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- The Virtual Observatory (VO) and the AVO
- VO-Science: the first VO-based refereed astronomical paper
- The near future
Astronomy in the XXI century

Radical changes are needed!

- Huge surveys: 100M sources at <3k spectra/night ⇒ >100 yr!

- Ever fainter sources: surpassed the identification limits of 8 - 10m telescopes (R_{mag} ≈ 25)

- Huge data collections: downloading Sloan Digital Sky Survey (SDSS) DR3 (~ 1/2 of total) images (6 Tb) ⇒ ~ 2.3 months at 1 Mb/s (ESO’s speed); catalogs (2.3 Tb) ⇒ ~ 1 month. On DVDs ⇒ ~ 1,300 of them.

- Ever increasing amount of data (~ 1 Tb/night)
The solution: Virtual Observatory

- An innovative, *evolving* system, which takes advantage of astronomical data explosion
- It will allow users to interrogate multiple data centres in a seamless and transparent way and to utilize at best astronomical data
- Data analysis tools (*in-situ*) and models will be made more accessible
- It will allow new *SCIENCE* by moving Astronomy beyond era of “classical” identification by combining all available information: data mining (increase obs. efficiency) + statistical identification (less need for spectra)
- Good communication \(\Rightarrow\) common language! Adoption and definition of VO standards and protocols within the International Virtual Observatory Alliance (IVOA: http://ivoa.net)
- And it’s all happening now: see the many talks and posters [\(>\) 1/5]
International Virtual Observatory Alliance

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
Virtual Observatory in Europe

- R&D on scientific requirements and technology for building a EURO-VO, 50% funded by European Community

- Phase A, 2001 - 2004/5
- Driven by strategy of scientific VO annual demonstrations
- Science Working Group established to provide scientific advice to AVO project
Two scenarios:
- Extragalactic: **Obscured (Type 2) Quasars**
- Galactic: **Classification of Young Stellar Objects (YSO)**

Multiwavelength, heterogeneous, and complex data: VLA, CGPS, ISO, 2MASS, USNO, 2.2m/WFI, VLT/FORS, HST/ACS, XMM, and Chandra (images, spectra, and catalogues)

Access to any **VO-compliant** data: seamless and transparent access to ESA ISO & XMM archives and ESO data products

**AVO**: from First Light (2003 demo) to First Science!

ESA/ESO Press release May 28
Relevant Quotes ...

- Slashdot
  - “We are using laboratories which don’t physically exist to detect things we can’t actually see …”
  - “It’s official: The Universe Sucks”
- Deutschland Radio
  - “The observatory might be virtual but the science is very real!”
The AVO Prototype

- Evolution of Aladin (Centre de Données astronomiques de Strasbourg [CDS])
- Downloadable Java application ([http://www.euro-vo.org/twiki/bin/view/Avo/SwgDownload](http://www.euro-vo.org/twiki/bin/view/Avo/SwgDownload))
- Registry of services (Générateur de Liens Uniformes: GLU)
- Extensible toolset with plug-ins which allows easy access to images (manipulation), spectra, catalogues, with overlays, plotting facilities, catalogue extraction, and a cross-correlation utility [ASTROGRID, VOIndia, STSci]
- Interoperable with other VO tools

(see next talk!)
Discovery of QSO 2s with VO tools

- GOODS (Koekemoer’s talk) HST/ACS data & catalogues
- Chandra X-ray catalogues
- Select absorbed X-ray sources
- Cross-match X-ray and optical
- Check against spectroscopy
- Apply empirical estimator for \( L_x > 10^{44} \) erg/s: QSO 2
Data available at selected point are highlighted in tree.

Field of view outlines are plotted automatically.

Image metadata.
redshift = 3.046

Lyα  C IV

January 2004: AVO First Science
January 2004: AVO First Science

~ 30 new obscured QSOs in GOODS CDFS+HDFN x 4 increase
VO Science!

- AVO is doing cutting-edge science by exploiting the data beyond “classical” identification limits ($R > 25$)
- AVO provides “statistical” identification of sources using multiwavelength information
- VO tools enable astronomers to reach into new areas of parameter space with little effort
- “AVO should enable everyone to compete with the GOODS team (on their data)”

[G. Gilmore, SWG meeting, June 2002]
The AVO Science Reference Mission

- The Science Reference Mission (SRM) defines key scientific results that the full-fledged (Phase B) EURO-VO should achieve when fully implemented.
- Will consist of science cases, with related requirements, against which the success of the EURO-VO will be measured.
- Being put together right now, with input from the Science Working Group, final version by January 2005.
- My main message to the SWG: THINK BIG!
The last AVO Demo

- Ambitious! Two scenarios being worked on:
  - Extragalactic: Star Formation Histories in Galaxies (ELAIS fields)
  - Galactic: Transition from Asymptotic Giant Branch (AGB) to Planetary Nebulae (PN)
- Multiwavelength, heterogeneous, and complex data (images, spectra, and catalogues): VLA, IRAS, ISO, 2MASS, MSX, Spitzer, 2.2m/WFI, INT/WFS, IUE, Chandra
- Technical side: distributed workflows, registry harvesting, sophisticated astronomical applications as Web services
- AVO ⇒ EURO-VO; VO-TECH: 6.6 M€ from EC, 12 FTEs (+ 12 from partners) for VO development at Edinburgh, Leicester, Cambridge, ESO, CDS, and INAF.
Summary

- The Virtual Observatory is happening, because it has to!
- Astronomy IS being done with Virtual Observatory tools!
- AVO (soon to be EURO-VO) is committed to the pursuit of science with VO tools through:
  - Scientific demonstrations
  - Science papers
  - Science Reference Mission
- "Astronomical research with the VO": Jan. 05 AAS
AVO prototype downloadable at
http://www.euro-vo.org/twiki/bin/view/Avo/SwgDownload