table

Current status of astronomical research institutions

Institutions of the NASU (National Academy of Sciences of Ukraine) or MESU (Ministry of Education and Science of Ukraine)	Number of Scientists	Number of Cand. Sci.	Number of Dr. Sci.	Research Fields
Main Astronomical Observatory of the NASU www.mao.kiev.ua	92	50	12	Space Geodynamics; Positional Astronomy; Astrophysics: Solar System Bodies, Sun, Stars; Extragalactic Astronomy; High-energy Astrophysics; Ground-based and Space-born Instrumentation
Institute of Radio Astronomy of the NASU www.ri.kharkov.ua	168	55	17	Radio Astronomy (all types of celestial bodies) and Radio Physics; Ground-based Instrumentation
**SRI "Crimean Astrophysical Observatory" of the Taras Shevchenko National University of the MESU www.crao.crimea.ua	69	36	10	Astrophysics: Solar System Bodies, Sun, Stars, Extragalactic Astronomy; High-energy Astrophysics; Radio Astronomy (cm-waves);Ground-based and Space-born Instrumentation
SRI "Astronomical Observatory" of I.I. Mechnikov National University of Odessa, MESU www.astro-observ.odessa.ua	37	12	4	Positional Astronomy; Astrophysics: Solar System Bodies, Stars, Galaxy, Extragalactic Astronomy, Cosmology; Ground-based Instrumentation
Institute of Astronomy of V.N. Karazin National University of Kharkiv, MESU www.astron.kharkov.ua	38	15	7	Positional Astronomy; Astrophysics: Solar System Bodies, Sun, Extragalactic Astronomy
Astronomical Observatory of the Taras Shevchenko National University of Kyiv, MESU, www.observ.univ.kiev.ua	31	28	6	Positional Astronomy; Astrophysics: Solar System Bodies, Sun, Stars, Extragalactic Astronomy; Cosmology; High-energy Astrophysics;
Astronomical Observatory of Ivan Franko National University of Lviv, MESU astro.lnu.edu.ua	21	6	2	Positional Astronomy; Astrophysics: Sun, Stars, Extragalactic Astronomy, high-energy astrophysics; Cosmology;

Current status of astronomical research institutions

Institutions of the NASU (National Academy of Sciences of Ukraine) or MESU (Ministry of Education and Science of Ukraine)	Number of Scientists	Number of Cand. Sci.	Number of Dr. Sci.	Research Fields
International Center for Astronomical, Medical, and Ecological Research of the NASU www.terskol.com	20	8	1	Optical Observational Astronomy
SRI "Mykolaiv Astronomical Observatory", MESU www.mao.nikolaev.ua	15	4	1	Positional Astronomy; Ground-based Instrumentation
Laboratory of Astrophysics and Cosmology of Bogolyubov Institute of Theoretical Physics of NASU http://bitp.kiev.ua/en/department/aep	5	4	2	quantum field theory and its applications to particle physics, gravity theory and condensed matter physics
Laboratory of Physical Electronics and Space Research Laboratory of the Uzhgorod National University https://www.uzhnu.edu.ua/en/cat/deps-lab_space	12	3	0	monitoring of satellites
Department of Mathematics. Physics and Astronomy of the Odessa National Maritime University, MESU http://www.onmu.odessa.ua/ua/korablebudivnij/ksf-kaf/vishcha-ta-prikladna-matematika/pro-kafedru-vpm.html	22= 7 astro +15 math, phys	11= 4 astro + 7 math,phys	2= 1 +1	Astrophysics: Variable Stars, Interacting Binary Stars; photometric and polarimetric monitoring; Astroinformatics: Algorithms and Programs for Advanced methods for Data Analysis; modeling of ground-based and space observations; Catalogs of Results
Department of Astronomy and Space Physics, Taras Shevchenko National University of Kyiv http://space.univ.kiev.ua/en/	11	4	2	Ionospheric researches

Current status of astronomical research institutions

Institutions of the NASU (National Academy of Sciences of Ukraine) or MESU (Ministry of Education and Science of Ukraine)	Number of Scientists	Number of Cand. Sci.	Number of Dr. Sci.	Research Fields
Department of Astrophysics of Ivan Franko National University of Lviv http://physics.lnu.edu.ua/en/department/kafedra-astrofizyky	10	4	2	Astrophysics: physics of white dwarfs, interstellar medium, nebular astrophysics, dwarf galaxies; Cosmology.
Department of Theoretical Physics and Astronomy of I.I. Mechnikov National University of Odessa http://www.chair.astro-observ.odessa.ua/sciencework.php	8 (7)	4	2 (1)	Stellar astrophysics, asteroids, comets, meteors and near the dust layer, observation and study of motion and physics satellites, Astrometry, Radio astronomy, Astronomical instrument.
Department of Astronomy of V.N. Karazin National University of Kharkiv http://www.physics.karazin.ua/en/chairs/ka.html	11	5	5	physical conditions at the Moon and Solar System Bodies
Radio Astronomy Research Laboratory named BL Kashcheyev of Kharkiv National University of Radio Electronics http://nure.ua/branch/naukovo-doslidna-laboratoriya-radioastronomiyi-geofiziki-tadistantsiynogo-zonduvannya-im-b-l-kashheyeva	3	1	1	Interpretation of meteor radar observation data together with data about Solar system small bodies, astroinformatics (meteor data bases)
Разом:	568(499)	250(214)	77(67)	

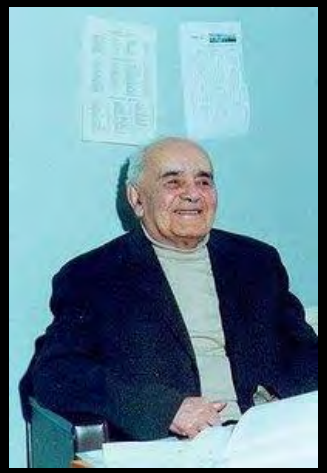
ASTRONOMY SCIENTIFIC SCHOOLS OF UKRAINE IN XX CENTURY

A number of well-known astronomical achievements is connected with activities of so-called “scientific schools”, namely founded by

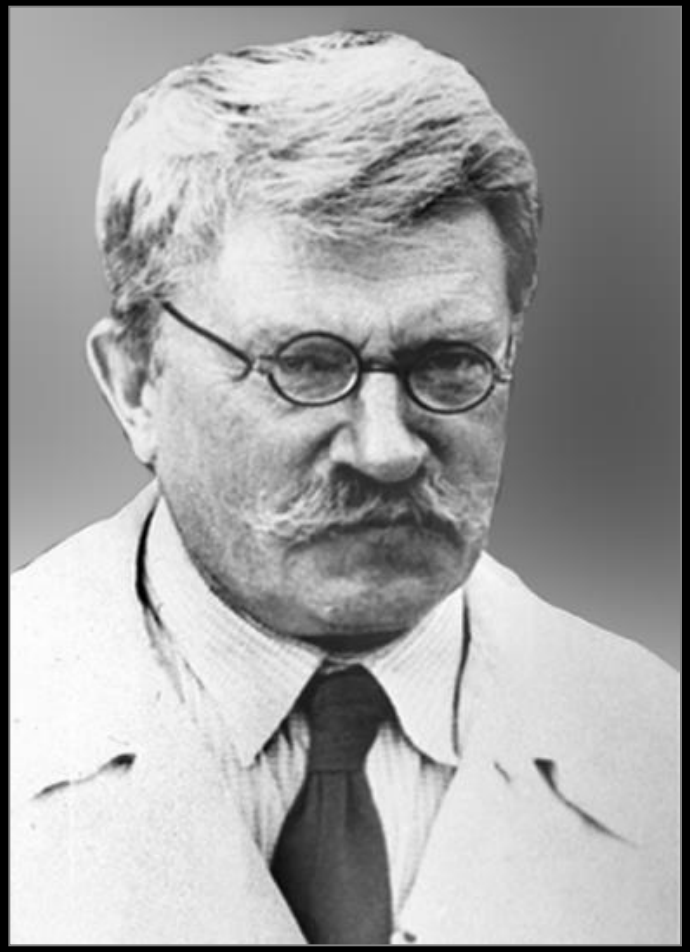
Alexander Ya. Orlov, Nikolai P. Barabashov,

Grigory A. Shajn, Vladimir P. Tsesevich,

Sergei K. Vsekhsvyatsky, Andrei B. Severny, Semen Ya. Braude and others.



A.YA. ORLOV (1880 — 1954)
ASTROMETRY AND ASTROGEODYNAMICS



1926 : Founder and first director of the Poltava Gravimetrical Observatory

1944 : Founder and first director of the Main Astronomical Observatory

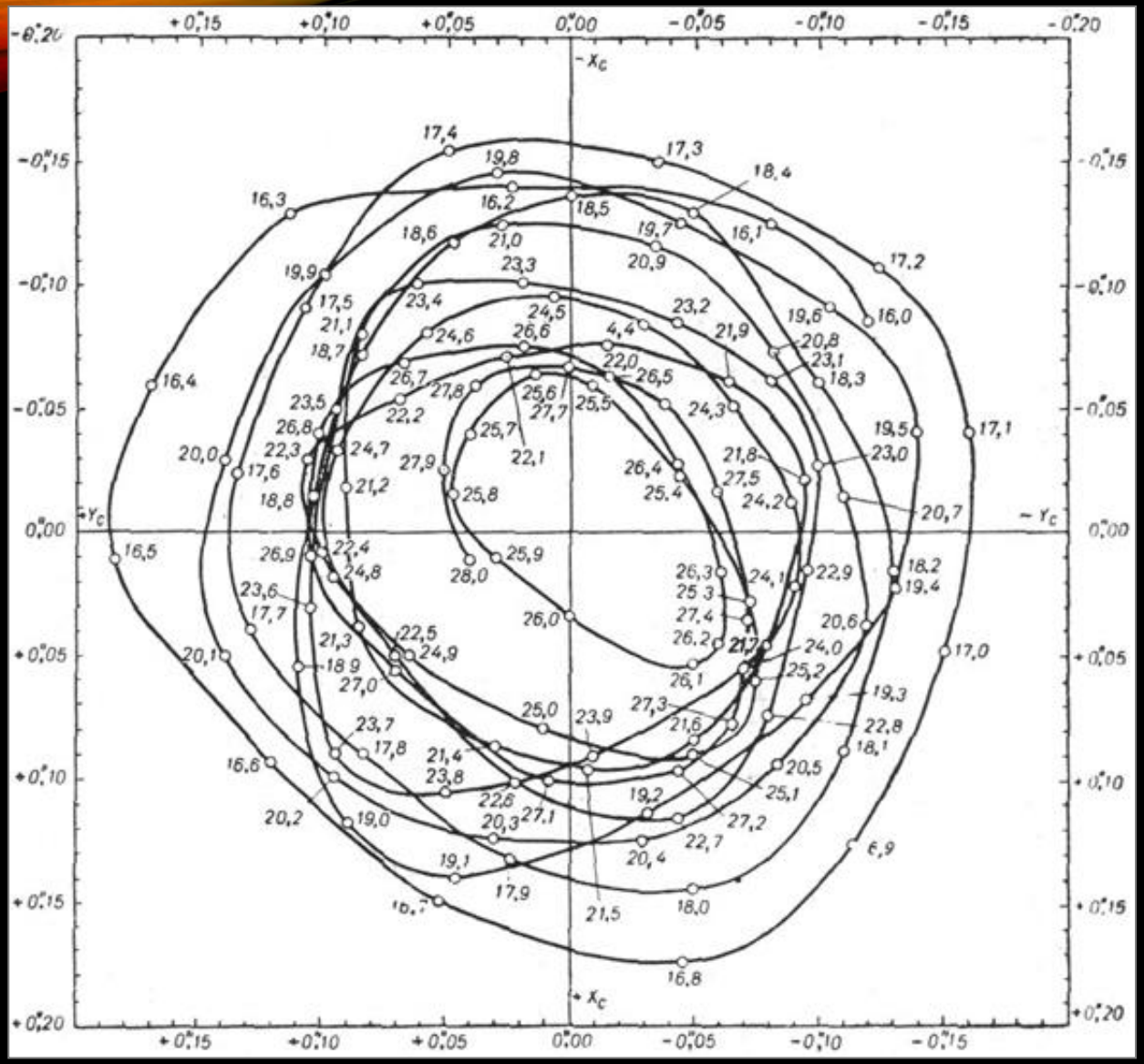
RESEARCH FIELDS:

- Positional astronomy
- Rotation of the Earth
- Geodesy and gravimetry

FOLLOWERS OF THIS SCHOOL

Z.N. Aksentyeva

Ye. P. Fedorov



Рух полюса Землі в системі Орлова

Ground-based programmes
Positional Astronomy
Planets around L-dwarfs with Astrometry

Participants:

Switzerland: Geneva Observatory, Drs. J.Sahlmann, D.Segransan, D. Queloz, M. Mayor, S. Udry

Ukraine: Main Astronomical Observatory of NASU, Dr. P. Lazorenko

Spain: CSIC-INTA, Dr. E. Martin

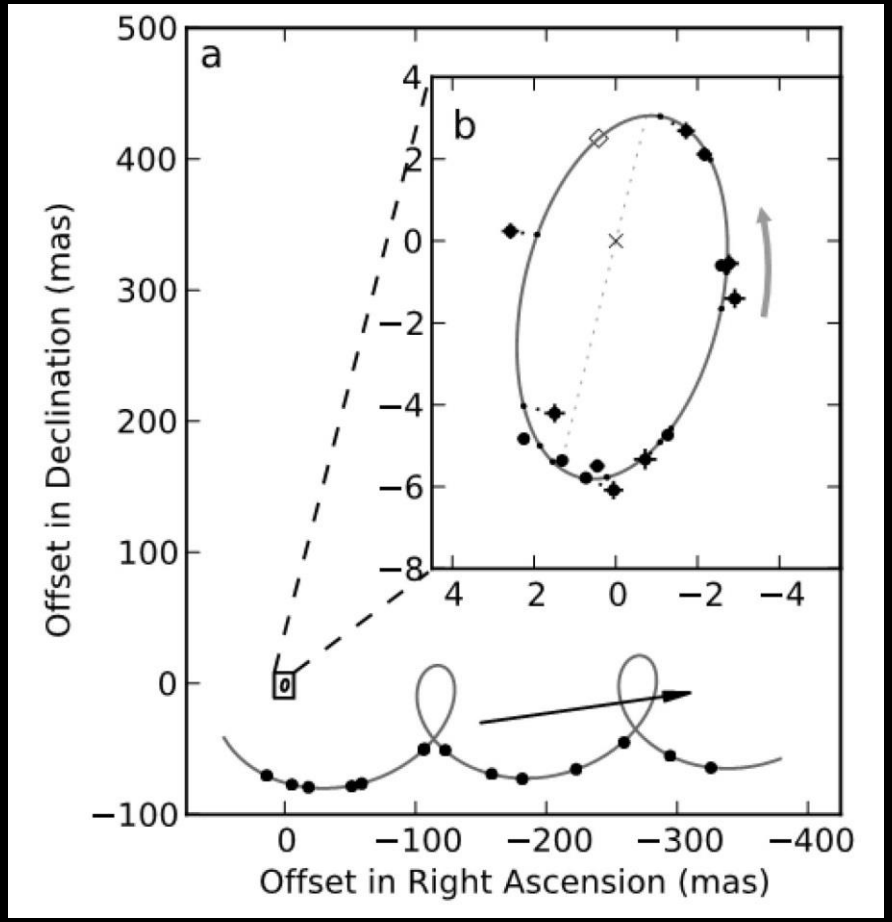
Objective is to study of the possibility extrasolar planets existence around ultracool dwarfs.

Ground-based programmes
Positional Astronomy
Planets around L-dwarfs with Astrometry

Technique & some results

Using FORS2/VLT optical imaging for high precision astrometry the search for planets and substellar objects around ultracool dwarfs is undertaken to investigate their multiplicity properties for very low companion masses.

Astrometric measurements were made with an accuracy of two tenths of a milli-arcsecond over two years that reveal orbital motion of the nearby L1.5 dwarf DENIS-P J082303.1-491201 located at 20.77± 0.08 pc caused by an unseen companion that revolves about its host on an eccentric orbit in 246.4 ±1.4 days.



S.K. VSEKHSVYATSKY (1905 – 1984)

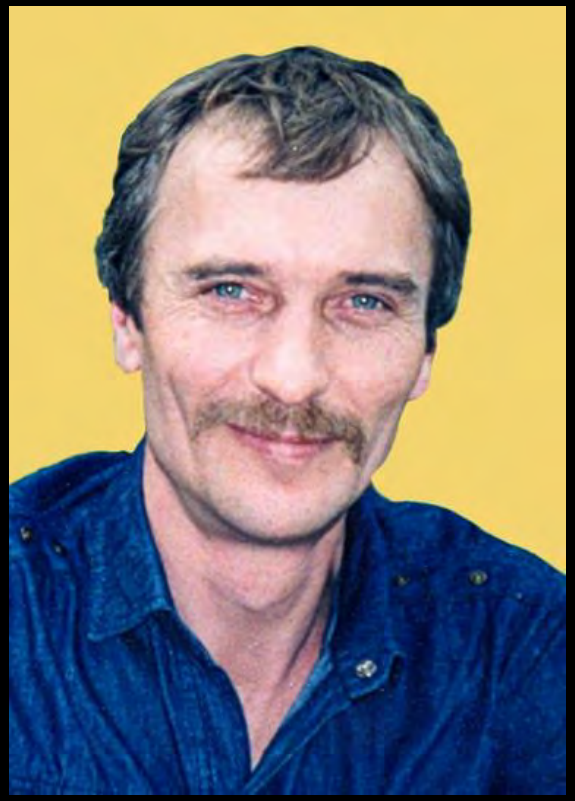
PHYSICS OF COMETS
SPACE PHYSICS

1939 - 1981: Chair of the Astronomy departament of the Kyiv University

FOLLOWERS OF THIS SCHOOL

L.M. Shulman

K.I. Churyumov and others



P.P. Korsun

RESEARCH FIELDS:

- Physics and Chemistry of Comets
- The Origin of the Solar System

V.P. TSESEVICH (1907 — 1983)
PHYSICS OF VARIABLE STARS

1933 — 1937 : Director of the Astronomical Observatory in Dushanbe (Tadzhic Republik)

1944 — 1983 : Director of the Astronomical Observatory of the Odesa University

FOLLOWERS OF THIS SCHOOL

V.G.Karetnikov

I.B.Pustyl'nik

N.S.Komarov

O.F. Pugach

S.M. Andrievsky

T.V.Mishenina

I.L. Andronov

V.V.Kovtyukh

Research fields:

- Variable stars of different types
- Chemical and dynamic evolution of stars and galaxies

The results of researches are published in journals: AJ, A & A, MNRAS, PASP, HiA, Astrophysics, KPCB, and others.

N.P. BARABASHOV (1894 — 1971)
PHYSICS OF MOON AND PLANETS

1930 — 1971 :
Director of the Astronomical Observatory of the Kharkiv University

FOLLOWERS OF THIS SCHOOL

I.K. Koval

O.V. Morozhenko

I.N. Belskaya

Yu.G. Shkuratov

and others

Ground-based programmes

Solar Systems Bodies & Exoplanets

PROGRAM OF PHOTOMETRIC OBSERVATIONS OF NEAR-EARTH AND SMALL MAIN-BELT ASTEROIDS

70-cm telescope at Abastumani | 1.5-m telescope at Maidanak | 2-m telescope at Rozhen






PROGRAM OF PHOTOMETRIC OBSERVATIONS OF NEAR-EARTH AND SMALL MAIN-BELT ASTEROIDS

70-cm telescope near Kharkiv | 1-m telescope at Simeiz | 70-cm telescope at Lisnyky






G.A. Shajn (1892 — 1956)

1944 : Founder and first director of the Crimea Astrophysical Observatory

A.B. Severny (1913 — 1987)

Observational astrophysics
Solar physics

1952 — 1987 : Director of the Crimea Astrophysical Observatory

RESEARCH FIELDS:

- Stellar spectroscopy
- Solar activity and oscillations
- Space research

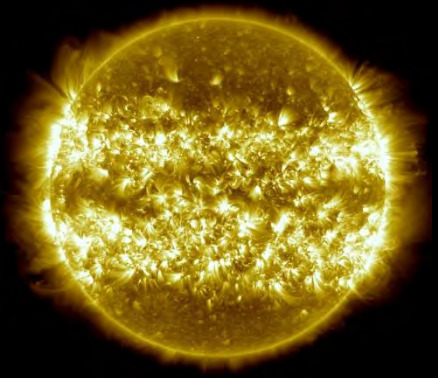
FOLLOWERS OF THIS SCHOOL IN UKRAINE

SOLAR PHYSICS

- T.T. Tsap
- E.A. Gurtovenko
- P.R. Romanchuk
- R.I. Kostyk
- N.G. Shchukina
- S.M. Osipov
- V.G. Lozitsky


проф.
Е. Гуртовенко


Член-кор. НАНУ Н. Щукіна




с.н.с.
С. Осипов


член-кор. НАНУ
Р. Костик

Досягнення геліофізиків ГАО НАНУ

2016


Сонячний телескоп Ернеста Гуртовенка

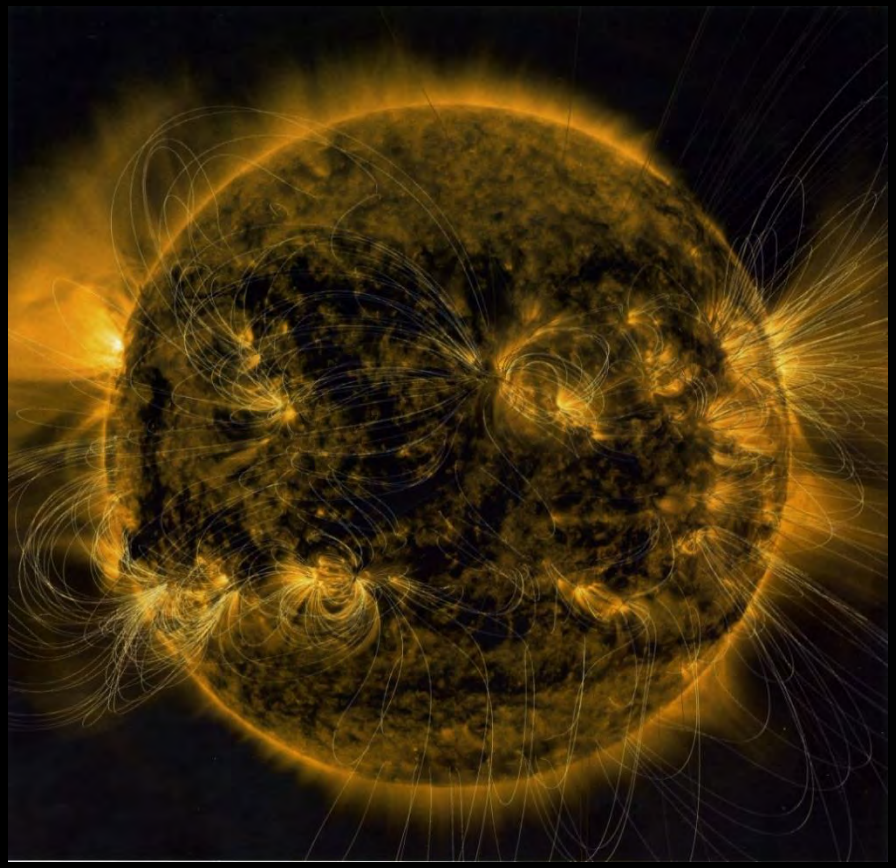
Моніторинг довгострокових змін сонячних спектральних ліній на телескопі Гуртовенка

Отримані результати – ключ до розуміння природи активності Сонця та її взаємозв'язку зі станом міжпланетного середовища та екосистем Землі.

Сонячний телескоп Ернеста Гуртовенка
(вид всередині)

- Сонячний телескоп Ернеста Гуртовенка по своїй спектральній роздільній здатності входить до трійки найпотужніших телескопів світу.
- У відділі фізики Сонця розроблені унікальні технології обробки спектральних спостережень Сонця

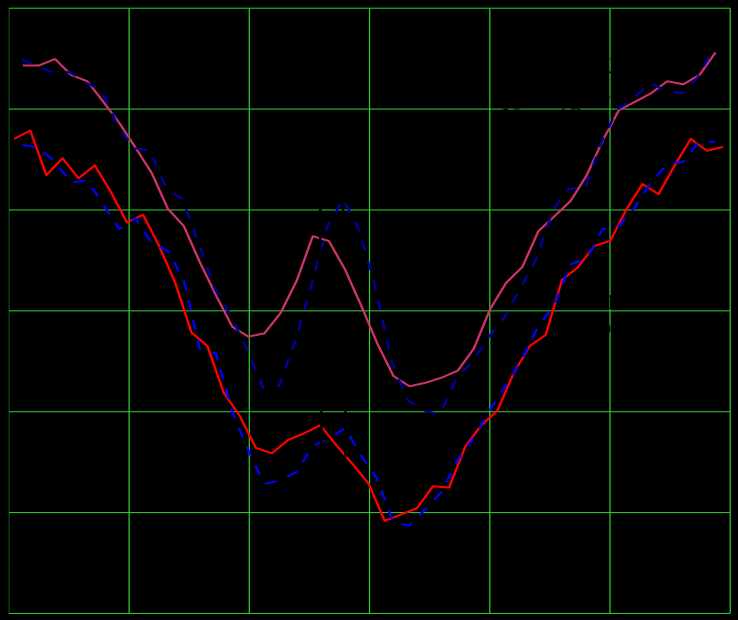
SUN MAGNETIC FIELD



Виявив спостережні свідчення існування у сонячних спалахах
екстремально сильних магнітних полів напруженістю 20-90 кГс.

Основний аргумент на користь таких полів – поява достовірого розщеплення емісійних піків у спектральних лініях з дуже малими і емпірично визначеними факторами Ланде (близько 0.01) у п'яти потужних сонячних спалахах.

Lozitsky V.G.



Спостережене розщеплення емісійних піків

в лінії FeI 5434.5 Å (g_{eff} = - 0.014) у винятково потужному сонячному спалаху 28.10.2003

балу X17.2 / 4B.

Основні результати опубліковані в журналах Solar Physics, Monthly Not. Royal Astron. Society,

Advances in Space Research, Kinem. Phys. Celest. Bodies та ін.

S.YA. BRAUDE (1911 — 2003)
RADIOASTRONOMY

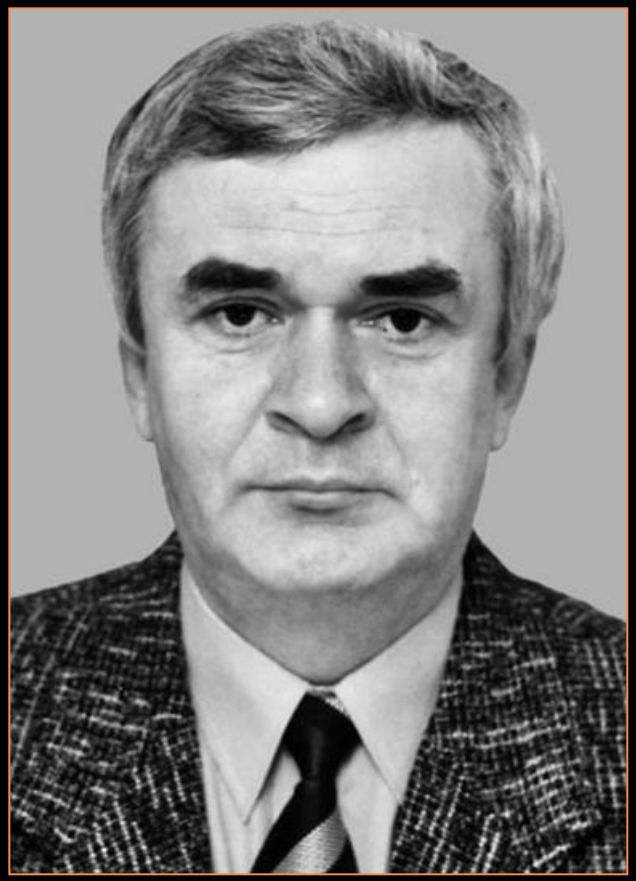
1958 : Founder of the Radioastronomical Observatory at Grakove village near Kharkiv sity

1985 : Founder of the Radioastronomical Institute of the NASU

RESEARCH FIELDS:

- Radiophysics
- Low frequency radioastronomy

FOLLOWERS OF THIS SCHOOL



O.O. Konovalenko

A.V. Men’

ASTRONOMY TECHNOLOGICAL PROGRAMMES

RADIO ASTRONOMY

Ukraine possesses of unique interferometer system URAN (Fig.2) The distribution of the radio astronomy means on the Ukraine territory is following: Radio telescopes UTR-2, URAN-1, URAN-4 belong to IRA NASU;

URAN-2 and URAN-3 belong to Poltava Gravimetric Observatory of NASU respectively.

Ukrainian instruments are actively using in the international collaboration with France, Austria, Germany, the Netherlands, India, Japan, Russia, Belgium, Great Britain. Ukrainian radio astronomers are involving officially in the international radio astronomy Projects for various topics (The Sun, space weather, Saturn, interplanetary medium, interstellar medium, pulsars, active stars, exoplanets, etc.).

Fig.2. URAN-1…URAN-4 radio telescopes,
(angular resolution is near one arcsec for the base line 950 km)

General remark 1

Three types of astronomy programs could be considered:

-of international level

-of national level

-of institutional level

There are the space-based and grand-based programs.

GROUND-BASED ASTRONOMICAL PROGRAMMES

- Positional Astronomy
- Solar Physics
- Solar System Bodies & Exoplanets
- Physics of Stars and Galaxies
- Extragalactic Astronomy
- e-Astronomy, GRID & Data Network

GROUND-BASED PROGRAMMES
POSITIONAL ASTRONOMY
INTERNATIONAL CELESTIAL REFERENCE FRAME

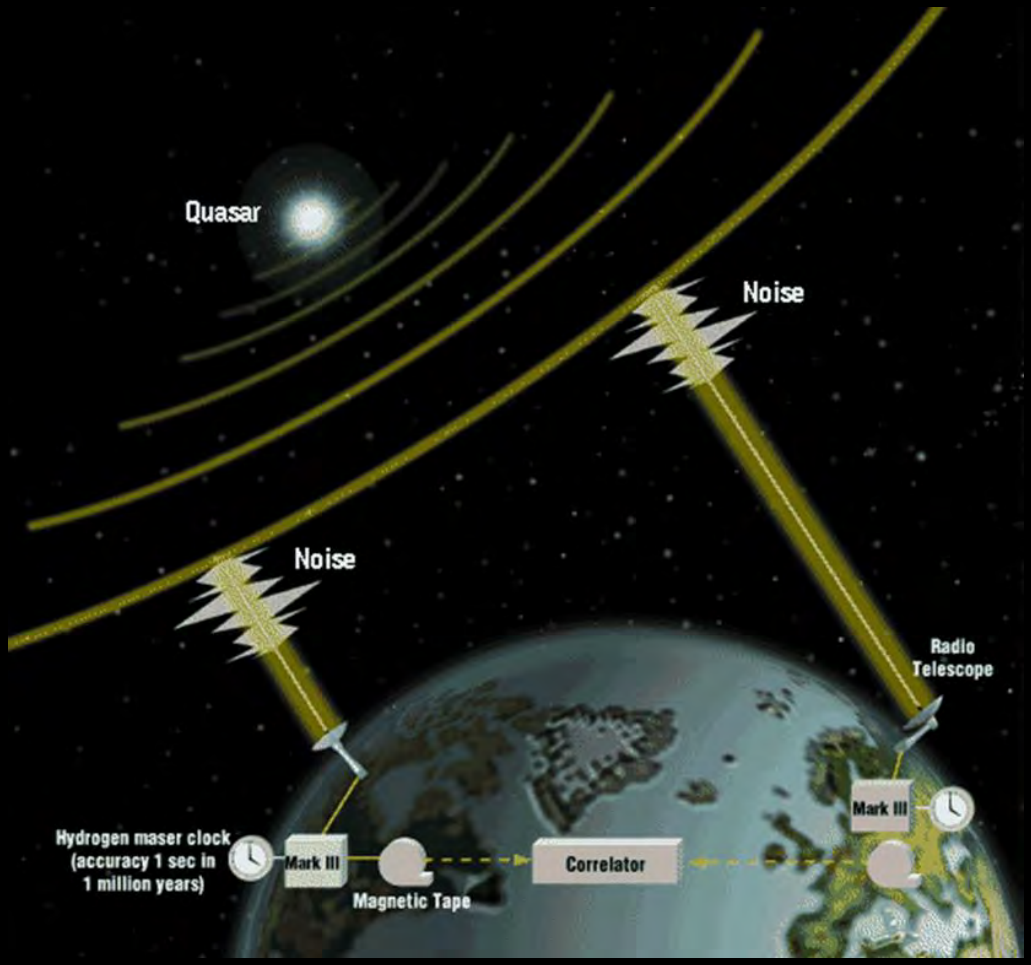
Participants:

- **USA:** NASA Goddard Space Flight Center

- **Ukraine:** Main Astronomical Observatory NASU, Dr. Ya. Yatskiv; Crimean Astrophysical Observatory MESU, Dr. A. Volvach
- and others

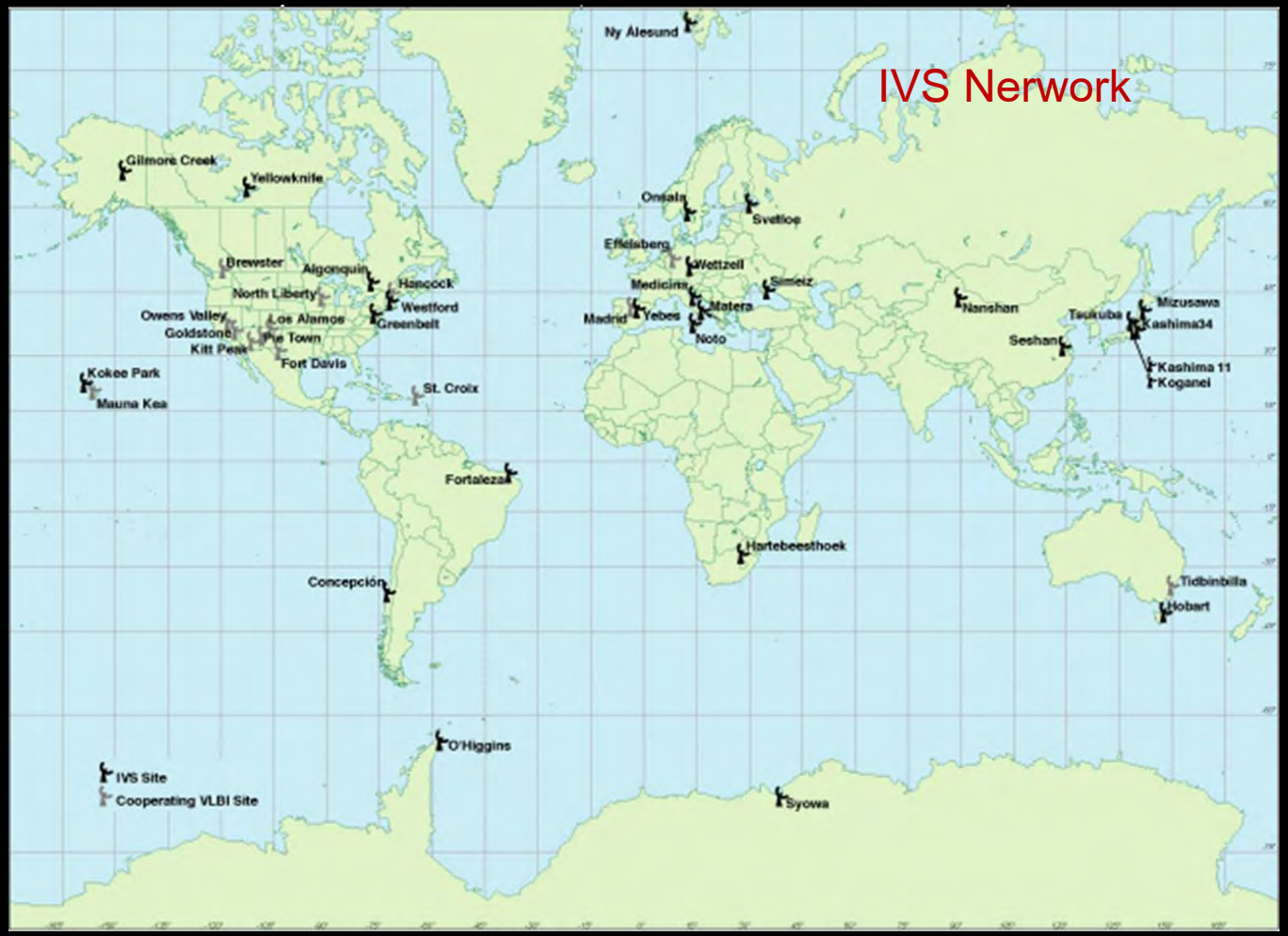
Objective is to upgrade the ICRF2 and construct the ICRF3.

Ground-based programmes
Positional Astronomy
International Celestial Reference Frame



VLBI is a geometric technique: it measures the time difference between the arrival at two Earth-based antennas of a radio wavefront emitted by a distant quasar. Using large numbers of time difference measurements from many quasars observed with a global network of antennas, VLBI determines the Inertial Reference Frame defined by the quasars and simultaneously the precise positions of the antennas.

Ground-based programmes
Positional Astronomy
International Celestial Reference Frame



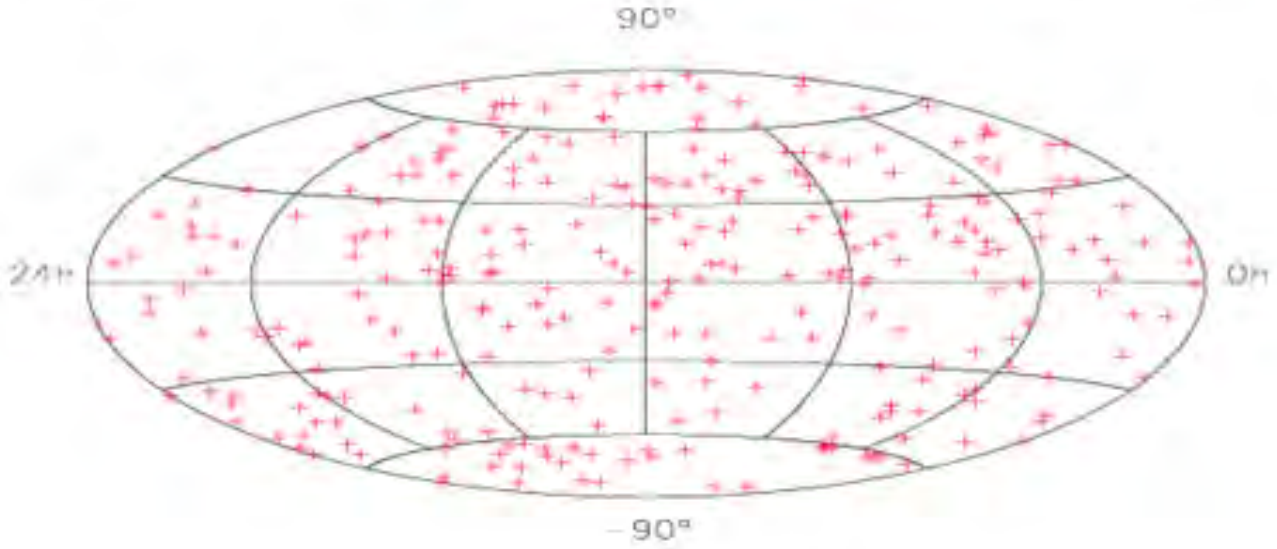
Ground-based programmes
Positional Astronomy
International Celestial Reference Frame

General characteristics of CRF solutions

Name of catalogue	Number of sources		Software	Analysis center
aus007a	1564	1516	OCCAM6.2	GA
bkg001a	3019	2978	CALC 10.00, SOLVE rev. 2007.10.31	BKG
gsf007b	3414	3378	CALC 10.00/10.01, SOLVE rev. 2008.12.05	GSFC
iaa008c	2961	2918	QUASAR	IAA
mao008a	3555	3512	SteelBreeze	MAO
opa008b	3244	3214	CALC 10.00, SOLVE rev. 2008.12.05	OP
usn010b	3414	3380	CALC 10.00, SOLVE rev. 2007.11.08	USNO
maoC08a	3572	3572	Combined	MAO

Ground-based programmes
Positional Astronomy
International Celestial Reference Frame

Second Realization of the International Celestial Reference Frame (ICRF2)



- Image shows the 295 defining sources of the ICRF2 on the celestial sphere
- ICRF2 contains precise positions of 3414 compact extragalactic radio sources
- Sources are typically quasars - very distant extragalactic radio sources
- ICRF2, adopted at the 2009 IAU General Assembly, effective since 1 January 2010 (replaced ICRF1)

GROUND-BASED PROGRAMMES POSITIONAL ASTRONOMY

OPEN STAR CLUSTERS IN THE MILKY WAY

Participants:

Germany: Astronomisches Rechen-Institut, Zentrum fur Astronomie der Universitet Heidelberg, Dr. S. Roeser, Dr. E. Schilbach; Leibniz-Institut fur Astrophysik Potsdam, Dr. R.-D. Scholz

Russia: Institute of Astronomy of RAS, Prof. A.E. Piskunov
Ukraine: Main Astronomical Observatory of NASU, Dr. N.V. Kharchenko

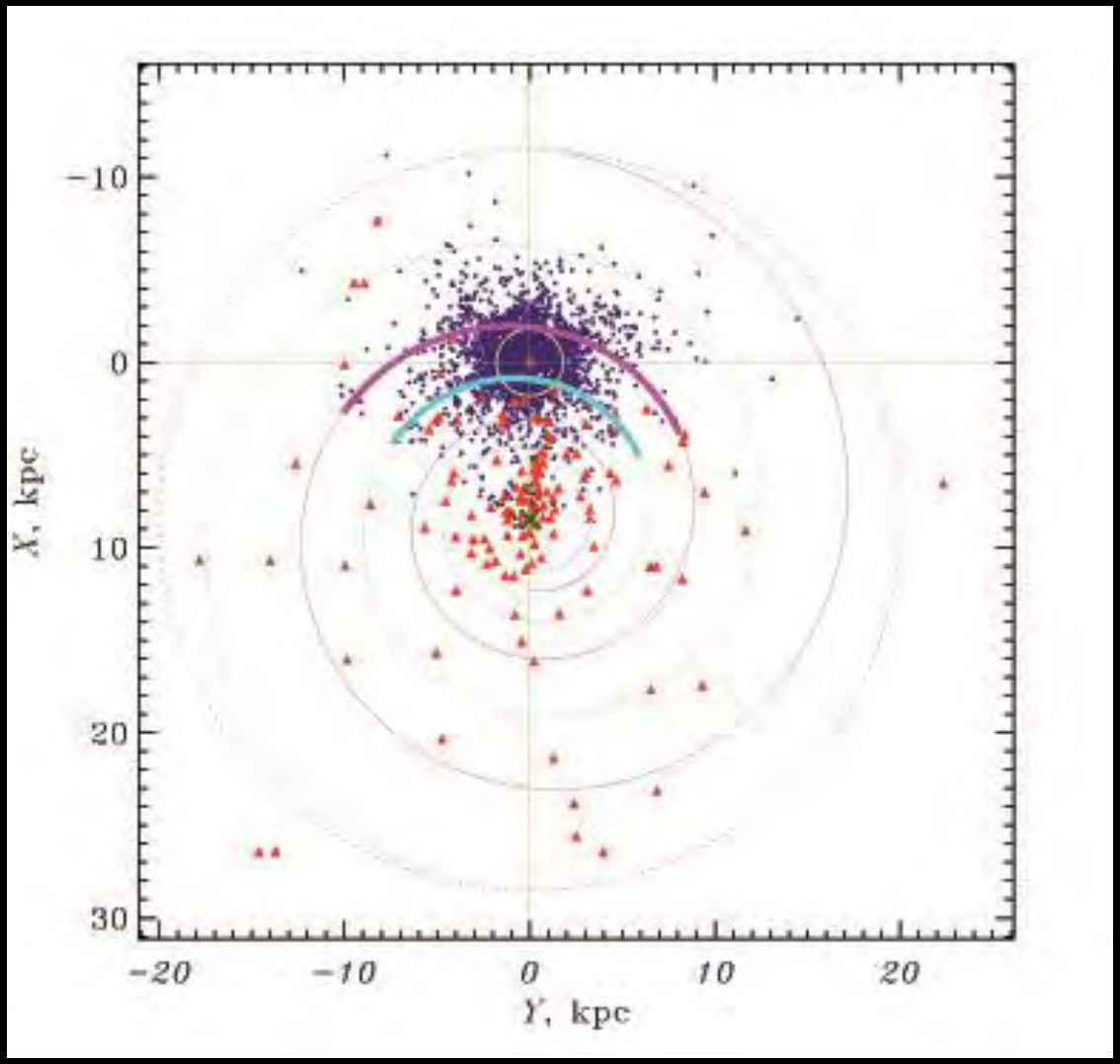
Objective of the project is to use stellar clusters as tracers of the evolution of the Milky Way and to estimate their contribution to the stellar content of the Galaxy at every stage of a clusters' life up to a few tens kpc. Using new deep, all-sky surveys (f.e. 2MASS, SDSS, PPMXL), we will carry out the largest, most complete, homogeneous and comprehensive photometric and kinematic census of stellar clusters and associations to data.

Ground-based programmes
Positional Astronomy
Open star clusters in the Milky Way

Results

- Up to now the largest input list of 3784 targets from the literature was compiled and confirmed that 3006 are real objects: stellar associations, open and globular clusters. For each confirmed object we determined the exact position of the cluster centre, the apparent size, proper motion, distance, color excess, tidal radius and age. For about 1500 clusters, these basic astrophysical parameters have been determined for the first time.
- Based on uniformly determined cluster parameters (kinematics, age, distance, tidal radius, mass, luminosity function, metallicity), we will derive the cluster dispersal rate and explore what governs it, along with the star formation history of the Galaxy as traced by clusters.

Ground-based programmes
Positional Astronomy
Open star clusters in the Milky Way



GROUND-BASED PROGRAMMES POSITIONAL ASTRONOMY

PLANETS AROUND L-DWARFS WITH ASTROMETRY

Participants:

Switzerland: Geneva Observatory, Drs. J.Sahlmann, D.Segransan,

D. Queloz, M. Mayor, S. Udry

Ukraine: Main Astronomical Observatory of NASU, Dr. P. Lazorenko

Spain: CSIC-INTA, Dr. E. Martin

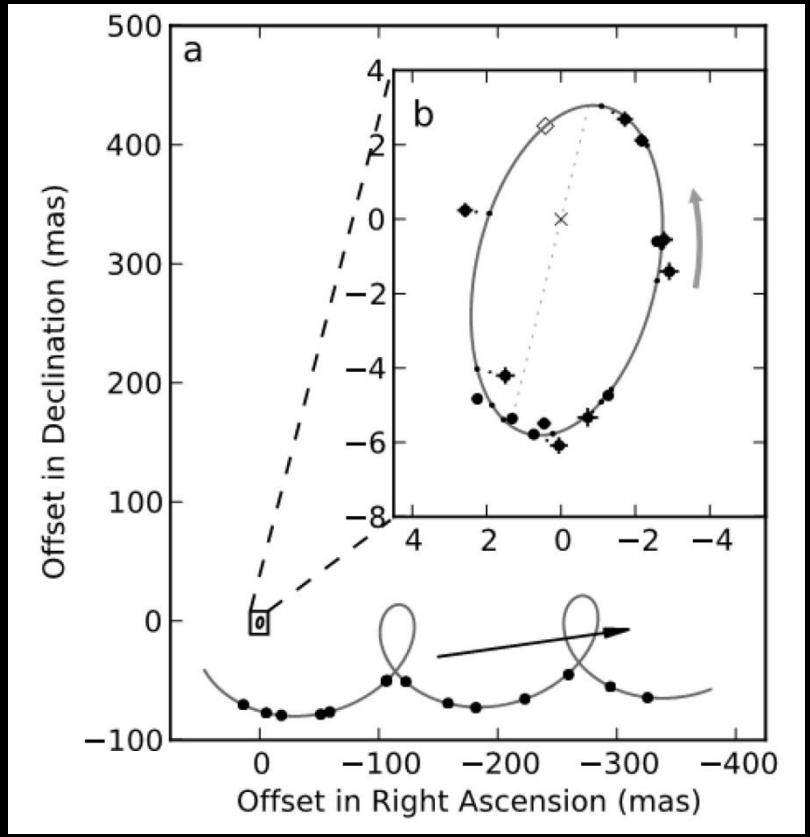
Objective is to study of the possibility extrasolar planets existence around ultracool dwarfs.

Ground-based programmes
Positional Astronomy
Planets around L-dwarfs with Astrometry

Technique & some results

Using FORS2/VLT optical imaging for high precision astrometry the search for planets and substellar objects around ultracool dwarfs is undertaken to investigate their multiplicity properties for very low companion masses.

Astrometric measurements were made with an accuracy of two tenths of a milli-arcsecond over two years that reveal orbital motion of the nearby L1.5 dwarf DENIS-P J082303.1-491201 located at 20.77± 0.08 pc caused by an unseen companion that revolves about its host on an eccentric orbit in 246.4 ±1.4 days.



GROUND-BASED PROGRAMMES SOLAR PHYSICS

MAGNETISMO SOLAR Y ESPECTROPOLARIMETRIA EN ASTROFISICA (2004-2006)
MAGNETISM AND POLARIZATION IN ASTROPHYSICS (2007-2009)

Participant's:

Spain: Instituto de Astrofísica de Canarias, Drs. H. Socas Navarro, J. Trujillo Bueno et al.; CAB, Dr. J. Cernicharo

Ukraine: Main Astronomical Observatory of NASU, Dr. N.G. Shchukina

Switzerland: Istituto Solari Ricerche, Drs. M. Bianda, R. Ramelli

USA: NCAR, Drs. R. Casini, R. Centeno, B.W. Lites; NSO, Dr. H. Uitenbroek; Univ. Kentucky, Dr. M. Elitzur; Univ. Alabama, Dr. K. Kobayashi

Sweden: Univ. Stockholm, Dr. J. de la Cruz

Italy: Univ. Florencia, Dr. E. Landi Degl'Innocenti

France: THEMIS, Dr. A. López Ariste

Japan: NAOJ, Dr. S. Tsuneta

Objectives are to explore in depth the physics and origin of polarized radiation in astrophysical plasmas as well as its diagnostic use for understanding cosmic magnetic fields, with emphasis on the magnetism of the extended solar atmosphere.

GROUND-BASED PROGRAMMES SOLAR PHYSICS

MAGNETISMO SOLAR Y ESPECTROPOLARIMETRIA EN ASTROFISICA (2004-2006) AND MAGNETISM AND POLARIZATION IN ASTROPHYSICS (2007-2009)

The longitudinal Zeeman effect and the Hanle diagnostics were used to find small-scale magnetics fields in the quiet solar photosphere

The results of Hanle diagnostics indicated that the bulk of the quiet solar photosphere is significantly magnetized, due to the ubiquitous presence of an unresolved magnetic field with an average strength $\langle B \rangle \approx 130$ G.

GROUND-BASED PROGRAMMES SOLAR PHYSICS

SOLAR SPECTROPOLARIMETRY

Spain: Instituto de Astrofísica de Canarias, Drs. E.V. Khomenko, M. Collados Vera, N. Vitas et al.; IAA, drs. L.R. Bellot Rubio, J.C. del Toro Iniesta

Ukraine: Main Astronomical Observatory of NASU, Drs. N.G. Shchukina, R.I. Kostik

USA: Stanford University, Dr. A. Sainz; Sac Peak, Dr. C. Beck

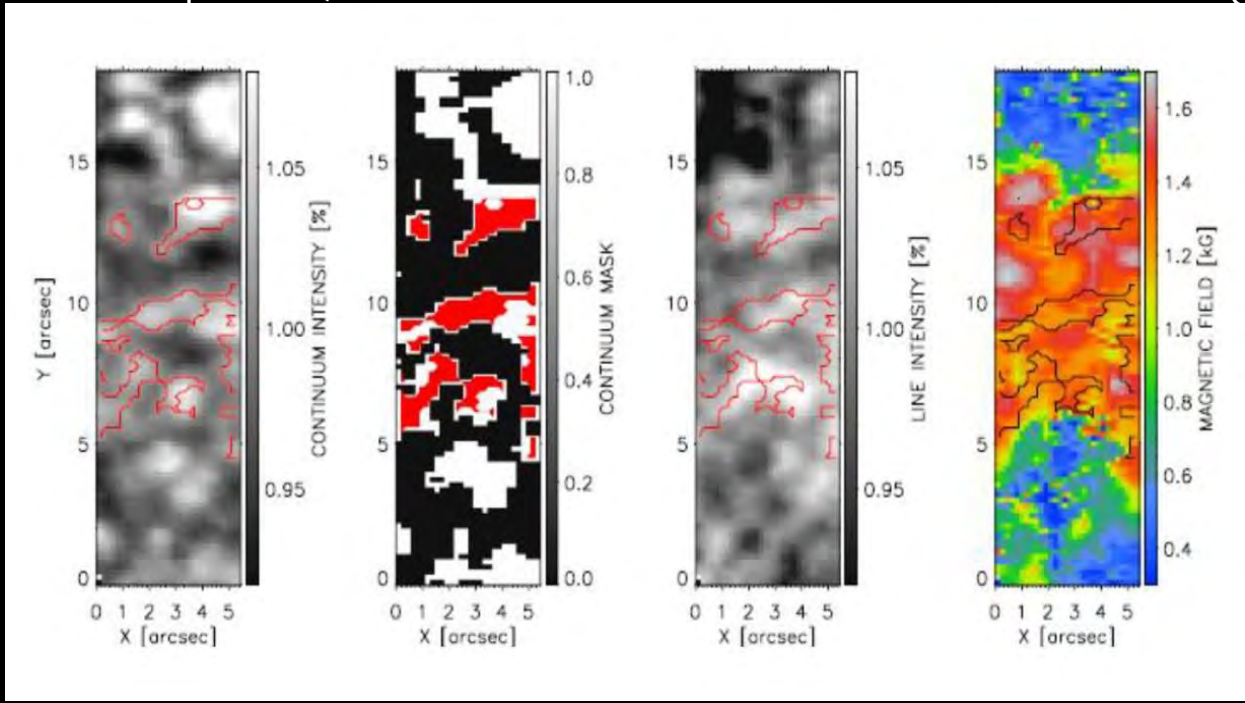
Germany: Kiepenheuer Institut für Sonnenphysik, Drs. W. Schmidt, D. Soltau, Th. Berkefeld, R. Rezaei; MPI für Sonnesystemforschung, Drs. S.K. Solanki, A. Gandorfer; Potsdam IA, C. Kuckein

Australia: Univ. Melbourne, Dr. P. Cally

Italy: Univ. Tor Vergata, Dr. M. Stangalini

Objective is the study of the diverse manifestations of the magnetic field in the solar atmosphere and in other stars. These include distinct structures as sunspots, weak quiet-sun fields or chromospheric and coronal features such as filaments and prominences.

The observations at the German Vacuum Tower Telescope (Observatorio del Teide, Tenerife, Spain) using two different instruments: the Triple Etalon SOlar Spectrometer (TESOS) were made to measure velocity and intensity variations along the photosphere in the Ba II 4554 Å line; and, simultaneously, the Tenerife Infrared Polarimeter (TIP-II) to the measure Stokes parameters and the magnetic field strength at the lower photosphere in the Fe I 1.56 μm lines. The convective velocities of granules in the facular area decrease with magnetic field while the convective velocities of intergranular lanes increase with the field strength. The strong magnetic field of the facular area seems to stabilize the convection and to promote more effective energy transfer in the upper layers of the solar atmosphere, since the convective elements reach greater heights.



The panels from left to right are: Ba II 4554E continuum intensity in units of its spatially averaged value; mask applied to locate granules and intergranular lanes; Ba II 4554E line center intensity in units of its spatially averaged value;magnetic field strength in units from the inversion of Fe I IR lines. Contours mark the location of granular areas with the magnetic field above 1.2 kG.

GROUND-BASED PROGRAMMES
SOLAR SYSTEMS BODIES & EXOPLANETS

STUDY OF PHYSICAL PROPERTIES OF TRANSNEPTUNIAN OBJECTS AND CENTAURS

• cooperative project of
Paris Obs., France (A. Barucci),
Kharkiv Obs., Ukraine (I. Belskaya)
Armagh Obs, UK (S. Bagnulo)
Helsinki Obs., Finland (K. Muinonen)

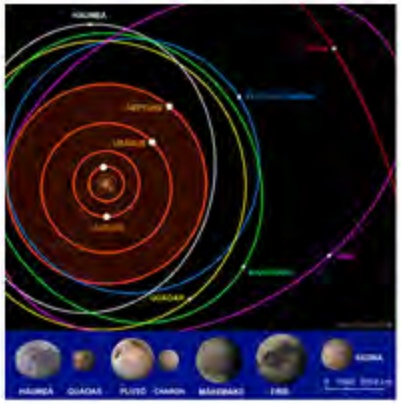
• the main goal is to study surface properties by different techniques (the polarimetry team is headed by I. Belskaya) and provide essential information about the conditions in the early Solar System environment at large distances from the Sun

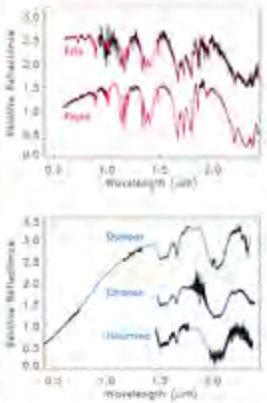
• observations at 8 m telescope (VLT) to provide good-quality data for faint objects (20-22 mag) using FORS, ISAAC and SINFONI instruments; ~400 h of observing time in the service mode were granted since 2007.

GROUND-BASED PROGRAMMES
SOLAR SYSTEMS BODIES & EXOPLANETS

MAIN RESULTS

- The first taxonomy of transneptunian objects.
- Number of relationships between physical and dynamical properties of TNOs needed to test and improve the models of Solar system origin and evolution.
- Detailed information on the composition and surface texture of all large bodies (D>1000 km) discovered so far beyond Neptune.





The figure (on the left, adapted from Gavin Rymill 2006) shows the circular orbits of the eight planets versus the eccentric orbits of the biggest TNOs.
On the right the two groups of spectra: Eris and Pluto with methane ice dominated spectra and Quaoar, Haumea and Charon with water ice dominated spectra.

Barucci, M.-A. et al. The Messenger 141, 15 (2010); Icarus, 214, 297 (2011).
Belskaya I.N. et al. A&A, 479, 285 (2008); Icarus 210, 472 (2010)

Ground-based programmes

Solar Systems Bodies & Exoplanets

PROGRAM OF PHOTOMETRIC OBSERVATIONS OF NEAR-EARTH AND SMALL MAIN-BELT ASTEROIDS IN INSITUTE OF ASTRONOMY OF KARAZIN KHARKIV NATIONAL UNIVERSITY

- *Searching for binary asteroids and determining parameters of the binary systems: In cooperation with Czech astronomers from Ondrejov Astronomical Observatory, Czech Academy of Sciences. More then 20 binary asteroids have been detected and/or investigated.*
- *Detection of Yarkovsky-O'Keeffe-Radzievskii-Paddack effect (YORP effect) for an asteroid as a result of photometric observations: In cooperation with Czech astronomers from Institute of Astronomy of Charles University in Prague. Three of four asteroids with detected to date YORP effect have been discovered (Apollo, Geographos, Eger).*

In Ukraine the coordinated photometric observations in frame of the program have been carried out with the 70-cm telescope at Kharkiv Observatory, the 1-m telescope at Simeiz Observatory, and the 70-cm telescope at Lisnyky Observatory. Additional observations have been made in cooperation with Abastumani Observatory (Georgia) on the 70-cm and 1.25-m telescopes, with Maidanak Observatory (Uzbekistan) on the 60-cm and 1.5-m telescopes, with Rozhen Observatory on the 2-m telescope. All of these telescopes have been equipped with modern CCD-cameras.

Ground-based programmes

Solar Systems Bodies & Exoplanets

PROGRAM OF PHOTOMETRIC OBSERVATIONS OF NEAR-EARTH AND SMALL MAIN-BELT ASTEROIDS

70-cm telescope near Kharkiv

1-m telescope at Simeiz

70-cm telescope at Lisnyky

PROGRAM OF PHOTOMETRIC OBSERVATIONS OF NEAR-EARTH AND SMALL MAIN-BELT ASTEROIDS

70-cm telescope at Abastumani

1.5-m telescope at Maidanak

2-m telescope at Rozhen

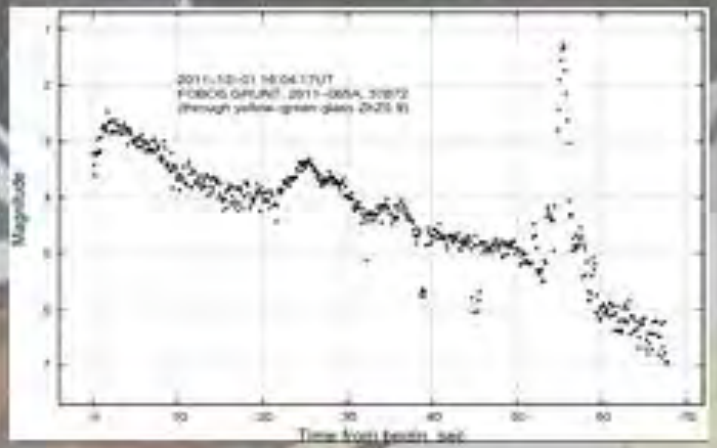
Ground-based programmes

Solar Systems Bodies & Exoplanets

Collaboration between Lviv AO and Shanghai AO (China)

International cooperation between Lviv Astronomical Observatory and Shanghai Observatory of Chinese Academy of Sciences started in 2010.

In 2011 Lviv AO received the CCD Camera from ShAO for the satellites observations. Especially the Chinese colleagues were interested in the satellite carried by the Russian cosmic mission Fobos-Grunt. The results of observations (light curves) were sent to ShAO (Dr. Z.H. Tang).



GROUND-BASED PROGRAMMES PHYSICS OF STARS

Rocky Planets Around Cool Stars (ROPACS)

FP7 Marie Curie Actions - Networks for Initial Training (ITN)

Grant Agreement Number 213646, PITN-GA-2008-213646.

Participants:

United Kingdom: University of Hertfordshire;
University of Cambridge

Spain: Instituto de Astrofísica de Canarias;
Instituto Nacional de Tecnica Aeroespacial

Germany: Max-Planck-Gesellschaft zur Foerderung der Wissenschaften

Ukraine: Main Astronomical Observatory of NASU, Dr. Ya.V. Pavlenko

GROUND-BASED PROGRAMMES PHYSICS OF STARS

Rocky Planets Around Cool Stars (ROPACS)

The network's objectives are the following:

- To carry out observational programmes to place constraints on transiting systems, using

measurements of the primary and secondary eclipses.

- To develop a theory observational techniques to study the properties of cool stars and cool star systems, and study how these properties relate to the presence (or not) of orbiting extra-solar planets.

Main goals of the MAO's node: to develop cool star atmospheric models.; to measure spectroscopy of cool star hosts over a broad/useful spectral range.; to fFit cool star properties with models, and assess the implications for orbiting planets.

GROUND-BASED PROGRAMMES
PHYSICS OF STARS
ROCKY PLANETS AROUND COOL STARS (ROPACS)

CM Dra spectrum analysis

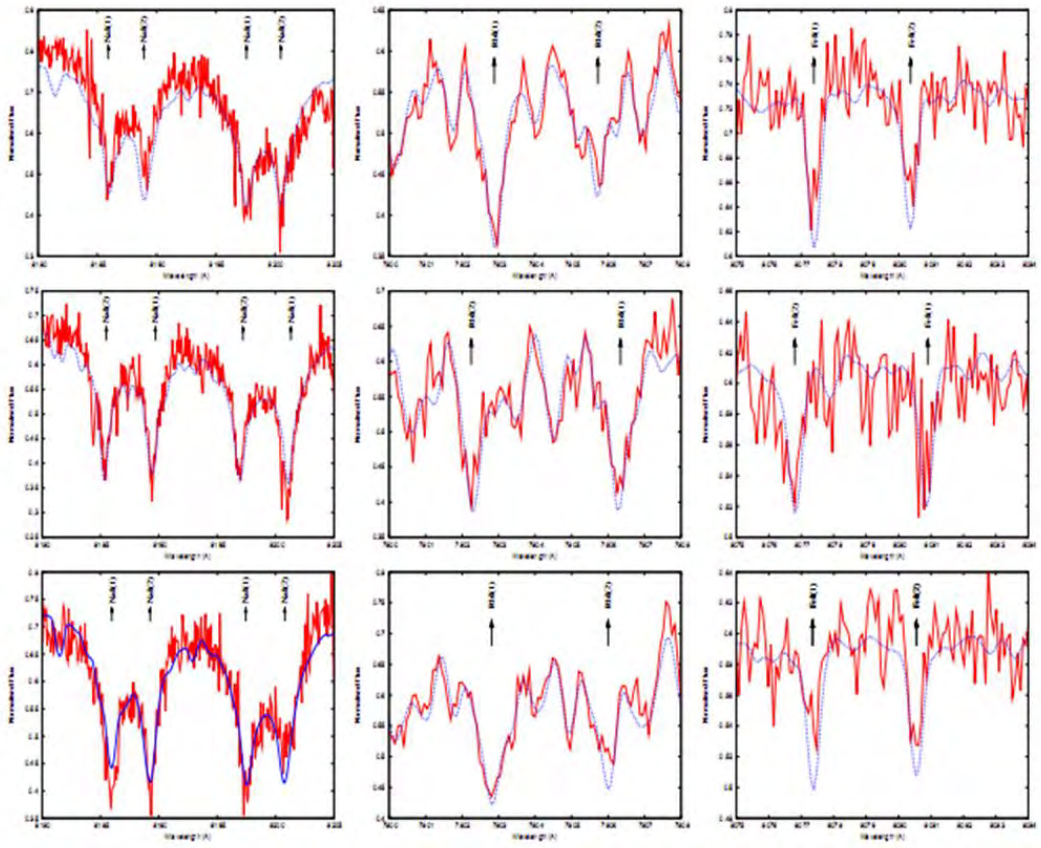


Figure 3. Fits to observed spectra at the phases $\phi = 0.11$ (first line); $\phi = 0.49$ (second line); $\phi = 0.89$ (third line) for $T_{\rm eff}(A) = 3200$ K, log g (A)=5.0 and [M/H](A)=-0.5; $T_{\rm eff}(B) = 3200$ K, log g (B)=5.0 and [M/H](B)=-0.5 in regions NaI 8185 Å and NaI 8197 Å, RbI 7802 Å, FeI 8077 Å lines respectively

The effective temperature and metallicity of the CM Draconis binary components were determined. CM Dra is the benchmark object for the theory of cool dwarfs formation and evolution. It is double-lined eclipsing binary system which consists of two M dwarfs. In our analysis we used 29 echelle spectra from the archive of the 4.2-m William Herschel Telescope. The spectra were obtained at high-resolution spectrograph (UES) in different phases. We fitted our calculated synthetic spectra of the CM Dra system as a whole to the observed spectra at all phases. The effective temperature Tef=3220 +/- 55~K and metallicity [M/H]=-0.47 /-0.25 were obtained for both components of CM Dra from analysis of the best fit parameters for the spectral regions containing strong enough atomic absorption lines, i.e. NaI 8185 A, NaI 8197 A, RbI 7818 A and FeI 8077 A.

Ground-based programmes
Physics of Stars
Rocky Planets Around Cool Stars (ROPACS)

The analysis of WTS-1b and WTS-2b, namely two first extrasolar planets found by the WFCAM Transit Survey from observations at the 3.8-m United Kingdom Infrared Telescope (UKIRT) in 2007 August, was carried out. Planets were discovered by analysis of light curves comprising almost 1200 epochs with a photometric precision of better than 1% to J~16 were constructed for ˜60 000 stars and searched for periodic transit signals. For one of the most promising transiting candidates, high-resolution spectra taken at the Hobby-Eberly Telescope (HET) allowed us to estimate the spectroscopic parameters of the host star, a late-F main-sequence dwarf (V = 16.13) with possibly slightly subsolar metallicity, and measure its radial velocity variations. The combined analysis of the light curves and spectroscopic data resulted in an orbital period of the substellar companion of 3.35 d, a planetary mass of 4.01 ± 0.35 MJ and a planetary radius of 1.49-0.18+0.16 RJ. WTS-1b has one of the largest radius anomalies among the known hot Jupiters in the mass range 3-5 MJ. The high irradiation from the host star ranks the planet in the pM class. Based on observations collected at the 3.8-m United Kingdom Infrared Telescope (Hawaii, USA), the Hobby-Eberly Telescope (Texas, USA), the 2.5-m Isaac Newton Telescope (La Palma, Spain), the William Herschel Telescope (La Palma, Spain), the German-Spanish Astronomical Centre (Calar Alto, Spain), the Kitt Peak National Observatory (Arizona, USA) and the Hertfordshire's Bayfordbury Observatory.

GROUND-BASED PROGRAMMES PHYSICS OF STARS

EVOLVED STARS: CLUES TO THE CHEMICAL EVOLUTION OF GALAXIES (POSTAGBINGALAXIES)

FP7 Marie Curie Actions - People International Research Staff Exchange Scheme.

Grant Agreement Number 269193, PIRSES-GA-2010-269193.

Participants:

Latvia: Latvijas Universitate

Poland: Nicolaus Copernicus Astronomical Centre of the Polish AS

Ukraine: Main Astronomical Observatory of NASU

China: Yunnan Astronomical Observatory of Chinese AS

United States: The Lutheran University Assoc., Inc.

Russia: Institute of Astronomy of the RAS

Objectives: (1) the pulsation and dynamical phenomena in the (outer) atmospheres, (2) the structure and mass-loss history, (3) the chemistry and the kinematics of the outflows.

GROUND-BASED PROGRAMMES PHYSICS OF STARS

EVOLVED STARS: CLUES TO THE CHEMICAL EVOLUTION OF GALAXIES (POSTAGBINGALAXIES)

Objectives for MAO NASU

1. Observation of cool R CrB stars at 2.6 m Crimean and 2.0 m Terskol telescopes, data reduction and interpretation.

2. Self-consistent analysis of spectra of R CrB stars using computed model atmospheres, taking account of molecular and atomic opacities. Model atmospheres will be computed for the abundances obtained by our analysis. Fits to the low-resolution spectra will be used to determine the basic parameters. Process of abundance and basic parameters determinations will be repeated iteratively till the convergence of the model.

3. Fits of computed spectra to the observed fluxes in the optical and infrared spectral regions. Determination of the temporal changes of the main physical parameters.

4. Evolutionary changes of abundances in atmospheres of R CrB stars. Validation of existing theories of evolution of R CrB stars; are they genuine post-AGB stars or binary mergers.

Li in F supergiants

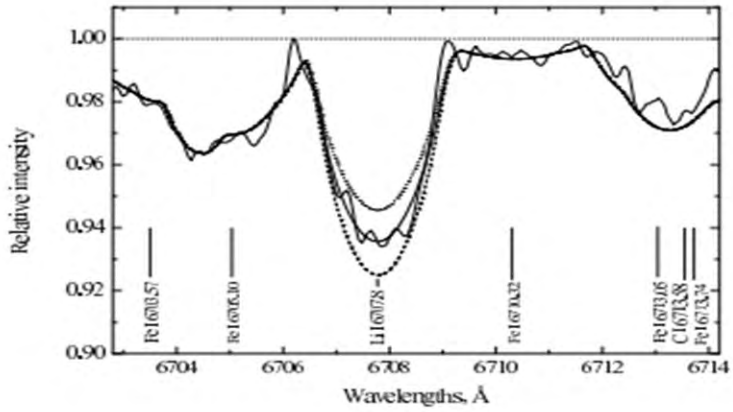


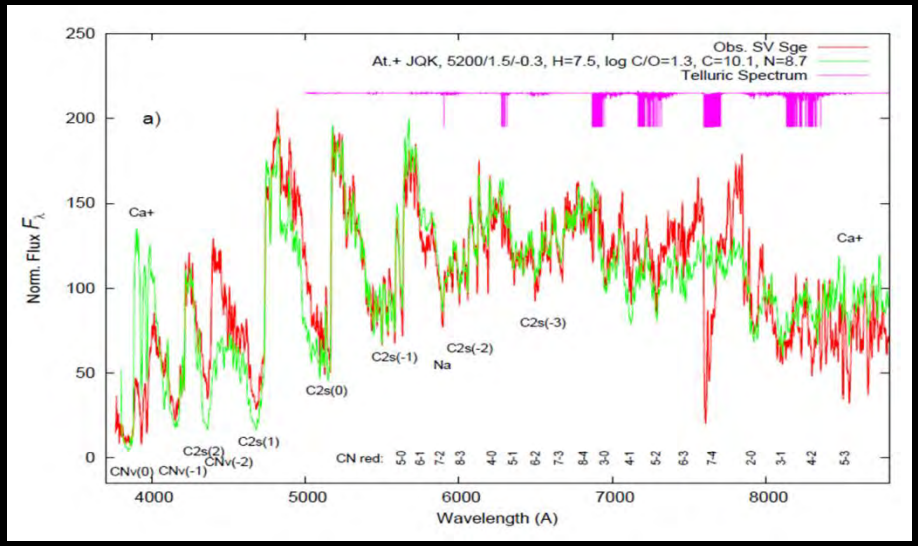
Figure 4. Observed spectrum (thick solid curve) and synthetic ones in the Li I 6707.8 line region for the Li-rich F-type giant HR 7008 with the relatively high rotational velocity $v \sin i = 58$ km s^{-1}. The Li I 6707.8 line is computed for three Li abundances: the basic abundance $\log \epsilon(\mathrm{Li}) = 3.07$ (thin solid curve) and two others corresponding to the uncertainty ± 0.12 dex (dashed and dotted curves).

GROUND-BASED PROGRAMMES PHYSICS OF STARS

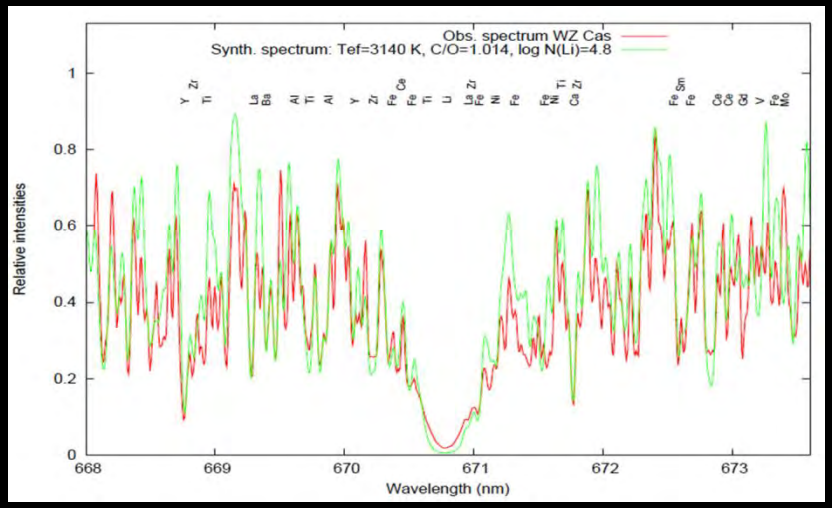
EVOLVED STARS: CLUES TO THE CHEMICAL EVOLUTION OF GALAXIES (POSTAGBINGALAXIES)

Study of post-ABG-stars.

R CrB stars. Fits to SEDs of SV Sge.



Li in the evolved stars. Fits to Li resonance doublet in WZ Cas spectrum.



GROUND-BASED PROGRAMMES PHYSICS OF STARS

The Synchronous Network of distant Telescopes

Participants:

Ukraine: Main Astronomical Observatory of NASU,
Dr. B. Zhilyaev, O. Svyatogorov, I. Verlyuk

Russia, Ukraine: International Centre for Astronomical, Medical and Ecological
Research, peak Terskol, Kabardino-Balkaria,
Dr. A. Sergeev, M. Andreev

Ukraine: Crimean Astrophysical Observatory of MESU, M. Lovkaya

Bulgaria: Institute of Astronomy and Rozhen NAO; Space Research Institute of Bulgarian AS; Institute of Mathematics and Informatics,
Dr. S. Antov, R. Konstantinova-Antova, R. Bogdanovski

Greece: University of Thessaloniki
S. Avgoloupis, J. Seiradakis, M. Contadakis

GROUND-BASED PROGRAMMES PHYSICS OF STARS

The Synchronous Network of distant Telescopes

The Synchronous Network of distant Telescopes (SNT) represents an innovative approach in observational astrophysics. All the telescopes of the Network are equipped with standardized photometric systems (based on photomultipliers). The unified timing systems (based on GPS-receivers) synchronize all the apertures to UTC with an accuracy of 1 microsecond and better. The essential parts of the SNT are the original software for operating and data processing.

Described international Network successfully works for more then 10 years.

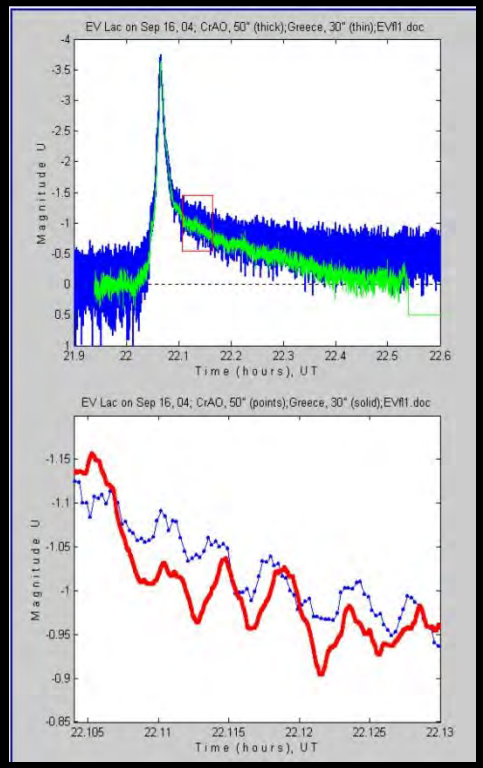
The obtained unique observational data made it possible to discover new fine-scale features and flare-triggered phenomena in flaring red dwarfs.

GROUND-BASED PROGRAMMES PHYSICS OF STARS

THE SYNCHRONOUS NETWORK OF DISTANT TELESCOPES

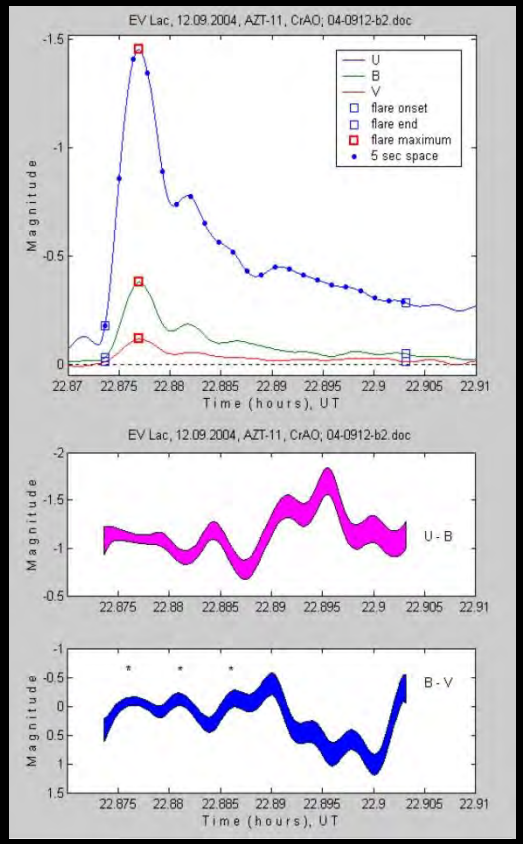
Transient processes in stars

The SNT allows us to discover brightness oscillations during flares of stars. These oscillations allows to diagnose plasma of stellar coronae. Oscillations in flares are caused by magneto-acoustic waves in coronal loops of stars. Such a flare oscillation provides an excellent opportunity to obtain coronal properties like the size of a flare loop or the local magnetic field strength.



Two-site photometry of a flare on EV Lac, 2004 September 16, as seen simultaneously by telescopes sited in Ukraine (points) and Greece (solid).

Fast colorimetry of the flare star allowed estimating the temperature at maximum brightness and its size



UBV colorimetry of a flare on EV Lac. The temperature near flare peaks amounts to ~ 18500 K. The size of flare area amounts to ~ 1.1% of the apparent stellar disk.

GROUND-BASED PROGRAMMES

PHYSICS OF STARS

CCD photometry of a faint cataclysmic variable stars and relative objects in the Crimean astrophysical observatory

Ground-based programmes

Physics of Stars

Photometry of the cataclysmic variables in the Crimean astrophysical observatory in 1975 – 2012 years with 38-cm, 50-cm, 1.25-m and in the primary focus of the 2.6-m Shajn mirror telescope.

The most significant results:

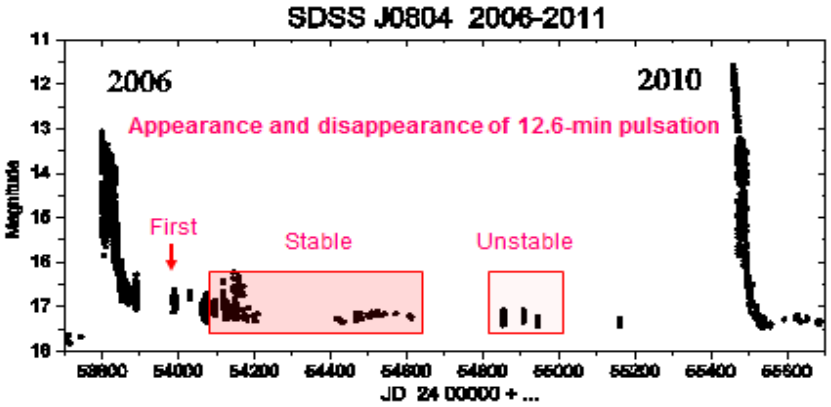
Discovery of the non-linear spin-orbital synchronization in the asynchronous polar V1500 Cyg, finding of the observational evidences of the complex magnetic field structure in the asynchronous polar BY Cam; finding of a strong dependence of its accretion geometry on the magnetic field orientation;

Discovery of the 2006 outburst in the dwarf nova EZ Lyn, its identification, discovery of the 12.6-min nonradial pulsations of the accreting white dwarf and their evolution, discovery of the brown dwarf counterpart in this binary;

Discovery of the nodal precession of accretion disk in the dwarf nova MN Dra

Discovery of the optical counterpart to the black hole in the X-ray nova J0422+32;

Classification of the ROSAT sources 1RXS J184542+483134, 1RXS J003828.7+250920 and 1RXS J105120.5+672550.



The light curve of cataclysmic variable EZ Lyn (=SDSS J0804) in 2006—2011. Intervals of the first detection of the nonradial WD pulsations, stable and non-stable their behavior are marked.

Ground-based programmes

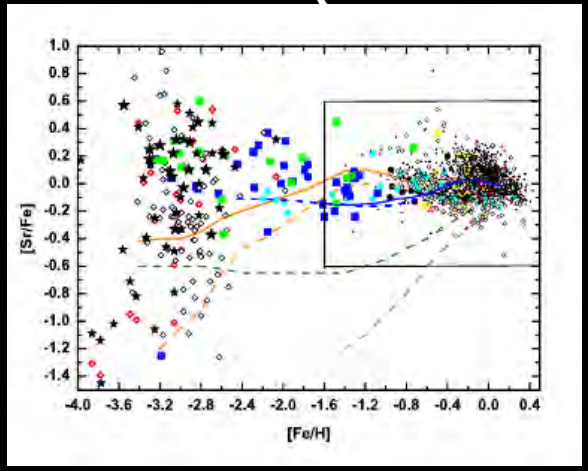
Physics of Stars

"Stars, Stellar Explosions, and the Origin of the Elements"

SCOPES project No. IZ73Z0-152485 **2014-2017.**

Switzerland: Departement Physik, Universität Basel
(F. K.Thielemann);
Observatoire de Genève, Université de Genève
(C. Charbonnel);

Ukraine: Astronomical Observatory, Odesa National University,
Odesa (T.V. Mishenina).



The run of [Sr/Fe] with [Fe/H] in the Galaxy

Observations were made at 1.93 m telescope of the observatory OHP (France).

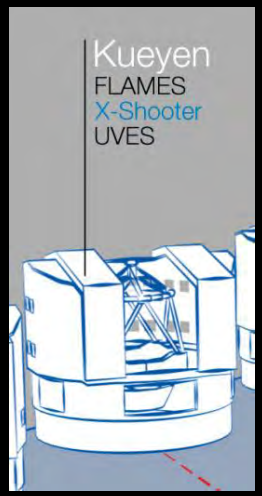
“Galactic evolution of the chemical elements”

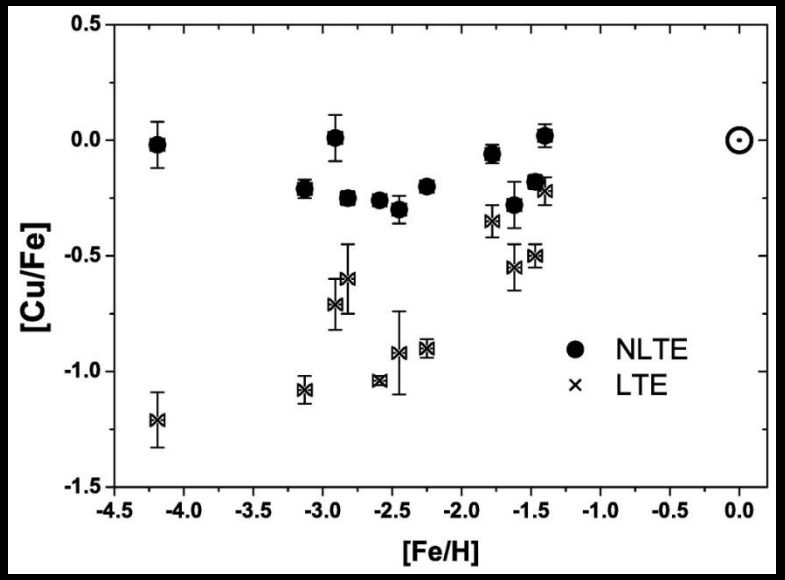
USA: Department of Astronomy, Case Western Reserve University, Cleveland, (R.E.Luck); University of Washington (G.Wallerstein); University of Hawai'i (R.P.Martin);

Brazil: Instituto de Astronomia, Geofнsica e Ciкncias Atmosfйricas, Universidade de Sгo Paulo, (J. R. D. Lйpine, et. all);

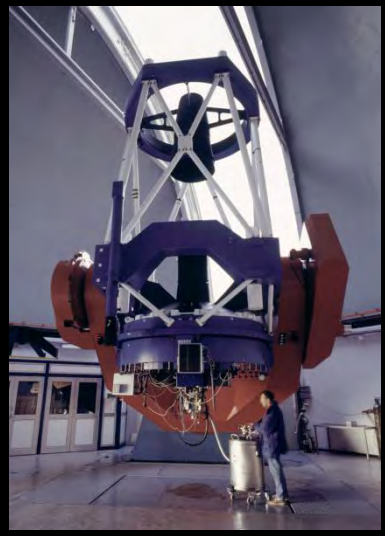
France: GEPI, Observatoire de Paris (M. Spite, M., F. Spite F., et. all); Universitй Cфte d’Azur (V.Hill);

Ukraine: Astronomical Observatory, Odesa National University (S.M.Andrievsky, et. all).





[Cu/Fe] vs. [Fe/H]..



“Milky Way metallicity gradient from Classical Cepheids. Chemical evolution of Galaxy”

USA: G.Wallerstein, R.E.Luck, P. Martin

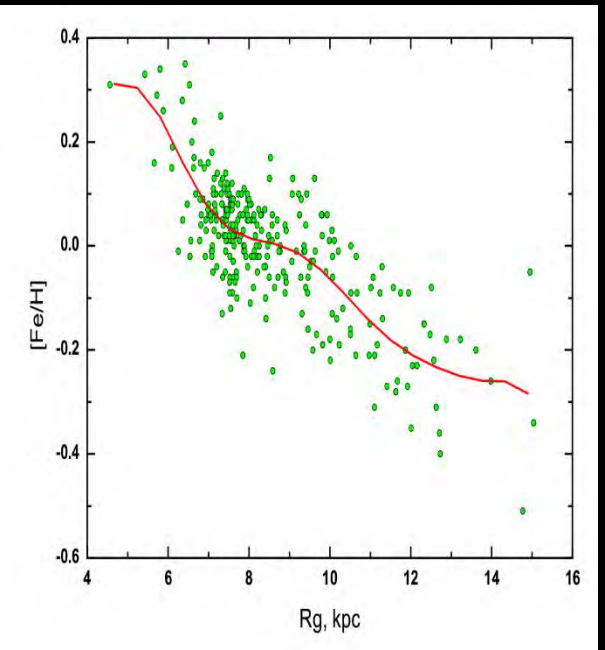
France: M. Spite M., F. Spite F., P. Bonifacio, P. Francois.

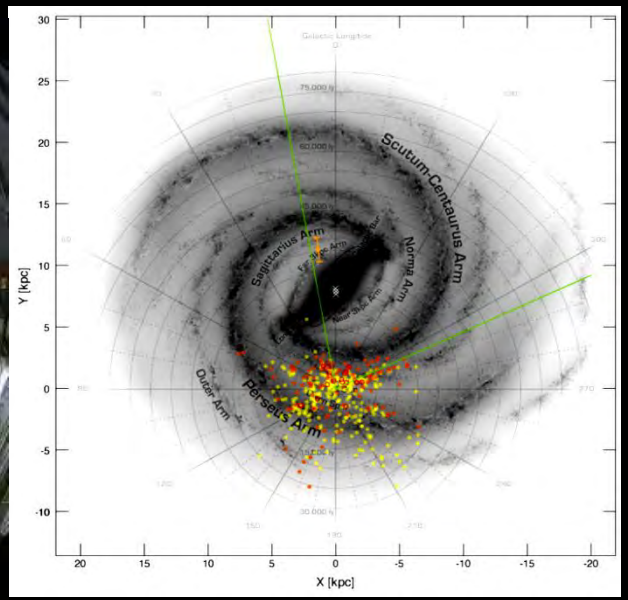
Germany: B.Lemasle

Italy: G.Bono

South Africa: A. Knyazev

Ukraine: Astronomical Observatory, Odesa National University, Odesa (S.M.Andrievsky, V.V.Kovtyukh)

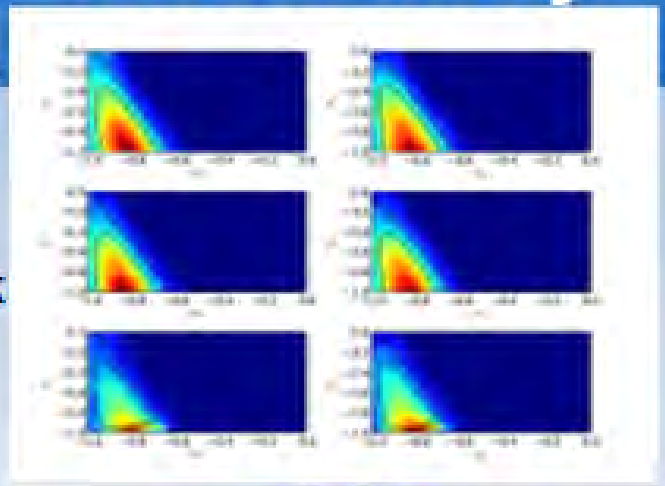




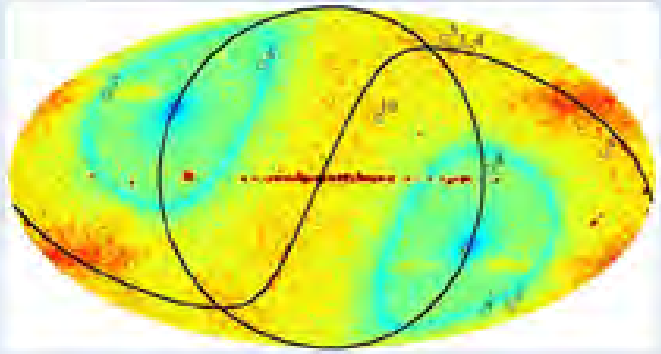
GROUND-BASED PROGRAMMES
EXTRAGALACTIC ASTRONOMY

International collaboration of Lviv Astronomical Observatory

Collaboration with Geneva Cosmology Group (Department of Theoretical Physics, University of Geneva) on observational constraints on cosmological models with different types of dark matter and dark energy (e.g. scalar fields with barotropic equation of state) and new cosmological tests



- Cooperation with Astronomical Observatory of the Jagiellonian University (Cracow, Poland) on artefacts in the CMB maps and Gamma-ray bursts as cosmological probes



Ground-based programmes

Cosmology and Gravity theories

International collaboration of Odesa Astronomical Observatory

with

CERN (Switzerland), North Carolina Central University (USA), University of Cologne (Germany),
INAF - Osservatorio Astronomico di Bologna (Italy), University of the Basque Country UPV/EHU (Spain),
Universidade da Beira Interior (Portugal), Charles University (Czech Republic),
Jilin University (China), Istanbul Technical University (Turkey).

A.I.Zhuk (Odessa)

Main topics:

Large scale structures of the Universe, gravitational interaction in the Universe, dark matter and dark energy, alternative gravitational theories

The results of researches are published in journals: PhLB, EPJC, PhRvD, IJMPh, PDU, and others.

GROUND-BASED PROGRAMMES
E-ASTRONOMY, GRID & DATA NETWORK

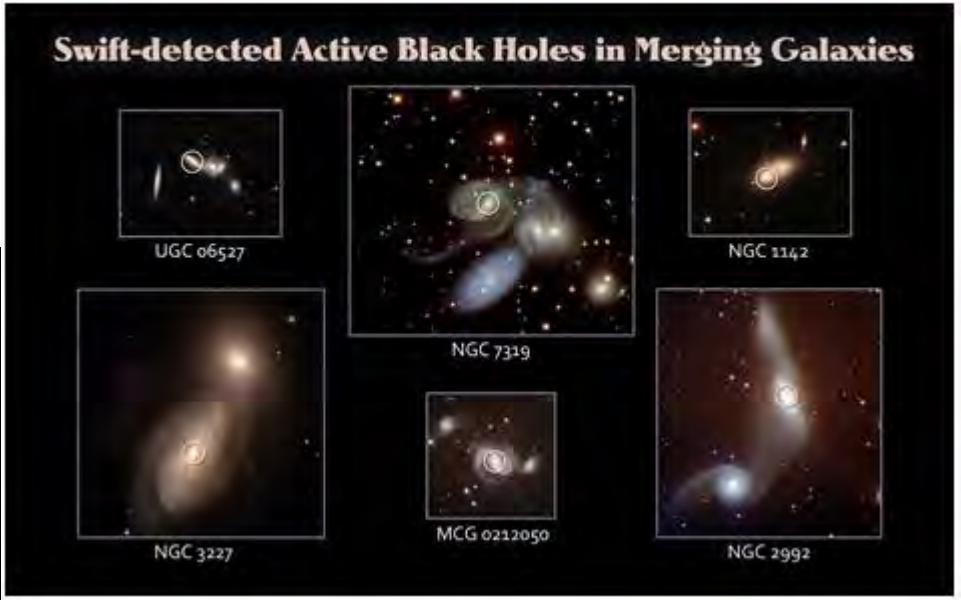
High performance, massively parallel, direct N-body simulations of galaxy center with black holes on GPU clusters across Europe.

MAO, Kiev, Ukraine:
Peter Berczik, Alexander Veles, Igor Zinchenko...

ARI, Heidelberg, Germany:
Rainer Spurzem, Andreas Just, Eva Grebel
+ more PhD students & postdocs under new SFB 881.

+ strong collaboration with NAOC, Beijing, China.

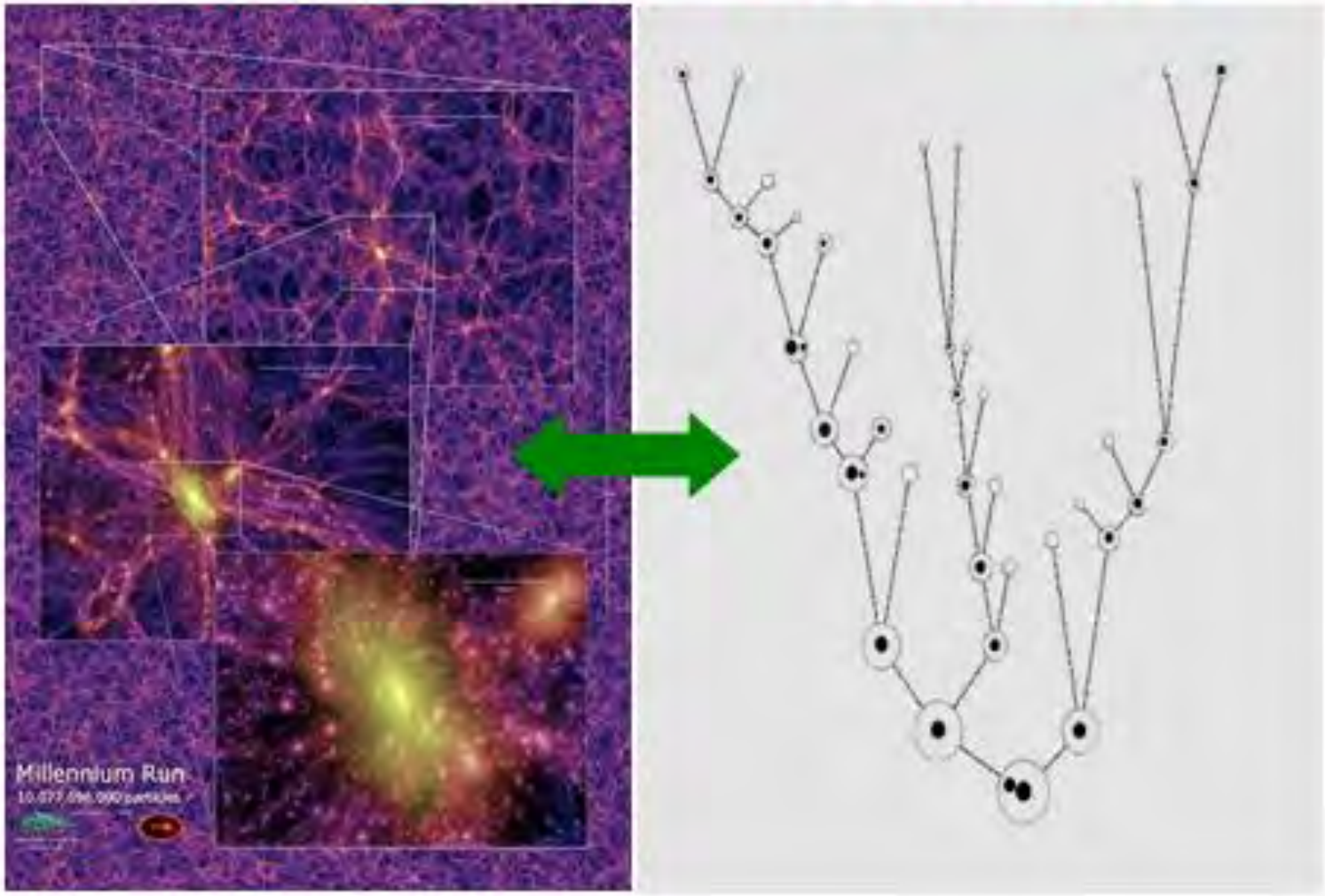
Galaxy Collisions ≈ BH's collisions



Ground-based programmes

e-Astronomy, GRID & Data Network

Galaxy Collisions ≈ BH's collisions



NASU APPLIED ASTRONOMY & SPACE SCIENCE PROGRAMMES

SCIENTIFIC BASIS, METHOD/HARDWARE/INFORMATION SUPPORT OF DEVELOPMENT OF MONITORING SYSTEM ON THE TERRITORY OF UKRAINE (GEO-AN)

Objectives of GEO-AN:

1. Arranging for studies and model development on:

a) Sun's invariability on various time scales;

b) Interplanetary space processes;

c) Earth's magnetosphere and ionosphere;

d) Atmosphere-ocean interaction;

e) Sold Earth's phenomena, including seismicity and geodynamics.

2. Creating data aguisition and data support systems in field of geosciences.

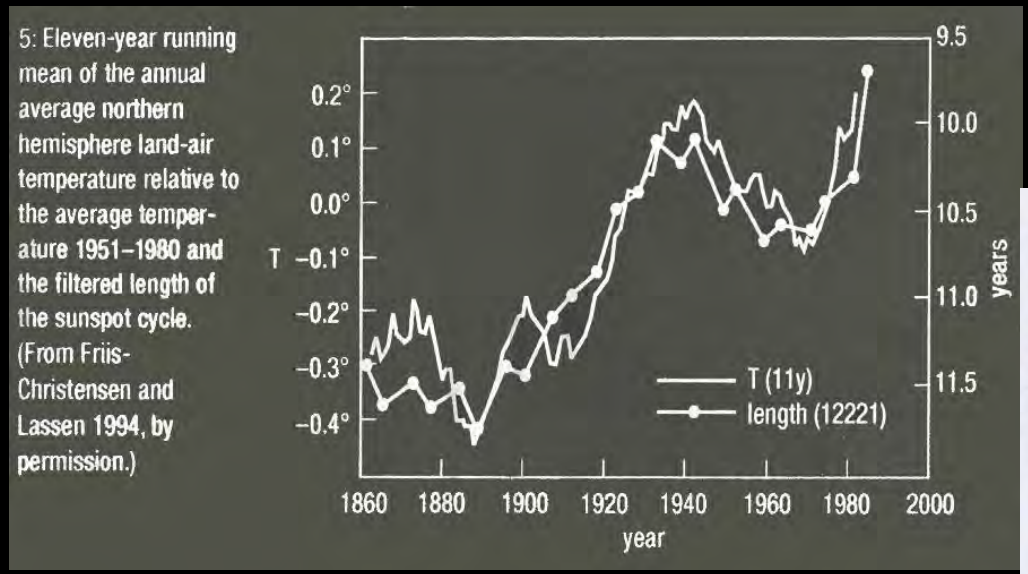
3. Assessing implementation of the GMES and GEOSS action plans in Ukraine.

NASU APPLIED ASTRONOMY & SPACE SCIENCE PROGRAMMES

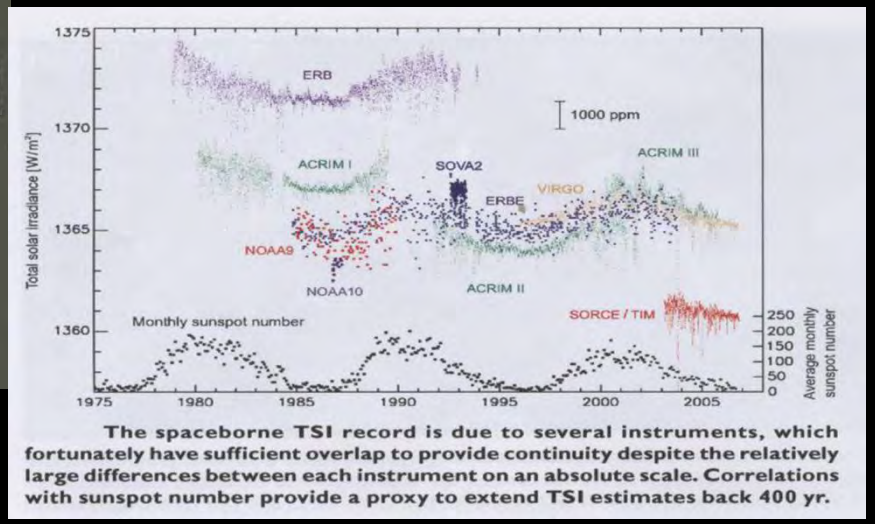
SCIENTIFIC BASIS, METHOD/HARDWARE/INFORMATION SUPPORT OF DEVELOPMENT OF MONITORING SYSTEM ON THE TERRITORY OF UKRAINE (GEO-AN)

Sun is our star e.i. stormy star. There are many well-known Solar phenomena observed by ground- and space-based techniques. Some of these phenomena are interrelated. It is necessary to understand,

How Sun's outbursts affect our home planet?



5: Eleven-year running mean of the annual average northern hemisphere land-air temperature relative to the average temperature 1951–1980 and the filtered length of the sunspot cycle. (From Friis-Christensen and Lassen 1994, by permission.)



The spaceborne TSI record is due to several instruments, which fortunately have sufficient overlap to provide continuity despite the relatively large differences between each instrument on an absolute scale. Correlations with sunspot number provide a proxy to extend TSI estimates back 400 yr.

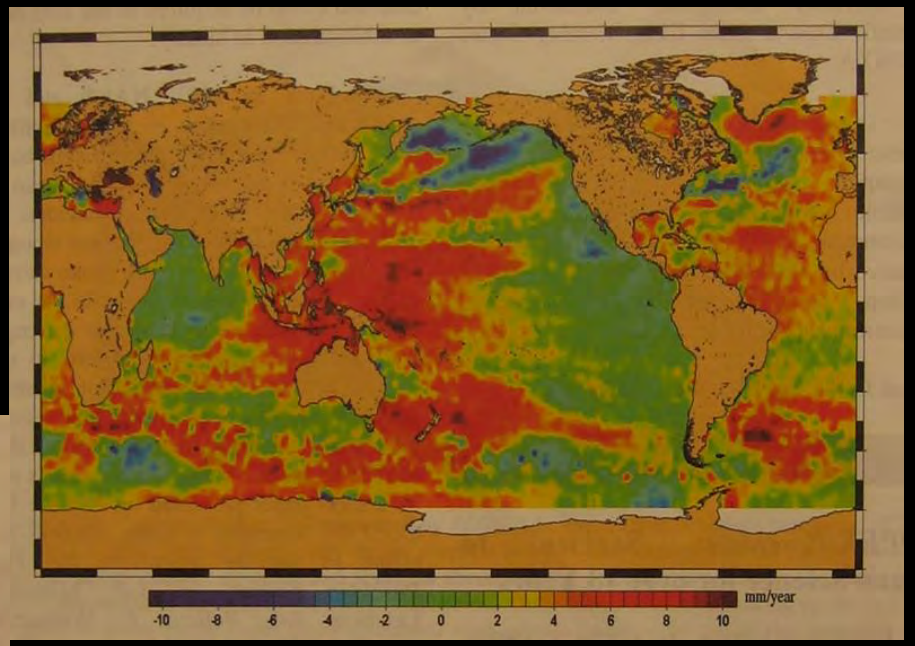
NASU APPLIED ASTRONOMY & SPACE SCIENCE PROGRAMS

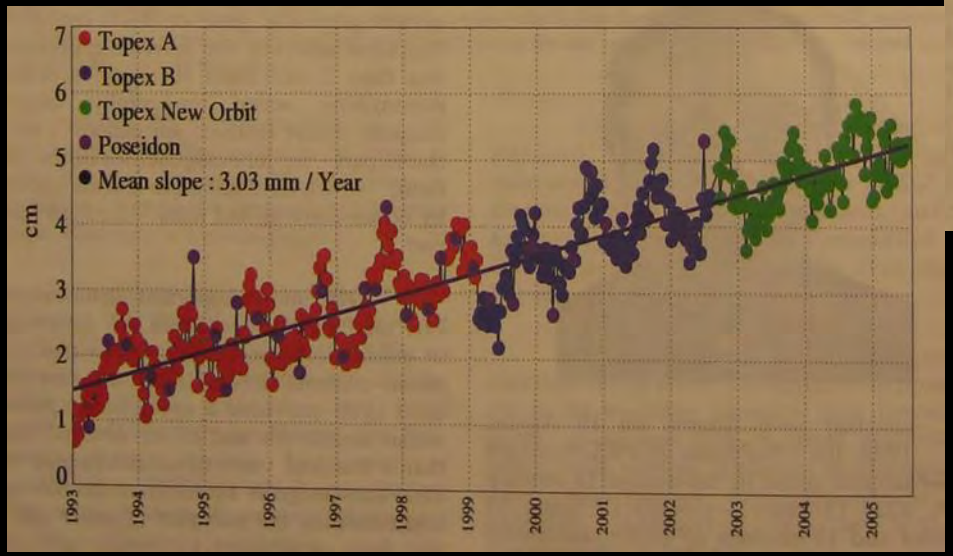
SCIENTIFIC BASIS, METHOD/HARDWARE/INFORMATION SUPPORT OF DEVELOPMENT OF MONITORING SYSTEM ON THE TERRITORY OF UKRAINE (GEO-AN)

Earth Watch.

Continuous observation and monitoring of the Earth's land, atmosphere, ocean and ice caps for: Study such phenomena as El Nino, ozone "hole", greenhouse effect, etc.;

Study of the interactions between the cloud, radioactive and aerosol processes that play a role in climate regulation; others related to Space Environment Domains.

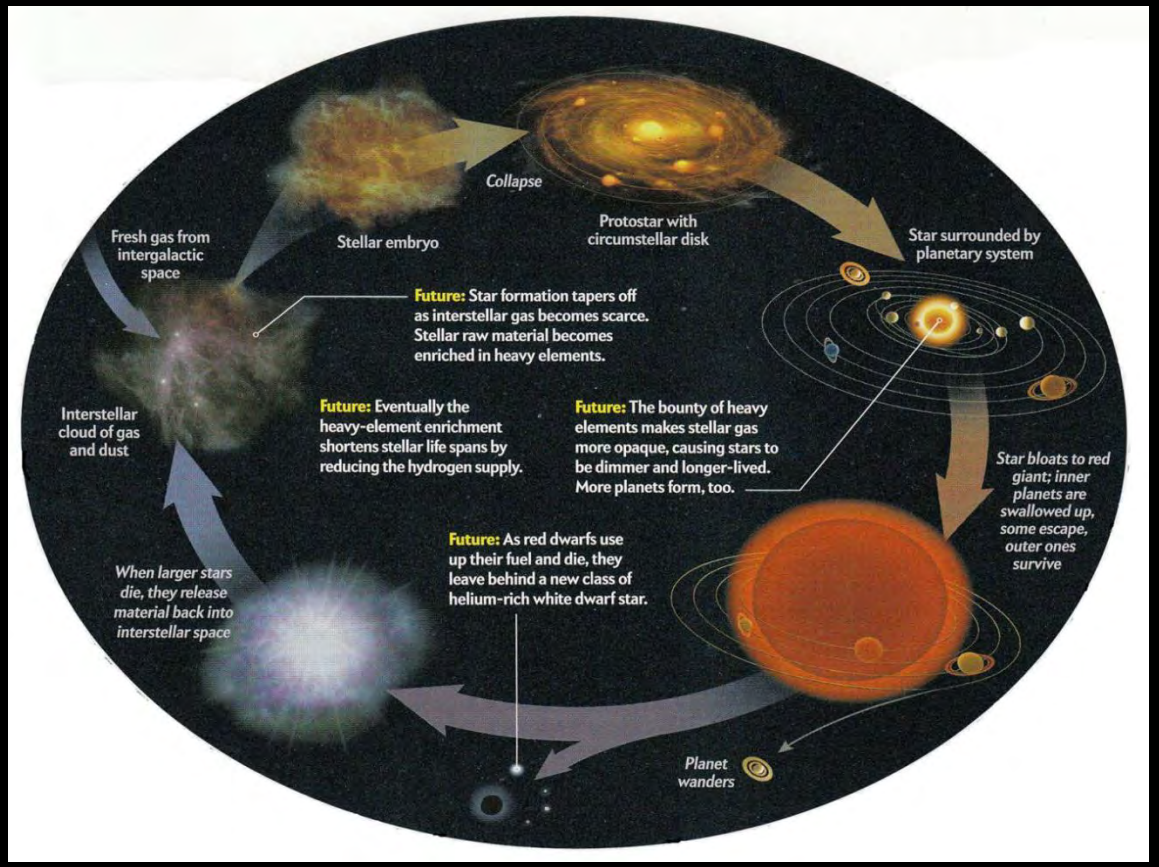




NASU APPLIED ASTRONOMY & SPACE SCIENCE PROGRAMMES

STUDY OF THE GEO-SPACE PHENOMENA

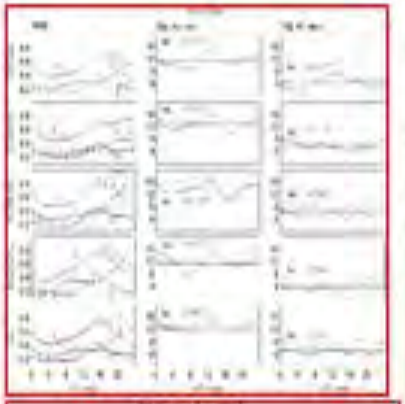
Space Science
Space Weather
Space Debris
Space Hazard

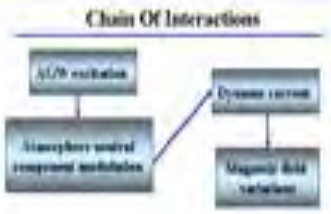


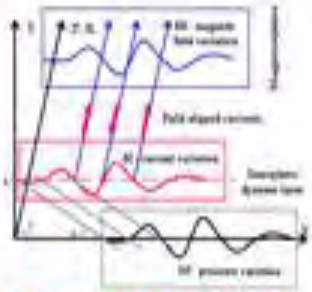
NASU APPLIED ASTRONOMY & SPACE SCIENCE PROGRAMS

STUDY OF THE GEO-SPACE PHENOMENA

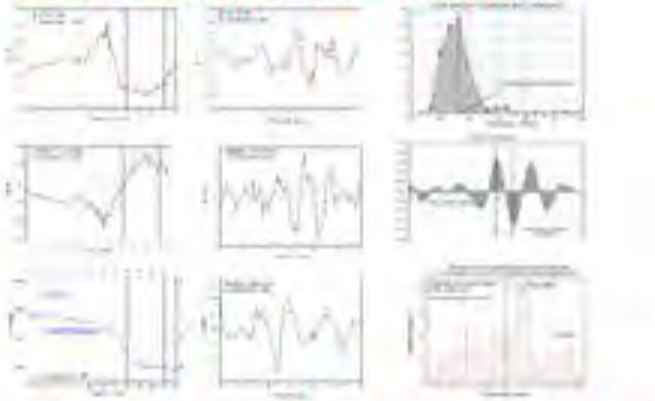
Радіоастрономічний інститут





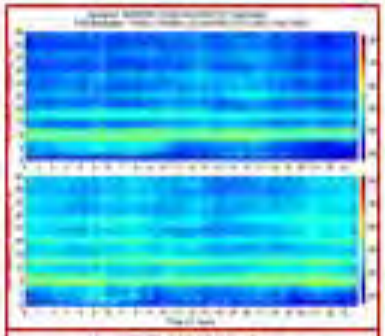


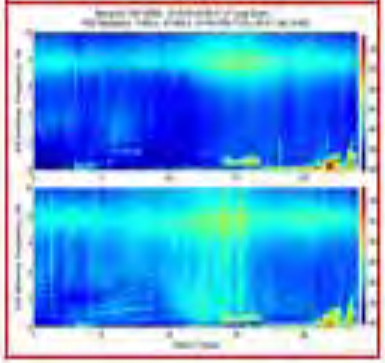
METEO – MAGNETIC DATA PROCESSING

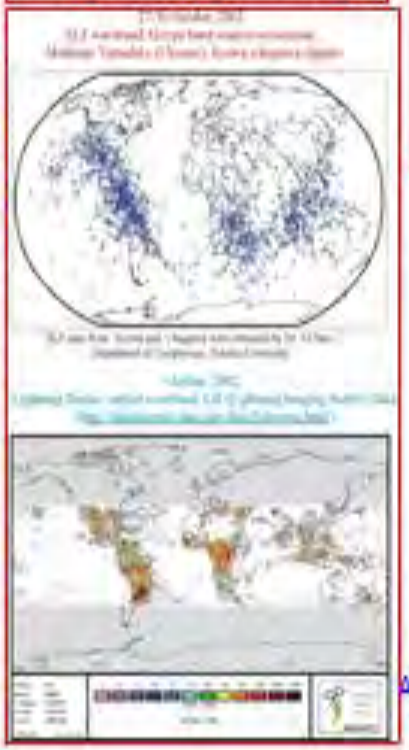


Number of Cyclones - N = 260; Observation Interval - 1956-2006

Average time delay - τ_N = 30-40 min; Average period T_N = 70 -90 min

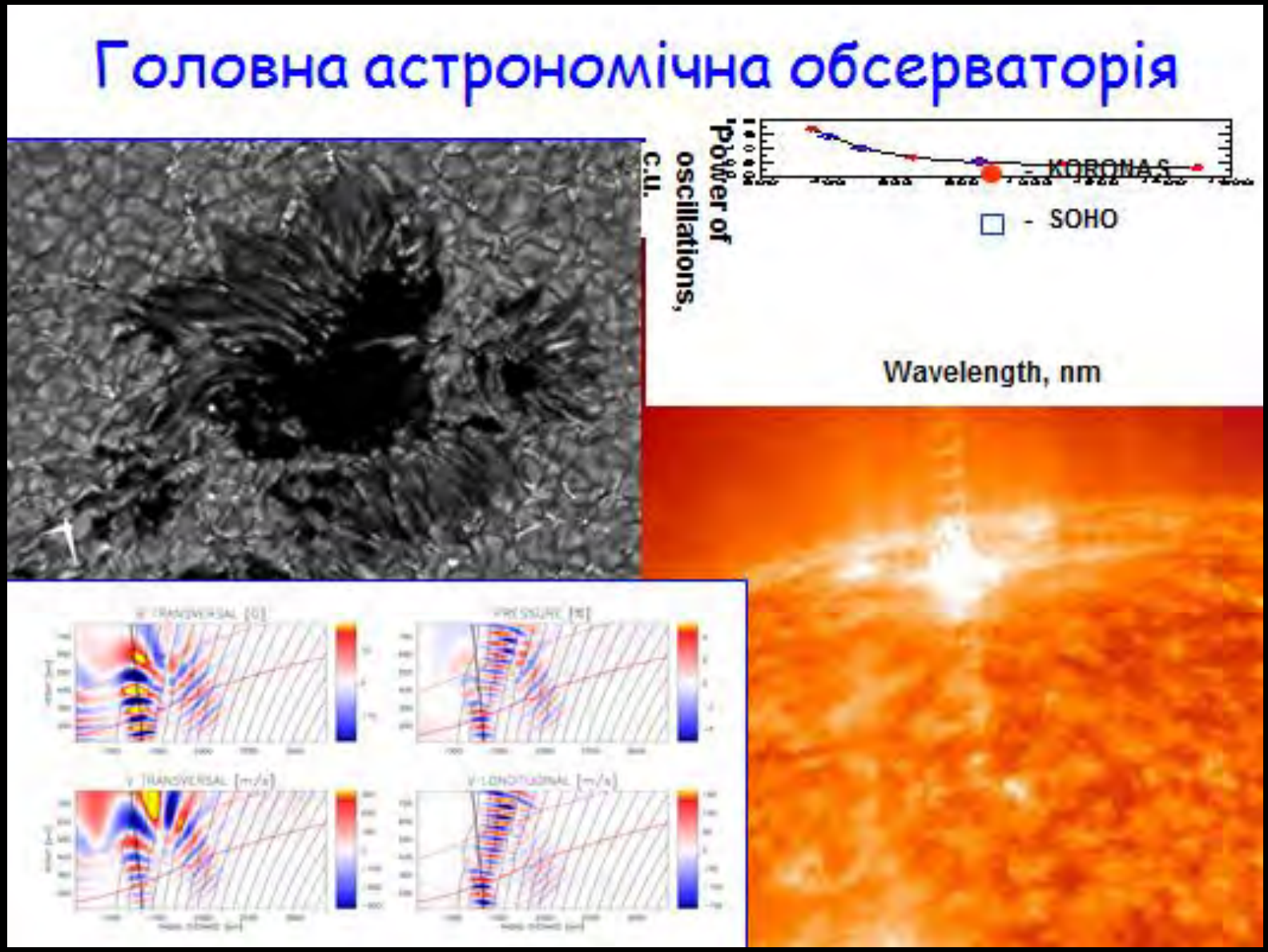






NASU Applied Astronomy & Space Science programmes

Study of the GEO-SPACE phenomena (2009-2011)

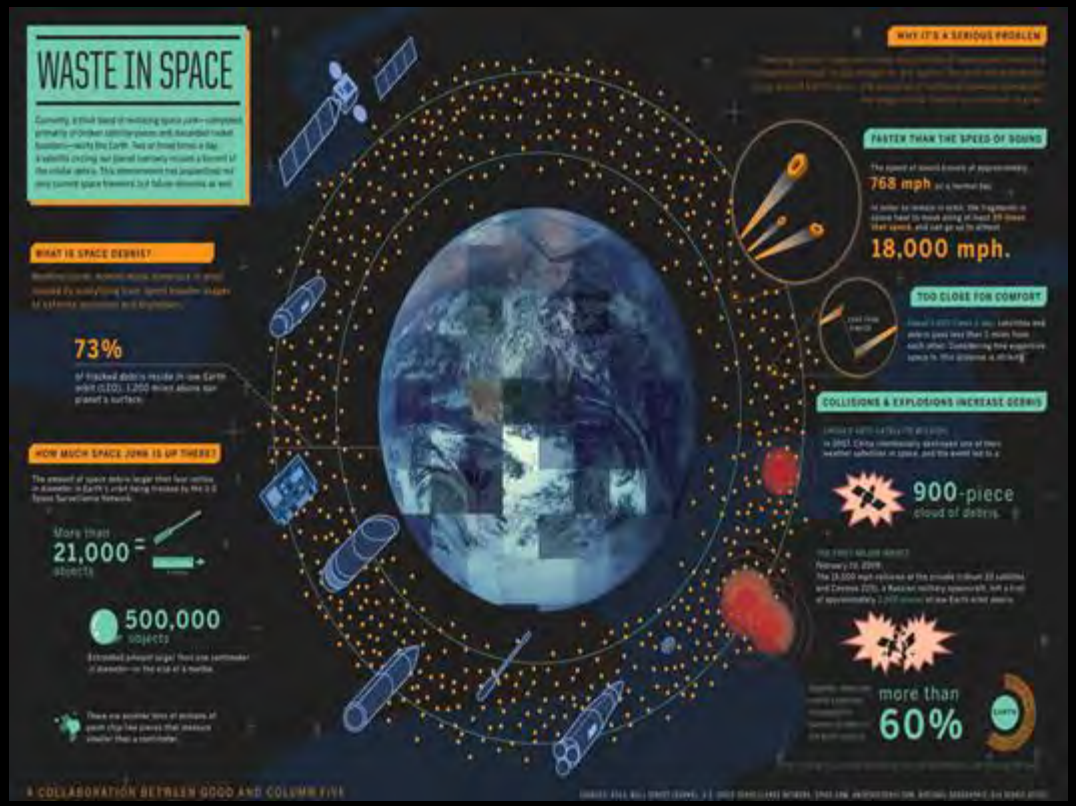


NASU Applied Astronomy & Space Science programmes

Study of the GEO-SPACE phenomena (2009-2011)

Name	Quantity	Dimension
SC	~ 4 000	Diff.
SV	~ 2 000	Diff.
SF	~ 10 000	>20 cm

Space Debris



OBSERVATIONAL SERVICES (ASTRONOMY & RELATED SCIENCES)

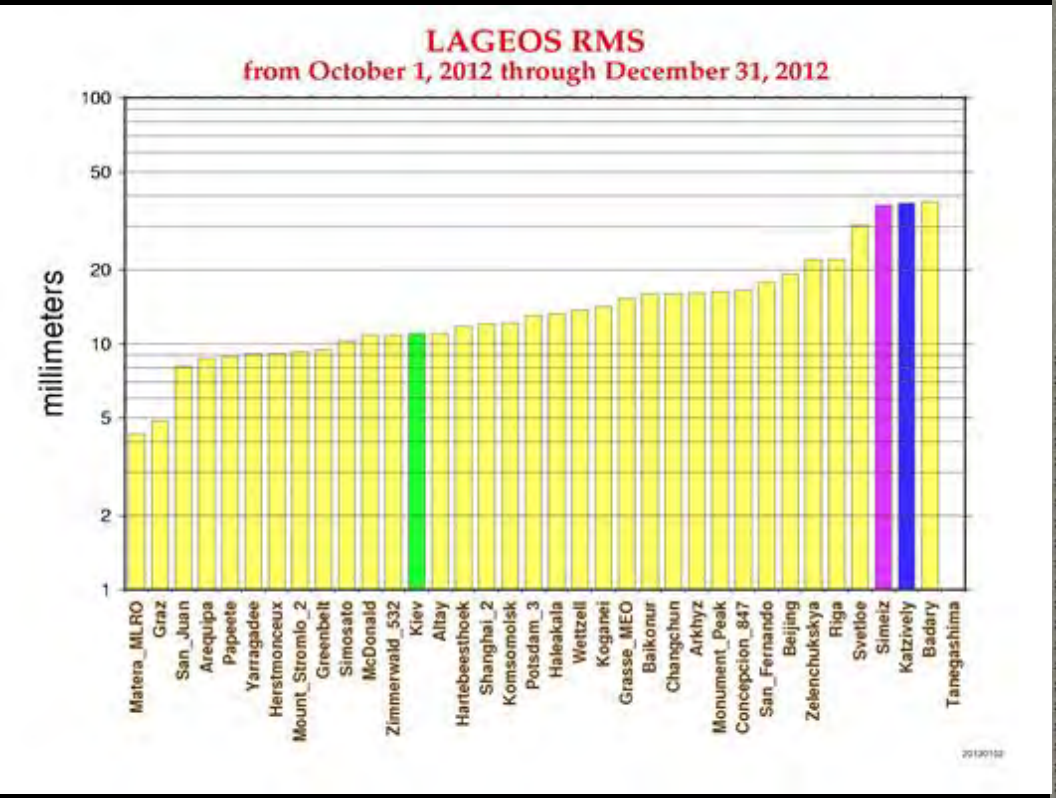
- International Earth Rotation Service (IERS)
- Space Geodesy Services (SGS)

  ILRS, IVS, IGS, DORIS

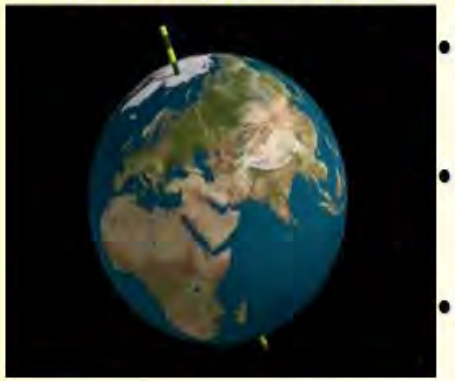
Participants: more than 100 observational services (20 in Ukraine)

Objectives: Definition and realization of coordinate systems and frames; determination of the Earth Rotation Parameters; study of global geodynamics

OBSERVATIONAL SERVICES (ASTRONOMY & RELATED SCIENCES)



Earth's time-variable data on



- Shape
- Gravity field
- Rotation

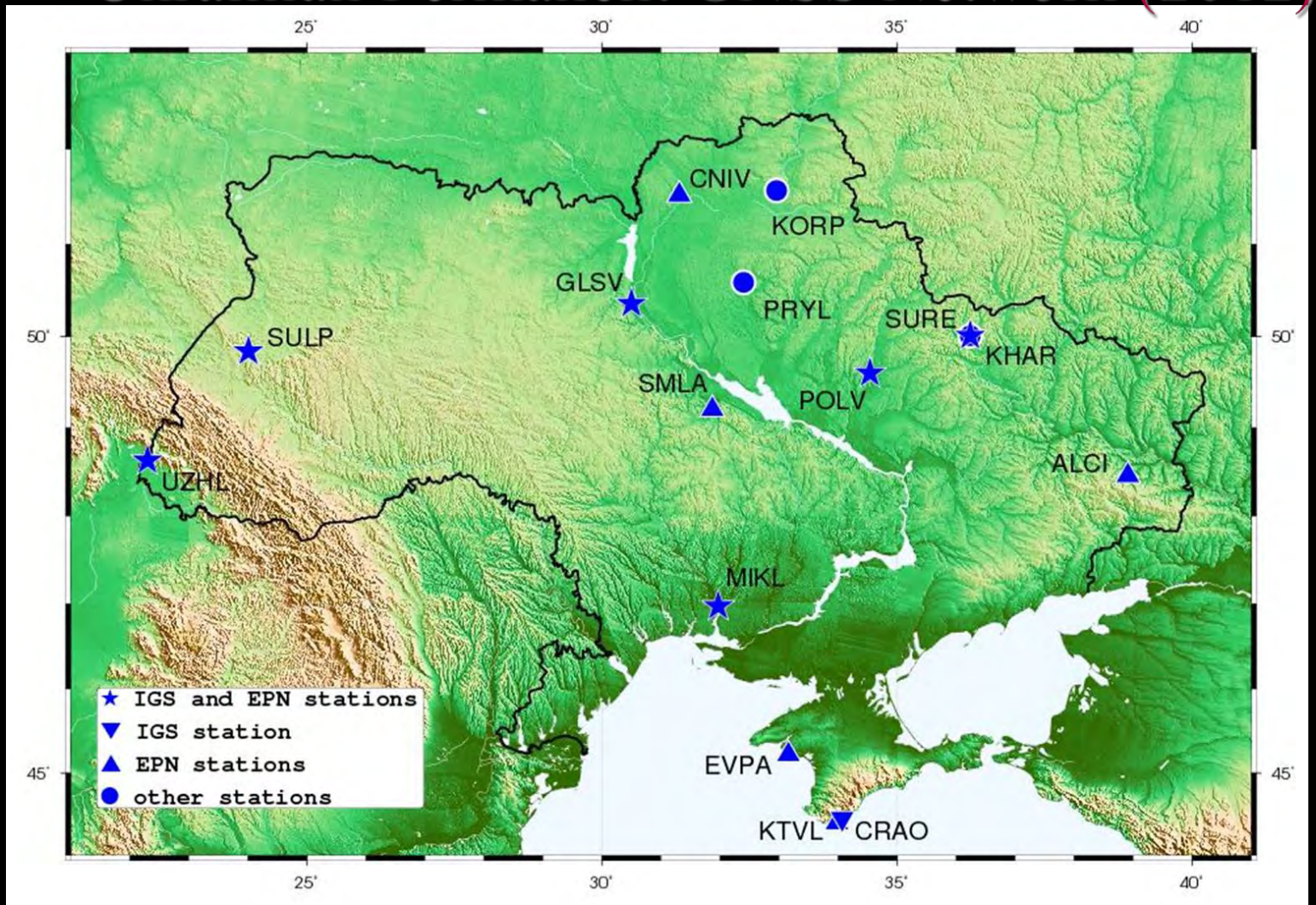
The shape of planet Earth

SLR network of Ukraine

Name	Domes	Started in	Remarks on discontinuation
Kiev 1824	12356S001	1996	
Katsiveli 1893	12337S006	1984	
Simeiz 1873	12337S003	1998	
Lviv 1831	12368S001	1998	

OBSERVATIONAL SERVICES (ASTRONOMY & RELATED SCIENCES)

Ukrainian Permanent GNSS Network (2012)



OBSERVATIONAL SERVICES (ASTRONOMY & RELATED SCIENCES)

VLBI station of Ukraine

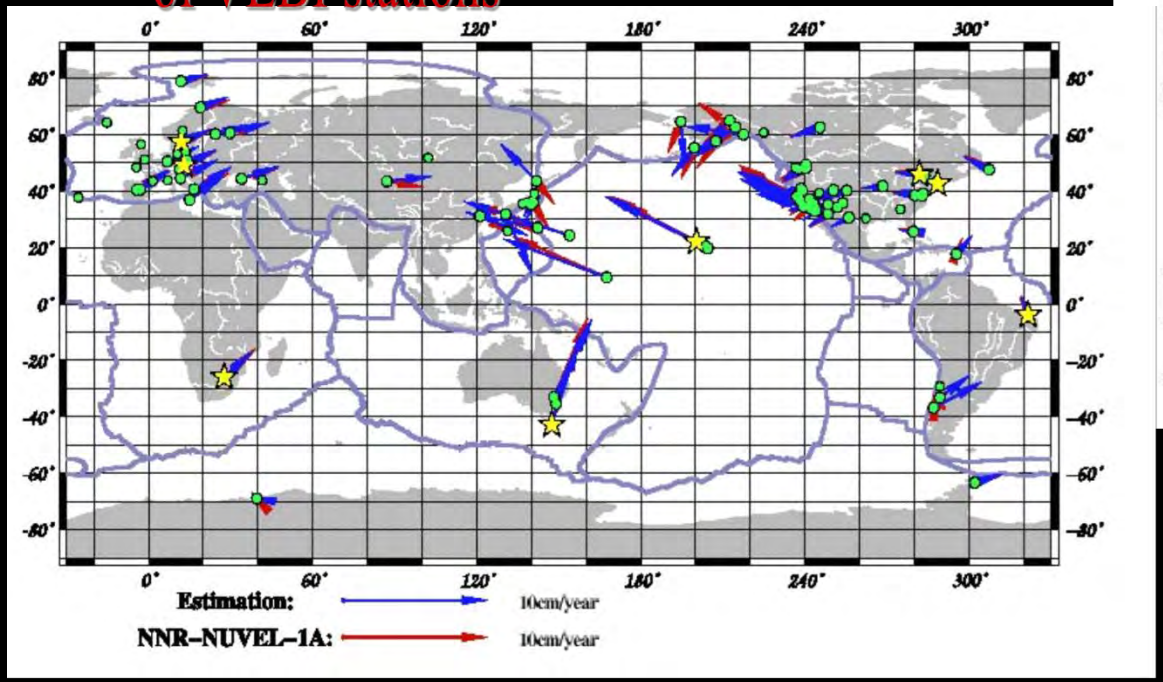
Name of station: Simeiz (Crimea) VLBI station
IERS DOME NUMBER : 123375008
EQUIPMENT: Radiotelescope RT-22
Mark-5A and Mark-5B+
recording systems
H-maser for time and frequency

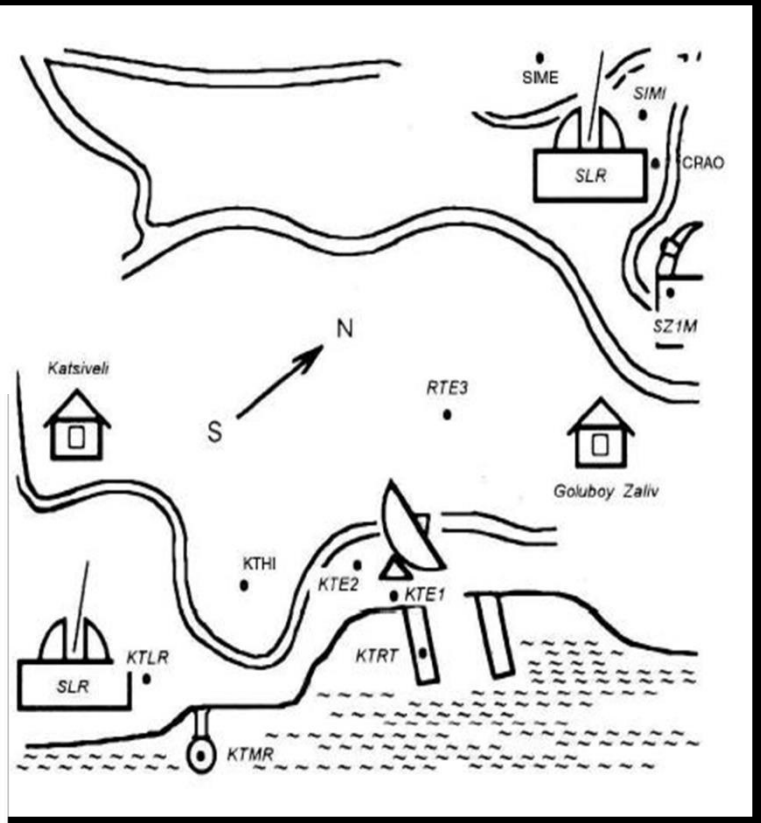
The radiotelescope RT-22 has a steering parabolic mirror with diameter 22 m and focal length 9525 mm . The surface has a root mean square accuracy 0.25 mm and effective area 210 m^2 which does not depend on elevation angle at frequencies 2.3 and 8.4 GHz. The antenna has an azimuth-elevation mounting with axis offset -1.8 ± 0.2 mm. Working range in azimuth is [-210, 210°] (zero is to the south) and in elevation [-1°, 85°]. Maximum slewing rate is 1°.5/sec. The control system of the telescope provides accuracy of pointing at the level of 10".

Observational Services (Astronomy & related Sciences)

IS UKRAINE ABLE TO MEET NEW CHALLENGES FOR INTERNATIONAL SPACE GEODESY SERVICES?

Coordinates and velocities of VLBI stations





The "Simeiz-Katsiveli" space geodynamics co-location site
(Black Sea area to west of Yalta city)

Observational Services (Astronomy & related Sciences)

UMOS (Ukrainian network of optical stations)

UMOS	Members
Kiev	Main Astronomical Observatory
Nikolav	RI "Nikolaev Astronomical Observatory"
Odessa	Astronomical Observatory of Odessa National University
Lviv	Astronomical Observatory of Lviv National University
Uzhgorod	Space Research Laboratory of Uzhgorod National University
Alchevsk	State interuniversity center of satellites laser ranging observations "Orion"
Evpatoria	National Space Center
Dunaevcy	Center of the Special Information Receiving and Processing and the Navigation Field Control

UMOS

Telescopes

Observational Services (Astronomy & related Sciences)

UMOS (Ukrainian network of optical stations)

UMOS

Activities

- Modernization / automation of old telescopes
- Manufacturing of new telescopes
- Development of **original observation techniques**
- Development of observation and processing software
- Angular observations of satellites on all orbit types
- Photometry observations of satellites on low orbit
- Development of software for **orbit calculation and catalogue maintaining**
- Development of software for **analysis of tumbling behavior and shape**

UMOS

Angular observations

Observed object types:

- Low Earth orbit (LEO) satellites down to mini satellite size
- LEO space micro satellites and debris ≥ 0.1 m size
- Geostationary Earth orbit (GEO) space debris ≥ 1 m size
- Middle Earth orbit satellites (MEO) ≥ 2 m size
- High Elliptical orbit satellites

Goals:

- Orbit calculation:
  - maintaining of own orbit catalogue
  - calculation of close approaches distances

UMOS

Mechanical tracking technique

Odessa KT-50 telescope

- Lens: **F = 3000 mm, D = 500 mm**
- Camera: **TV CCD**
- **LEO observations**:
  - limited magnitude: **11 mag**
  - angular random/systematic error: **0.5/0.5 arcsec**
  - feature: **parallel photometry observations**

UMOS

Electronically tracking technique

Nikolaev KT-50 telescope

- Lens: **F = 3000 mm, D = 500 mm**
- Camera: **full frame CCD + rotator**
- **LEO observations:**
  - limited magnitude: **14 mag**
  - angular random/systematic error: **0.6/1.4 arcsec**
- **MEO, GEO observations:**
  - limited magnitude: **16 mag**
  - angular random/systematic error: **0.3/0.7 arcsec**

UMOS

Photometry observations

Most observed objects:

- Topex, Envisat, Jason, EgyptSat, Sich-2, Midas

Goals:

- Determination of tumbling periods :
  - stabilization
  - secular variations
- Comparing of observed light curve with modeled one:
  - orientation
  - structural health
- Classification of light curves:
  - shape type (sphere, cube, plane …)

ASTRONOMY TECHNOLOGICAL PROGRAMMES

Objective: in order to remain at the proper place of world astronomy, Ukraine must ensure new technological developments for providing the necessary platforms for new instruments and facilities.

Radio Astronomy

Ukraine is leading country in field of decametric radioastronomy thanks to activity by Prof. S.Ya. Braude and his followers. Ukraine possesses of world largest decameter wavelength (frequencies are 8-32 MHz) radio telescope UTR-2

Fig.1. The UTR-2 radio telescope, N-S arm (1.8 km×60m)
f = 8…32 MHz, $A_{eff\,max}$ = 150 000 sq.m

ASTRONOMY TECHNOLOGICAL PROGRAMMES

RADIO ASTRONOMY

Ukraine possesses of unique interferometer system URAN (Fig.2) The distribution of the radio astronomy means on the Ukraine territory is following: Radio telescopes UTR-2, URAN-1, URAN-4 belong to IRA NASU;

URAN-2 and URAN-3 belong to Poltava Gravimetric Observatory of NASU respectively.

Ukrainian instruments are actively using in the international collaboration with France, Austria, Germany, the Netherlands, India, Japan, Russia, Belgium, Great Britain. Ukrainian radio astronomers are involving officially in the international radio astronomy Projects for various topics (The Sun, space weather, Saturn, interplanetary medium, interstellar medium, pulsars, active stars, exoplanets, etc.).

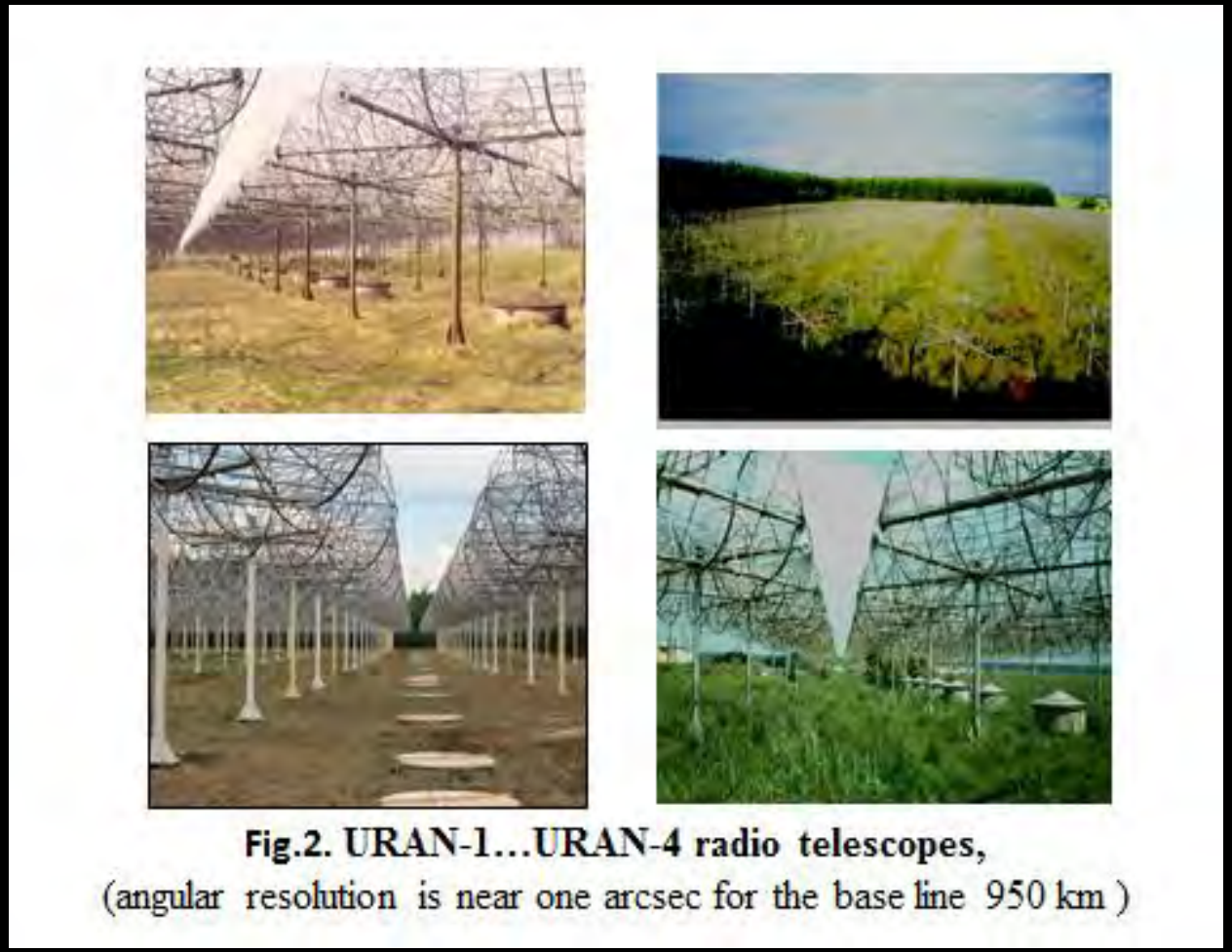


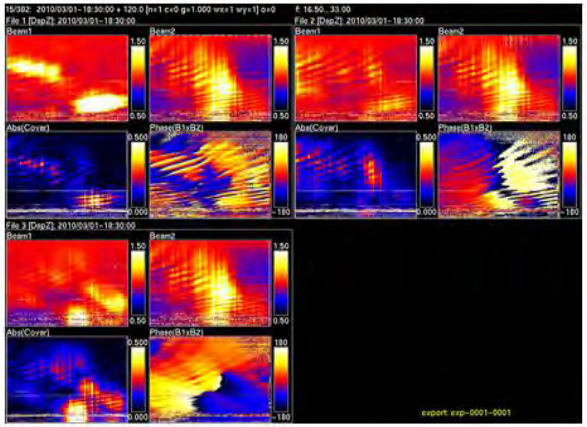
Fig.2. URAN-1…URAN-4 radio telescopes,
(angular resolution is near one arcsec for the base line 950 km)

Astronomy technological programmes

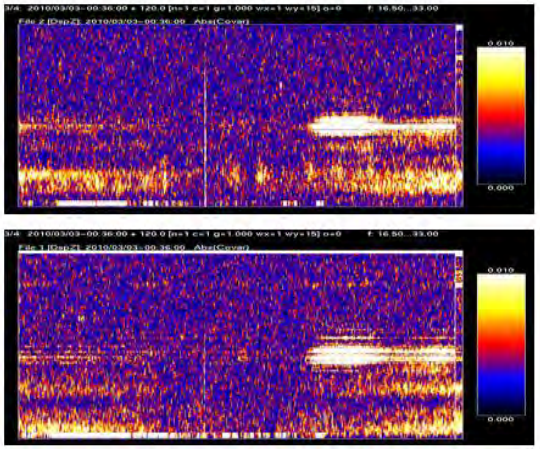
Radio Astronomy

Many priority astrophysical results and discoveries were obtained by the implementation of these instruments due to the best sensitivity; spatial, frequency and temporal resolution; dynamic range; informatively; and efficiency. One result connected with the high sensitive dynamic range and interference immune observations of the interplanetary ionosphere scintillations (in the frame of the space weather problems) by using UTR-2 is presented on Fig.3a (see also another results in this slide).

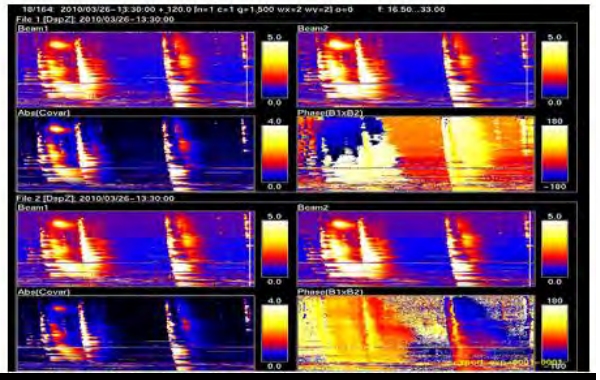
Fig.3a. Typical IPS and non-typical ionospheric scintillations of 3C 144 in 3-beam operation mode of UTR-2



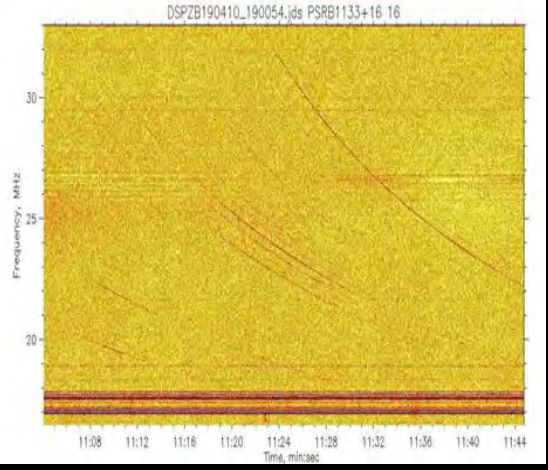
Saturn Electrostatic Discharges (SED) in ON-OFF mode of UTR-2
(first detection by ground-based means)



Solar bursts in 2-baseline operation mode,
"North-West" and "South-West" antennas of UTR-2
(first detection of new types and fine time-frequency structure of the sporadic solar radio emission)



Dynamic spectra of PSRB1133+16
(first detection of the separate pulses of pulsars)



Astronomy technological programmes

Radio Astronomy

- The European radio community is actively testing the new technology for decameter radio interferometer LOFAR. Therefore, Special Program of NASU for the deep modernization and upgrade of the world largest UTR-2 radio telescope is adopted. It includes, in part, the development and installation of the new generation high dynamic range super multichannel digital spectrum analyzes.
- Furthermore it is very important

the creation of new generation low frequency additional radio telescope on the UTR-2 observatory, it is GURT (Giant Ukrainian Radio Telescope). This new radio telescope has broader band (10-80 MHz), high sensitivity, dynamic range and efficiency.

- This activity is supporting by the

international PICS Project (Ukraine-France) "Development of low frequency radio astronomy with ultra-high sensitivity and resolution". Ukrainian radio astronomers give strong contribution to the creation of the low-frequency LSS (LOFAR Super Station) radio telescope in France and to the development of the world low-frequency radio astronomy in whole.

Fig.8. Active antenna elements of the new generation GURT radio telescope in Ukraine

TELESCOPES OF THE RESEARCH INSTITUTE "ASTRONOMICAL OBSERVATORY" OF ODESSA NATIONAL UNIVERSITY

Telescope with a mirror diameter 1 m. Installed in Slovakia. Jointly operated by Astronomical Observatory of Odessa National University (Ukraine) and Vihorlat Astronomical Observatory (Slovakia). Vihorlat Observatory is a new one. It is situated at the Kolonice Sedlo in the north-east of Slovakia. Observatory coordinates: latitude = 48° 57' N, longitude = 22° 16' E. Altitude is 465 m above sea level.

Telescope characteristics: Argunov – Faschevskyi optical system, focal length is 9 m. The Cassegrain focus of the telescope is equipped with the high-speed two-star photometer, which was constructed in Astronomical Observatory of Odessa National University.

The main observational programs are focused on the study of eclipsing binaries, cataclysmic and symbiotic stars, stars of RR Lyr and BY Dra types.

A new automatic telescope, a 800-millimeter main mirror catadioptric anastigmatic aplanat, is mounted at Mayaki station in suburb of Odesa. It is equipped with a focal corrector and a professional CCD camera.

Telescope is used for observations of geostationary objects, comets, and asteroids.

SPACE-BASED ASTRONOMICAL PROGRAMMES

- **Previous projects (with Ukrainian contribution)**

Solar Physics: CORONAS-I, CORONAS-F, CORONAS-Foton,

Space Physics: INTERBALL, ISS

Radioastronomy: RadioAstron

- **On-going projects (with Ukrainian contribution)**

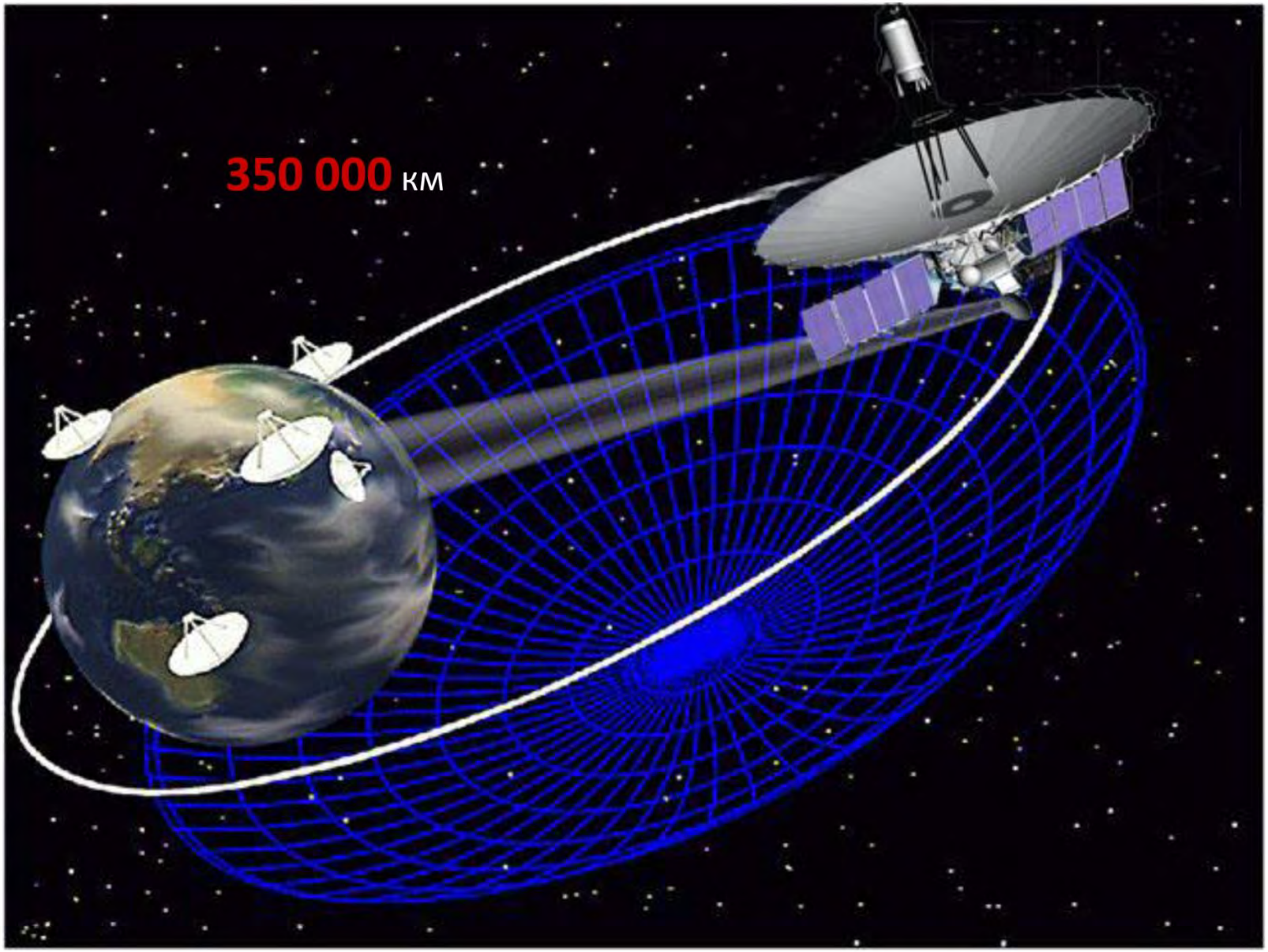
Solar System Body Physics: ExoMars, GAIA, UNO

- ***Future projects (Ukrainian-led and contribution)***

Space Physics: IONOSAT-Micro (2019); IONOSAT (2021), Aerosol-UA (2022)

Astrophysics: BRAUDE-M (?)

Ground – Space radio interferometer Program “RadioAstron”
(wavelengths is 1.35 – 92 cm; D max is 350 000 km; Ang.res. is 10 microarcsec)



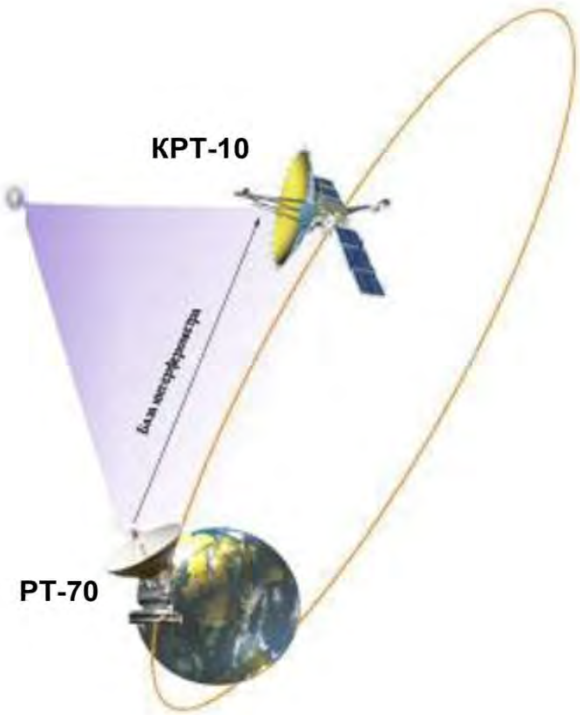
SPACE-BASED PROGRAMMES: RADIOASTRON

- RT-70 radio telescope (Evpatoria, Ukraine, National Space Center of SSAU) as the ground segment of this mission was prepared and upgraded by Institute of Radio Astronomy NASU for this mission since 2011. The interferometric responses were detected for many radio sources, base-lines, and frequency ranges.

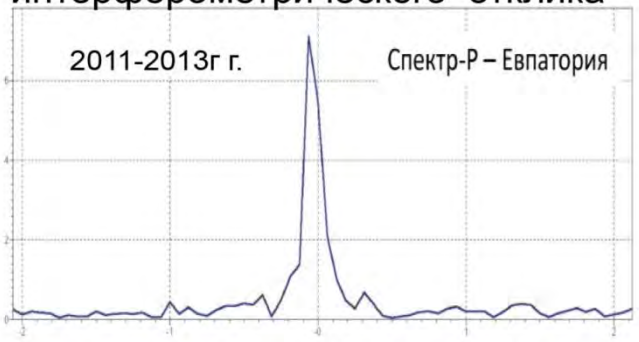
Space-based programmes: RadioAstron

Radio interferometric response for the base RT-70 – SRT-10 (50 000 km)

Детектирование интерферометрическго отклика на рекордно большой базе 50 000 км РТ-70 (Евпатория) – КРТ-10 (КА “Спектр-Р”)



Фурье-преобразование интерферометрического отклика



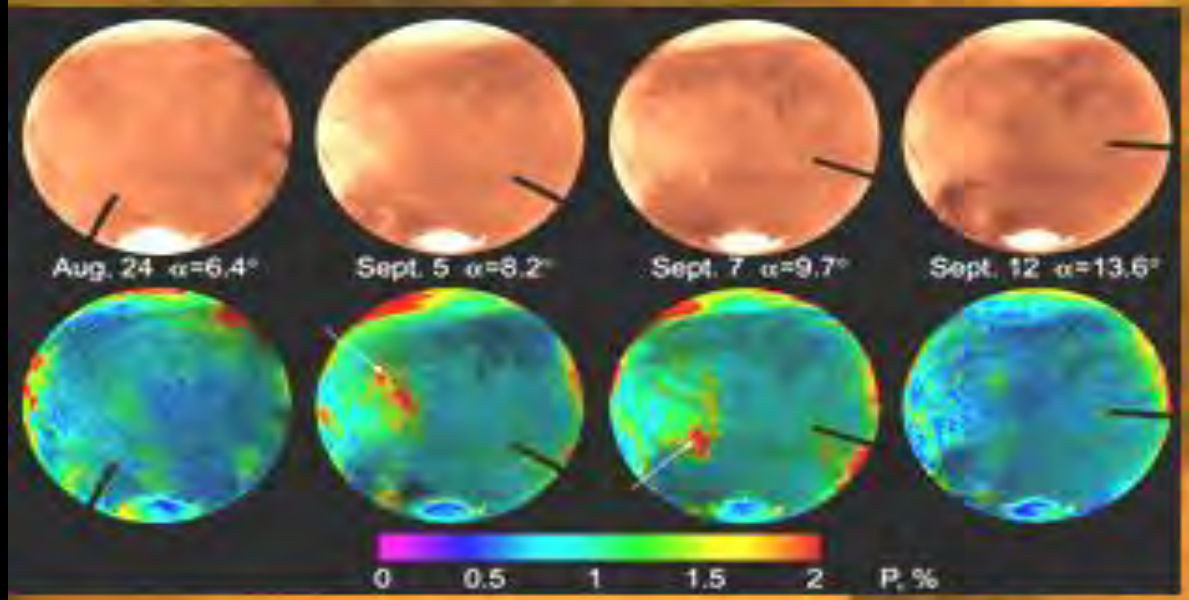
Диапазон волн	6 см
Радиоисточник	Активная галактика BL Lacerate
Расстояние между антенами (база)	50 000 км
Угловое разрешение	240 мкс дуги

SPACE-BASED PROGRAMMES:
HUBBLE TELESCOPE'S PROJECTS

Polarimetry of Mars with Hubble Telescope

Astronomical Institute of Kharkov National University, Ukraine

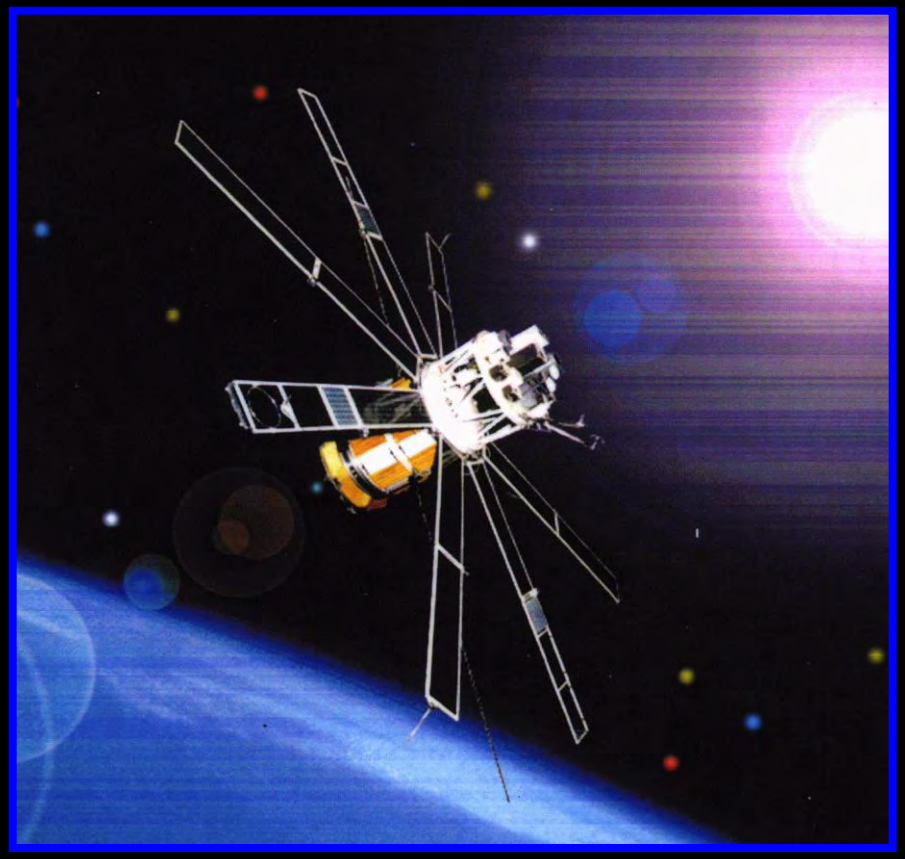
A new type of Martian clouds seen in UV range with HST polarimeter was discovered (see arrows in figure). The couds consist of small water crystals.



HST Proposal 9738, 2002: "Spectroscopy and Polarimetry of Mars at Closest Approach" by J. Bell, G. Videen, **Yu. Shkuratov**, M. Wolff, R. Morris, and K. Noll

Геліосейсмологія

Космічний проект CORONAS - DIFOS

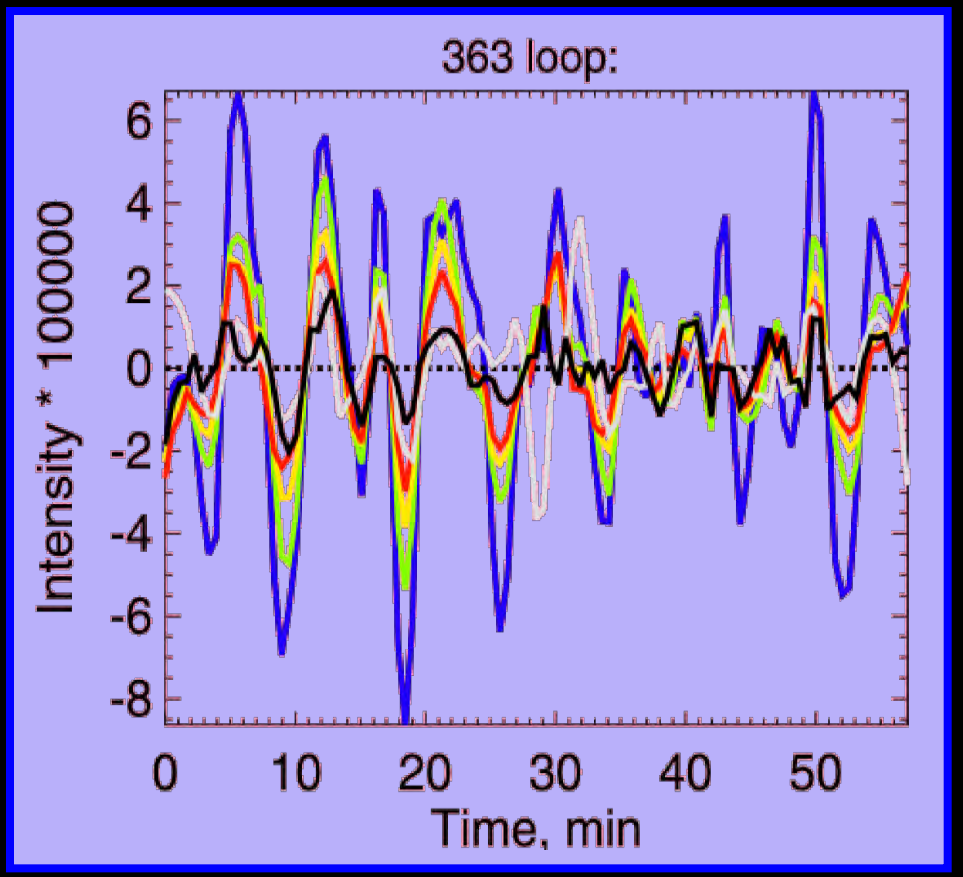


За допомогою приладу DIFOS проведені космічні спостереження глобальних коливань яскравості Сонця в п'яти довжинах хвиль на орбітальних станціях КОРОНАС-І & КОРОНАС-Ф

CORONAS-I: 16.03.1994 – 07.05.1994
CORONAS-F: 31.07.2001 - 04.12.2005

Е. Гуртовенко, Л. Кесельман, Р. Костик, С. Осипов

Вперше виявлені аномалії 5-хвилинних коливань яскравості та швидкості. Гравітаційні моди коливань Сонця не знайдені.



Поверхня Сонця коливається з різними періодами. Найпотужніші коливання (акустичні) відбуваються з періодом ≈ 5 хвилин.
Амплітуда яскравості – 10^{-5} яскравості центру диска Сонця.

SPACE-BASED PROGRAMS GENERAL CONCLUSIVE REMARKS

- Spectacular astronomic results have been obtained in Europe through a large range of space missions (e.g. Cassini, XMM, Cluster, Mars-Express, SOHO, Kepler, Venus-Express, Hershel, Planck).

  Ukraine didn't participated in these mission. Some teams of the Ukrainian astronomers access data collected by these space missions.

- A relevant Ukrainian participation has been in Russian–led space missions up to 2014 (e.g.ISS, FOBOS, RadioAstron).

- It is specially important, given the current world space activity, to prepare national astronomical space projects (e.g. UkrSelena and BRAUDE-M)

UKRAINIAN ASTRONOMICAL ASSOCIATION

STATUS OF THE UKRAINIAN ASTRONOMICAL SOCIETY (UAA)

- UAA was founded in 1991 and since this year the UAA coordinates the astronomical activity in Ukraine.
- The UAA consists of 15 Institutional Members & dozens of Individual Members.
- The UAA is served as the National Committee of astronomers in Ukraine. There are more than 1500 persons in Ukraine involved in astronomical researches.

Links with Government:

Expert`s opinion on Projects of

the National Academy of Sciences of Ukraine

the Ministry of Industrial Policy

the Ministry for Education and Science

Interbranch scientific & engineering technology Projects

Publicly funded observatory:

Ahdrushivka observatory

The most important national universities which have astronomy and space related faculties:

Shevchenko National University of Kyiv
V.N. Karazin National University of Kharkiv
I.I. Mechnikov National University of Odesa
Ivan Franko National University of L'viv
National Technical University "Kyiv Polytechnical Institute"
National University of Dnipropetrovsk
V.I. Vernadsky Taurian National University in Simferopol
National University of Uzhgorod
Zhukovsky National Aerospace University in Kharkiv

- 80% of the entering students finish their education in 5 years
- 50% of students, who finished their education, continue to work in astronomy
- 30% of holders of a Specialist's diploma or Master's Degree defend a Candidate Thesis within 3 - 7 years after they graduate

HIGH SCHOOL

From 2016 the MES of Ukraine has merged the specialties of physics and astronomy into common one -104 "Physics and Astronomy".

HIGH SCHOOL

Universities	The number of graduates by years		
	2016	2017	2018
KNU	12b + 5м	12b + 10м	14b + 9м
KhNU	8b	9b + 2м	8b + 7м
ONU	1м	1b + 2м	1b + 1м
LNU	3м	7м	5м
b – bachelor; м – masster	20b + 9м	22b + 21м	23b + 22м

- ✓ В КНУ освітня програма «Астрономія» дозволяє набирати студентів в бакалавратуру окремо від освітньої програми «Фізика». Ліцензійний обсяг підготовки бакалаврів за цією програмою – 25 осіб. МОН щороку виділяє 8 – 12 бюджетних місць, що корелює з кількістю заяв абітурієнтів в попередній рік, переважно заяв з 1-м пріоритетом. За правилами МОН кількість бюджетних місць в магістратурі складає 50% від випуску бакалаврів поточного року. Всі, хто не втрапить на бюджет, можуть іти на контракт (близько 32 тис.грн за рік). Останні декілька років з'явилась нова тенденція – виїзд на магістерські програми за кордон, раніше їхали переважно в аспірантуру.
- ✓ В ОНУ не оформлено вступ на спеціальність 104 за окремими навчальними планами, тому студенти протягом навчання можуть обирати фізику або астрономію.
- ✓ У 2016 та 2017 роках на фізичний факультет ЛНУ здійснювався набір на спеціальність 104 без поділу на спеціалізації. З 2018 р. студенти можуть обрати спеціалізацію "Теоретична фізика та астрофізика". Очікується, що як мінімум половина з них будуть орієнтовані на астрономію.

SOME PROBLEMS OF HIGH SCHOOL

- There is slow degreasing of the number of student in astronomy from 75 (in 2002) to about 50 (at present).
- One of the problem is passing the External independent testing (EIT) for physics resulted from low level of teaching the physics in school.
- MES of Ukraine has established a limit of the number of student for special groups (not less then 10). In case of astronomy it is not appropriate. Adequate number is 3 - 5.
- Astronomical textbook and teaching facilitate have to be approved.

SECONDARY SCHOOL

PHYSICS and ASTRONOMY			
Subject PHYSICS		**Subject ASTRONOMY**	
Class	Hours/Week	Class	Hours/Week
Secondary education of 2nd degree			
7	**2**		
8	**2**		
9	**3**		
Secondary education of 3rd degree		**Secondary education of 3rd degree**	
10	**3** (Standard level - STL) **6** (Specific level - SPL)		
11	**2** (STL) **3** (Academic level - AL) **6** (SPL)	**11**	**0.5** (STL) **0.5** (AL) **1** (SPL)

ПРОБЛЕМИ СЕРЕДНЬОЇ ШКОЛИ

- Школи, за винятком 40-50 фіз.-мат. ліцеїв по всій Україні, випускають учнів, які не здатні осилити університетські курси фізики і математики. В суспільстві створена стійка відраза до науки взагалі і точних наук зокрема. Зменшення потоку абітурієнтів призводить до автоматичного зменшення кількості ставок викладачів в університетах.
- В школах працюють, за невеликою кількістю винятків, вчорашні трієчники, кращі випускники шкіл не йдуть в педагогічні університети вже впродовж більше 30 років. Вчителі самі дуже приблизно знають матеріал, який викладають. Більшість вчителів фізики не здатні розв'язувати стандартні задачі з фізики.

ПРОБЛЕМИ СЕРЕДНЬОЇ ШКОЛИ

У переліку спеціалізацій спеціальності 014 "Середня освіта" (підготовка вчителів для шкіл) відсутня Астрономія. За її відсутності у назві спеціалізації 014.08 ЗВО мають повне право ігнорувати астрономічні курси та спецкурси, а тому багато майбутніх вчителів фізики просто не знатимуть астрономію.

Перелік предметних спеціалізацій спеціальності 014 «Середня освіта (за предметними спеціалізаціями)», за якими здійснюється формування і розміщення державного замовлення

Шифр	Предметні спеціалізації
014.01	Середня освіта (Українська мова і література)
014.02	Середня освіта (Мова і література (із зазначенням мови))
014.03	Середня освіта (Історія)
014.04	Середня освіта (Математика)
014.05	Середня освіта (Біологія)
014.06	Середня освіта (Хімія)
014.07	Середня освіта (Географія)
014.08	Середня освіта (Фізика)
014.09	Середня освіта (Інформатика)
014.10	Середня освіта (Трудове навчання та технології)
014.11	Середня освіта (Фізична культура)
014.12	Середня освіта (Образотворче мистецтво)
014.13	Середня освіта (Музичне мистецтво)
014.14	Середня освіта (Здоров'я людини)

Директор департаменту вищої освіти О. І. Шаров

Publications

- Information Bulletin of the Ukrainian Astronomical Assotiation
- Astronomical Calendar (annual)
- Odesa Astronomical Calendar (annual)
- Scoolar Astronomical Calendar (annual)
- Textbooks of astronomy for students:

  Celestial Mechanics, Physics of Planetary atmospheres, Solar physics,

- Magazines: Svitoglyad (”World view”), Vselennaya, Prostranstvo, Vremya (“Universe .Space. Time.”)
- Books on History of Astronomy

Science funding is worse

Beginning in 1991, the total expenditure (budgetary and off-budgetary) for research and development (R&D) has been reduced by factor of 4 (750 000 000 USD in 2004). The gross expenditure on R&D as a percentage of GDP also has been reduced by a factor of two. The total budgetary expenditure on science and technology (S&T) in 1991 – 2002 in relative terms of purchasing-power parity has also deteriorated by one-half to 2 030 000 USD in 2002 (Yatskiv 2004).

Science in Ukraine, including astronomical research, is now facing a difficult time due to economic limitations of the nation and the need for upgrading the existing scientific infrastructure.
The key problems are both the low GDP activities and the fact that even the low budgetary expenditures on science and technology have not been effectively spent.
In 2005 the adopted budget is 20 400 000 000 USD with 5% devoted to R&D.

Prestige

The need to raise the prestige of the scientific profession irrespective of the low salaries for young scientists and engineers.

Secondary astronomical education

How to increase the number of new textbooks ?
How to organize regular training of astronomy teachers ?

Thank you for your attention!