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Astronomical Virtual Observatories: Enabling Science

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Abstract

The Astronomical Virtual Observatory (VObs) aims to provide a research environment that will enable new possibilities for scientific research based on data discovery, efficient data access and interoperability. This paper highlights the global VObs standards, European up-take of VObs methods, and the importance and results of early science use.

1. Global Standards

The VObs can be seen as the continuation of a long-term trend toward greater standardisation in astronomy [1]. Internationally agreed standards are key to making astronomy data archives and services around the world work together [2]. The International Virtual Observatory Alliance (IVOA, http://www.ivoa.net, Fig 1.) develops standards through its Working Groups, with close links to the astronomy data centre and research communities through Interest Groups and participating projects. As many VObs projects are moving into an operational phase there is now a greater emphasis on maintenance of standards and assessment of feedback from implementations. Specific science drivers are being used to provide focus on high priority areas, and to ensure the developments are relevant to the research community.

2. European Participation

European involvement in VObs is coordinated through Euro-VO (www.euro-vo.org), and includes technical development, and engagement with the astronomy community. Activities focused on Data Centres have brought the community together in workshops on 'publishing data to the VObs', and a census of Data Centres [3] shows a rich diversity of archives and services with a high level of intent to use VObs techniques. The goals of the VObs are also supported in the European 'Strategic Plan for European Astronomy' in the AstroNet Roadmap [4] which recommends the archiving of data and use of VObs.

Figure 1: The 17 international members of the IVOA

3. The Virtual Observatory in use

Concurrent science use of VObs alongside of the technical developments is essential for keeping the projects on track. VObs tools and services are maturing and already provide powerful and innovative tools for astronomers. A list of science papers which have made significant use of VObs tools is maintained on the Euro-VO web pages. These papers cover many topics in Astronomy from quasars to the faintest dwarf stars.

3.1 Schools and Training Materials

Use of VObs tools for science is assisted by Euro-VO at various different levels:

i) Research Initiative projects selected by peer review ranked proposals are provided with scientific and technical support to complete in-depth science programs over a one year period. For example the study of galaxy disks in a sample of ~30000 galaxies in Fathi et al. [5].

ii) A series of 'VO Schools' coordinated by Euro-VO and national VObs projects have reached some 500 participants across Europe in 2009-2010. These schools are typically targeted at young participants at the student and post-doctoral levels. These 2-4 day schools are comprised of tutorials that introduce VObs tools using real science cases. Participants also receive help to pursue their own science projects. These schools have proved to be the most productive way of engaging with young Astronomers, and provide copius direct feedback on the usability of the tools and services.

iii) On-line materials in the form of worked 'Scientific Tutorials' are available on the Euro-VO web pages, and provide an up to date resource of training materials and a list of tools sorted by function. IVOA also provides highlights of new capabilities of VObs tools via a newsletter available at www.ivoa.net/newsletter.

3.2 VObs Tools

The tools and services used in the schools make the most of the first interoperability gains provided by the VObs.

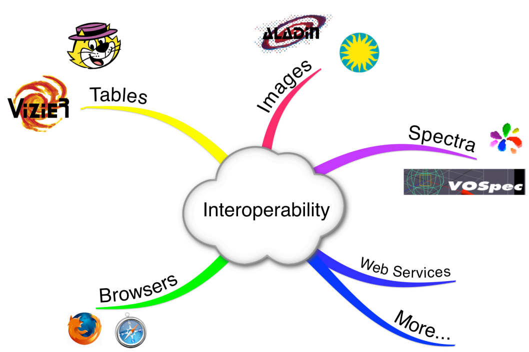

Figure 2: VObs standards provide interoperability between the most common data types of Images, Catalogues and Spectra. The logos indicate some of the tools specializing in these areas.

One may search for image, catalogue and spectral data across all archives registered in the VObs, and use these data in tools that work together (Fig 2.). The tutorials highlight cross matching of catalogues, visualization of multiwavelength data (Fig 3) and filtering of large data sets. Tools may be connected together in innovative ways, and there is increasing integration with mainstream astronomy software that is becoming 'VObs enabled'.

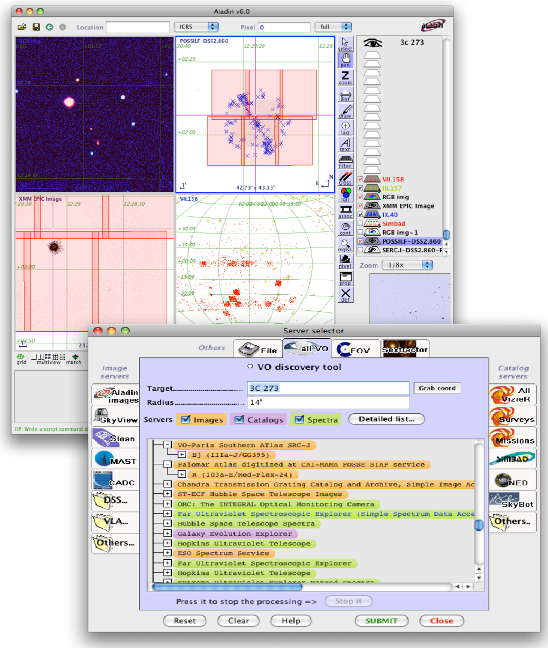

Figure 3: The Aladin 'sky atlas' tool provides access to VObs data, and provides detailed visualization of sky coverage and catalogues in an extensible and interoperable interface.

References

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