A Giant Step: from Milli- to Micro-arcsecond Astrometry
Proceedings IAU Symposium No. 248, 2007
W. J. Jin, I. Platais & M. A. C. Perryman, eds.

doi:10.1017/S1743921308020152

Worldwide R&D of Virtual Observatory

C. Z. Cui[1] and Y. H. Zhao[1]

[1]National Astronomical Observatories, Chinese Academy of Sciences, Beijing 100012, China
email: ccz@bao.ac.cn

Abstract. Virtual Observatory (VO) is a data intensive online astronomical research and education environment, taking advantages of advanced information technologies to achieve seamless and uniform access to astronomical information. The concept of VO was introduced in the late 1990s to meet the challenges brought up with data avalanche in astronomy. In the paper, current status of International Virtual Observatory Alliance, technical highlights from world wide VO projects are reviewed, a brief introduction of Chinese Virtual Observatory is given.

Keywords. miscellaneous, methods: miscellaneous, astronomical data bases: miscellaneous

1. Introduction

During the last decade, advances in technologies have been changing the abilities and ambitions of astronomers. New technologies on telescope design and fabrication bring more powerful telescopes then ever to astronomers. Large scale digital sky surveys are prospering with the appearance of CCD mosaic camera. The scale of numerical simulations is also increasing rapidly with the development of hardware and software. As a result of these advances, data avalanche is occurring in astronomy. Furthermore, driven by the multi-waveband sky surveys and observations, new astronomical fields appear and are becoming more and more popular such as multi-waveband research, multi-archive data mining, time domain analysis, precise cosmology (Lawrence, 2006). To meet the challenges brought up by the above changes, a Virtual Observatory (VO) concept was initiated (Szalay & Gray, 2000). Virtual Observatory is a data intensive online astronomical research and education environment, taking advantages of advanced information technologies to achieve seamless and uniform access to astronomical information. The power of the World Wide Web is its transparency. It is as if all the documents in the world are inside your PC. The idea of the VO is to achieve the same transparency for astronomical data and information (Quinn *et al.*, 2004). VO is a science driven cyber-infrastructure for the 21st century astronomy.

2. International VO activities

After National Virtual Observatory (US-VO), the first funded VO project, VO projects were initiated in different countries and regions. International Virtual Observatory Alliance (IVOA) was formed in June 2002 with a mission to "facilitate the international coordination and collaboration necessary for the development and deployment of the tools, systems and organizational structures necessary to enable the international utilization of astronomical archives as an integrated and interoperating virtual observatory." At present, the IVOA consists of 16 projects. VO framework includes agreed standards, interoperable data collections, interoperable services and applications. IVOA focuses its work on development of standards. Now, more then 20 specifications have been published by IVOA working groups.

Following the concept of VO and IVOA specifications, a new prosperous era is coming for astronomical softwares and services. New applications, VO-enhanced legacy services are supporting astronomer's research more and more strongly. Core services from US-VO provide functions including data discover, service registry, catalog coverage, object cross match, source extraction and identification. UK VO project, AstroGrid, deploying the world's only unified VO operational service "AstroGrid", gives astronomers a "one-stop" access to all the world's astronomy data from a desktop. Many other new applications are released by world-wide VO projects and contributors such as VOPlot, VOSpec, VisIVO, SAADA. At the same time, existing applications and systems are upgraded and enhanced to support VO including CDS services (SIMBAD, VizieR, Aladin), NED, SciSoft, IRAF, TOPCAT, Montage, SExtractor.

3. VO in China

Chinese Virtual Observatory (China-VO) is the national VO project in China initiated in 2002 (Cui & Zhao, 2004). The China-VO aims to provide VO environments for Chinese astronomers. It focuses its research and development on applications and VO science in the following five fields: (1) China-VO Platform, providing VO environments for Chinese astronomical community; (2) Uniform Access to Global Astronomical Resources and Services, importing international resources to China and sharing Chinese resources to international community; (3) VO-ready Projects and Facilities, collaborating with astronomical projects to ensure they are VO-compliant; (4) VO-based Astronomical Research Activities, guiding and training astronomers to use VO; (5) VO-based Public Education, developing non-professional services for the public.

During the last several years, several VO applications and services have been initiated and developed by the China-VO. For example, VOFilter, an XML filter for OpenOffice.org Calc to load VOTable files; SkyMouse, a smart interface for astronomical on-line resources and services; FitHAS (FITS Header Archiving System), a toolkit for FITS file providers; VO-DAS, an OGSA-DAI based service system to provide unified access to astronomy data. Furthermore, the China-VO is collaborating with LAMOST, a Chinese ambitious spectral survey project, to make it VO-enabled, sharing its archives and software to the VO.

VO is trying to link on-line resources and services together at a higher level. More and more VO supported resources and services are available. How to do a better science using these tools? VO is not a simple thing – it is a new kind of research environment astronomers need to learn about. Astronomers need learn how to survive in the VO era.

Acknowledgements

The China-VO is supported by NSFC under contract No. 60603057, 90412016 and 10778623, and Beijing Science and Technology Nova Project under contract No. 2007A085.

References

Cui, C. & Zhao, Y. 2004, *PNAOC* 1(3), 203

Lawrence, A. 2008, in: K. A. van der Hucht (eds.), *Highlights of Astronomy*, The Virtual Observatory in action : new science, new technology, and next generation facilities. vol. 14, in print

Quinn, P. J., Barnes, D. G., Csabai, I., *et al.* 2004, in: P. J. Quinn & A. Bridger (eds.), *Proceedings of the SPIE*, Optimizing Scientific Return for Astronomy through Information Technologies, vol. 5493, p. 137

Szalay, A. & Gray, J. 2000, *Science* 293, 2037