Current Status of Chinese Virtual Observatory

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General Information

In the recent years, the telescopes, detectors, computers and Internet are developing rapidly in China. At the National Astronomical Observatories of China (NAOC), most optical telescopes are equipped with 2k*2k CCD detectors. The latest types of PCs (for example, Intel PVI 2.4GHz CPU, 512MB or more DDR RAM) are used by the NAOC astronomers. The LAN bandwidth at NAOC has reached 100Mbps. Several Grid projects are on the way in China, for example the Chinese National Grid (CNGrid) sponsored by the Ministry of Science and Technology (MOST) and the Chinese University e-Science Grid (CUEG) granted by the Chinese Educational Ministry.

Astronomical data is increased rapidly in China. The Beijing-Arizona-Taiwan-Connecticut large field multi-color sky survey (BATC) archives have reached about 400 GB since 1994. The World Data Center for Astronomy (WDC-Astronomy), which is hosted at NAOC, has collected about 1TB national and international astronomical data. The NASA astrophysics data system (ADS) and the VizieR catalogue service of the CDS have been mirrored at NAOC successfully.

Basic technical and astronomical circumstances for Virtual Observatory (VO) have been improved in China. In late of last year, the NAOC and the Large Sky Area Multi-Object Fiber Spectroscopic Telescope (LAMOST) project initiated a VO project, namely the Chinese Virtual Observatory (China-VO).

The China-VO would provide new opportunities for astronomical society of China:

- Share our data (BATC, LAMOST, etc.) with international astronomers
- Acquire data and technologies from other IVOA partners
- Provide a convenient portal for native users accessing national and international archives
- Bring up a group of VO-oriented astronomers, engineers and graduates
- Education and outreach

In 3 years from 2002 to 2005, the China-VO can get about 1 million RMBs (about 0.12 million US dollars) from the WDC-Astronomy and the CNGrid project.

China-VO Main Tasks

a) Feasibility of Virtual Observatory in China
Although in the last several years some experiences on large astronomical archives have been accumulated, it is quite deficient compared to other well-known data centers. What's more, although Grid/Web services are brand new for most of the IVOA partners, computer science and technology in China is relative undeveloped.

There are many difficulties for us in the accomplishment of the China-VO. Whether it is feasible on astronomy, technology and funding, a prototype of the China-VO will give the answer.

b) Interoperation of astronomical data
The China-VO will cooperate with other IVOA partners to solve some common challenges including the definition of a whole set of interoperability standards and protocols.

c) Automatic processing of astronomical spectra
The China-VO will mate with the LAMOST project. Being a powerful spectroscopic sky survey telescope, the LAMOST needs and will develop a toolkit to automatically process its huge spectral data. The China-VO will play an active role in developing the toolkit and making it available to the International Virtual Observatory (IVO).

d) VO-oriented LAMOST
The LAMOST sky survey needs a well-predefined target catalog, which will benefit from the abundant international astronomical archives interconnected through the IVO. The large data set of the LAMOST spectroscopic sky survey is very valuable for researches on astronomy and astrophysics. An important task for the China-VO is to make the LAMOST scientific archives online accessible as soon as they are available.

China-VO Architecture

The system design for the China-VO relies strongly upon the Grid technique, especially on the OGSA/GT3.x. In August 2003, the first demonstration of the China-VO will run on the Globus Toolkit 3.0.

Just from the beginning, we plan to design grid service on data access, service registration and management, user interface.

Following traditions of astronomical society and for funding reasons, free software and open source software will be adopted widely in the China-VO, for example, Linux OSs, the MySQL DBMS, the Apache toolkit and the J2EE platform.

Available data resources

a) BATC archives
The BATC large field multi-color sky survey is a cooperative long-term program by astronomical institutions in Beijing, Arizona, Taipei and Connecticut. Since its first light in 1994, the survey has produced a database about 400 GB that can be used to derive the photmetric redshifts of nearby galaxies, providing essential information regarding the structure of the local universe and nearby galaxy clusters.

There are 15 intermediate-band filters in the BATC filter system, which covers an optical wavelength range from 3000 to 10000 angstroms. The observational goal of the BATC survey is to obtain accurate spectrophotometry for all stellar and diffuse objects in 500 one deg^2 areas of the northern sky centered on nearby spiral galaxies,

active galaxies, QSOs and various calibration fields for Galactic and extragalactic objects, as well as random fields at high galactic latitudes.

The observations are carried out with the 60/90cm f/3 Schmidt Telescope of the NAOC, located at the Xinglong station. A Ford aerospace CCD camera with 15 micro pixel size 2048*2048 is mounted at the main focus of the Schmidt telescope. The field of view is about 60 arcmin.

b) International archives
Being the only data center for astronomy in the World Data Center (WDC) system, the WDC-Astronomy has collected a large number of archives from international colleagues.

The main international survey archives available at WDC-Astronomy are listed here:

Archives	**Size (GB)**
2MASS catalog	30
DSS	60
DSS-II	>360
Einstein Archives	5
FIRST catalog	0.01
GSC/GSCII	4.5
Hipparcos / Tycho catalog	6
NVSS catalog	0.5
RealSky	5
ROSAT Archives	27
USNO-A1.0 catalog	5
USNO-A2.0 catalog	6
SDSS EDR	60

If possible, the SDSS DR1 will be mirrored after its release in June 2003.

Scientific Demonstrations
At present, two scientific demonstrations are selected by the China-VO. The first, cone search service, will act as a test-bed for the system; the second, spectral line auto-detecting service, will be the first service on automatic processing of astronomical spectra.

a) Cone search
Using the Hierarchical Triangulated Mesh (HTM) spatial partitioning scheme developed by SDSS, we plan to design a fast cone search service responds to a user request for information based on a right ascension, declination, and radius about that position. User can select the output format from VOTable/XML, TXT and HTML.

b) Spectral line auto-detecting
The service will be developed to estimate the continuum level and the position of strong lines in one-dimensional spectrum automatically. In order to obtain detailed information on the continuum, a wavelet filter bank will be used. After continuum fitting, the service will distinguish between emission-line galaxies (ELGs) and non-ELGs. Then, it will search for strong lines and measure the line width and the equivalent width of absorption lines.

China-VO Roadmap

At present, the China-VO has set up cooperation with some national partners including:

- Department of Astronomy, Peking University
- Astrophysics Center, Tsinghua University
- Yunnan Astronomical Observatory, NAOC, Chinese Academy of Sciences
- Computer Network Information Center (CNIC), Chinese Academy of Sciences
- Institute of High Energy Physics, Chinese Academy of Sciences

There is a working group for the China-VO, which members come form those institutions.

Being similar to a VO, the Integrated Astrophysics Research Environment (IARE) is under developing at the Astrophysics Center, Tsinghua University.

The CNIC will act as a major node in the CNGrid equipping with a Dawning 4000 supercomputer, which is a high-performance grid platform with peak-performance of 4 Tflop/s. Based on the Globus Toolkit, data grid middleware are developing at CNIC.

At the first step, a test-bed will setup at NAOC. Then we will test distributed data access between NAOC and CNIC. Beyond this, a national wide VO will be tested among the partners. During the process, the China-VO will cooperate with the IVOA to test international interoperation.

The following is a draft roadmap for the China-VO, which will be updated when the updated IVOA roadmap is released at the Seattle meeting.

Jul. 2002:
    Draft of the China-VO Architecture
Oct. 2002:
    China-VO Architecture
    Online access for most collected archives
    Being an IVOA member
Jan. 2003:
    System requirement analyses and scientific goals definition
    Architecture design
    Initial cone search service
May. 2003:
    Cone search service
    Initial spectral line auto-detecting service
    Initial online access to the China-VO
Aug. 2003:
    Spectral line auto-detecting service
    Initial China-VO functional demo
    China-VO 0.0
Jan. 2004:
    Friendly data access service
    China-VO 1.0
Jan. 2005:

Basic data mining and knowledge discovery services
China-VO 2.0

Consideration of The IVOA and the IAU GA 2003

We are still at the beginning of the roadmap. Deep understanding of Grid and VO standards and protocols is needed for us. At present, we hope the following problems could be discussed at the Seattle meeting:

- Cooperation between VOTable and FITS
- Delivery and replica of (server-side/client-side) grid service
- Classification and definition of astronomical archives
- Encoding high-energy astrophysical data based on VOTable

Dr. Yongheng Zhao will attend the IAU GA. If possible, Mr. Chenzhou Cui would attend the great conference also.

Useful Links

[BATC] http://vega.bac.pku.edu.cn/bac/bac.htm
[China-VO] http://www.china-vo.org/
[CUEG] http://www.ist.vrc.zju.edu.cn/escience/en/e-Science.htm
[LAMOST] http://www.lamost.org/
[WDC] http://www.ngdc.noaa.gov/wdc/wdcmain.html
[WDC-Astronomy] http://badc.lamost.org/