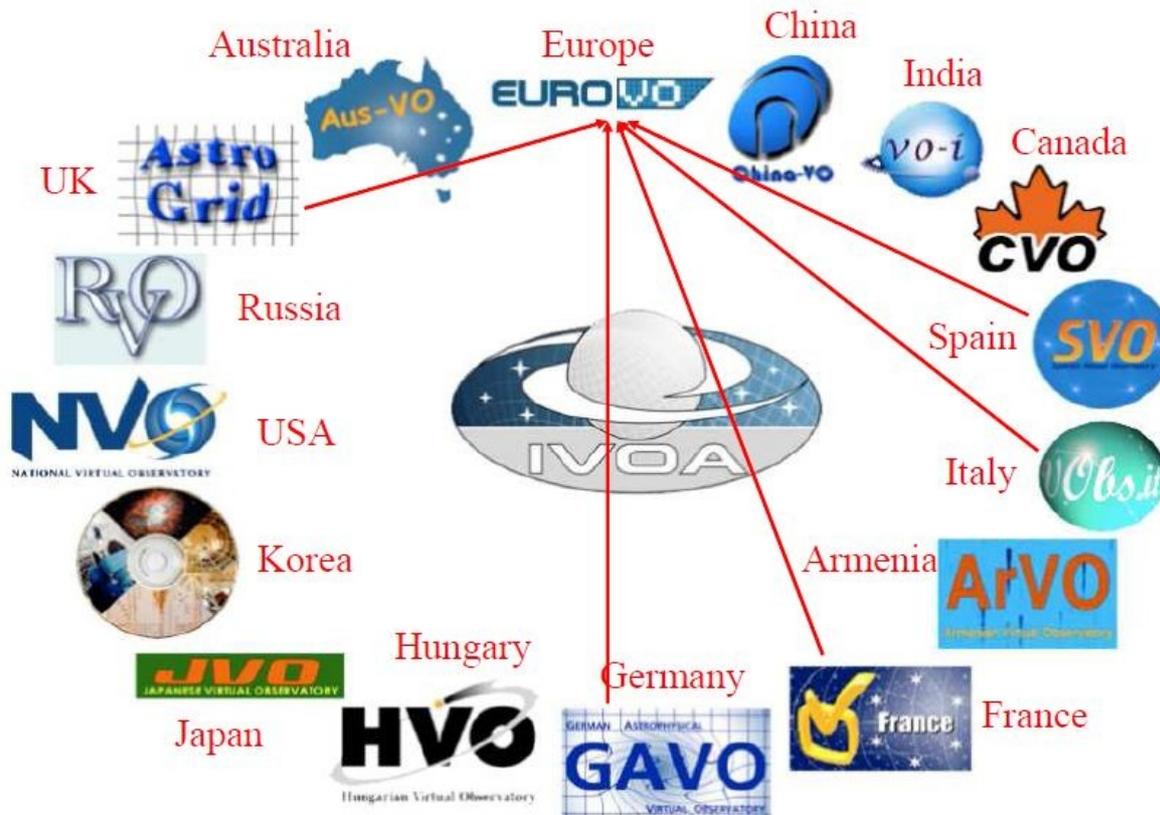


Project BULGARIAN VIRTUAL OBSERVATORY

The present project addresses the principles and objectives stated in the national strategy for scientific research. Its implementation will result in bringing into accordance the scientific politics of the Republic of Bulgaria and the other countries in the European Union and in the development of the Bulgarian scientific potential in the field of fundamental sciences. The project directs toward the following priorities of the strategy: Elaboration of the researchers' skills; Enhancing the quality and the competitiveness of the scientific results; Building research networks opened to the united scientific space of the European Union; Integration of the research activities and higher education; Wider penetration of information technologies both into science and education; Enrolling young scientists by further stimulating their initiative and work and by facilitating their carrier progress. Meanwhile the project addresses the clearly formulated objective – storage of and accessibility to the activities of ours in the area of the astronomical researches.

Virtual observatory could be defined as a collection of integrated astronomical data archives and software tools that utilize computer networks to create an environment in which research can be conducted. Several countries have initiated national virtual observatory programs that combine existing databases from ground-based and orbiting observatories, scientific facilities especially equipped to detect and record naturally occurring scientific phenomena. As a result, data from all the world's major observatories will be available to all users and to the public. This is significant not only because of the immense volume of astronomical data but also because the data on stars and galaxies have been compiled from observations in a variety of wavelengths - optical, radio, infrared, gamma ray, X-ray, etc. In a virtual observatory environment, all these data are integrated so that they can be synthesized and used in a given study. The idea is old but its realization becomes possible in the last 6-7 years- e. g. this is new direction of worldwide significance.



State of the Scientific Research

During the autumn of 2001 (**26.09.2001**) six organizations from Europe put the establishment of the **Astronomical Virtual Observatory (AVO)** – **ESO, ESA, Astrogrid, CDS, CNRS, and Jodrell Bank**.

The **International Virtual Observatory Alliance (IVOA)** was founded in June 2002. By January 2009, the IVOA has grown to include 16 funded VO projects – Fig.1 above.

The EURO-VO project aims at deploying an operational VO in Europe. This builds on the development experience gained with its predecessor, the Astrophysical Virtual Observatory project (AVO), which conducted a research and demonstration program on the scientific requirements and technologies necessary to build a European VO. In coordination with the European astronomical infrastructural networks OPTICON and RADIONET, and through the membership and support of the IVOA, EURO-VO will seek to obtain the following objectives:

1. technology take-up and full VO compliant data and resource provision by astronomical data centers in Europe;
2. support to the scientific community to utilize the new VO infrastructure through dissemination, workshops, project support, and VO facility-wide resources and services;
3. building of an operational VO infrastructure in response to new scientific challenges via development and refinement of VO components, assessment of new technologies, design of new components and their implementation.

The EURO-VO project is open to all European astronomical data centers. Initial partners include ESO, the European Space Agency, and six national funding agencies, with their respective VO nodes: Istituto Nazionale di Astrofisica (INAF, Italy), Institut National des Sciences de l'Univers (INSU, France), Instituto Nacional de Tecnica Aeroespacial (INTA, Spain), Nederlandse Onderzoekschool voor Astronomie (NOVA, Netherlands), Particle Physics and Astronomy Research Council (PPARC, UK), and Rat Deutscher Sternwarten (RDS, Germany).

The EURO-VO project joins together Three Centers

1. the EURO-VO Data Centre Alliance (DCA)
2. the EURO-VO Facility Centre (VOFC)
3. the EURO-VO Technology Centre (VOTC).

State of the Scientific Research in Bulgaria

At the time being Bulgaria is not a member of the European Astronomical Virtual Observatory (EURO -VO) and as the Bulgarian Virtual Observatory (BG-VO) is not a legal entity, we are not members of IVOA.

a) Basic astronomical institutions in Bulgaria

Potential Bulgarian centers for astronomical data are: Rozhen National Astronomical Observatory, Belogradchik astronomical observatory, the Institute of Astronomy - Bulgarian Academy of Sciences, the Department of Astronomy – Sofia University, Shumen University, Plovdiv University, and several People's astronomical observatories.

b) Main objectives, expected effect and results:

- To unite the Bulgarian astronomical data, to provide them to the rest of the world and to integrate them into the IVO;
- To provide the Bulgarian astronomical community with a convenient access to the world data grid;
- To use Bulgarian instrumentation to provide observational data in remote mode when needed;
- To develop Bulgarian electronic astronomical educational resources.

c) what's done?

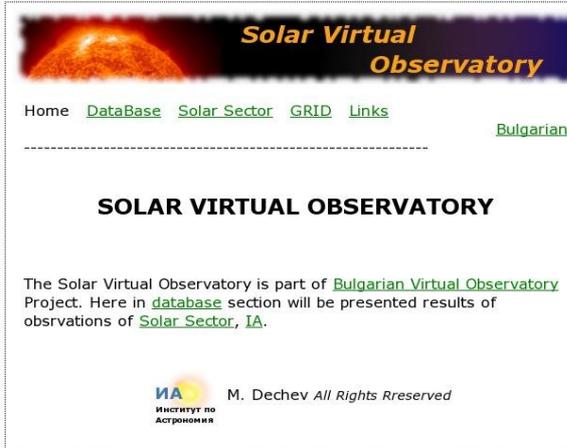
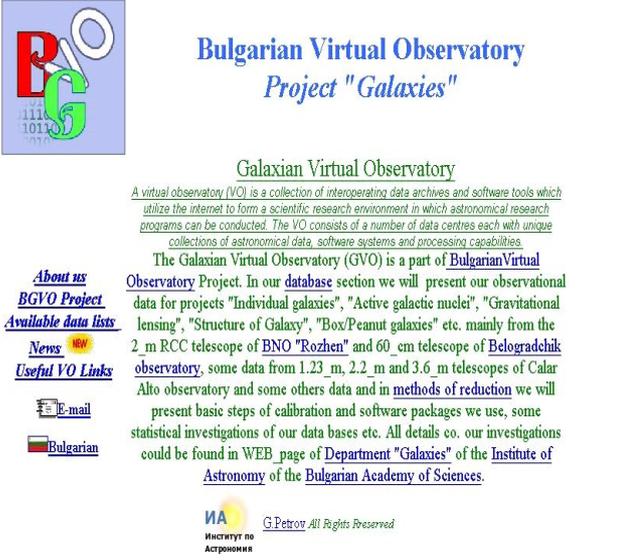
Bulgaria participated in the Astrogrid project with the HyperLeda database (<http://draco.skyarchive.org/~hyperleda/>) and with WFPDB. With the support of COST Action 283 in Bulgaria was organized one of the main workshops: iASTRO MC MEETING & WORKSHOP – “VIRTUAL OBSERVATORIES: Plate Content Digitization, Archive Mining and Image Sequence Processing” 27-30 April 2005, Sofia, Bulgaria, with more than 70 participants from 17 countries,

(http://www.bgvo.org/WS-SOFIA_2005). In February 2007, the Institute of Astronomy, BAS, initiated its participation into the EURO-VO Data Center Alliance (EuroVO-DCA) of the European Virtual Observatory. A regional working meeting of the VO was held in January 2008 in Sofia: Virtual Observatory Info-Workshop, Sofia, Bulgaria, January 24-25, 2008, <http://www.bgvo.org/VODAY2008/>. It was organized in collaboration with leading Bulgarian scientific institutions: the Institute of Astronomy, BAS, the Institute of Mathematics and Informatics, BAS, the Space Research Institute, BAS, and Sofia University. The Following VO Data Centers attended the workshop: Serbian BELDATA, Romanian ROVO, German GAVO and Hungarian HVO. The scientific program could be find on www.bgvo.net.

There is a group of **Wide Field Plate Archive** (WFPA), working for the Institute of Astronomy of the Bulgarian Academy of Sciences (IA-BAS). The research team has the know-how for the storage of astronomical data, collected through the methods of astronomical photography. They are developing WFPDB as a main source of information for the world-wide astronomical archives of wide-field observational data and the therein stored photographic plates. Information for about 500 000 astronomical plates is accessible through the web-based system of WFPDB, www.skyarchive.org/search.html. The digitalization of the available data is planned at the very beginning of the creation of the WFPDB.

In the framework of the Bulgarian Virtual Observatory the Sun department (Institute of Astronomy, BAS) launched a web-site www.astro.bas.bg/sun/SVO (fig. 2a), as well as and the Galaxies department (Institute of Astronomy, BAS) launched its web-site Galaxian Virtual Observatory – www.astro.bas.bg/galaxies/gvo/bgvo_galaxies.html (fig. 2b).

Fig. 2 – An illustration of the web-sites of both the Solar and Galaxian Bulgarian virtual observatories.

<p>a) The Solar virtual observatory web-site (main page); the database section where the data from the solar coronagraph will be stored</p> 	
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Topicality of the project theme

The Bulgarian scientific institutions using archival materials often are impeded at their access to contemporary scientific information and processing of archive data. There have been various approaches to the access and storage of observational data, theoretical elaborations, etc. in the years. Nowadays the approach preferred is digitization of the information, including scanning of documents in machine-readable form and their storage in a database. In such a way the easy access to and security of the unique observational data and materials is guaranteed. The modern Bulgarian science still tries to find a way for sharing resources as digitization affords an opportunity for general access to rare documents and collections via internal network, Internet, or secure international communication channels for exchange of specialized scientific data.

In this context the Bulgarian Virtual Observatory project represents building of an information system, including the existing and making a set of new digital resources for investigation, storage, and popularization of the Bulgarian scientific heritage by the achievements of advanced information technologies. This is at the root of the of the Bulgarian academic and university science progress, solving the issue of wide access to the specific scientific apparatus of high significance for the development of the Bulgarian fundamental science and its relations to other scientific branches.

The basic objectives of the Astronomical Virtual Observatory could be outlined as follows:

- To provide comparative analysis of large sets of multiwavelength data;
- To reuse data collected by a single source;
- To provide uniform access to data;
- To make data available to less-advantaged communities;
- To serve as an educational tool.

The Virtual observatory includes:

- Tools that make it easy to locate and retrieve data from catalogues, archives, and databases worldwide;
- Tools for data analysis, simulation, and visualization;
- Tools to compare observations with results obtained from models, simulations and theory;
- Interoperability: services that can be used regardless of the clients computing platform, operating system and software capabilities;
- Access to data in near real-time, archived data and historical data;
- Additional information - documentation, user-guides, reports, publications, news and so on.

The aim of this project is Bulgaria to be a member of the European and International Virtual observatory society. As the 2-m RCC telescope is in operation for more than

25 years, and the 3 smaller telescopes are widely used, there are a lot of observational astronomical data in almost all fields of astronomy and astrophysics, unfortunately only in the optical region of the spectrum. Large quantities of our data are from telescopes of other observatories, too. **Reducing all our data to the common system, organizing a well functioning data server and using unified astrophysical tools** for analysis of astrophysical data are the main purposes of this project facing the future.

Step-by-step instructions for scanning of astronegatives – plates and spectra, will be drafted; selected standards and the results of the scanning and analysis of these standards will be a part of this instruction.

For the purpose above on the server of BG-VO there will be installed **POSTGRESQL**, together with **SAADA tools to transform our FITS files in the standard format for VO-tools**.

Such kinds of tasks never finish – they are all the time opened for updates, upgrades, adding new data and ideas. **The project is facing the future.**

In the course of the project implementation a **Bulgarian terminology of Virtual observatory specification** will be proposed and distributed amongst our astronomical community.

All these make the project **up-to-date and actual**. Virtual Observatory may turn out to be young astronomers' destiny. Knowledge they acquire is on a higher level (science is developing all the time) and presumes the use of more and more heterogeneous data. Science without Internet and access to data bases happens very rarely.

The participants in the project have the unique chance to be the founders of the Bulgarian Virtual Observatory. The overall complete vision over the available observational data gives us a chance to assign research projects on a large scale practically with no limitation on the topics, level of complexity, and expected results.

Project Objectives

The Bulgarian Virtual Observatory **final objectives** are all observational data and documents in our plate archives, private documentary collections, photographs, papers that are unpublished or published in hardly accessible issues, monographs and PhD theses of Bulgarian scientists that had worked in the area of astronomy, to become public (stored up in the database or web-site). The materials will have practical application in research activities due to the achievements of the contemporary software applications, hardware for information scanning and processing, web-servers, etc. In different phases of the project PhD students will be incorporated in scientific areas defined by the team.

The scientific project puts its following **specific objectives**:

- Creation of a uniform data information array for the Bulgarian astronomical surveys;

- Facilitating the access to all possible sources for students, PhD students, teachers, and researchers from Bulgaria and abroad;
- Specifying the basic directions for development of the Bulgarian astronomical science by digitizing, electronic publishing, and analysis of resources of high scientific value;
- Storage of original sources, valuable for the development of the contemporary Bulgarian society, by their electronic publication;
- Assure a favorable environment for young scientists and PhD students. PhD students, young scientists, and students (where it is possible) will be captured in the project for specific activities;
- A potential for future development of the scientific group, implementing the project. The successful implementation of the project objectives suggests sustainability of the achieved results after the project completion;
- The developed principles and methodology of search, publication and accessibility to various resources, infrastructure built (techniques, software, trained staff, etc.) and the digitized resources in the correspondent online database will practically lay the foundation of a **center for digitization** based at IA-BAS and Rozhen NAO. IA-BAS has the know-how for storage of observational data on astronomical photographic plates. IA-WFPDB is a major information source for the wide field world astronomical archives and the photographic plates stored therein. At the moment IA-WFPDB comprises: a catalog of archives and a catalog of wide field photographic astronomical observations.

The results from the project can directly influence the scientific cooperation of IA with other Bulgarian universities and institutes, as well as the international cooperation on various academic programs. The project sustainability could be further facilitated by the direct relation between the research objectives and the results obtained, especially regarding encouragement of the research work of PhD students and students using digitized resources for preparation of theses on their bachelor's and master's degrees in Sofia and Shumen universities.

Project Implementation Description

- **Research Tasks**

The project is expected to support and promote the scientific research by securing access to the main data and sources of the Bulgarian astronomical research. Creation of a uniform information array of fundamental scientific data when fast access to information is prerequisite and even a necessary condition for successful work, in fact is one of the major tasks of the project. A similar database will be helpful for each future scientific research. The database is envisioned to be developed in several basic directions:

- Observational data from the era of astronomical plates, digitized and adjusted to the requirements of the Virtual observatory;
- Digital observational reformatted in accordance with the requirements of the Virtual observatory;
- Textbooks, lectures, courses, etc., prepared by collaborators of the IA, Sofia and Shumen Universities, etc.
- Publications, dissertations and diploma papers;
- Specialized software;
- Securing access to hardly accessible or rarely used science sources;
- Introducing interdisciplinary approaches to scientific research;

The successful implementation of the project will ensure access to various types of sources. This is a prerequisite for interdisciplinary approaches to scientific research. The collaboration of astronomers, physicists and mathematicians in the present project will give opportunity for interdisciplinary investigations with the approaches of the different sciences integrated. The sphere of scientific problems that is being solved and can be solved by means of Virtual Observatory is limited ONLY by the level of our knowledge as VO practically unifies all achievements of modern astrophysics into a powerful product for scientific research.

Virtual Observatory Advantages

- new, better, faster, and easier science;
- comparative analysis of multi-instrument data;
- improving the preparation, development, building of new ground-based and space-based projects;
- improving new observational proposals;
- comparison of real data with simulated data – to provide feedback to new insights, new models, new physics;
- allows new approaches to multi-wavelength research, affording opportunities for new discoveries.

Exemplary Scientific problems to be solved during the Virtual observatory development:

- Circumstellar disks: from pre-Main Sequence stars to stars harboring planets
- Intermediate Velocity Clouds
- Which star will go Supernova next?
- Initial Mass Function within 1 kpc: from planetary to stellar masses
- Initial Mass Function for massive stars

- The contribution from low and intermediate mass stars to the interstellar medium
- Galaxy Formation and Evolution from $z = 10$ to $z = 0.1$
- Build-up of supermassive black holes
- The Formation and Evolution of Galaxy Clusters
- Correlation of Cosmic Microwave Background, radio/mm and optical/NIR Galaxy Surveys.

The Bulgarian Virtual Observatory will afford opportunity for the solving of several ***specific scientific problems***: variability of the luminosity and absorption spectrum of galaxies with active nuclei, gravitational lenses, search for variable stars in stellar aggregates, evaluation of the star cluster parameters, search for binary open clusters, study of small bodies in the Solar system etc.

Virtual observatory software

DATA DISCOVERY

Aladin: An interactive software sky atlas allowing the user to visualize digitized images of any part of the sky, to superimpose entries from astronomical catalogues.

VO Desktop: A desktop application for working with the Virtual Observatory. It can explore data resources, query remote catalogues, and construct workflows to automate tasks.

Datascopes: A Web Service for discovering and exploring data in the Virtual Observatory from archives and data centers around the world.

SPECTRAL ANALYSIS

VOspec: A multiwavelength spectra analysis tool, with access to both Spectral services (SSAP) and Theoretical Spectral services (TSAP).

SPLAT: A spectra analysis tool.

Specview: 1-D spectral visualization and analysis.

Euro3D: Analyze datasets in Euro3D FITS format.

DATA VISUALISATION AND DATA HANDLING

Topcat: An interactive graphical viewer and editor for tabular data. (It identifies a number of different astronomically significant formats (including FITS and VOTable), more formats are to be added).

VOPlot: A tool to visualize astronomical data.

VisIVO: A visualization and analysis software for astrophysical data. VisIVO can handle both observational and theoretical data.

SED BUILDING AND FITTING

VOSED: SED Builder & Fitting Tool.

Yafit: An SED fitting tool.

BULGARIAN VIRTUAL OBSERVATORY (BGVO) - STRUCTURE

At the time being Bulgaria is not a member of the European Astronomical Virtual Observatory and as the Bulgarian Virtual Observatory is not a legal entity, we are not members of IVOA. The main purpose of the project **Bulgarian Virtual Observatory** is Bulgaria to take its place amongst the leading astronomical institutions in the world. Initially the available extragalactic, star clusters and associations observations will be incorporated in the Bulgarian astronomical data centre and the Solar observations will be added.

a) Basic astronomical institutions in Bulgaria

Potential Bulgarian centers for astronomical data are: Rozhen National Astronomical Observatory, Belogradchik astronomical observatory, Institute of Astronomy - Bulgarian Academy of Sciences, Department of Astronomy, Sofia University, Shumen University, Plovdiv University, and several People's Astronomical observatories.

b) Main objectives, expected effect and results:

- To unite Bulgarian astronomical data, to provide them to the rest of the world and to integrate them into the IVO
- To provide Bulgarian astronomical community with a convenient access to the world data grid
- To use Bulgarian instrumentation to provide observational data in remote mode when needed
- To develop Bulgarian electronic astronomical education resources

1.1. Bulgarian Virtual Solar Observatory

We plan to present in the database section newly obtained data from the solar coronagraph in the National astronomical observatory Rozhen. In the near future we plan to drive the database section by means of PostgreSQL databases. As a part of this project a grid of solar observational centers located mainly in the People's observatories around the country should be built. The provided data (mainly disk images) will also be stored in that section.

Many of the research problems in solar physics require access to large amounts of data in various wavelength bands. The VSO is a set of data archives and analysis tools distributed at sites that already host such system. The technical concepts of the VSO include federated distributed archiving, an adaptive metadata thesaurus, a single unified intuitive graphic user interface, context-based searches, and distributed computing (grid systems).

There are three main initiatives: the European Grid of Solar Observations (EGSO), funded by the European Commission; the US Virtual Solar Observatory

(VSO), funded by NASA; and the Sun Earth Connector (CoSEC), founded by NASA under the International Living with a Star (ILWS) program.

The Virtual Solar Observatory would facilitate solar physics researchers allowing easy search of all data base archives and a unified reduction of the data.

There are several large fields of solar research that would be facilitated by VSO. These fields include:

- Space weather would greatly benefit from the more reliable and detailed knowledge of the solar surface signature of the eruptive events, such as solar flares, eruptive prominences (filaments) and especially imminent CMEs. This requires correlating time series of coronal images, filament positions, and surface quantities such as vector magnetic fields and x-ray emission in several wavelengths.
- The structure of a sunspot atmosphere, which is still poorly understood. A composite data set of vector magnetic field maps, space-based UV spectra, and temporal sequences of EUV images could yield a more complete description of the density, magnetic field, velocity, and turbulence with the height above sunspots.
- The mechanism, which blocks solar energy in sunspots and creates fluctuations in the solar irradiance, is poorly understood. Observations of the surface vector magnetic field and the spatial intensity distribution in several wavelengths are needed for comparisons with theory.
- The statistics of active region life cycles are not known. Such a study requires multi-day time series of surface magnetic field, Doppler velocity, and intensity in several wavelengths.

- The subsurface structure of active regions is beginning to be probed by local helioseismology, in which subsurface properties are determined in small patches rather than globally averaged. These results must be placed in context, which requires both surface magnetic field measurements and time series of the Doppler velocity. This technique may eventually be able to locate active regions before they emerge on the surface, which would be useful for space weather predictions.
- The statistical evolution of the solar granulation properties over the course of an 11-year solar activity cycle has only been sparsely sampled. A consistently sampled study could reveal clues about the long-term behavior of the underlying near-surface flow field as well as provide insight into the driving and damping mechanisms of the solar oscillations. This problem requires multiyear time series of surface magnetic field, Doppler velocity, and intensity in several wavelengths.
- A long-standing mystery is the heating of the outer solar atmosphere. It is now known that substantial areas of the atmosphere are actually much cooler than the surface. Unraveling the complex thermodynamic and energy budget of the solar atmosphere requires the spatial and temporal correlation of observations in the infrared, visible, and UV with magnetic and velocity fields at different heights above the solar surface.

- The solar wind is believed to originate near the boundaries of coronal holes where the solar magnetic field is open to interplanetary space. However, the details of the physical process that accelerates the wind are still unknown. Research on this question requires images that show the location of coronal holes at either x-ray or infrared wavelengths in conjunction with data on solar wind speed, and surface quantities.

Present and potential state of solar observation in BG:

The Sun department is the youngest one in the Institute of astronomy; solar observations have been carried out since 2005. This is an advantage for the development of the observational instruments and facilities, as well as for the observational methods and data storage according to VSO requirements. The basic instruments in the solar tower at NAO – Rozhen are two.

- Lyot-coronagraph (150/2250) with H α filter (1.8Å) is intended for observations of the low corona and solar prominences.
- Solar refractor (150/1600) is in preparation for observations in white-light and H α line (photosphere and chromosphere).

Observations of the Sun in white-light have been carried out in seven Public AOs located in different towns in Bulgaria, especially those in Haskovo and Dimitrovgrad that have close, long-lasting collaboration with the Sun department.

Main goals:

The project of the Sun department for solar observation plans synoptic solar observations of the basic activity events in the three levels of the solar atmosphere – photosphere, chromosphere and corona. The basic phenomena of solar activity, for which there are real and potential conditions for observations with instruments in the solar tower at NAO – Rozhen are given in the **Table**. The effective synoptic observations of the Sun in our country need the creation of a national network for solar observation. Except for NAO – Rozhen, AO - Belogradchik, as well as the seven Public AOs will be gradually included in this network. Such a national network for solar observations will provide more homogeneous archives of solar data for the VSO.

What's done?

The VSO is a part of the Bulgarian Virtual Observatory. In the framework of the Bulgarian Virtual Observatory the Sun department (Institute of Astronomy, BAS) launched a web site www.astro.bas.bg/sun/SVO (**fig. 1a**). We plan to present in the database section newly obtained data from the solar coronagraph in the National astronomical observatory Rozhen.

Table. Types of solar data that could be provided from solar observations at NAO – Rozhen for the VSO archives

Instrument	Wavelength	Data type	Atmospheric level	Activity events
Coronagraph 150/2250	H α (6563 Å)	Limb images	Low corona	<ul style="list-style-type: none"> • eruptive prominences • surges • quiescent prominences
Refractor 130/1600	H α (6563 Å)	Full disk images	Chromosphere	<ul style="list-style-type: none"> • prominences at the limb • filaments on the disk • active regions • Hα flares
Refractor 130/1600	White-light	Full disk images	Photosphere	<ul style="list-style-type: none"> • sunspots • active regions • faculae • white-light flares

1.2 Bulgarian Virtual Observatory – galaxies (BGVO – galaxies):

Scientific problems in extragalactic astronomy and cosmology to be solved with Virtual observatory tools:

Individual objects – cross-references from

- NED (morphology, z, direct images, SED);
 - Skyview (multiwavelength images);
 - DSS (direct images);
 - NVSS, FIRST (radio images);
 - SDSS (multicolor images, spectra);
 - LEDA (direct images, morphology, different parameters).
- *Almost solved tasks:*
- Selecting objects by different parameters;
 - Building of the spectral energy distribution;
 - Determination of morphological parameters;
 - K-correction;
 - Evolution of galaxies...

Next steps:

- Power spectrum and correlation analysis;
- Cluster analysis for groups of objects;
- Study of the photometric evolution of groups of objects;
- Star Formation Histories in Galaxies (new VO computing concepts: towards the Grid; access to models);
- Galaxy Clusters as Probes of the LSS and its Evolution;
- Cluster selection using a variety of methods: galaxy overdensity, x-rays, Sjunaev-Zeldovich effect ...
- Understanding of selection effects;
- Data Mining in the Image Domain: Can We Discover New Types of Phenomena Using Automated Pattern Recognition? (Every object detection algorithm has its biases and limitations);
- Effective parameterization of source morphologies and environments;
- Multiscale analysis.

BG Virtual Observatory Galaxies will take a part in BGVO with its (to the end of 2008):

- Ca. 1800 FITS frames for 9 selected voids with ca. 6000 faint galaxies identified, together with 2 planetary nebulae in B, V, R, I.
- Spectral observation of galaxies and PIN (ca. 700 spectra, *all the spectra have to be scanned*), **including**:
 - Spectral observations of PIN (27 spectra for 9 PIN);
 - Spectral observation of active galaxies (ca. 100 spectra);
 - Spectral observation of High Surface Brightness Galaxies (ca. 300 spectra);
 - Image-tube system spectra of galaxies and standard stars, ca. 90% with 50 A/mm reverse dispersion, spectral region around H α ;
- Ca. 500 CCD images of Box/Peanut galaxies and control sample galaxies in (U, B), V, R, I – bands in FITS format;
- Ca. 1850 NIR frames for Box/Peanut galaxies in FITS format;
- Hundreds of CCD frames of quasars/gravitational lenses in FITS format (current project, observational data are added continuously);
- Hundreds of CCD frames of Active galactic nuclei in FITS format (current project, observational data are added continuously);
- Ca. 900 CCD frames of Open Clusters -12 probable binary clusters, 10 open clusters in the direction of the anticenter and 8 bright clusters in FITS format;

- Ca. 50 plates from the 2-m RCC telescope of Active galaxies and High Surface Brightness Galaxies. *All plates have to be scanned.*

1.3 BG Virtual Observatory Star clusters:

At the time being the **Star clusters** department with its ca. 300 plates from NAO-Rozhen is a part of the future BG-VO. *All plates have to be scanned in IA-BAS.* As an output of this project step-by-step instructions for scanning of astronegatives – plates and spectra, will be drafted. Some astro plates will be selected as standards and the results of scanning and analysis of these standards will be a part of these instructions

The basic problems to be solved after the integration of data into the total data base include:

1. Discovery of new and detailed study of the known variable stars in these aggregates;
2. The combined study allows us to use the results as a test of theoretical models of stellar structure and evolution;
3. The generalization of all available data for variable stars in star clusters enables the creation of a modern data base for their physical, pulsationary and evolutionary parameters;
4. Study of the spatial structure of star clusters to different limiting magnitudes.

1.4. BG Virtual Observatory Small bodies in the Solar System (BGVO - asteroids and comets):

The Solar system Department has at its disposal and will provide for BGVO Schmidt-telescope plates and FITS files for all three telescopes of Rozhen NAO acquired in different operational modes – see the following table:

Telescope \ mode	astrometric	photometric	polarimetric	spectral (low dispersion)
2 M RC			X	X X
50/70 Schmidt	X		X	
60 Cassegran	X			

Tasks :

- Scanning the plates from the Schmidt telescope of Rozhen NAO.
- Adjustments of the fits-headers of all available frames to the VO standards.
- Elaborating software for automatic detection of moving objects with respect to the background stars.

Scientific goals:

- Search for new small bodies in the solar system.
- Producing a database with physicochemical parameters of comets and survey of their variations.

- Producing a database of rotational light curves of asteroids and the study of the different types of objects.

1.5 Next steps – All high resolution stellar spectra from Rozhen NAO are planned to be a part of BGVO.

- **Methodology**

Virtual observatory instrumentation

The Astrophysical Virtual Observatory (AVO) project is related to investigation and demonstration programs, the conditions for science and technologies to build the Virtual observatory for the European astronomers. The AVO project was financed by the European Fifth Program for three years. Participants are 6 European organizations. It is based on the strategy of periodic scientific demonstrations of the VO technologies. For that purpose "AVO Prototype " is developed. The prototype includes a set of software, common rules for remote data access and remote calculations. The major software part is based on ALADIN visualization package of the French center for stellar data. The use of the VOTable format for astronomical tables is of great importance.

Astronomy is at a turning point. Major breakthroughs in telescope, detector, and computer technology allow astronomical surveys to produce massive amounts of images, spectra, and catalogues. These datasets cover the sky at all wavelengths from γ - and X-rays, optical, infrared, through to radio. The VO is an international, community-based initiative, to allow global electronic access to available astronomical data, both space- and ground-based. The VO aims also to enable data analysis techniques through a coordinating entity that will provide common standards, wide-network bandwidth, and state-of-the-art analysis tools.

1. Guidelines and How-To for Scientists

Here astronomers can find answers to some of the most common “how to” questions.

Search for data for a given source. This thread illustrates how to answer a typical VO question: what sorts of data do exist for an astronomical source? And how does one find them and access them?

Search for images for a given source. This thread illustrates how to answer a typical VO question: do images in a given wavelength range exist for an astronomical source? If so, how does one find them and display them?

How to generate the Spectra Energy Distribution of a source in an image. This thread illustrates how to answer a typical VO question: do spectra in a given wavelength range exist for source in a given field-of-view? Can one seamlessly build their Spectral Energy Distribution? The interoperability between Aladin (catalogue browsing, image visualization) and VOSpec (Spectral Energy Distribution visualization and analysis) allows you to answer these questions and accomplish these tasks with just a few mouse clicks.

How to generate and analyze Spectral Energy Distributions. This recipe shows how to generate and display a Spectral Energy Distribution with VOSpec, combining

spectra from various observatories in different energy bands, as well as user-produced spectra uploaded from the local disk. It also illustrates the usage of simple fitting tools in VOSpec, as well as the access to theoretical models and absorption/emission line databases, which have been incorporated in Virtual Observatory servers around the world.

Visualizing, manipulating and cross-correlating catalogs. There are a number of tools available for visualizing, manipulating and cross-correlating catalogues. Some of these tools are applications that are downloaded and run on the desktop, some can be started with “webstart” technology and others may be used as a service where the calculation is performed on a remote computer.

Data Access Worksheet. Step by step worksheet that demonstrates some ways to retrieve and visualize astronomical images, spectra and catalogue data using the Astrogrid/Euro-VO access mechanisms to VO services.

Merlin Imager. Of special interest for the radio community is Merlin Imager. The MERLIN radio interferometry archive contains visibility data. If an observation has been suitably calibrated, an image can be extracted on demand from anywhere in the field of view.

- **GRID and VO:**

Virtual Observatory is an outstanding Grid application involving the federation of many distributed astronomy data sources. A good illustration along these lines is The European Grid of Solar Observations (EGSO) that is a Grid test-bed based on solar data resources, which represents a step toward a virtual solar observatory.

There is greater interest in cross-correlating the datasets to find new phenomena. Each project will likely publish a database externalized as a set of Web services. Searches involving both spatial and time-domain constraints are typical tasks for the Virtual Observatory. The benefits of the existence of such VOs become obvious with the first major discovery made with the Virtual Observatory – the discovery of 31 previously undetected powerful supermassive black holes in the so-called GOODS (Great Observatories Origins Deep Survey) fields (Padovani et al., 2004).

There have been published more than 400 papers related to “Virtual Observatories”. In the references below the basic ones are selected. They cover all important aspects of the problem. These publications indicate that Virtual Observatories have a very high potential to enable new astronomical research.

2009, G. Petrov