WEB PORTAL FOR THE ARMENIAN VIRTUAL OBSERVATORY BASED ON ARMENIAN NATIONAL GRID INFRASTRUCTURE

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The volume of astronomical data is growing alarmingly quickly. The continuing improvement of internet and network technologies - such as TCP/IP, Java, XML, SOAP and REST, as well distributed computing infrastructures makes the virtual observatories (VO) a feasible ideal. The Armenian VO is a web portal for astronomical data and analysis system, and utilizes the standards developed by the International Virtual Observatory Alliance to communicate with the VO-compliant resources in the world. The portal of the Armenian VO is introduced in this article, which is designing a set of international open standards and tools for the discovery, access and processing of astronomical data

1. Introduction

During the recent years, large amounts of astronomical data have been obtained by ground-based and space telescopes covering all wavelength ranges, some of them being all-sky or large-area surveys covering dozens of thousands square degrees (ROSAT, XMM, and Chandra in X-ray; GALEX in UV; SDSS, USNO, MAPS, APM, and GSC in optical; 2MASS in NIR; IRAS, ISO, SST, AKARI, and WISE in IR/FIR; and NVSS and FIRST in radio).
At the meantime eInfrastructures are one of the key enablers of scientific research and of the development of Information Society in Europe and worldwide. The grid infrastructure [1-2] is recognized today in Europe and worldwide, together with the highspeed networking, as one of the basic components of the e-Infrastructure of research and education and soon of the entire knowledge-based society. A growing number of scientific communities adopted Grid technology and rely on it for their everyday work. During last years Astronomical and Astrophysical community has grown both in terms of astronomical research groups and related applications by

[1]The joint work has been done within the framework of the ISTC (International Science and Technology Centre) Project A-1606 (Development of Armenian-Georgian Grid Infrastructure and Applications in the Fields of High Energy Physics, Astrophysics and Quantum Physics).

involving more than 1000 researchers in Europe distributed in several VOs (ASTRO, MAGIC, PLANCK, DCA and others) of EGEE (Enabling Grids for E-sciencE) [3] and other international Grid Infrastructures and they have an impact on the research of a number of Astronomers in EU countries (for instance, in the case of Planck simulations, Grid activities affect more that 1000 astronomers involved in Planck consortium).

The Astrophysical Virtual Observatories have been created in a number of countries using their available databases and current observing material coming from both ground-based and space telescopes as a collection of interoperating data archives and software tools to form a research environment in which complex research programs can be conducted. At present the International Virtual Observatories Alliance (IVOA) [4] unifies 17 national VO projects and serves for coordination of the homogeneity and interoperability of existing astronomical data (images, spectra, catalogs, literature, etc.). The European Virtual Observatory (EuroVO) [5] is an example of an operational data and service grid. A crucial research activity is the interoperability between EuroVO and EGEE grid infrastructure. This produces a ”cyber-infrastructure” that supports Astronomers in any aspect of their research activity, from data discovery and query to computation, from data storage to sharing resources and files. The use of high performance computational resources in the Grid infrastructure is crucial to fulfil the needs of theoretical astronomers that use numerical simulations for their research activity.

The Armenian VO project (ArVO) [6] is being developed since 2005 and is a part of the International Virtual Observatory Alliance (IVOA). The purpose of the article to present the multi-functional Web Portal (see fig. 1) of the ArVO based on Armenian National Grid Infrastructure (ArmGrid) [7-8].

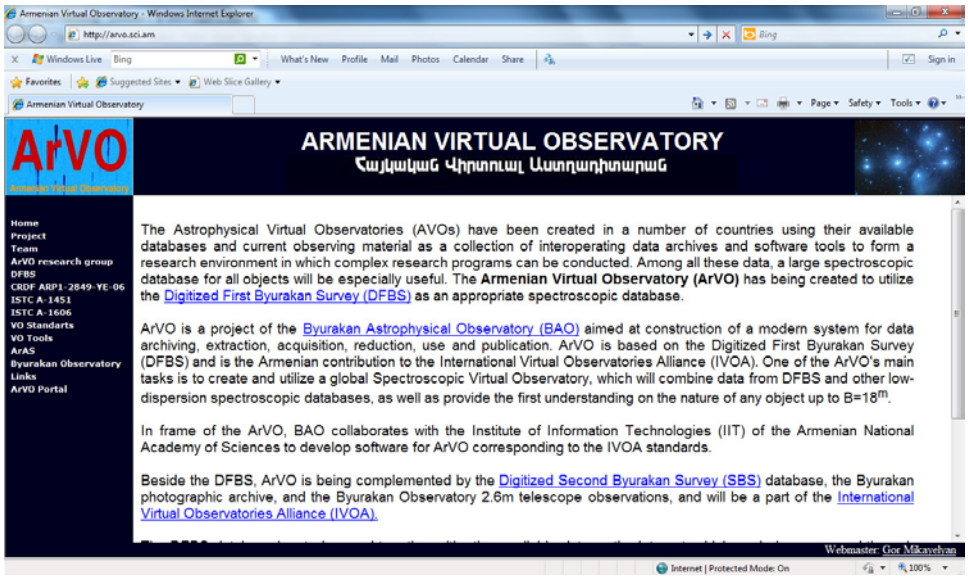

Fig. 1. Armenian Virtual Observatory Portal

The ArmGrid infrastructure (gLite middleware) consists of seven Grid sites located in the leading research (National Academy of Sciences, Yerevan Physics Institute) and educational organizations (Yerevan State University, State Engineering University) of Armenia. Apart from computing (416 cores) and storage resources, core Grid services which enable seamless access to all resources are provided to national users. The first Armenian national VO ARMGRID.GRID.AM has been established and registered in the Grid operations centre database in May 2009 [9]. The nodes of the Grid sites are interconnected by Myrinet and Infiniband High bandwidth or Gigabit networks. Many international projects, such as the projects funded by International Science and Technology Centre (Development of Scientific Computing Grid on the Base of Armcluster for South Caucasus Region, Development of Armenian-Georgian Grid Infrastructure and Applications in the Fields of High Energy Physics, Astrophysics and Quantum Physics) and EU Framework Programmes (South East European eInfrastructure for regional eScience) have contributed to deploy the ArmGrid

infrastructure. Armenia is a member of EGI (European Grid Initiative) [10] and actively takes part in all activities within the EGI.
The ArVO was created to utilize the Digitized First Byurakan Survey (DFBS) [11-12] as an appropriate spectroscopic database having low-dispersion spectra of some 20,000,000 objects, the largest number in the world databases. ArVO is a project of the Byurakan Astrophysical Observatory (BAO) [12] (in collaboration with the Institute for Informatics and Automation Problems of NAS RA) aimed at construction of a modern system for data archiving, extraction, acquisition, reduction, use and publication. One of the ArVO's main tasks is to create and utilize a global Spectroscopic Virtual Observatory, which will combine data from DFBS and other low-dispersion spectroscopic databases to provide the first understanding on the nature of any object brighter B=18m. Beside the DFBS, ArVO is being complemented by the Digitized Second Byurakan Survey database [13], the Byurakan photographic archive, and the Byurakan Observatory 2.6m telescope observations. Many new science projects will be available and may be carried out with high efficiency having the VO environment. The low-dispersion spectra are useful for search for new objects of given types by modeling their spectra (bright QSOs, new Markarian galaxies, planetary nebulae, cataclysmic variables, white dwarfs, carbon stars, etc.). In addition, these spectra help identifying new radio, IR, or X-ray sources when used along with other available photometric data. The large amount of photometric data is useful for variability studies and revealing new variables in the observed fields. New high proper motion stars can also be discovered by a comparison of many observations having large separation in years.

2. Web Portal for the Armenian Virtual Observatory based on Armenian National Grid Infrastructure

The portal is designing a set of international open standards and tools for the discovery, access and processing of astronomical data. The VObs infrastructure is build as a SOA [14] set of services that are in charge of authentication and authorization (GSI based), data discovery, task execution (Universal Worker Service), access to storage systems (VOspace). The goal is to realize the native integration of VO services within ArmGrid infrastructure. The VO and ArmGrid infrastructure interfaced through use of the gLite [15] middleware.
The portal based on SkyNode [16] toolkit for building a VO compliant data service. Skynode is a VO standard data access interface. A query is described in SQL-like syntax with astronomical extensions, and is transfered as a SOAP message over HTTP protocol. The Astronomical Data Query Language (ADQL) is a proposed standard for the interoperability in the development of the IVOA, which is based on SQL but is passed in parse tree form as XML. A mechanizm for generating ADQL queries has been developed within the environment.
The authorized users may upload the files remotely via Web interface or via special scripts from access node. All real data are stored in the dedicated storage element of the ArmGrid infrastructure and the headers in the database. In case of necessity, as a result of the request (see fig 2), the worker nodes analyze the data. Development of the final portal with multy-query functionalty is in process.

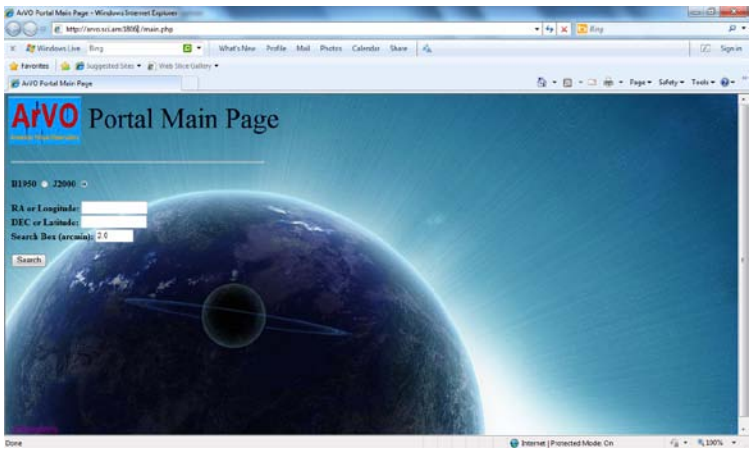

Fig. 2. Portal User Request Example

3. Conclusion

The users of VOs are a mature community concerning the knowledge and use of the Grid. In the future we aim at finishing the development of the portal, digitilizing more astronomical local data, applying IVOA standards in advance and increasing the number of researchers making use of the Grid infrastructure, and to support them. To reach this goal, we will actively participate with the relevant international organizations, such as IVOA and European Grid Initiative (EGI). We will also collaborate with the EuroVO projects to implement the latest technologies, packages and tools, as well as to interact with the astro VO within the EGI infrastructure by supporting all necessary packages and libraries for the VO.

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