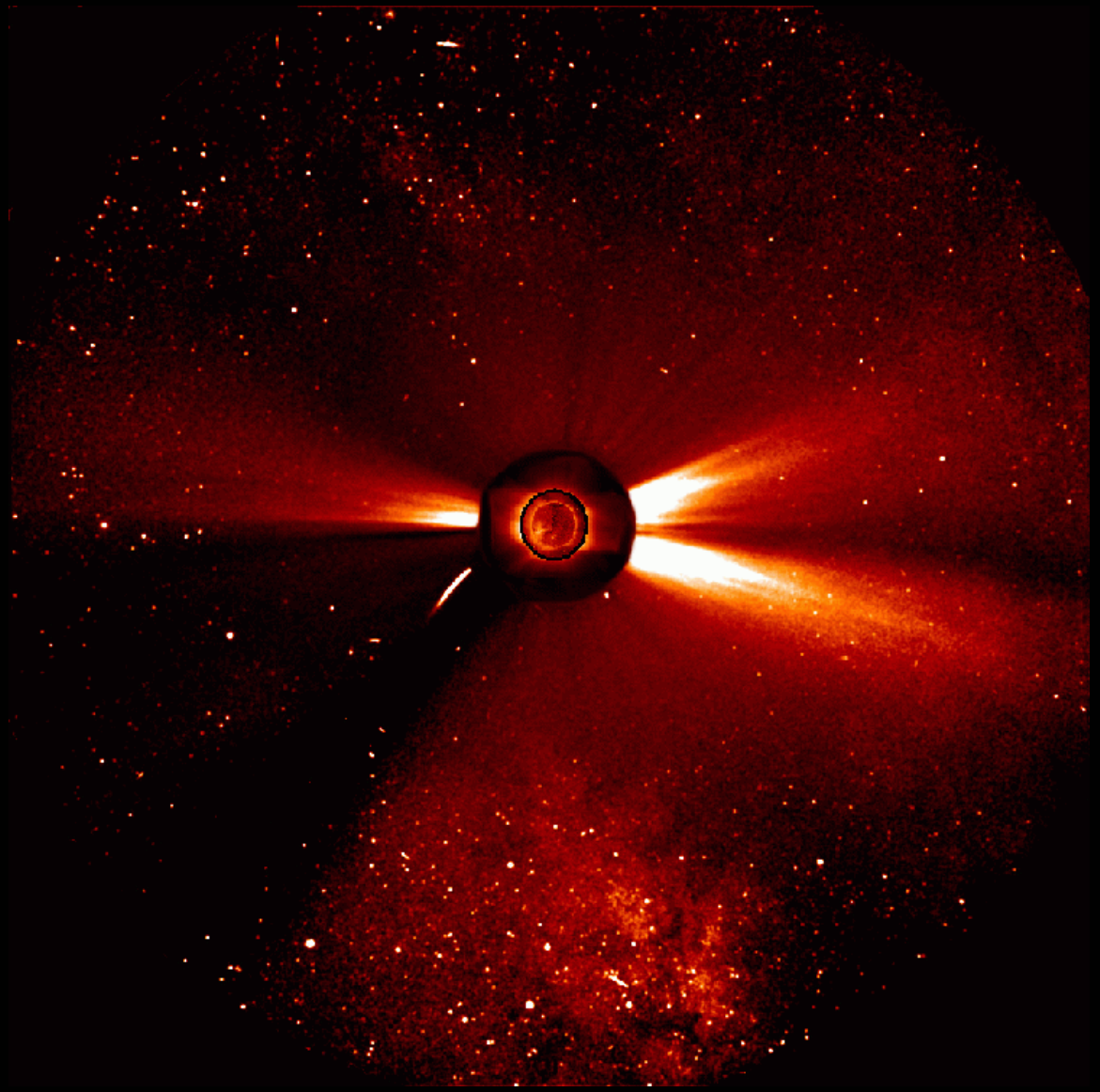
Sofia University “St Kliment Ohridsky”



University Center for Space Research and Technologies

University Centre for Space Research and Technologies, Sofia University performs scientific research and education in Space Research and Technologies, which have applications in electronics, telecommunications, geophysics, meteorology, ecology, GIS, archaeology and other fields.

The Centre coordinates and manages efforts of scientists from various departments of Sofia University and external scientific institutions in temporary research teams, which accomplish scientific tasks related to Space Research and Technologies. Centre forms temporary laboratories on different scientific high- priority hot topics. It ensures higher flexibility than this of most scientific institutes and university departments in the country.

The Centre have affiliated companies (O&K, Hydroloc, etc), internationally recognized Astronomical observatory IAU- 79 and active Astronomical student circle, which also performs scientific research.

Applied research fields of the Centre includes development of IR, UV and visible imaging systems and photometry for remote sensing observations from aircrafts, UAVs and satellites, Solar and Space Impacts on the Environment and applications of Space Research and Technologies in Archaeological research and prospecting. **It includes also research and location of asteroids and dangerous Near- Earth Objects (NEO) and assessment of the damage which they can produce in result of potential collisions.**

The Center has a highly qualified teaching staff, and its scientific production is published in journals, monographs and encyclopedias cited worldwide. Specialists of the Center lead national and international research projects and programs.

Specialists from the Center participate in large international collaborations and experiments in particle physics, such as ATLAS, CHORUS, DELPHI, HARP, OPERA and H1. They review articles in prestigious international journals; are members of the editorial boards of international journals, editors of foreign monographs; appraise Italian research projects and participate in the appraisal of Italian universities. They chaired scientific organizing committees of many international scientific schools and conferences.

The Center maintains intensive international relations and collaboration with universities and research institutions in Australia, Austria, Belgium, Brazil, Canada, China, Croatia, Czech republic, Egypt, France, Germany, Hungary, India, Indonesia, Iran, Iraq, Italy, Luxembourg, Portugal, Puerto Rico, Romania, Russia, Slovenia, South Africa, Serbia, Spain, Swisszerland, UK, USA and other countries.

The scientific results of the members of the Center are reflected in 750 publications in scientific journals, monographs (mostly foreign) and conference reports, of which, 560 articles in peer-reviewed journals with impact factor. They are cited 31290 times by foreign scientists and research groups. 89 of the articles have more than 89 citations each (h-factor 89).

Their results are presented in 167 reports at international congresses, conferences, symposia and schools, 23 of them have been invited or plenary talks.

Center's web page is: **http://www.phys.uni-sofia.bg/eng/departments/ucsrt/index.html**

Center's YouTube channel is

https://www.youtube.com/channel/UCyH3fFqMfKjLLI9jS4xnWHw

Center forms temporary laboratories, which work in its current directions of research, as its laboratory in Archaeo-geophysics..

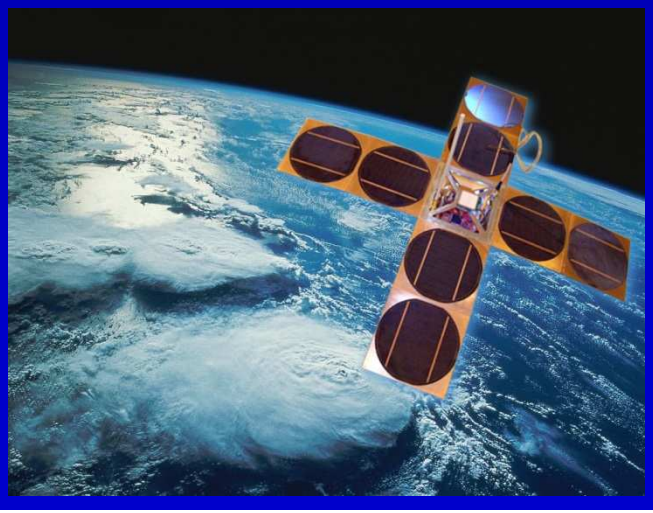
http://www.phys.uni-sofia.bg/bul/departments/ucsrt/agpl/index.html

Center performs scientific and educational activities in the field of space research and technology, which have applications in electronics, telecommunications, geophysics, meteorology, ecology, archaeology and other fields. It also performs research on properties of materials for space technology and nano-technology. Main educational activity of the Center are master's Programs on "Space research" and "Aerospace engineering". The main part of the training of staff for Bulgarian space program is conducted by the University Center for Space Research and Technology, as the only specialized university structure in this field in the country. Graduates in different specialties of science and engineering from other faculties and universities also study in the master programs of the Center.

PhD students from other European universities study at the Center as well as students from Russian Siberian State Aerospase University.

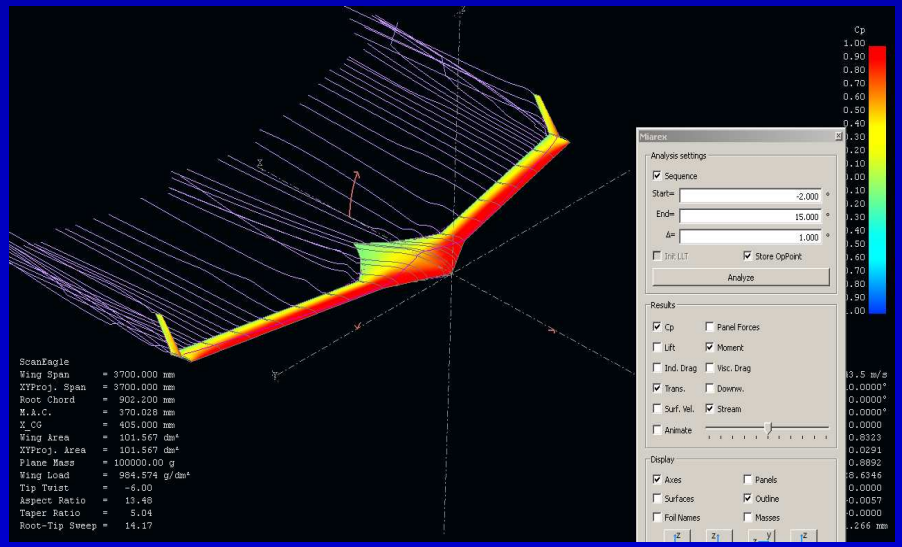
O & K co. Acceco systems capabilities

- **Participation in Sofia University microsat project**
- **Development of microsat prototype with folding solar panels: https://www.youtube.com/watch?v=fddeVdvJV0E**
- **Development of high-resolution imaging/video camera & high speed down/up link /DVB-S2/**
- **Development of micro thruster /hot gas/ for orbit transfer which is safe, due to the low pressure tank**



O & K co. Acceco systems capabilities

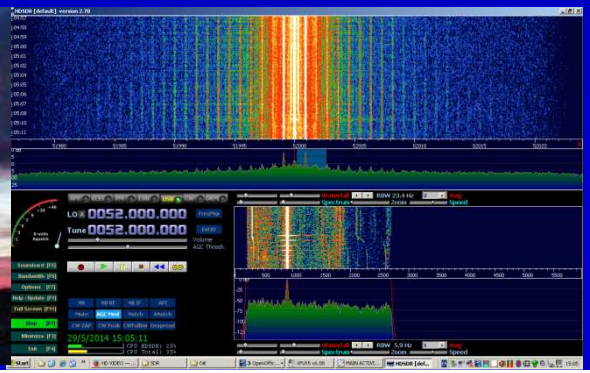
- **Development of unmanned aircraft systems**
- **Development of concept, design, prototyping and production of unmanned aircraft systems**
- **Development of high altitude, solar powered aircraft**

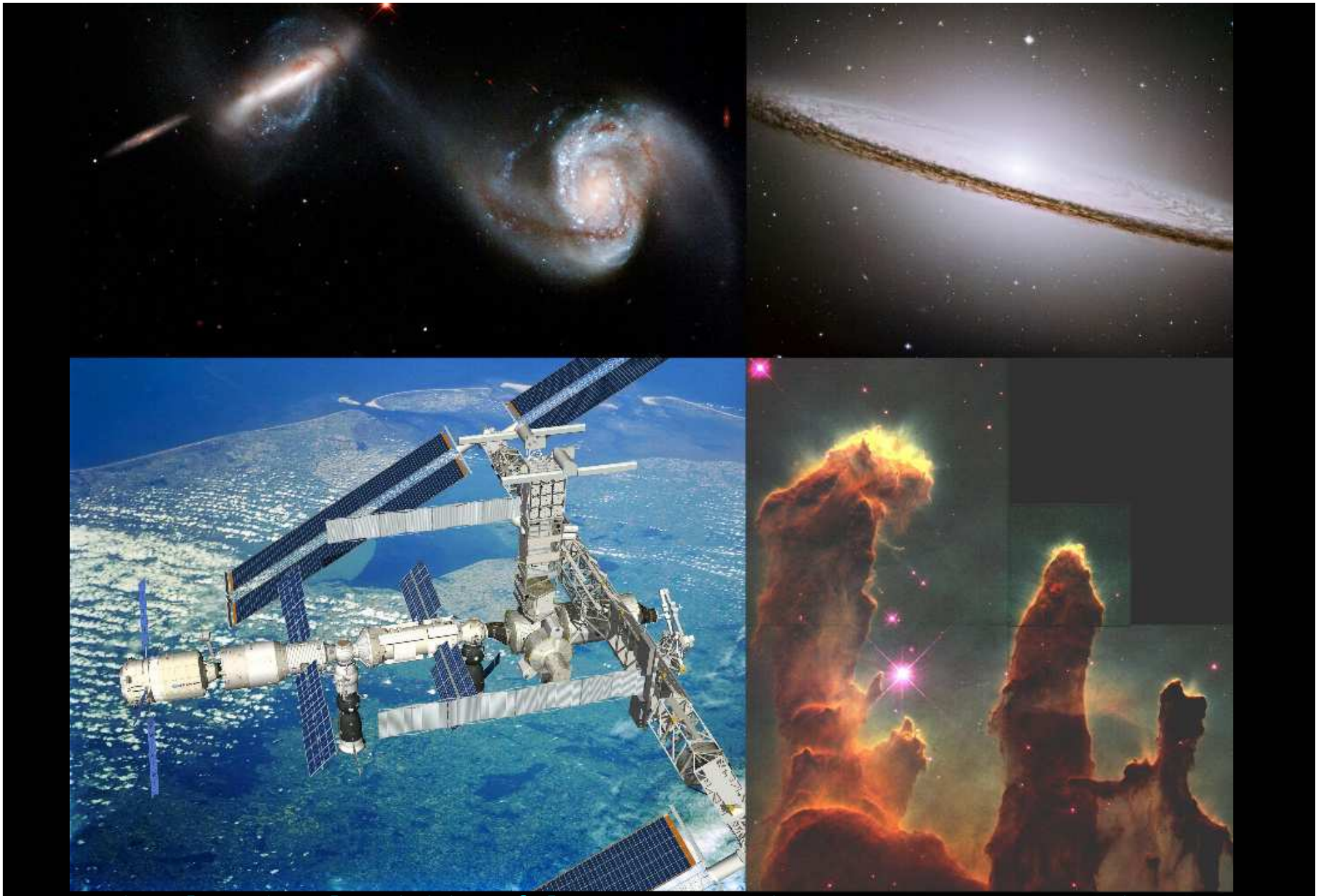


O & K co. Acceco systems capabilities

- Development of communication equipment and laboratory
- Development of satellite tracking station in VHF, UHF, L,S,X radio bands
- Development of Satellite optical tracking station
- Design, measurement and production of antennas and arrays.
- Design, test and production of high speed communication transiver DVB
- Soft defined radio core and FPGA integration with image sensor







Main educational activities of the Center are its Master's programs in Space Research and in Aerospace engeneering, teaching and supervising of PhD students

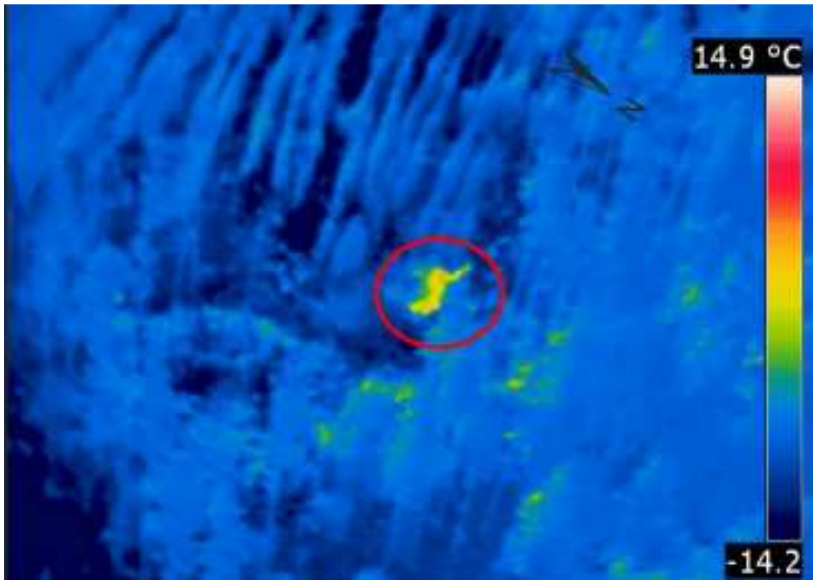
National Geographic shooting a movie for the research of specialists from the Center

http://www.disclose.tv/action/viewvideo/107101/Ancient_X_Files_S02E08_The_Great_Flood/

A New International Program on Techniques for Remote Location of Caves (RLC) started accordingly to the resolution taken by the Commission on Physical Chemistry and Hydrogeology of Karst on 25th July 2013, approved on 28th July 2013 by the General Assembly of the International Union of Speleology (UIS): **https://www.youtube.com/watch?v=2cmrC4qo8N8**

It will use thermal vision and UV- imaging devices mounted on drones and satellites. Equipment and techniques developed by this program can be directly applied also for remote location and preventive determination of propagation direction of forest fires. It is timely effort, because of the high international demand for such techniques.

This project aims to locate new unknown caves and caves in hardly accessible regions and will be extremely helpful to expand cave exploration in new regions and even on other planets. **Search for caves on Mars is of vital importance for the future manned exploration of the planet, because such caves are appropriate for shelters for the astronauts from the deadly cosmic rays radiation** at the first stages of the planet exploration. Exposure of the astronauts to cosmic rays radiation is one of the most difficult problems for manned exploration of the Moon and planets. So the final stage of the program is development of equipment suitable for mounting on space probes for search for caves on Mars.



IR- Termal vision image showing the entrance of the Naděje cave from a distance of about 350 m above, registered from a small airplane

RLC International Program consists of the following stages:

1. To optimize techniques on the surface and to calibrate it on mapped caves.
2. To use it to locate new unknown caves
3. To put observational instruments on airplanes and helicopters to locate caves in hardly accessible regions from the sky.
4. To put observational instruments on microsatellites.
5. To develop equipment suitable for mounting on space probes for location of caves on Mars.

So far this programme has 17 members from 11 countries.

Dr. Yavor Shopov from Sofia University is leader and Dr. Ivo Baroň from Geological Survey of Austria is co-leader of the programme

Scientific research fields
of University Center for Space Research and Technologies

Space Physics:

1.Elementary particles physics and Early Universe

I. Breaking of dynamic symmetry
II. Quantum field theory.
III. Kaon physics.
IV. Phenomenology of antisymmetric tensor particles.
V. Neutrino oscillations
VI. Early universe
VII. Quantum field theory with a fundamental length.
VIII. Experimental Particle Physics

2. Space Impact on the Environment

I. Solar Impact on Global Climate Changes
II. Solar terrestrial relations and solar forcing of the climate.
III. Orbital Variations of the Earth’s Orbit and their influence over Glacial Periods
IV. Cosmic Rays Impact on the Global Climate Changes
V. Solar Modulation of the Geomagnetic Activity and the related Processes
VI. Solar and Geomagnetic Activity Impact on Human Health

Scientific research fields
of University Center for Space Research and Technologies:

3. Solar physics

I. Solar Activity
II. Variations of Solar Irradiance
III. Structure and processes in the Solar Corona
IV. Heliospheric physics
V. Studies of the Solar Corona from Space Probes
VI. Studies of the Solar Corona from Stratospheric Flights
VII. Research of Solar Eclipses

4. Space Weather

Study of variations of the flux of dangerous high-energy particles in the Space.

5. Study of Asteroids and Comets interactions with the Sun and Earth

I. Study of collisions of asteroids and comets with the Sun and planets and their consequences.
II. Search for new asteroids and comets.

6.Variations of Cosmic Rays Flux and Production of Cosmogenic Isotopes

7. Applications of Space Research and Technologies in Archaeological research.

I **.** Applications of Space Technologies in Archaeological and Historical research
II. Applications of Space Research in Archaeological and Historical research

Scientific activities

Of the University Center for Space Research and Technology are in the field of:

1. Elementary Particles Physics and Early Universe

Cosmic factors affecting climate:

https://www.youtube.com/watch?v=jo9M3KDyBfI

1. Orbital variations in Earth's orbit changing insolation
2. Variations in solar radiation:
   a. Periodic
   b. Short-term fluctuations
   c. Explosive variations

3. Variations of cosmic rays (CR) changing the transparency of the atmosphere
   a. Variations in the CR caused by solar wind- multiply the effects of solar variations
   b. Own variations of galactic cosmic rays caused by explosions of supernova stars

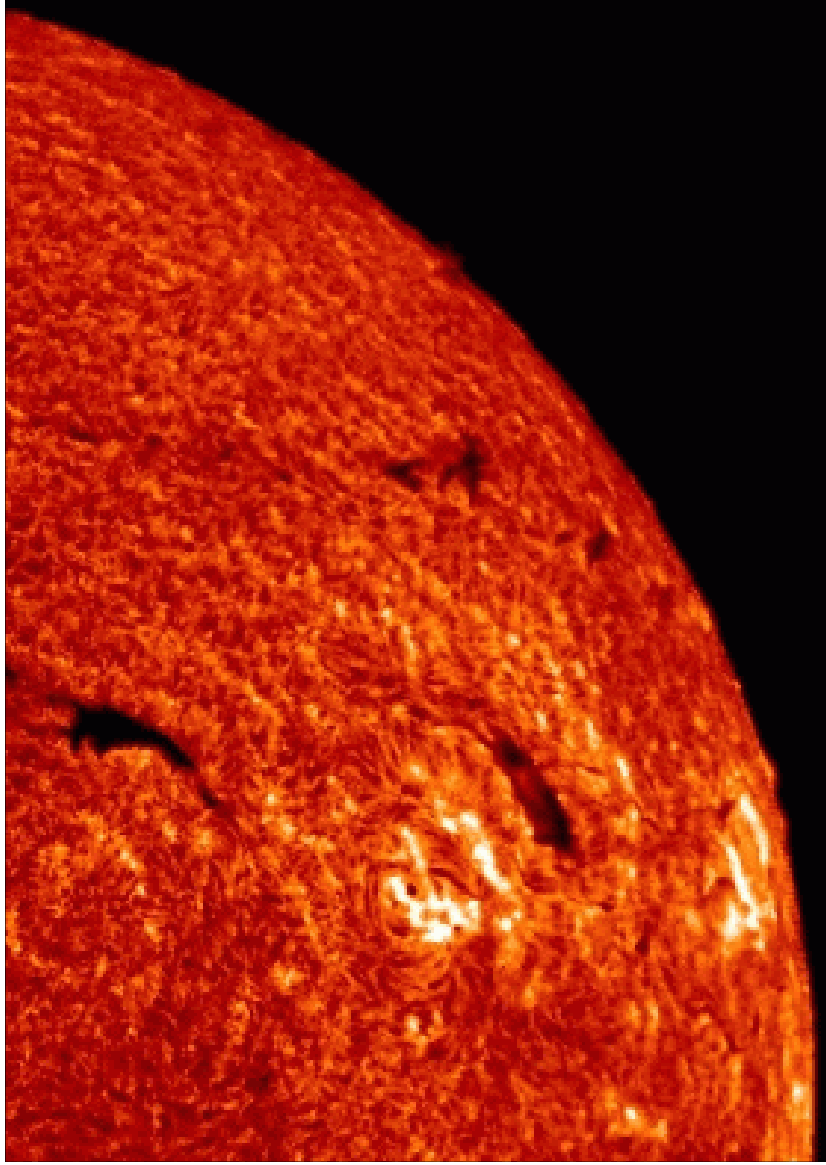
4. Small bodies in the solar system (meteors, comets, asteroids)
   a. Decrease of the transparency of the atmosphere by pulverizing of small bodies
   b. Explosions of small bodies hitting the Earth
   c. Deviation of the Earth's orbit due to collisions with large asteroids

5. Interplanetary dust

2. Cosmic impacts on the environment

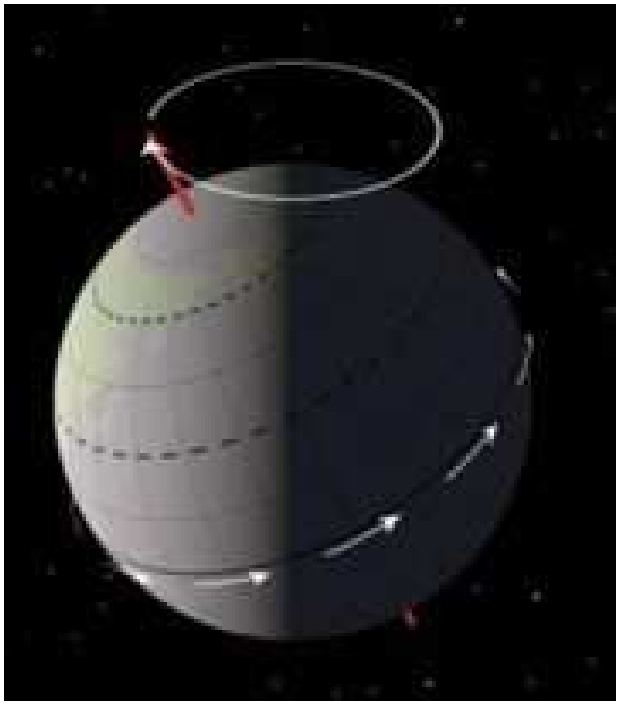
I. Solar effects on global climate change

https://www.youtube.com/watch?v=DCuBLMk73bo

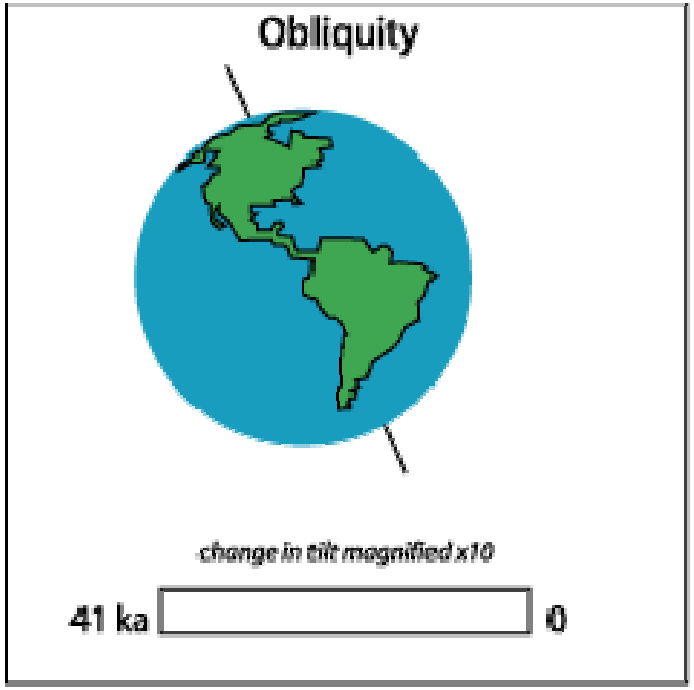


II. Orbital variations in Earth's orbit and their impact on the ice ages

According to the theory of Milankovitch, variations in Earth's orbit cause significant changes in solar irradiation of the Earth, that cause ice ages.

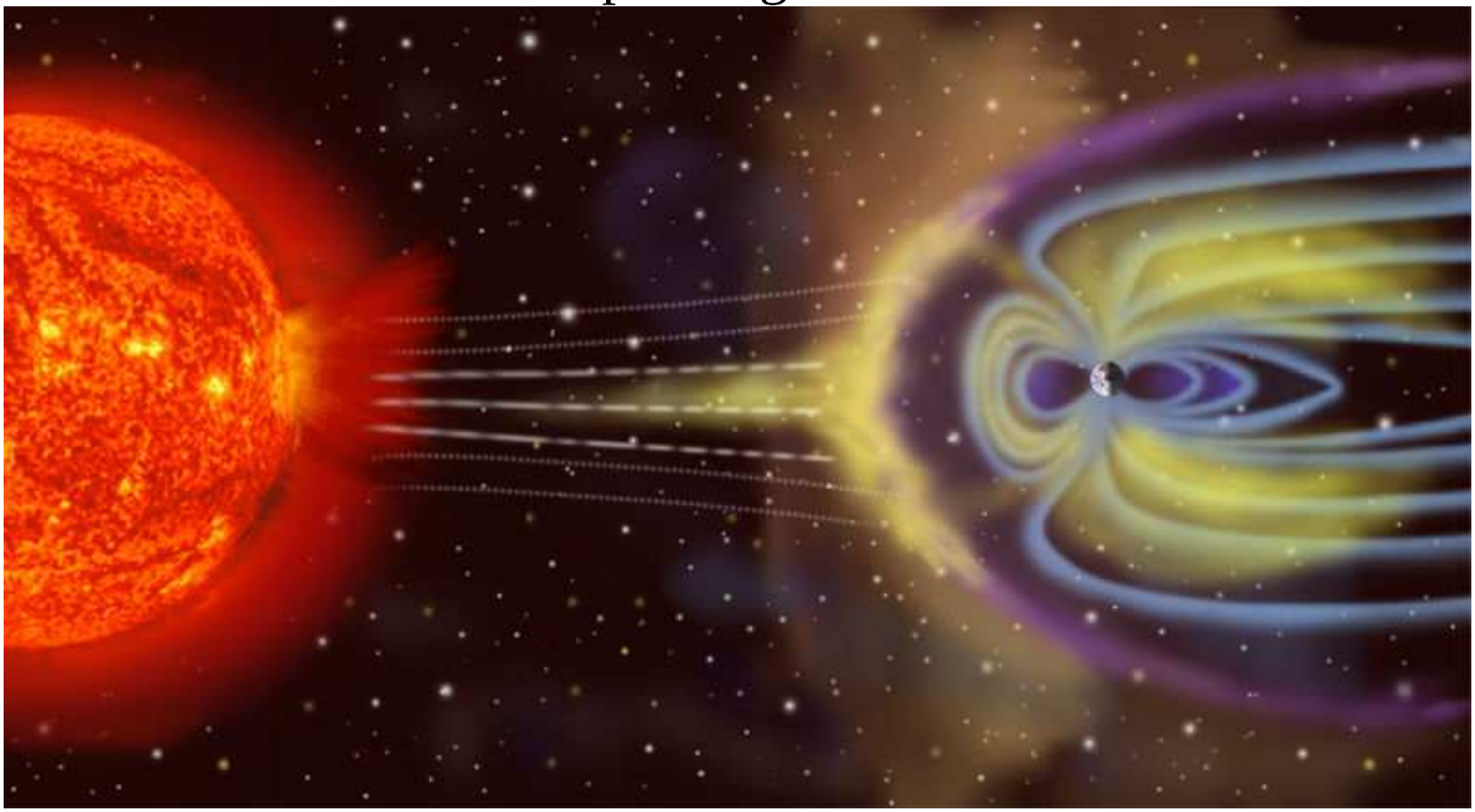


Precession of Earth's axis



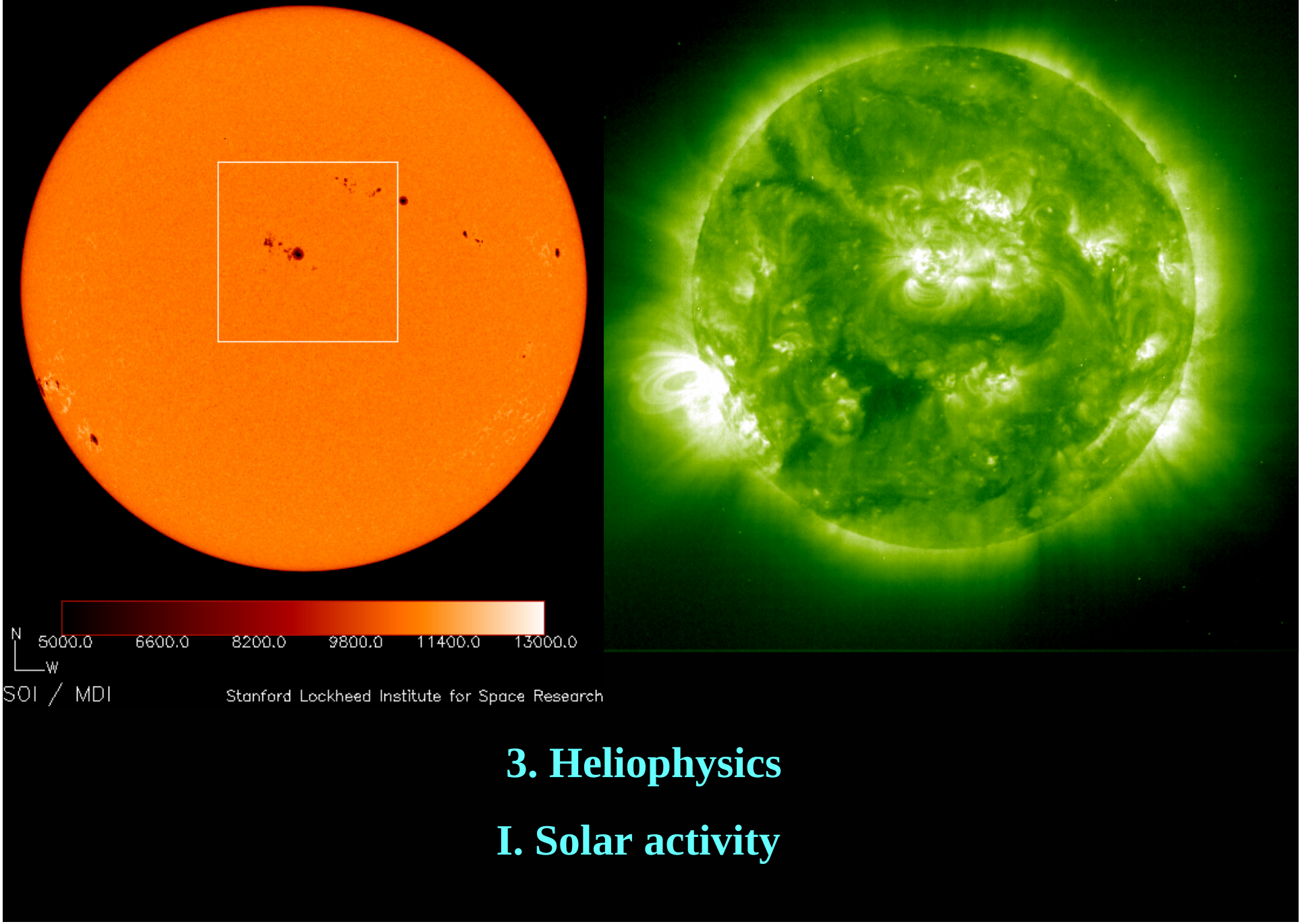
Change the slope of the earth's axis

III. Impacts of cosmic rays on the climate
IV. Solar modulation of geomagnetic activity and processes depending on it



Cosmic rays are centers of condensation of water in clouds. They are strongly modulated by the solar wind. More powerful solar wind leads to a weaker flow of cosmic rays, respectively to thinner clouds, greater transparency of the atmosphere, and greater sunlight exposure of the ground (Stoykova et al., 2008).

Same sunspots observed from Earth and from space in different spectral regions



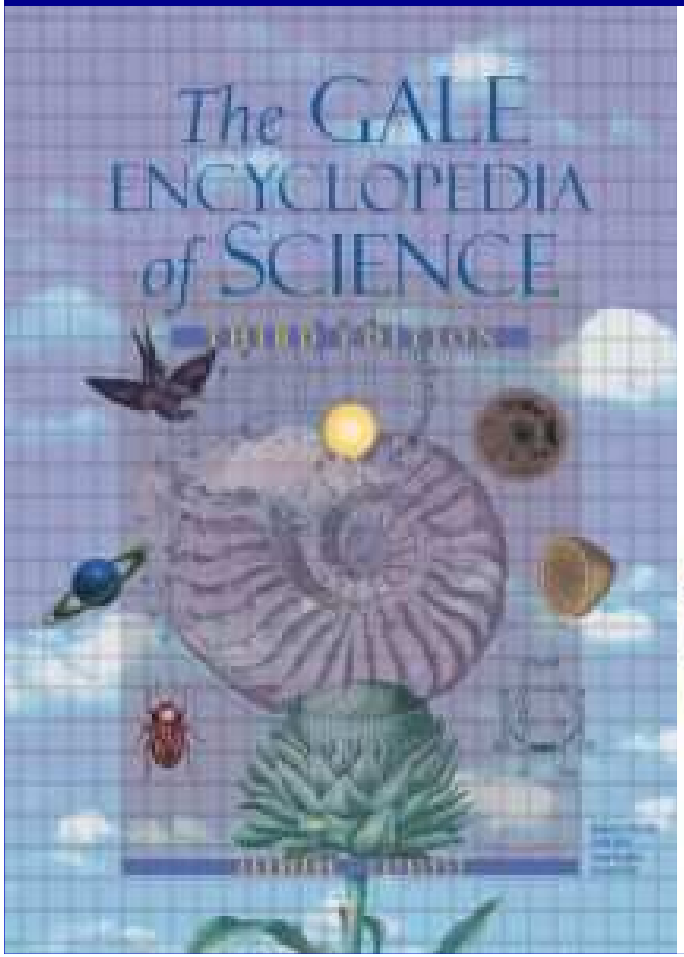
3. Heliophysics

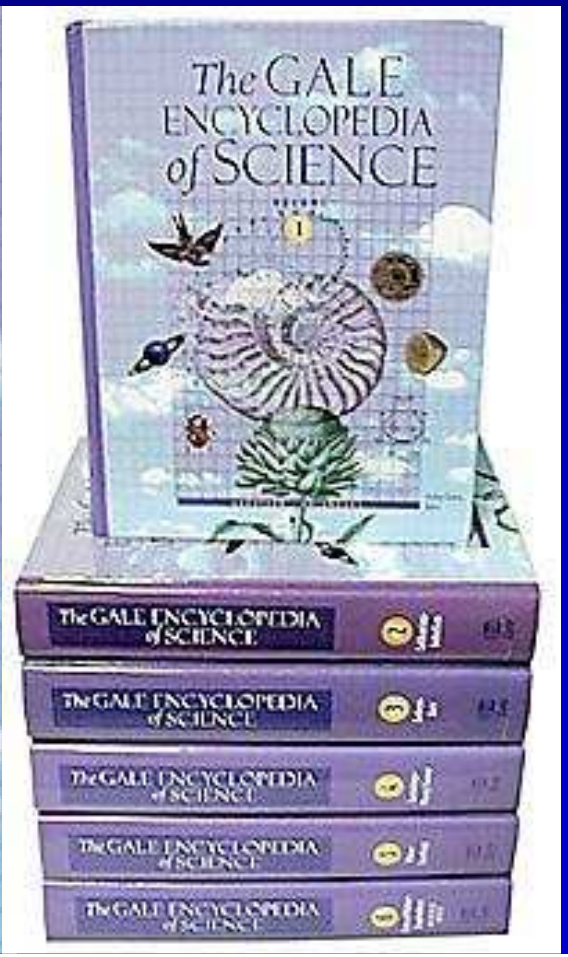
I. Solar activity

Some of the results obtained at the Center are fundamental to science, and were included in international encyclopedias, such as:

The Gale Encyclopedia of Science -3rd Edition, New York, London, 4607p.

The “Gale Encyclopedia of Science” is written at a level somewhere between the introductory sources and the highly technical texts currently available. This six-volume set covers all major areas of science and engineering, providing a comprehensive overview of current scientific knowledge and technology.





THOMSON

GALE

II. **Study of solar eclipses**

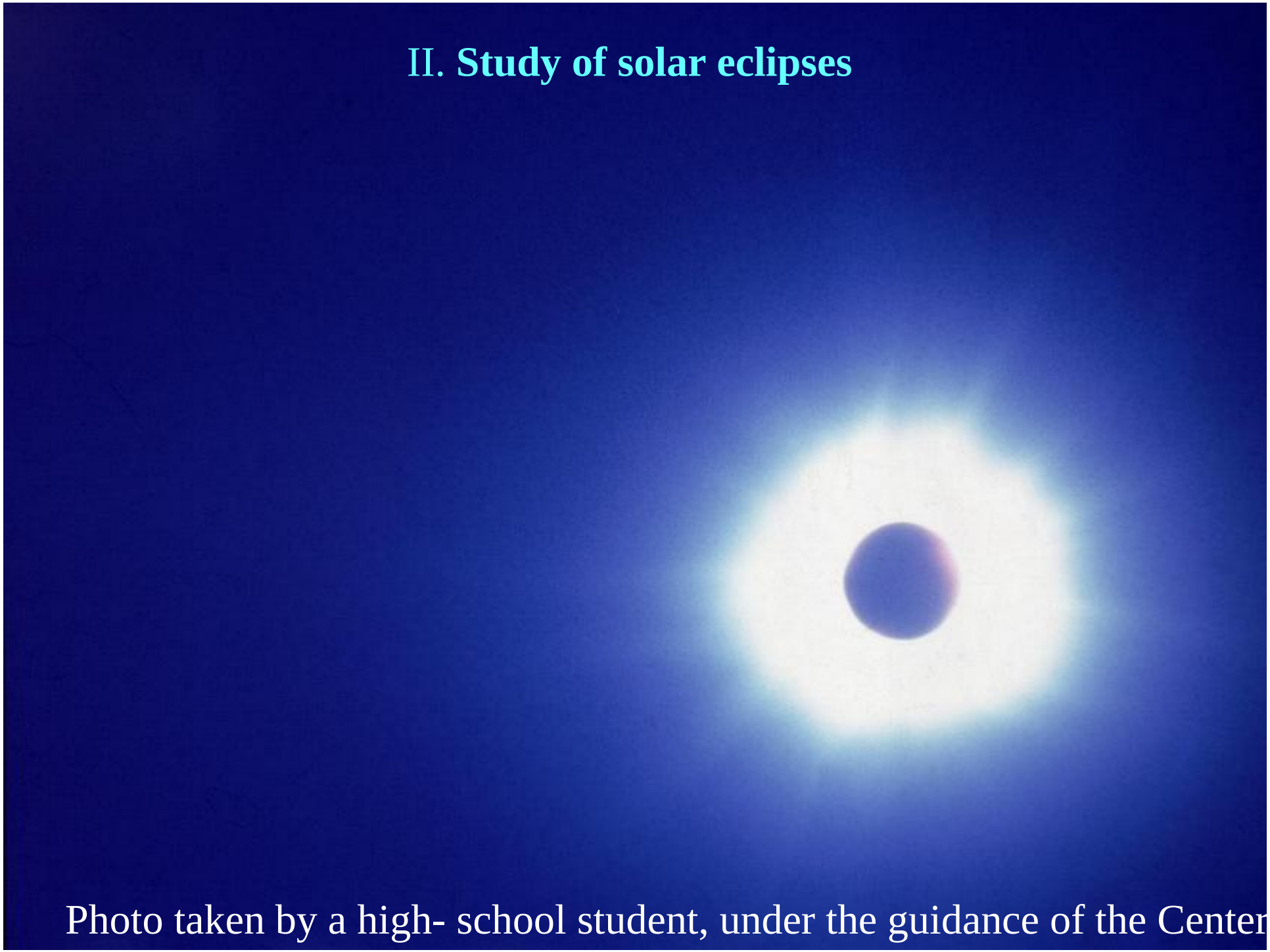


Photo taken by a high- school student, under the guidance of the Center

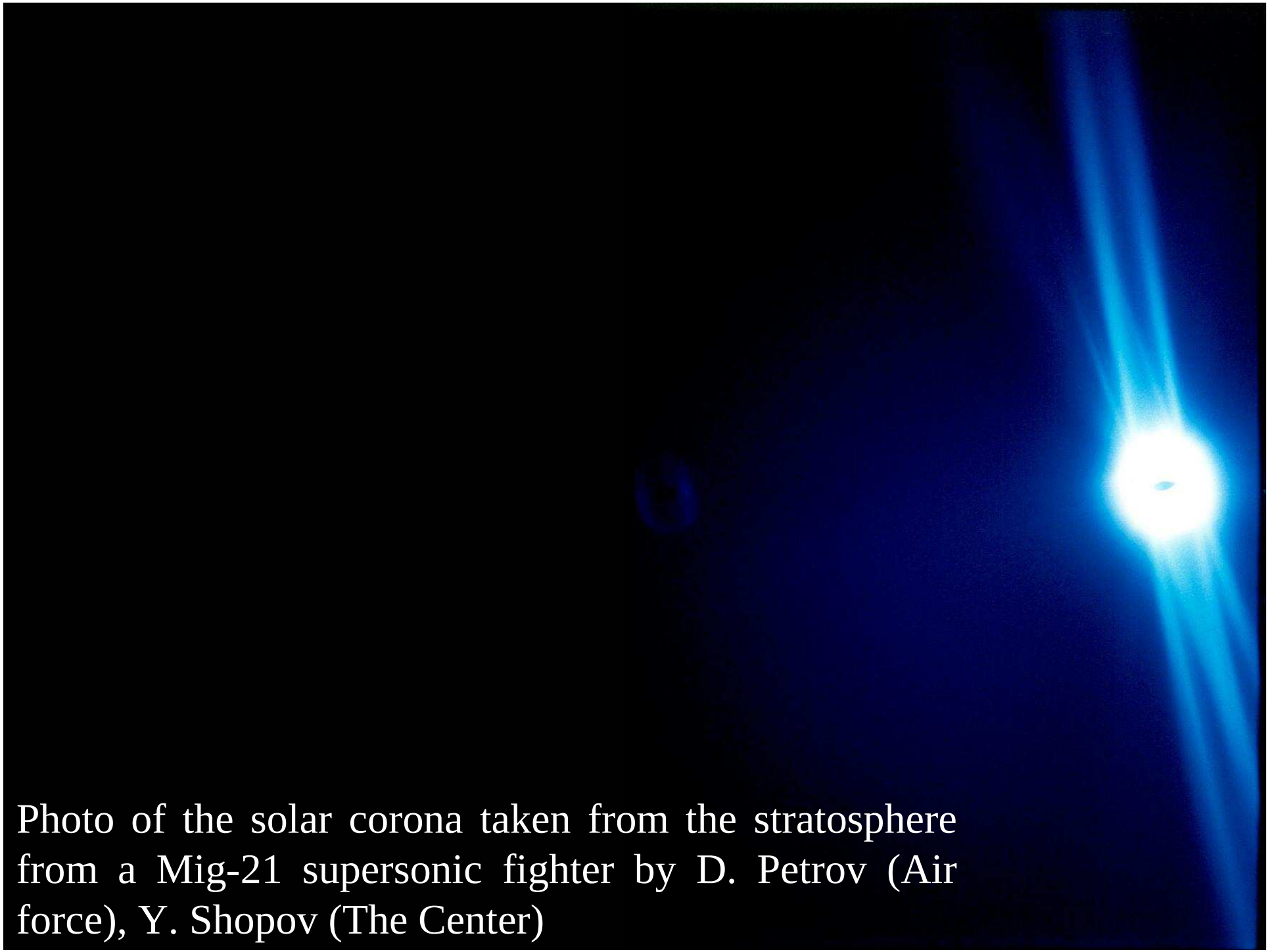
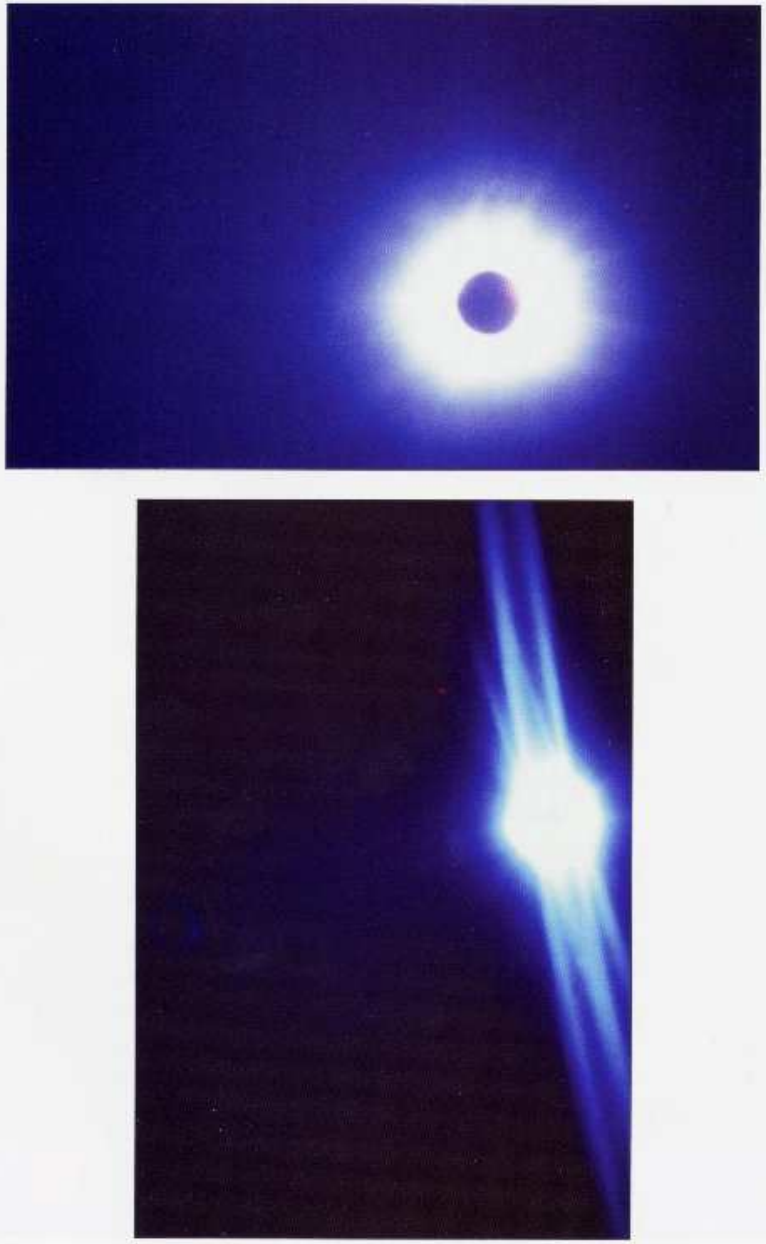


Photo of the solar corona taken from the stratosphere from a Mig-21 supersonic fighter by D. Petrov (Air force), Y. Shopov (The Center)



TOP: Far solar corona as seen during a total eclipse. See entry, "Eclipse," page 185. © *Y. Shopov. Reproduced by permission.*

BOTTOM: Giant coronal streamers, visible only from space or the upper stratosphere during an eclipse. See entry, "Eclipse," page 185. © *Y. Shopov. Reproduced by permission.*

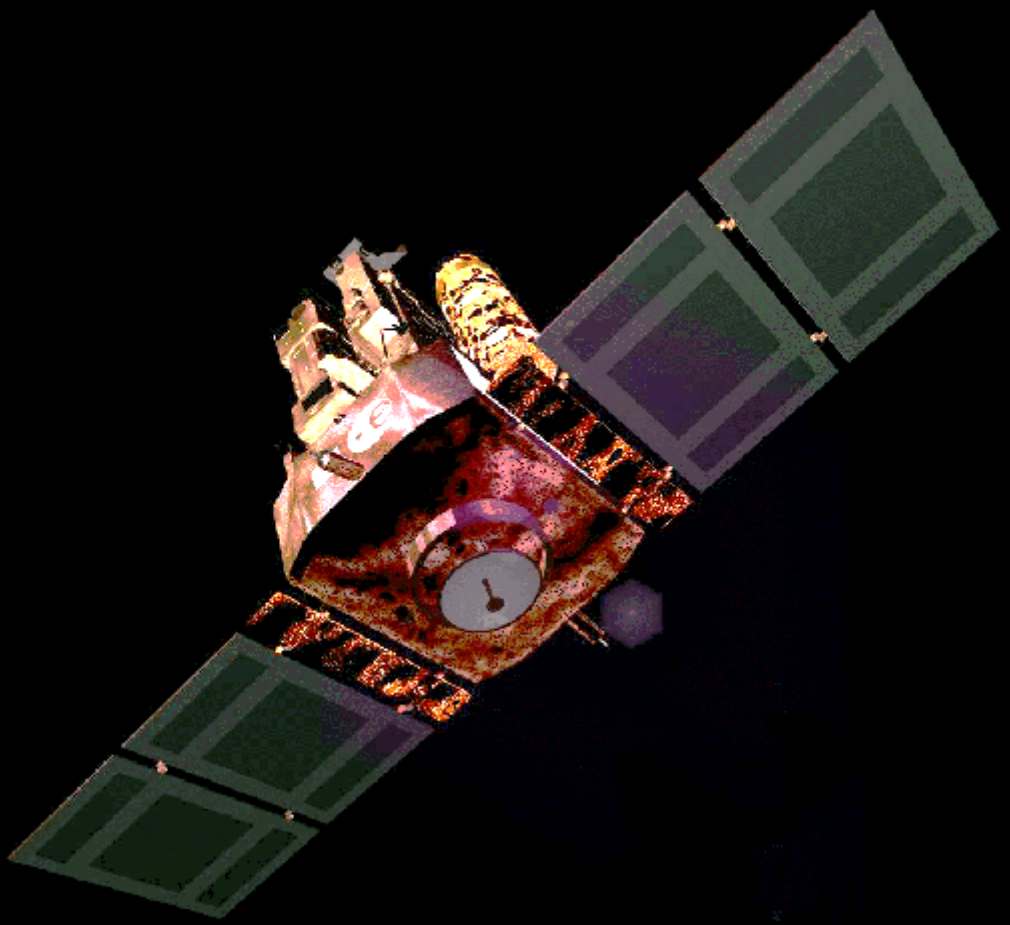
Observations above published in Encyclopedia: World of Earth Science

THOMSON GALE

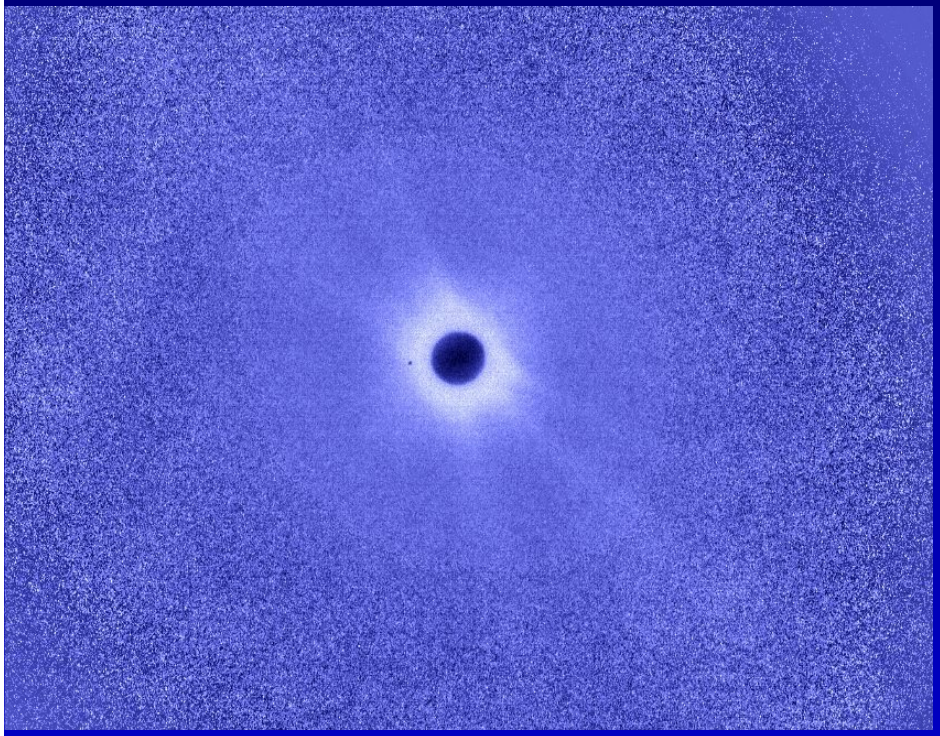
Publisher: Thomson Gale

Editors: Brenda Wilmoth Lerner, K. Lee Lerner, 2003, New York, London, p. 736

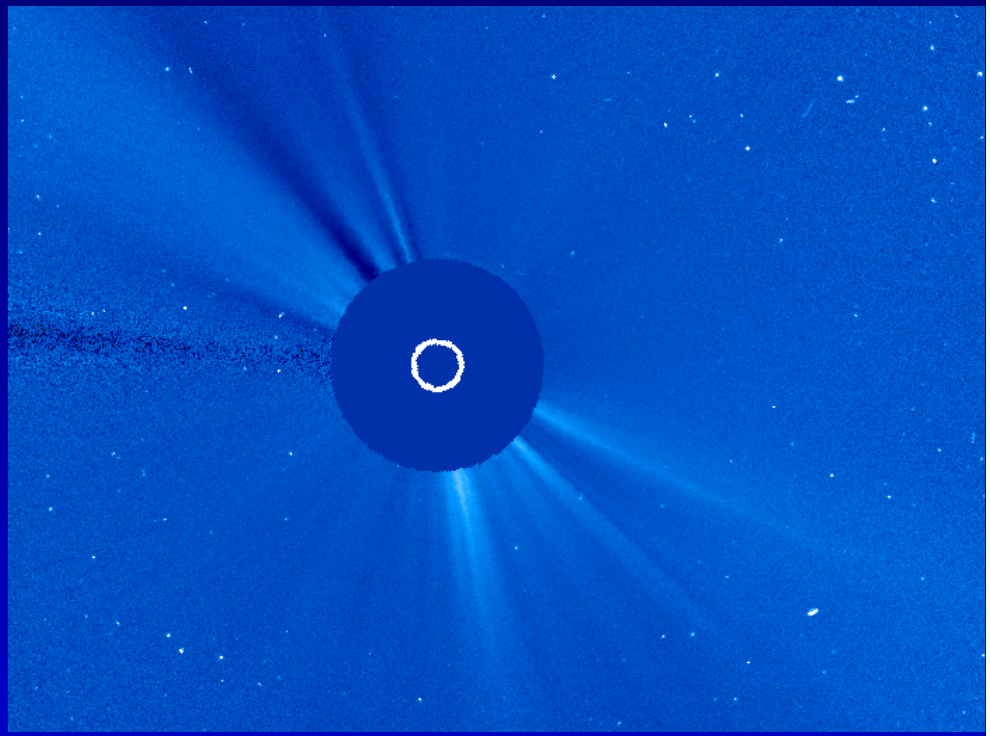
III. Study of the solar corona by satellites



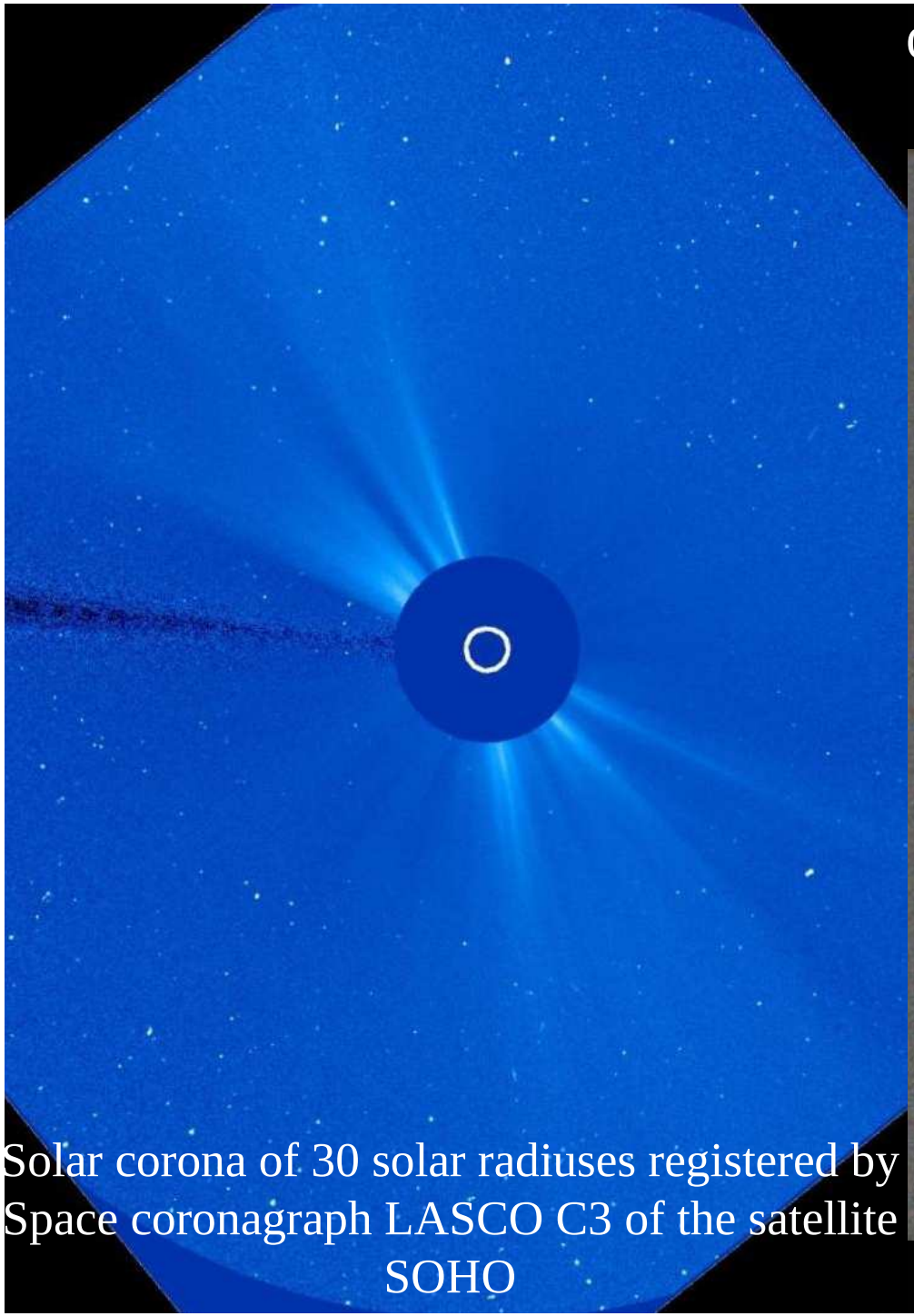
Solar orbital heliospheric observatory SOHO



Solar corona observed from ground observations by University Center for Space Research and Technology



Solar corona observed up to 30 Solar radius from the Space coronagraph LASCO C3 of the SOHO satellite



Solar corona of 30 solar radiuses registered by Space coronagraph LASCO C3 of the satellite SOHO

On this photo of the solar corona taken by our Center, are registered many details missing in the simultaneous observations by SOHO LASCO C3- coronagraph

IV. Study of the solar corona from stratospheric flights

това преминахме към варианта за снимки от кабината с два фотоапарата – „Практика" и „Пентакон" формат 6x6 cm.

Поради различни причини вариантът МиГ-29 скоро отпадна напълно. Остана възможността за работа от МиГ-21. Какво е предимството на самолета? Първо – така се осигурява 100 % надеждност на наблюдението, независимо от това добро или лошо е времето. Второ – на височина 13 000 m се елиминира основният поглъщащ слой атмосфера и качеството на снимките се доближава до това, получено в космически условия. Трето – при свръхзвукова скорост на полета се увеличава многократно времето за наблюдение – реално на скорост, съответстваща на M=1,4–1,5 при полет по права от Силистра до точка в морето на около 50 km от нос Калиакра (150 km), то е 6 min. За сравнение – на земята то е 2 min и 22 s.

Преди полета. Ръководителят на експеримента доц. Явор Шопов е отляво, отдясно е доц. Людмил Цанков

An editorial publication about observations the solar corona by UCSRT via stratospheric flight

IR image of a plane used by UCSRT for stratospheric observations of the solar corona

Photo of the solar corona taken from the stratosphere from a Mig-21 supersonic fighter by D. Petrov (Air force), Y. Shopov (The Center)

there. It is less than 30 minutes to totality. We zip around a traffic circle and head back from whence we came. Hot on our heels, the clouds from the coast are chasing us.

It is now 20 minutes to totality. We stop in a sunny spot. This is it. This is our site. Minutes later the coastal clouds overtake us. This is not it. We race on away from the coast. We stop again and again. Pulloffs along this road near the centerline are crowded with people gazing skyward. Each time — this is it, this is our site. Each time, the coastal clouds overtake us. Less than 10 minutes to totality. We push on. Clouds ahead, clouds behind. Partial blue skies to the left. Rudy, take this left; too late; take the next one; missed too; take the next one. The little lane goes straight, past a charming French country house and then, with 5 minutes to go until totality, into a deep woods. Of all the ways to miss an eclipse. We drive as fast as we can,

A Diamond Ring over Turkey

JOHN POST

(105mm lens at f/16, Agfa Ultra ISO 50 film, 6-second exposure)

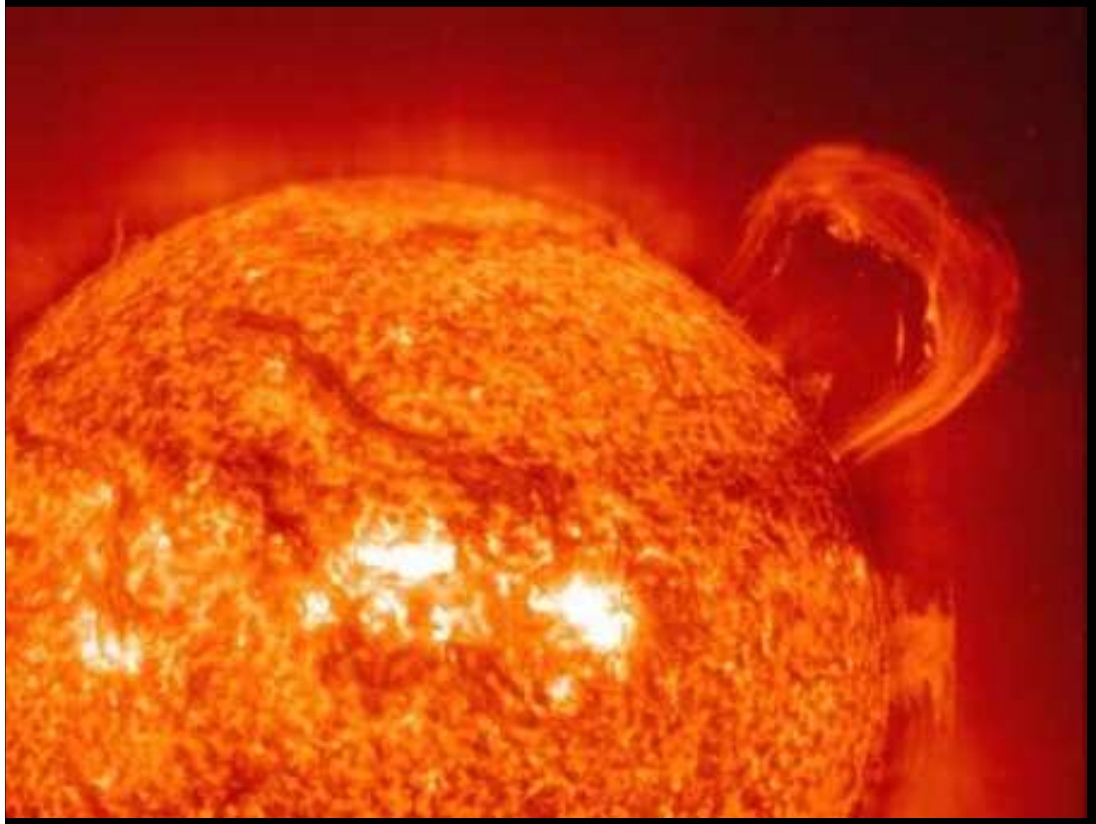
Giant Coronal Streamers

YAVOR SHOPOV

(taken from a military fighter cruising at 40,000 feet; shot on color infrared film)

A part of the same image above, published in an editorial note of Astronomy Journal

V.Variations of solar radiation, which can be measured only from the space

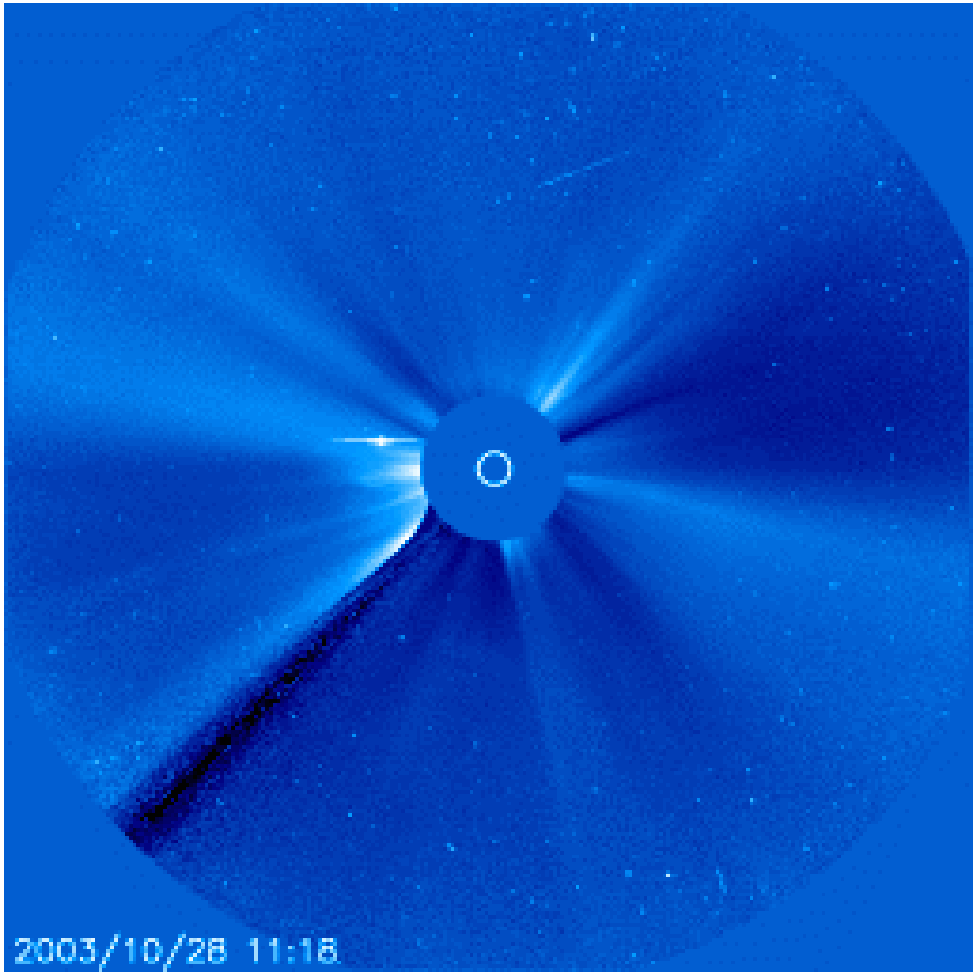


Solar protuberances

Photosphere flares (bright areas)

4. Space weather

Study of variations in the flow of dangerous high-energy particles in space

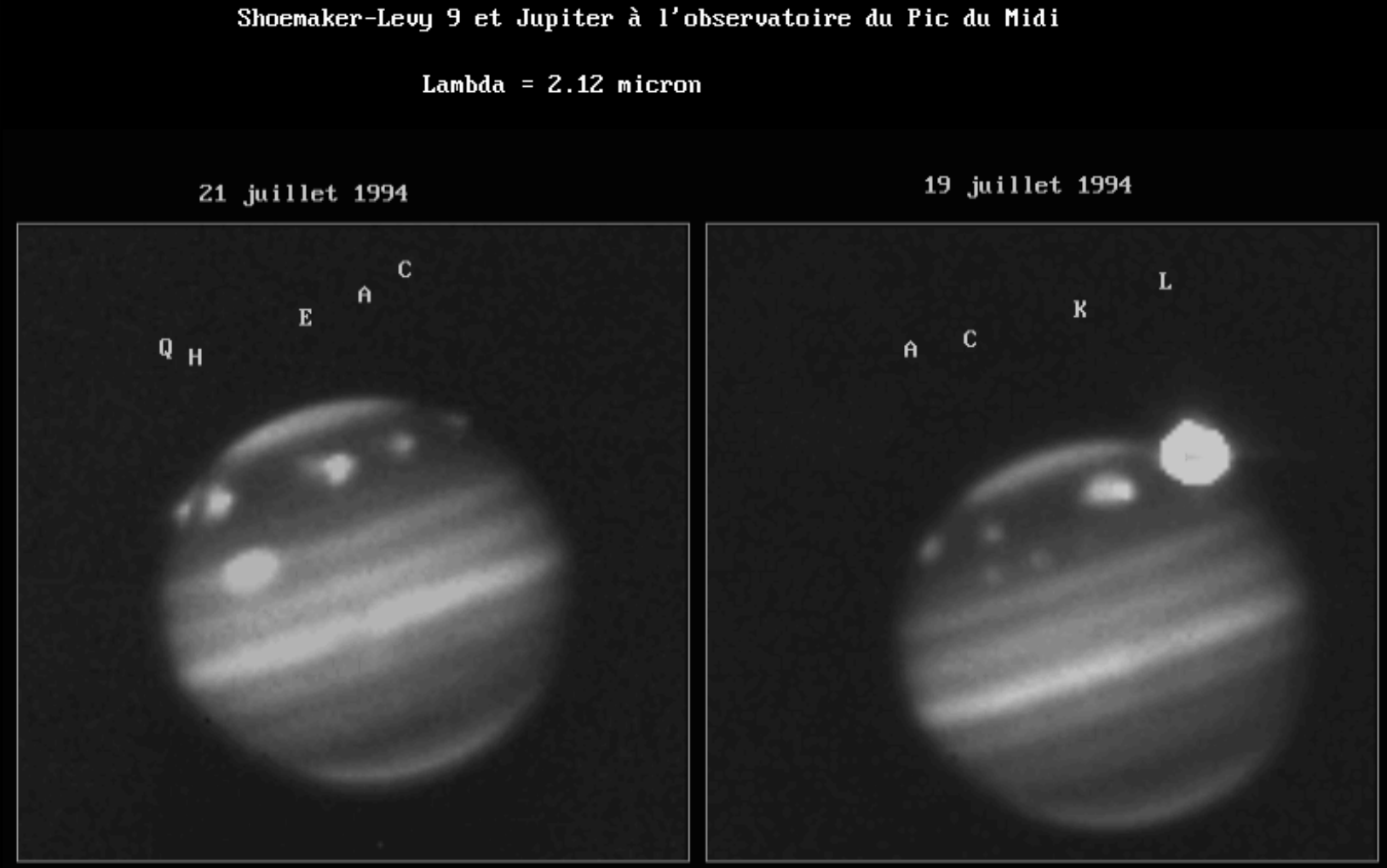


Coronal mass ejections (CME) emit dangerous high- energy particles in space that produce magnetic storms, which damage space equipment and endanger the health of astronauts

5.Study of asteroids and comets

I. Collisions of asteroids and comets with the Sun and planets

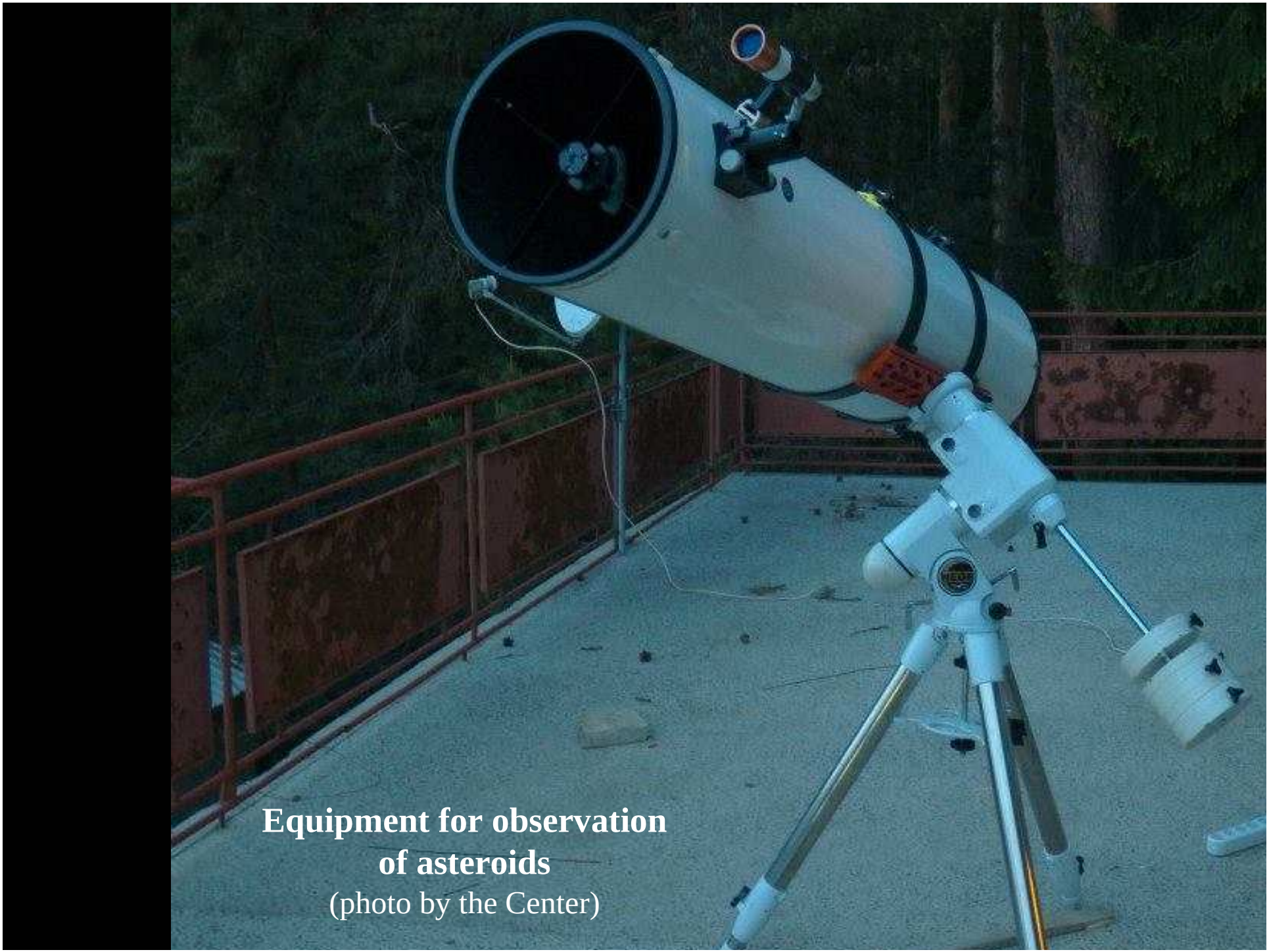
https://www.youtube.com/watch?v=2i72CxcTcaY
https://www.youtube.com/watch?v=SpUjXKWND4c
https://www.youtube.com/watch?v=8mCVV_VOVQ8



Collision of the largest piece L of Shoemaker- Levy comet with Jupiter

II. Searching for new asteroids and comets and determining of their orbit - a joint project with observatory A79

https://www.youtube.com/watch?v=xkQDY7I9Fc4
https://www.youtube.com/watch?v=0yr_86Wpmvw

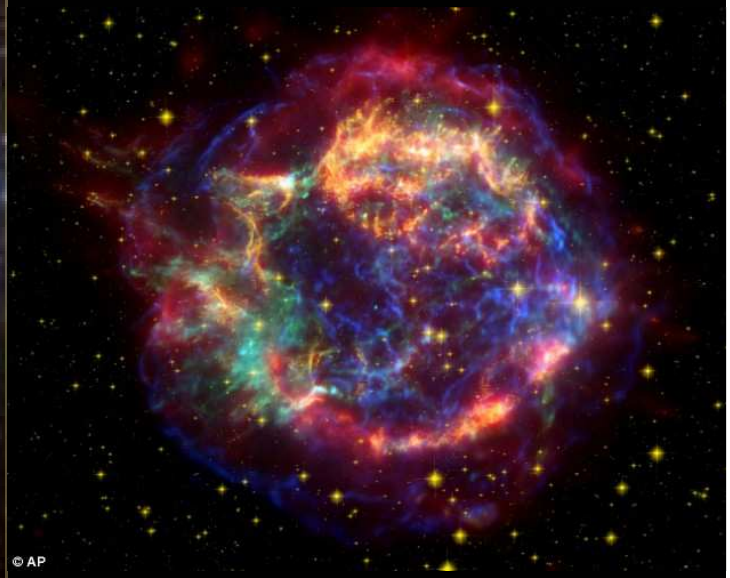


Equipment for observation of asteroids
(photo by the Center)

Infrared image of comet PanSTARRS (2013)
obtained by the UCSRT team

6. Variations of cosmic rays and production of cosmogenic isotopes

The supernova explosion



Remains

7. Applications of space research and technology in archaeological research

I . Applications of space technology

-a. Applications of space technology for searching of unknown underground objects by Ground penetration radar (GPR):

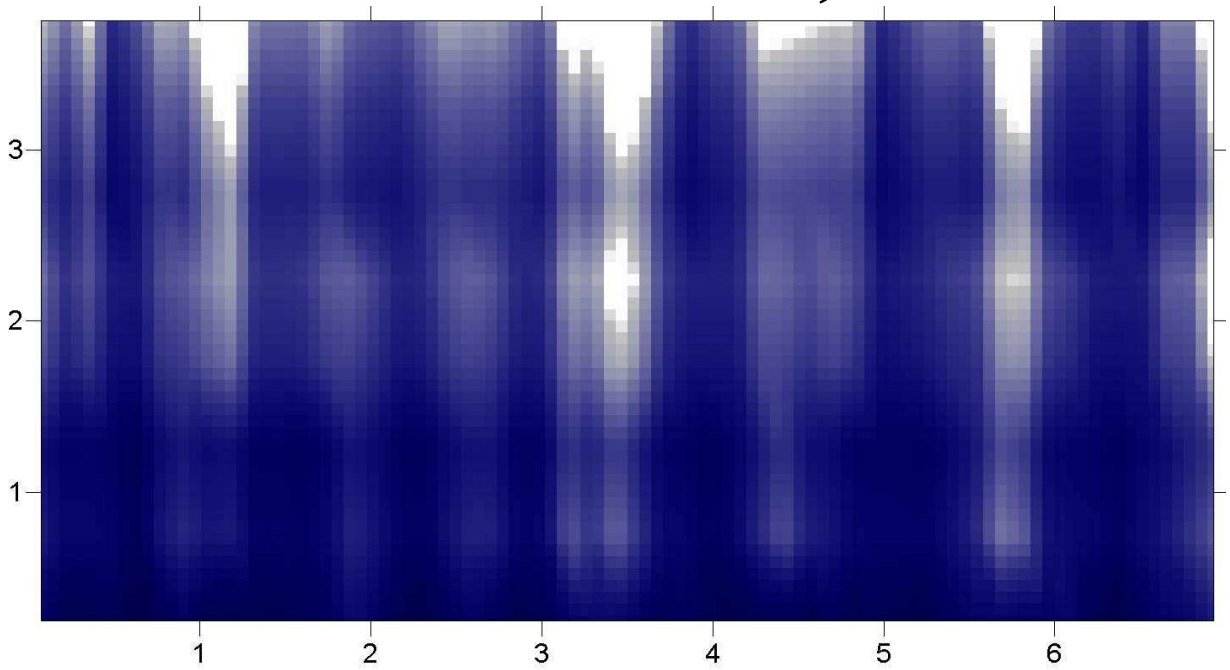
GPR is developed by NASA for the needs of the US space program to study the lunar ground. Later it became the only method to solve many geotechnical, geological, environmental, engineering and other tasks that require subsurface monitoring. It visualize underground futures on a computer in real time, during the scanning.

GPR it emerged as the most powerful archaeo- geophysical method that has many applications in archaeology. Our laboratory of Archaeo-geophysics is the only applied geophysical laboratory using GPR in the country for study the archaeological objects. Its website is: http://www.phys.uni-sofia.bg/bul/departments/ucsrt/agpl/index.html.

Scanning of an archaeological site by GPR by the team of archaeo- geophysical lab.

Underground objects from plastic, ceramics, concrete and asphalt were considered undetectable before the creation of GPR. GPR became the main method for locating and mapping of non-conductive, non-metallic and non-magnetic objects.

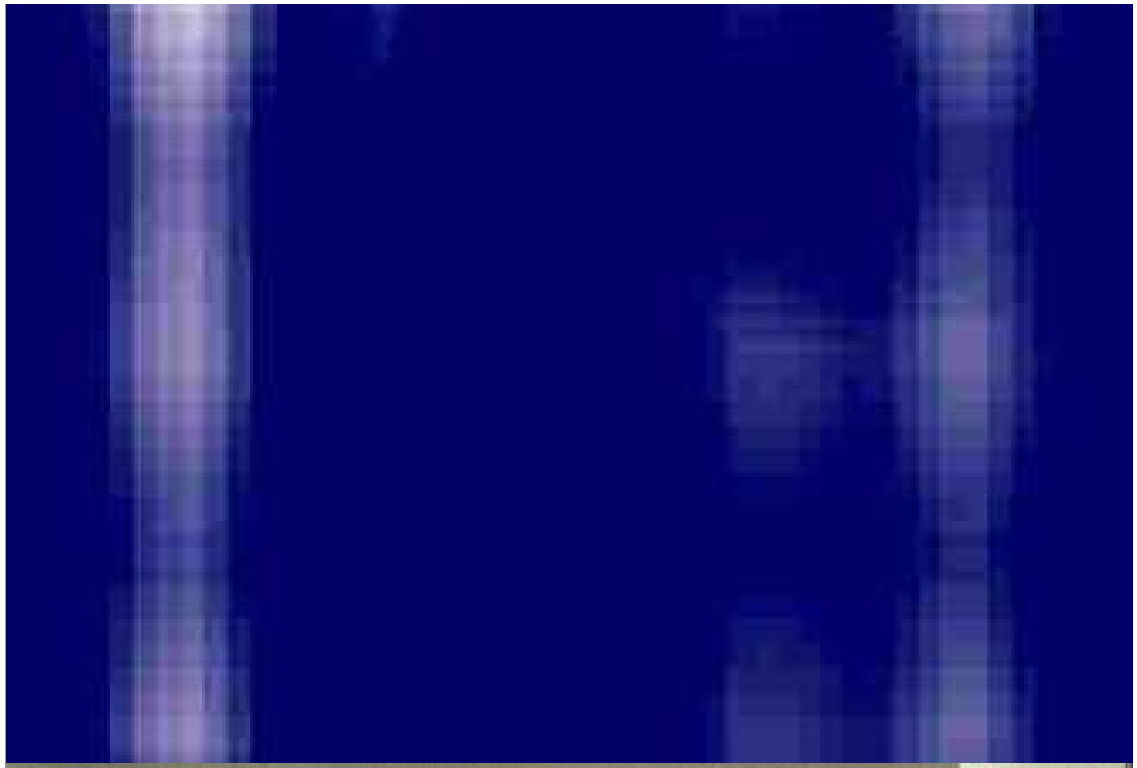
Research, location, determination of the depth and mapping of the structure of walls, voids and defects in the buildings



2-D map (in meters) of the radar signal from concrete girders measured from the 5th floor of the Physics Department through the concrete floor above them.
Even fluorescent lamps are visible between 3-4 and 4-5 meter scan!

Photography of buttresses (concrete girders) on the ceiling of 4-rd floor of the Physics Department measured with GPR

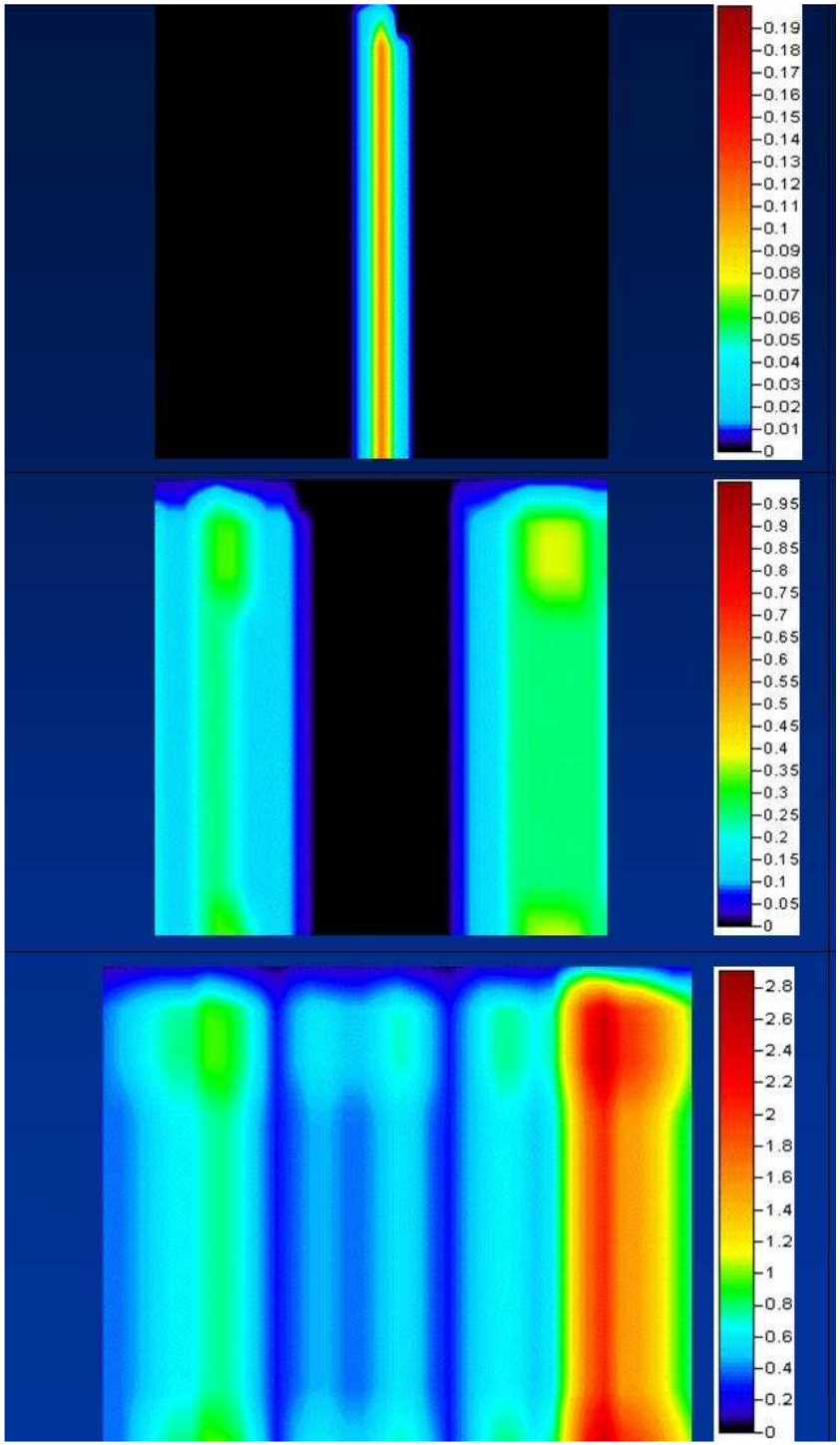
Prof. Y. Shopov,
Dr. D. Stoykova
(lab. Archaeo-geophysics)



2D map (in meters) of the radar signal of two concrete girders in the middle of the ceiling of the basement of the building B of the Physics Department measured from 17 meters above, from 5 floor through 5 concrete slabs with a total thickness of 3.25 m ! This depth is with 70% greater than the manufacturer's claimed maximum working depth of the device !!!

Photography of the buttresses (concrete girders) on the ceiling of the basement of Building B of Physics Department measured with GPR (above).

Prof. Y. Shopov,
Dr. D. Stoykova
(lab. Archaeo-geophysics)

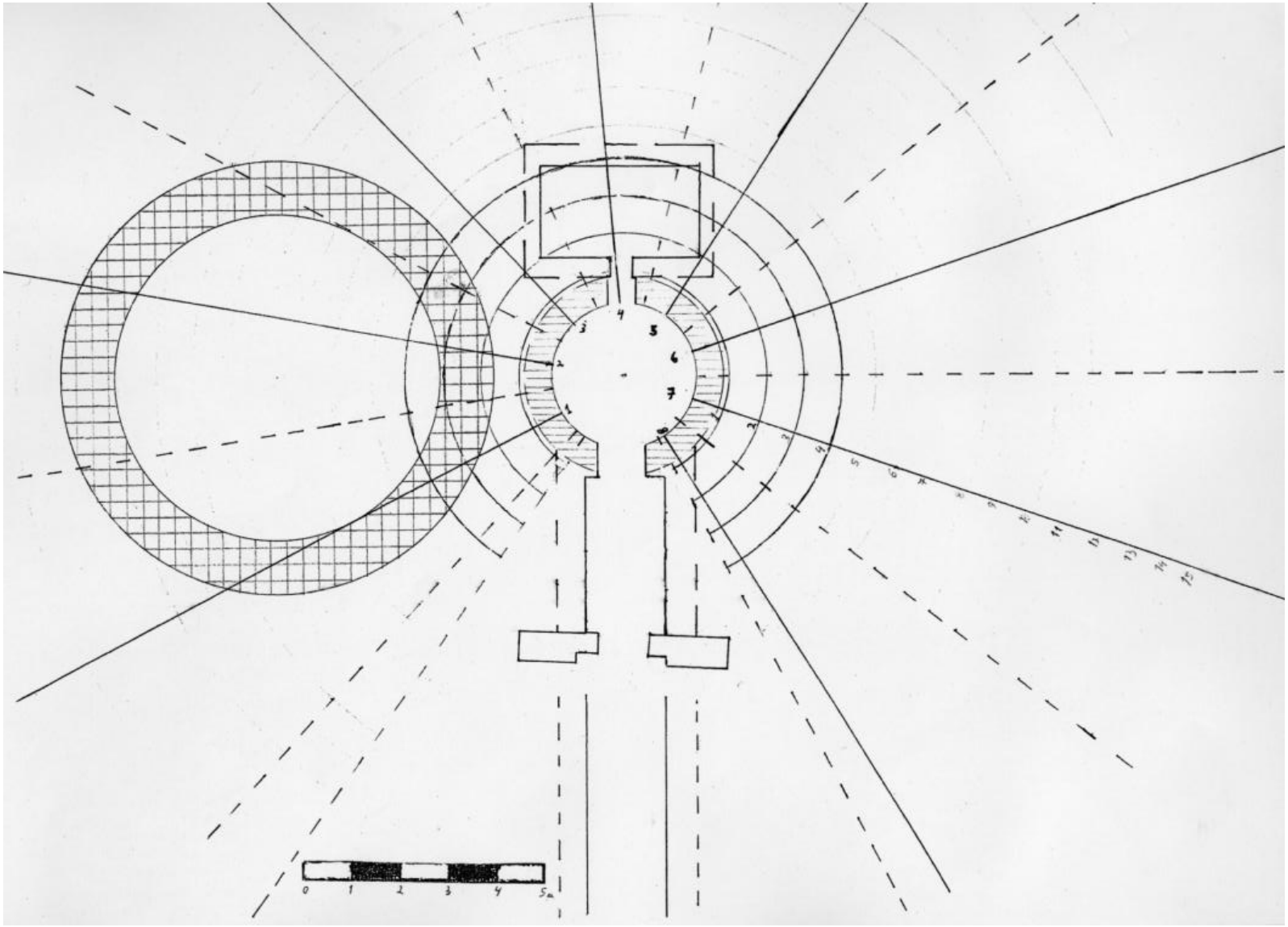


Vertical section of 0,75- 1.5 m from the wall of the circular chamber of the tomb in the mound "Golyamata Kosmatka". In the middle of the scan is transected outer wall of a unknown round building.

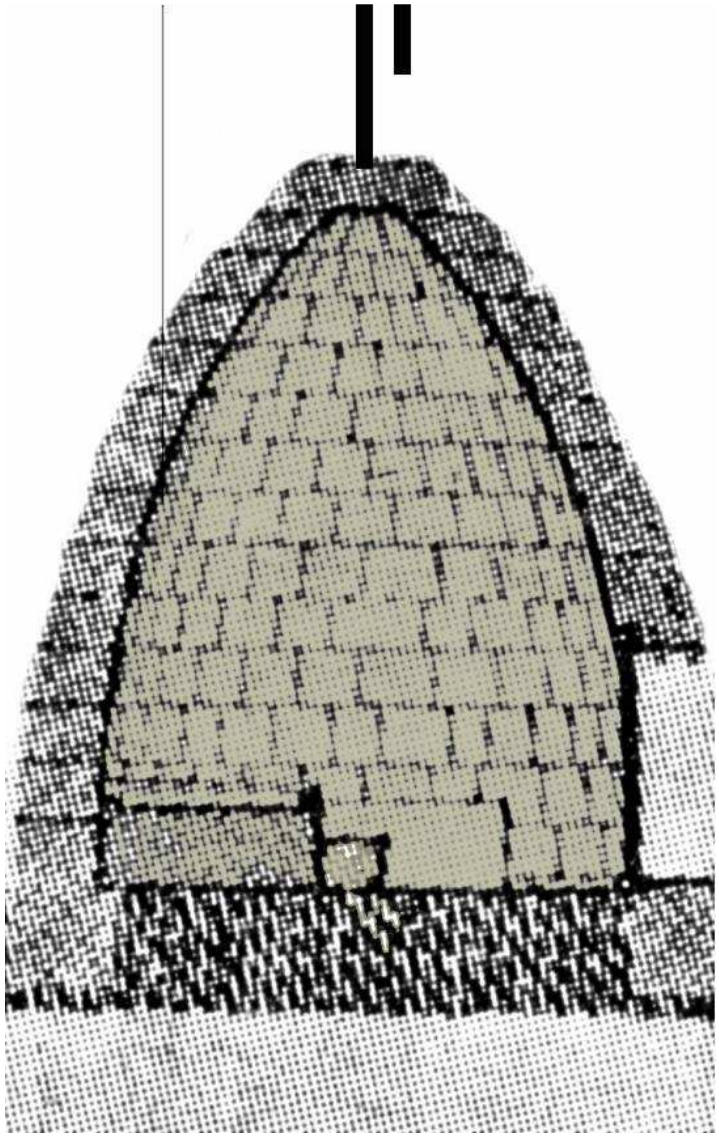
Vertical section of 1.5- 2.25 m from the wall of the circular chamber of the tomb in the mound "Golyamata Kosmatka". At the beginning and the end of the scan are transected outer walls of a unknown round building.

Vertical section of 4,50- 5.25 m from the wall of the circular chamber of the tomb in the mound "Golyamata Kosmatka". At the beginning and end of the scan are transected outer walls of a unknown round building. Three vertical lines between them may be columns inside the camber of the building.

Y. Shopov, Archaeogeophysics lab.



Resulting scans have resolution 0.1 m. on X and 0.5 on Y-axis. Obtained two-dimensional maps show that next to the circular chamber of the tomb is located a second unexcavated circular chamber. Unexcavated circular chamber is two times greater than that in the unearthed tomb. (Y. Shopov, Archaeogeophysics lab.)



Vertical section of part of the mound "Golyamata Kosmatka" in direction W-E through the measured anomaly with positions of the performed vertical electric sounding (thin line) and core drilling (thick line). Presumed profile of the dome is taken from the tomb near Mezek.

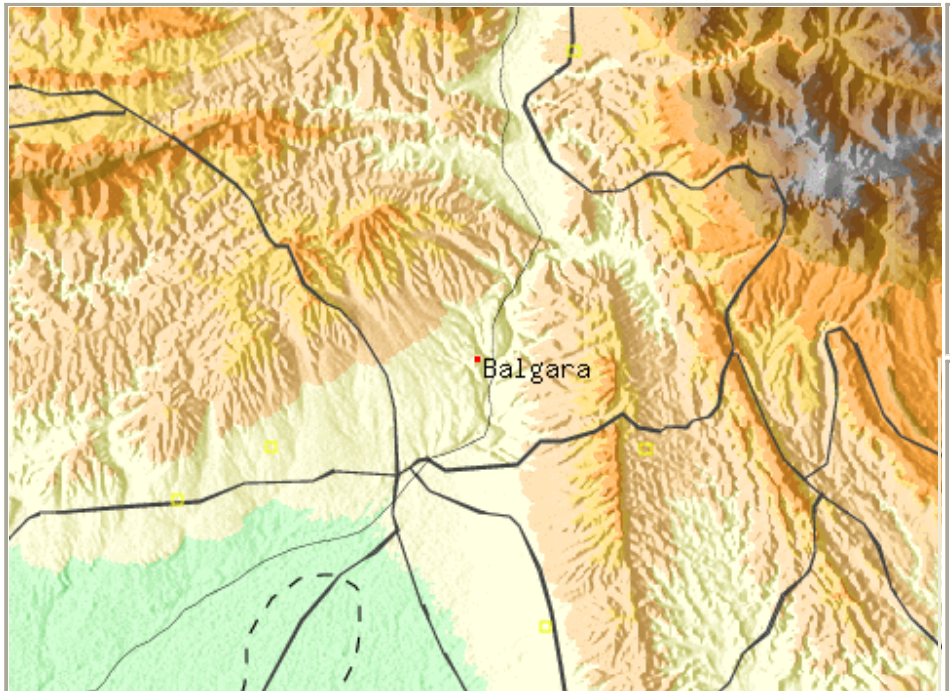
-b. Applications of space technology for locating and mapping of areas inhabited by ancient people and their migration:

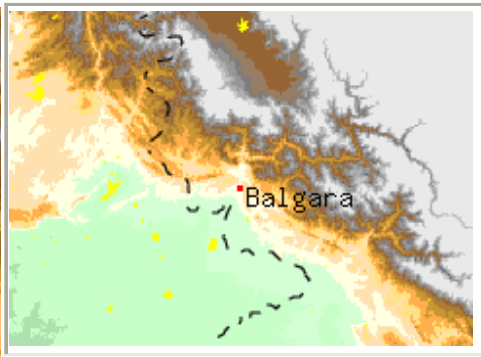
The method was developed in 2003 by a team from the Center. It uses satellite measurements of the location of archaeological monuments, ancient villages and historical sites from space to allow localization and precise mapping of territories which was inhabited by ancient people and their migration even before emerging of any writing culture.

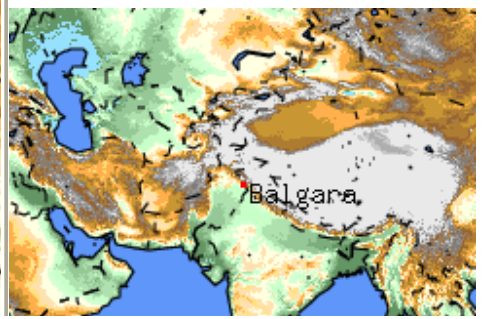
Balgara, India

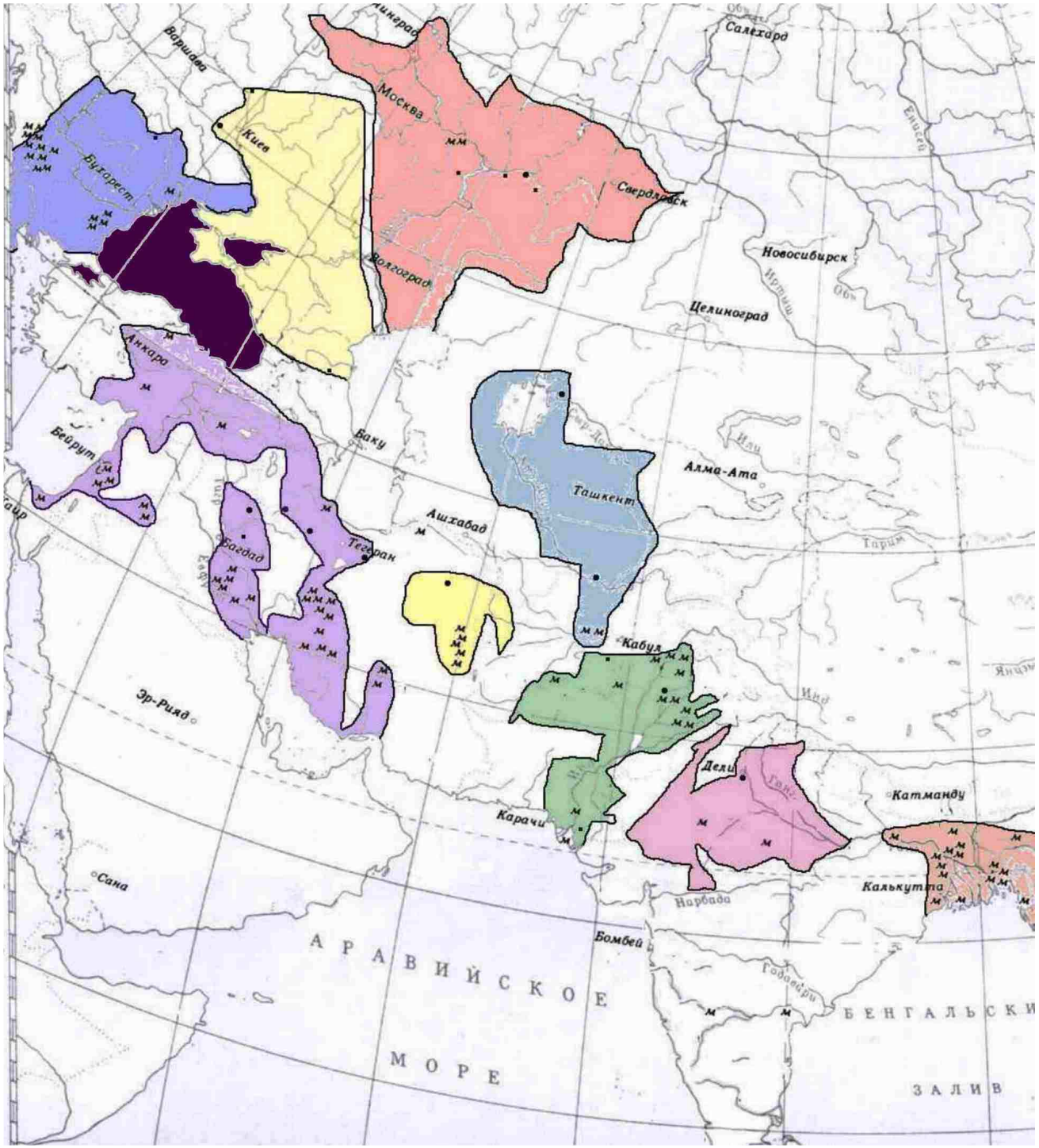
State of Jammu and Kashmir

Latitude	32.9444	**Longitude**	74.7764	**Altitude (feet)**	1105
Lat (DMS)	32° 56' 40N	**Long (DMS)**	74° 46' 35E	**Altitude (meters)**	336
Approximate population for 7 km radius from this point: 12009					

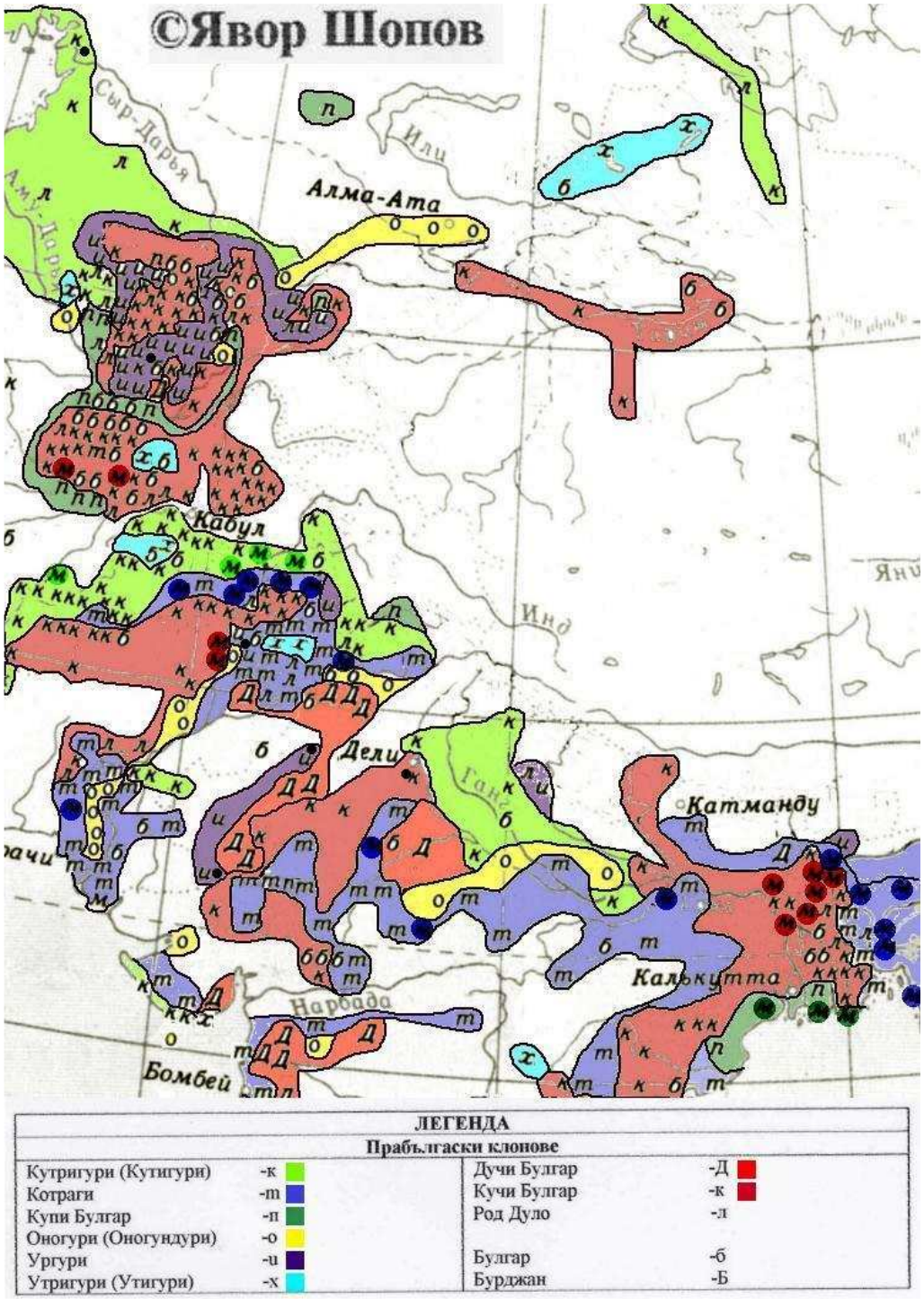








Map of toponyms formed from ethnic names of ancient Bulgarians, their branches (Kutigurs, Utigurs, Kuchi Bulgar, etc.) and dynastic families (Dulo), outlining areas once inhabited by the ancient Bulgarians made by the UCSRT team. Outlined areas marked with different hue show the limits of maximum expansion of various ancient Bulgarian territories or states that existed in different periods of time. With the symbol "m" are marked toponyms formed from Madar(a).



Map of former territories inhabited by different branches (Kutigurs, Utigurs, Onogurs, Urgurs, Kotrags, Kuchi and Duchi Bulgar) and dynastic families (Dulo) of ancient Bulgarians in the Indian peninsula and Central Asia made by the UCSRT team

1.Applications of space research in archaeological and historical research

a. Applications of space research for dating of archaeological sites

Space research is used to develop new methods of dating archaeological objects.

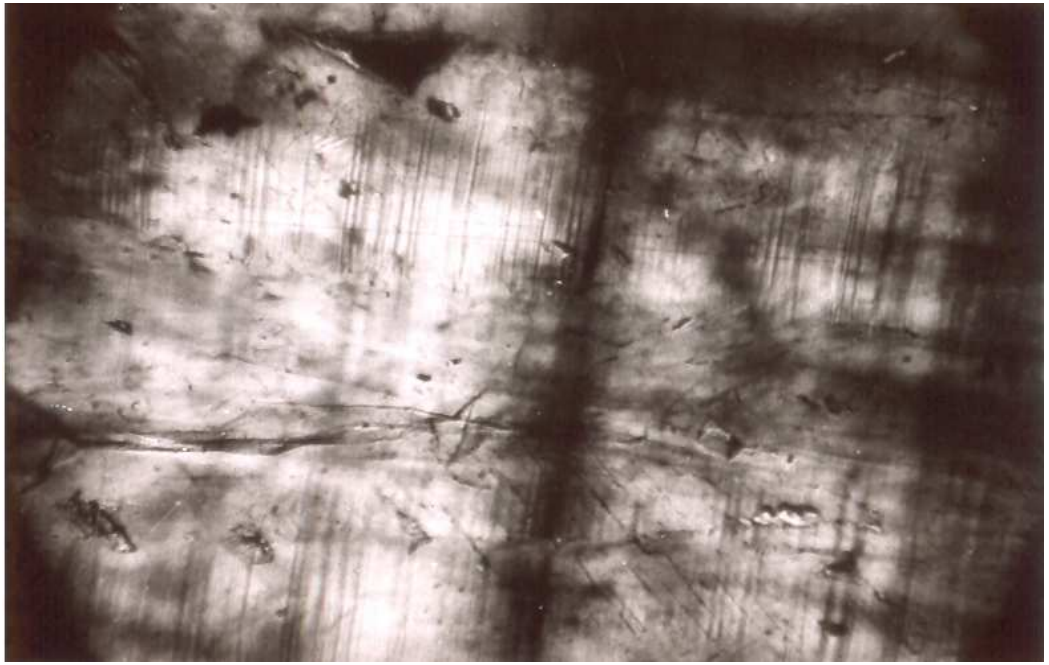


Photo by the Center

Annual micro banding of luminescence of calcites (known as Shopov-bands) used by the Center for development of the new Autocalibration dating method.

b. Studying the effects of cosmic phenomena and processes on migrations of ancient people

We study impacts of cosmic phenomena and processes on the sea level, which caused migrations of ancient people in the past.

-c.Using of methods for space research to study archaeological sites

RGB-photometry was developed by the Center for registration of the far solar corona (which is visible only from the space) by image processing of ground observations.

RGB-photometry of a ground photo of the solar corona made by University Center for Space Research and Technology

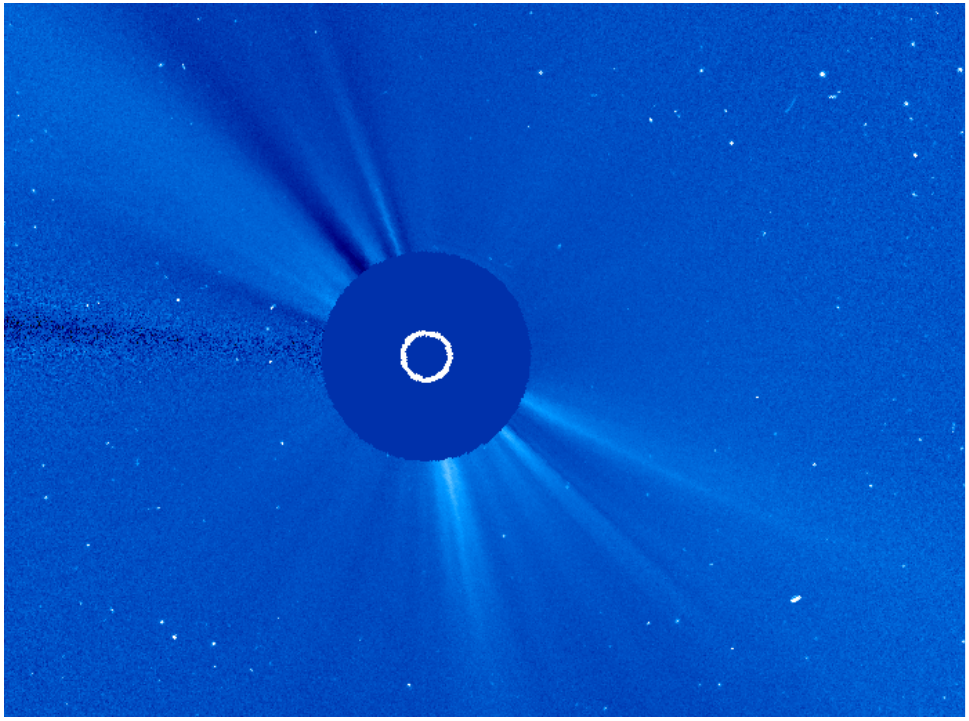
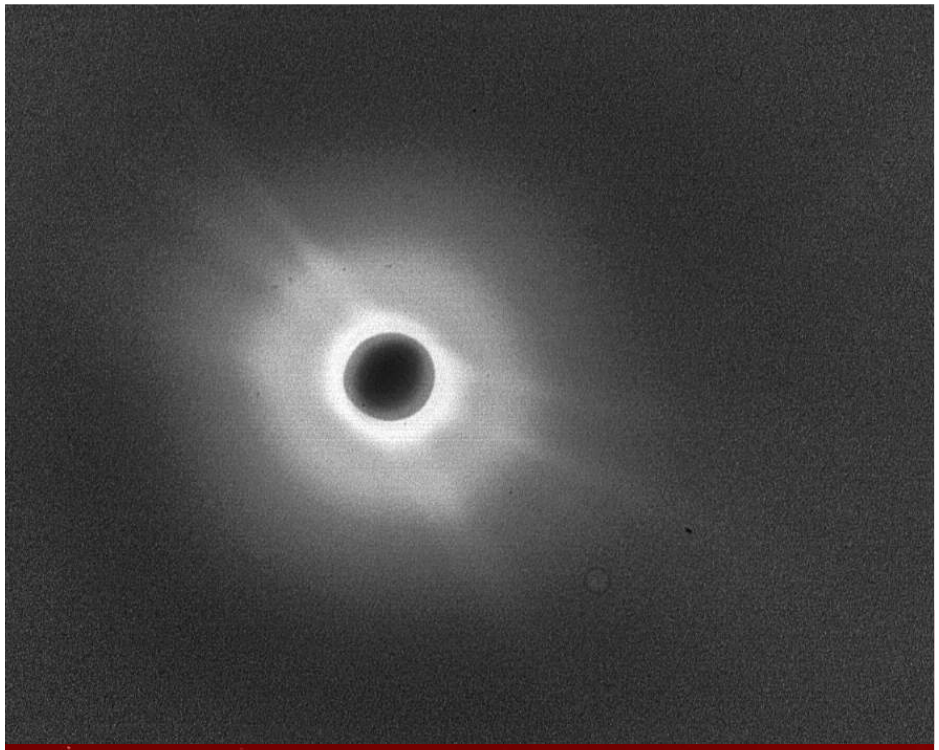


Photo of the solar corona made at the same time from the Space coronagraph LASCO C3 on SOHO satellite

RGB photometry was subsequently introduced by the Center for study of archaeological sites and monuments.

Photo of the 2006 solar eclipse made by the Center, processed by RGB-color photometry by the Astronomy Circle of University Center for Space Research and Technology



A composite image from images obtained from the space by SOHO UV-imaging telescope+ Space coronagraph LASCO C2 +ground observations at the same time made by Prof. Jay Pasachoff (president of IAU working group on Solar eclipses.

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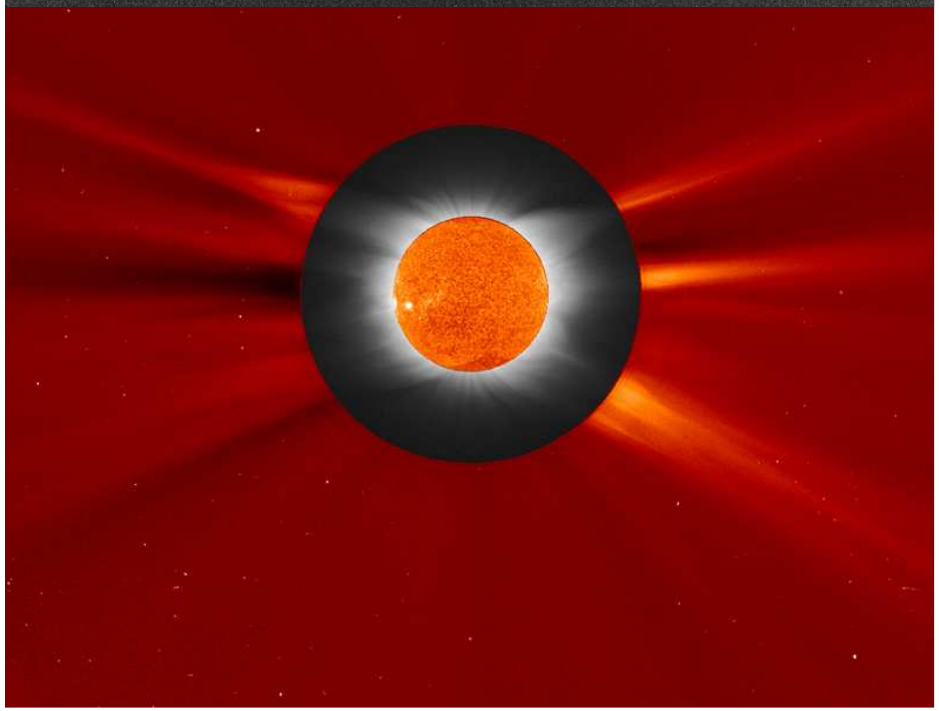

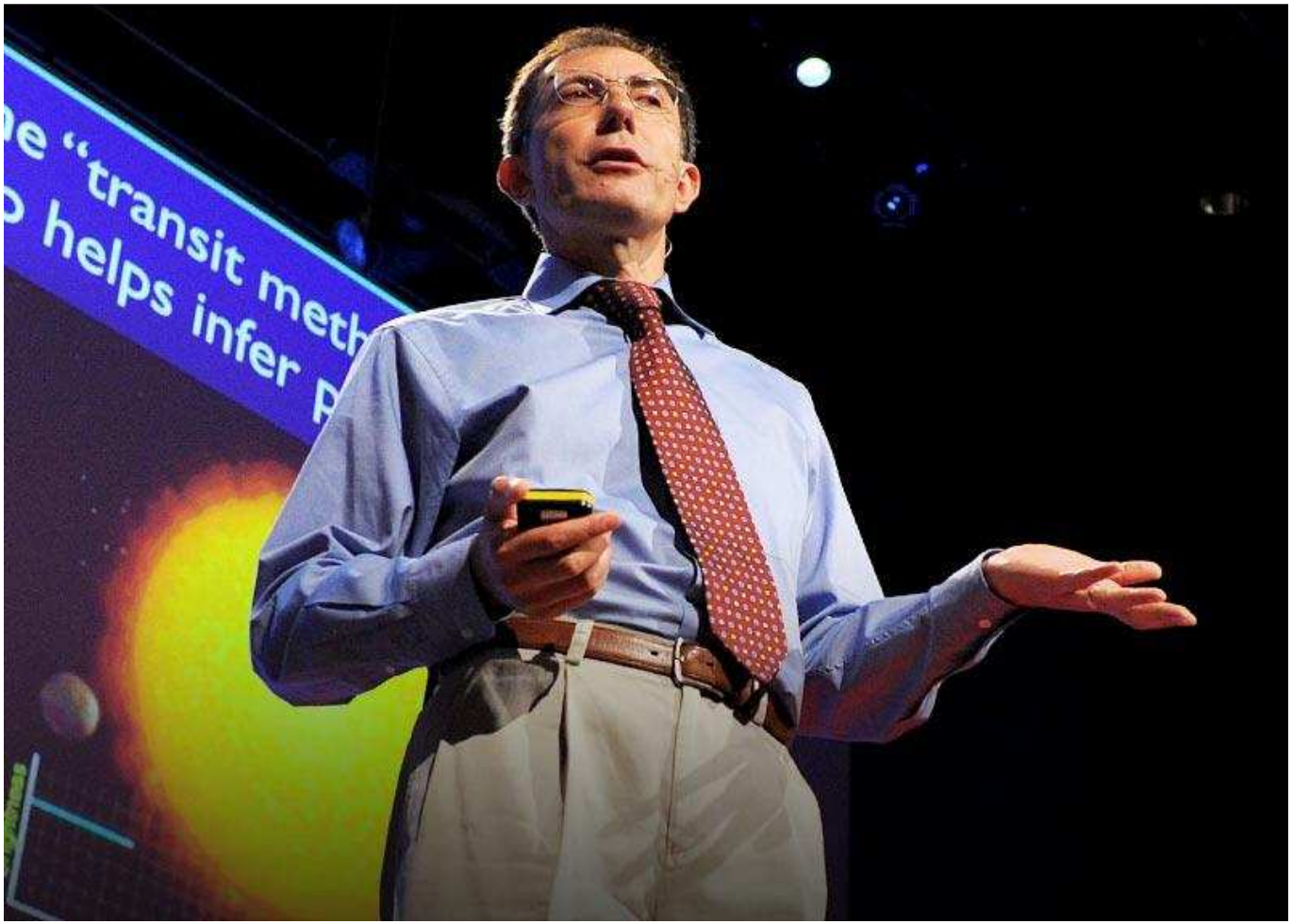

Former president of the Circle- Prof. Dimitar Sasselov, now Director of Harvard Origins of Life Initiative, http://origins.harvard.edu/people?page=1

Harvard University, Department of Astronomy

http://astronomy.fas.harvard.edu/people/dimitar-sasselov

Lecture of Prof. Dimitar Sasselov on Exoplanet Theory at the Circle:

https://www.youtube.com/watch?v=FCP-eBmQOxU

https://www.youtube.com/watch?v=fWEsfQU4Pic