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# The Virtual Observatory

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P. Padovani, June 29, 2010 - AstrolInformatics - VO School - 1/12





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## The way Astronomy works

- Telescopes (ground- and space-based, covering the full electromagnetic spectrum)  $\Rightarrow$  Observatories
- Instruments (telescope/band dependent)  $\Rightarrow$  Observatories/Consortia
- Data analysis software (instrument dependent)  $\Rightarrow$  Observatories/Consortia/Researchers
- *Active Archives*  $\Rightarrow$  Observatories/Agencies
- Publications  $\Rightarrow$  Journals
- Data curation (metadata + tables & catalogues)  $\Rightarrow$  Data curators
- ... and Public Outreach  $\Rightarrow$  Observatories/Agencies





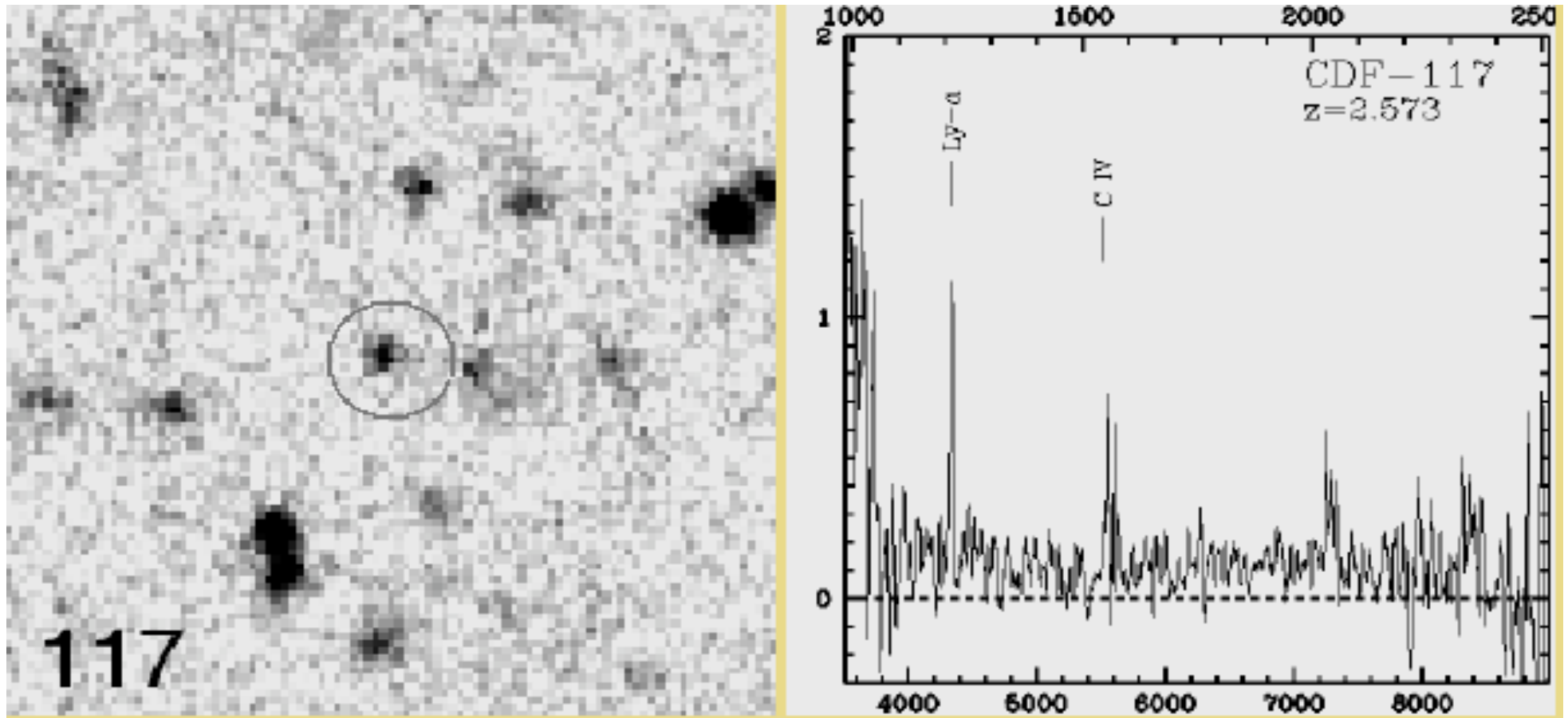
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## Information Avalanche

- Huge surveys: 100 million sources at  $< 3000$  sources per night  $\Rightarrow$   $> 100$  years to observe them
- Ever fainter sources routinely surpassing the identification limits of 8 - 10m telescopes [ $R \approx 25$ ]
- Huge data collections: download and data analysis on desktop problematic/impossible. Example: downloading Sloan Digital Sky Survey (SDSS) DR7 data:
  - ✓ images (16 Terabytes)  $\Rightarrow$   $\sim 5$  months at 10 Mbps (ESO's speed)
  - ✓ catalogues (18 Terabytes)  $\Rightarrow$   $\sim 6$  months
  - ✓ on DVDs  $\Rightarrow$   $\sim 7,600$  of them
- And data analysis?? (similar size for MACHO, 2MASS etc ...)





$R \sim 25.5$ , VLT/FORS2,  $t_{\text{exp}} \sim 2.5$  hrs (Szokoly et al. 2004)



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*courtesy of  
P. Quinn*





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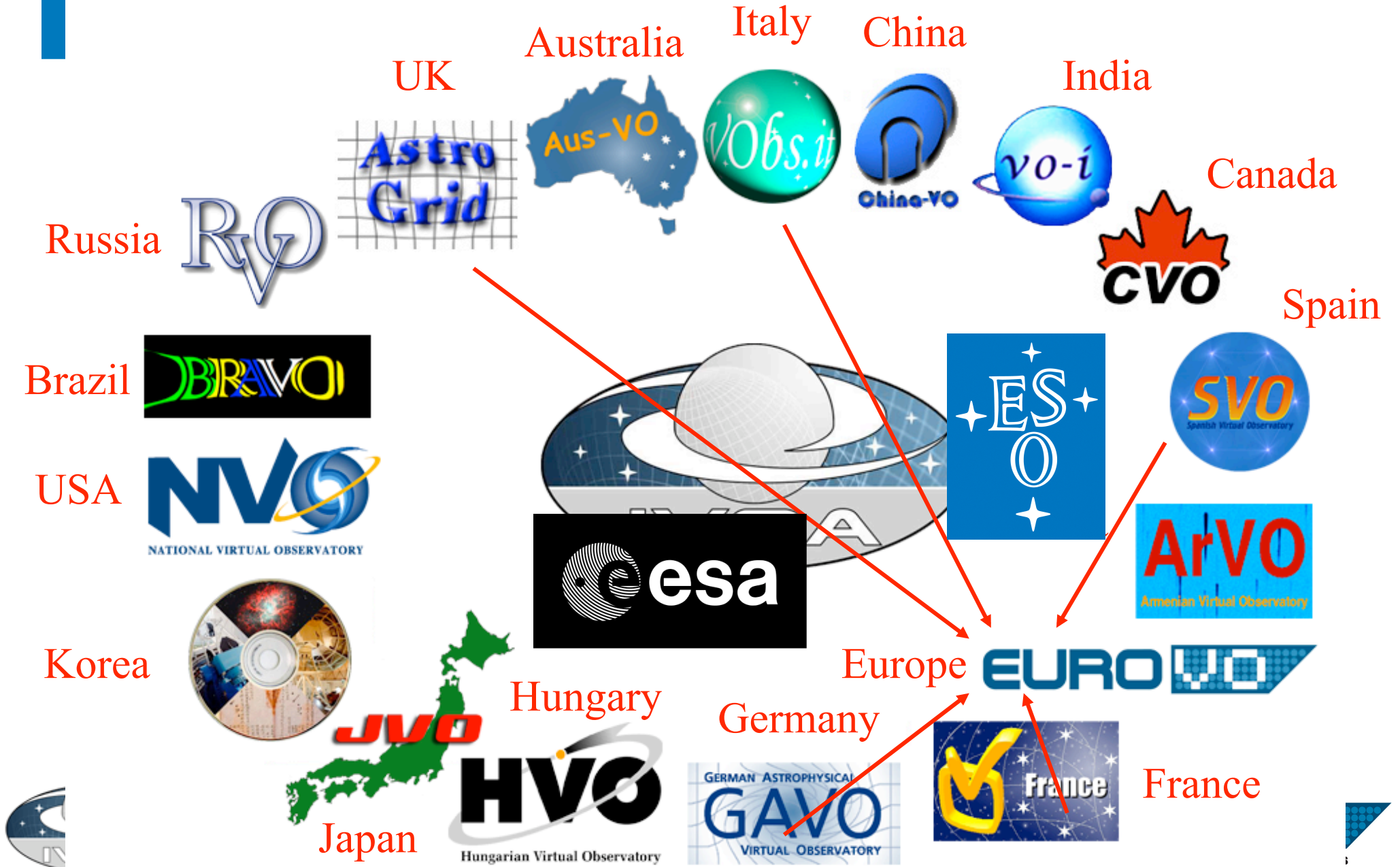
## The Virtual Observatory

- The Virtual Observatory (VO) is an innovative, still evolving, system to:
  - take advantage of astronomical data explosion (e.g., use statistical identification to diminish need for a spectrum  $\Rightarrow$  multi-wavelength, multi-parameter analysis)
  - allow astronomers to interrogate multiple data centres in a seamless and transparent way and to utilize at best astronomical data
  - permit remote computing and data analysis
  - foster *new science*
- Web: all documents inside PC; *VO: all astronomical databases inside PC*
- VO  $\Rightarrow$  democratization of astronomy!
- All of the above requires the various players to speak the same language  $\Rightarrow$  *VO standards and protocols defined and adopted within the IVOA (International Virtual Observatory Alliance), which includes 17 projects world-wide*



# International Virtual Observatory Alliance

17 Member Organizations





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## The European View: the EURO-VO

<http://www.euro-vo.org>

- Successor to the Astrophysical Virtual Observatory (AVO), which was a 5 M€, Phase A study (2001 - 2004/5) on the scientific requirements and technology for building the VO in Europe, 50% funded by European Community (Fifth Framework Programme [FP5])
- Includes 8 partners: ESO, European Space Agency (ESA), plus six national nodes: INAF (Italy), INSU (France), INTA (Spain), NOVA (Netherlands), PPARC (UK), and RDS (Germany)
- Has three components: Data Centre Alliance, Technology Centre, Facility Centre
- Partly funded by the EC but substantial partner support





An alliance of European data centres who will populate the EURO-VO with data, provide the physical storage and computational fabric and who will publish data, metadata and services to the using VO technology

An operational organization, that provides the EURO-VO with a persistent, centralized registry for resources, standards and certification mechanisms as well as community support for VO technology take-up and scientific programs. EURO-VO's "public face"

A distributed organization that coordinates a set of research and development projects on the advancement of VO technology, systems and tools in response to scientific and community requirements

@ ESO  
managed by  
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EURO VO

DCA

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DATA CENTRE ALLIANCE

VOFC

EURO VO  
TECHNOLOGY CENTRE

EURO VO  
FACILITY CENTRE



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## The EURO-VO Project: AIDA

- The “Astronomical Infrastructure for Data Access (AIDA)” project is funded by the EC FP7 through the Infrastructure call INFRA-2007-1.2.1 “Scientific Digital Repositories”
- AIDA has the same partners as the EURO-VO
- Project started on Feb. 1, 2008, which ensures continuation of European-wide VO activities at least until mid-2010
- AIDA is a combination of DCA, VOTC, and FC activities
- AIDA aims at unifying the digital data collection of European astronomy, integrating their access mechanisms with evolving e-technologies and enhancing the science extracted from these data-sets
- **One of AIDA’s main goals is to support the European astronomical community in their exploitation of astronomical data through VO tools**





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## The VO and science-ready data

- Astronomical research nowadays needs a variety of multi-wavelength data
- Access to individual archives is time-consuming and not easy: different astronomical archives have widely different access/search interfaces and standards/conventions
- Data reduction requires widely specialized, complex analysis software for various bands (radio, IR, optical, X-ray, etc.)
- Astronomers need and want reduced data!
- The VO provides access to science-ready data. But only if:
  - ✓ they exist!
  - ✓ the data provider has gone through the (often small) effort of “publishing them” to the VO (= following VO standards)





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## AstroInformatics - VO School

- Goal today: expose attendees to VO tools and services so that they can use them efficiently for their own research; based on our experience, this is the *most effective* way to introduce astronomers to the VO
- Methods:
  - lecture and tutor the participants on the usage of such tools
  - give real life examples of scientific applications
  - hands-on exercises

