



SCIENCE FROM THE ASTROPHYSICAL VIRTUAL OBSERVATORY

Paolo Padovani on behalf of the AVO Project Team

The second Astrophysical Virtual Observatory (AVO) science demonstration was held during an AVO Science Working Group meeting in January 2004 at ESO. This “First Science” event showed that AVO tools have evolved beyond the demonstration level to become respectable research tools. The AVO is now enabling astronomers to reach into new areas of parameter space with relatively little effort.

BACKGROUND

The breathtaking capabilities and ultra-high efficiency of new ground and space-based observatories have led to a data explosion calling for innovative ways to process, explore, and exploit these data. The Virtual Observatory (VO) is an innovative, evolving system that allows users to interrogate multiple data centres in a seamless and transparent way using new international standards for data access and mining protocols. The VO initiative is a global collaboration of the world’s astronomical communities under the auspices of the recently formed International Virtual Observatory Alliance (IVOA).

The Astrophysical Virtual Observatory (AVO) project is conducting a research and demonstration programme on the scientific requirements and technologies necessary to build a VO for European astronomy. The AVO has been jointly funded by the European Commission (under the Fifth Framework Programme [FP5]) with six European organizations participating in a three year Phase-A work programme. The partner organizations are ESO in Munich, ESA, AstroGrid, which is funded by PPARC as part of the United Kingdom’s E-Science programme, the CNRS-supported Centre de Données Astronomiques de Strasbourg (CDS), the TERAPIX Astronomical Data Centre at the Institut d’Astrophysique in Paris, the University Louis Pasteur in Strasbourg and the Jodrell Bank Observatory of the Victoria University of Manchester. As a coordinated effort, the IVOA partners are holding demonstrations of new VO capabilities on an annual basis.

AVO PROTOTYPE

The AVO recently held a Science Working Group meeting and related demonstration on January 27-28 2004 at ESO. On the technical side, the demonstration revolved around the AVO prototype. This is an evolution of Aladin, developed at CDS, and has become a varied set of software components, provided by AVO and international partners, which allows relatively easy access to remote data sets, manipulation of image and catalogue data, and remote calculations in a fashion similar to remote computing. The prototype is enabled by the VO infrastructure and interoperability standards that are being developed by all the VO projects under the auspices of the IVOA.

SCIENCE DEMONSTRATION

The AVO science demonstration this year dealt with an extragalactic case on obscured quasars, centred around the Great Observatories Origins Deep Survey (GOODS) public data, and a galactic scenario on the classification of young stellar objects.

New features, compared to last year’s demonstration (ST-ECF Newsletter 33), included the support of spectroscopic data, with direct links between imaging and spectral data of the same sources, seamless and transparent access to scientifically validated products from the ISO and XMM-Newton archives, usage of new standards (Simple Image and Simple Spectrum Access), and new tools (SpecView, Hyper-z, VOPlot, and a cross-matching service).

The demonstration was truly multi-wavelength, using heterogeneous and complex data covering the whole electromagnetic spectrum. These included: MERLIN, VLA (radio), ISO (spectra and images) and 2MASS (infrared), USNO, ESO 2.2m/WFI and VLT/FORS (spectra), and HST/ACS (optical), XMM and Chandra (X-ray) data and catalogues.

SCIENCE RESULTS

The extragalactic scenario resulted in the discovery of about 30 new optically faint, obscured quasar candidates, the so-called QSO 2, an improvement of a factor of 4 when compared to the nine such sources previously identified in the GOODS fields. By going about 3 magnitudes fainter than previously known objects we are sampling a region of redshift — power space so far un-

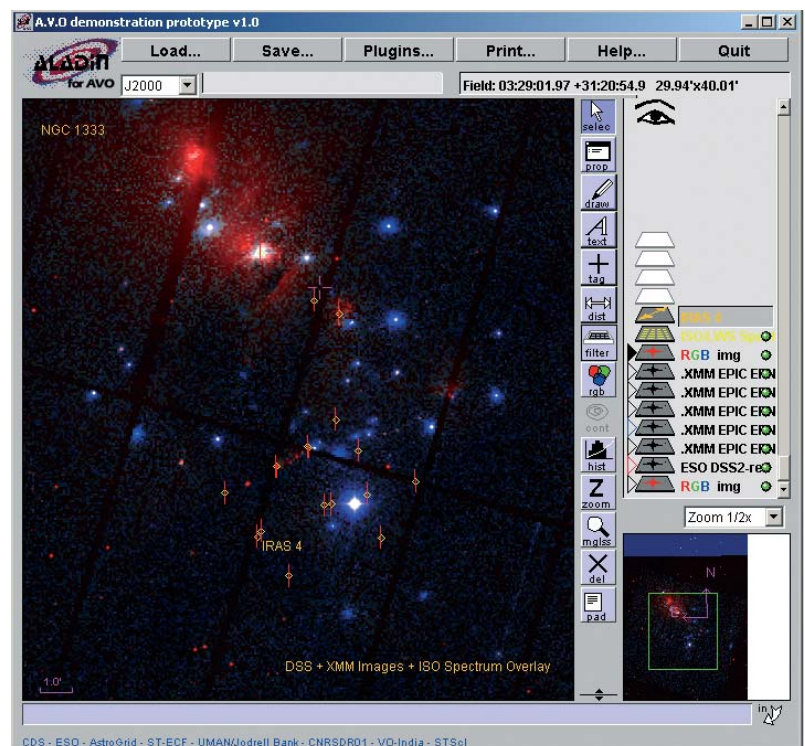


Fig 1: Composite optical (red — DSS2) and X-ray (blue — XMM Newton) image of the star-forming region NGC 1333. Symbols denote sources with infrared spectra taken with ESA’s ISO.

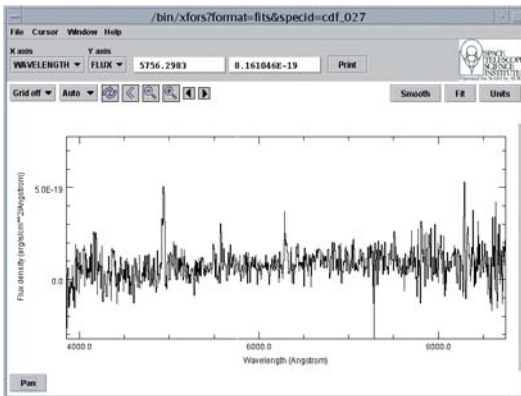
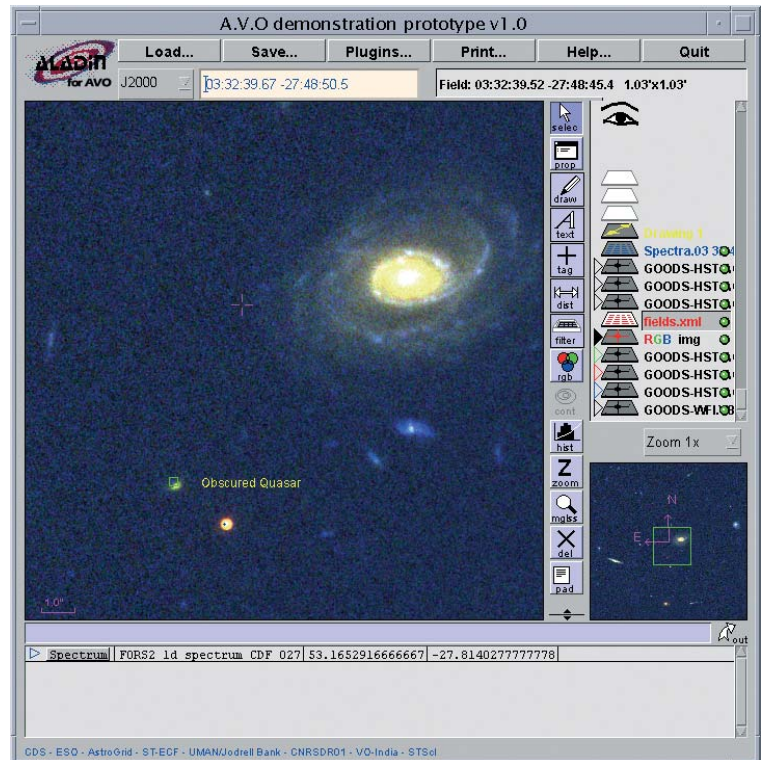


Fig 2: Example of the direct links between imaging and spectral data: an obscured quasar selected via its X-ray (Chandra) properties, imaged by the HST/ACS (right), and identified through an ESO/VLT FORS2 spectrum (above). The great majority of the new candidates are too faint to be classified even by the VLT or Keck.



reachable with “classical” (ie, non-VO) methods. The inferred QSO 2 surface density is much larger than current estimates and predictions. A paper describing these results has been submitted to Astronomy & Astrophysics. The demonstration showed that AVO is already starting to do cutting-edge science by allowing the exploitation of astronomical data beyond the classical identification limits. Astronomers are quickly moving beyond the era when source identification was done by taking a spectrum with a telescope, into an era when classification is achieved by using all the multiwavelength information available.

USING THE AVO PROTOTYPE

The AVO prototype used during the demonstration can be downloaded from the AVO Web site at: <http://www.euro-vo.org/twiki/bin/view/Avo/SwgDownload>. This page also contains detailed instructions on how to reproduce the AVO science demonstration (both the extragalactic and galactic scenarios). We encourage astronomers to download the prototype, test it, and also use it for their own research. For any problems with the installation and any requests, questions, feedback, and comments you might have please contact the AVO team at twiki@euro-vo.org. It should be noted that this is still a prototype: although some components are pretty robust some others are not.

CONCLUSIONS

The second AVO demonstration has shown that the AVO is mature enough to produce science results by exploiting astronomical data beyond classical identification limits ($R < -25$). The paper that came out of it represents the first significant

published science result that has been fully enabled via end-to-end use of VO tools and systems.

The AVO Phase-A will end on October 31 2005. The main AVO commitments before then are: to produce a Science Reference Mission, that is a definition of what the AVO should be when fully implemented (Phase B); to complete the definition of its science requirements; to complete the description of the data, archive interoperability and the necessary database technologies needed for a full implementation; and finally, to deliver the last AVO demo in January 2005. Work is well under way in all of these areas.

After Phase-A, the project will move towards the EURO-VO, which is the full-fledged 4-year European VO programme.



ACKNOWLEDGMENTS

The AVO was selected for funding by the Fifth Framework Programme of the European Community for research, technological development and demonstration activities, contract HPRI-CT-2001-50030.

REFERENCES

- AVO Home Page: <http://www.euro-vo.org/>
- AVO Science Working Group Meeting 2004: <http://www.euro-vo.org/twiki/bin/view/Avo/SwgMeeting04>
- AVO Prototype Download: <http://www.euro-vo.org/twiki/bin/view/Avo/SwgDownload>
- International Virtual Observatory Alliance: <http://www.ivoa.net/>