The Virtual Observatory: What is it and how can it help me?

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Spanish Virtual Observatory

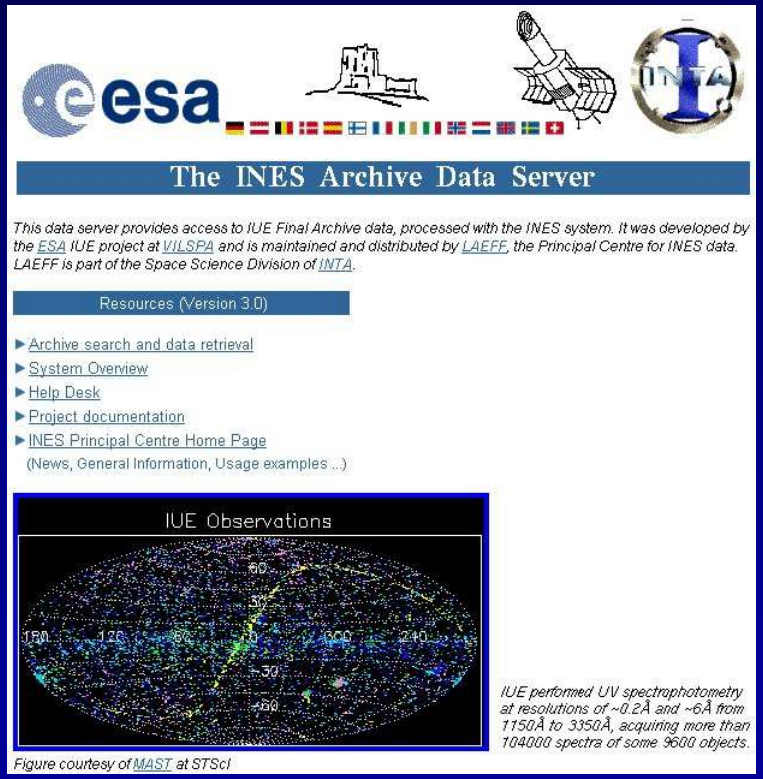
Astronomy in the XXI century

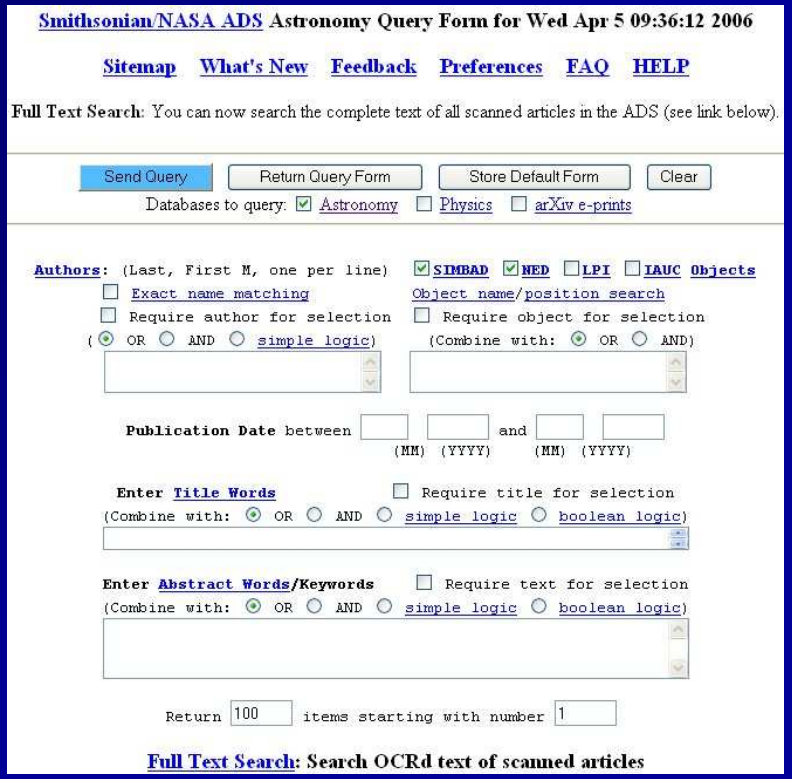
- The Internet revolution (the "dot com boom") has transformed the way we live...

Astronomy in the XXI century

... and work

- The availability of huge amounts of "on-line" information has drastically transformed the astrophysical research.





Astronomy in the XXI century

- The advances in technology (telescope design and fabrication, large-scale detector arrays,...) are now permitting to explore the Universe in a multi-parameter space.
- The advances in computational capabilities have provided the means to make, for the first time, direct comparisons between complex theoretical calculations and large, statistically significant observational databases.

BUT...

Astronomy in the XXI century (II)

- The progress in the scientific exploitation has not kept pace with the exponential growth of these vast new datasets.

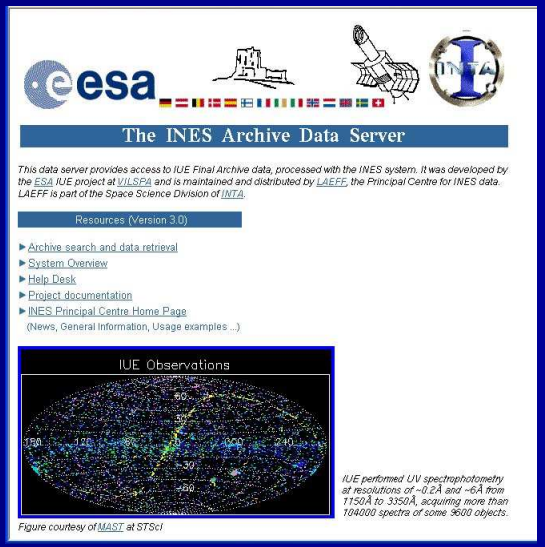
- This new scenario is demanding changes in the "classical" methodology.

Astronomical research: the classical way

I. Get the data

New data

Archive data



II. Reduce and analyze the data locally.

MIDAS

IDL

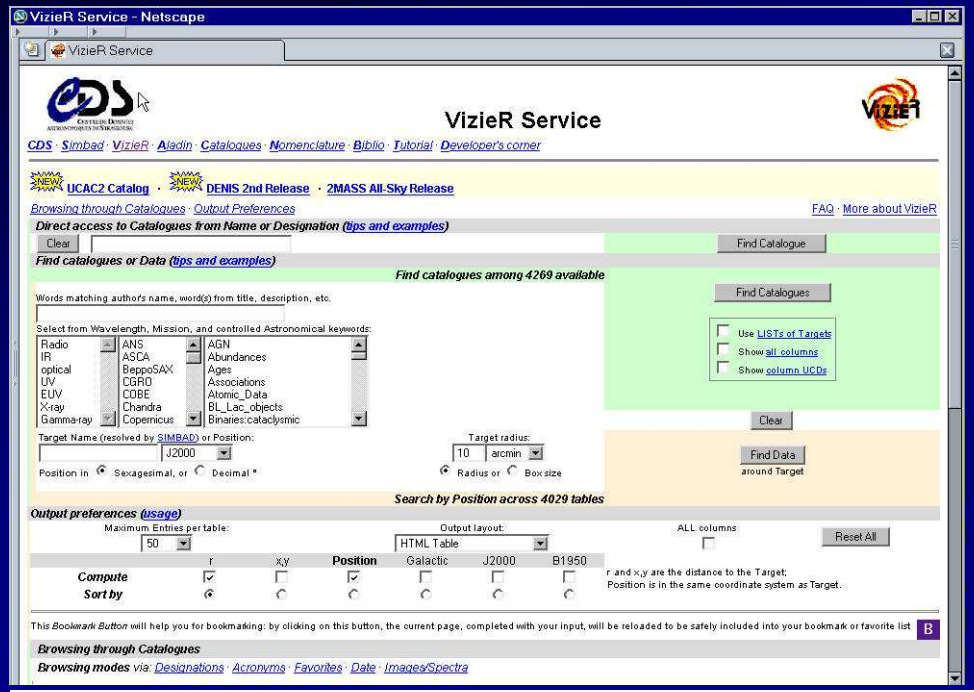
IRAF
Image Reduction and Analysis Facility

VO: a complementary approach

- The classical method has demonstrated to be quite inefficient when dealing with problems that require either:
  - ✓ Interoperability among data service and/or
  - ✓ Management of large volumes of data.

Interoperability problems: Easy questions with non-easy answers

➲ "Give me all objects in Vizier with V-Johnson."

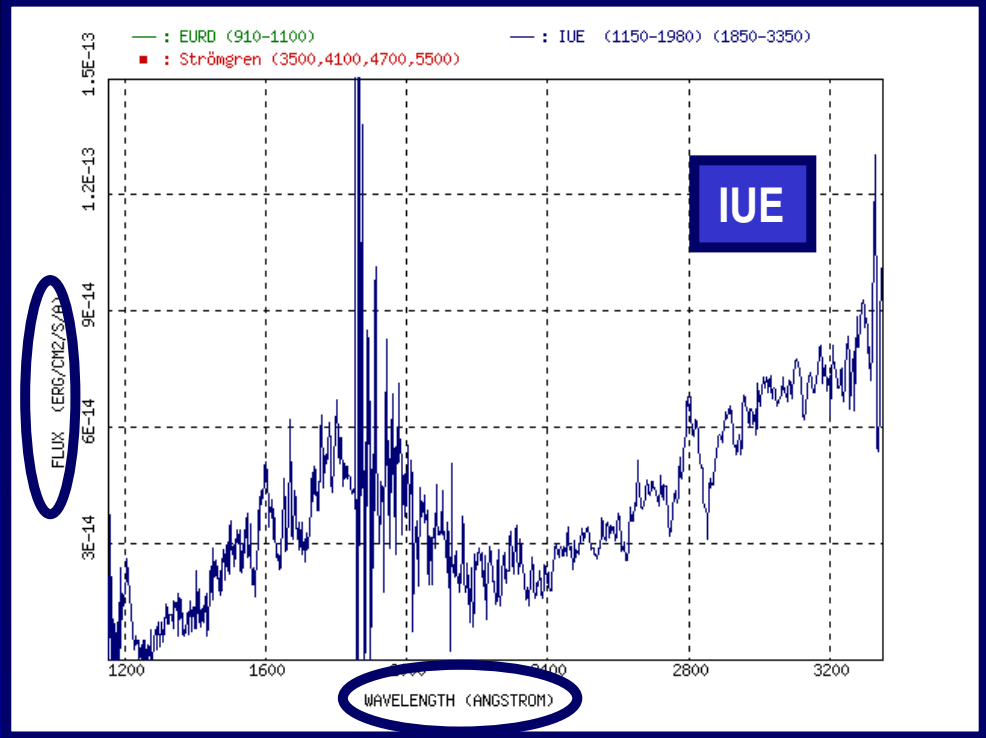


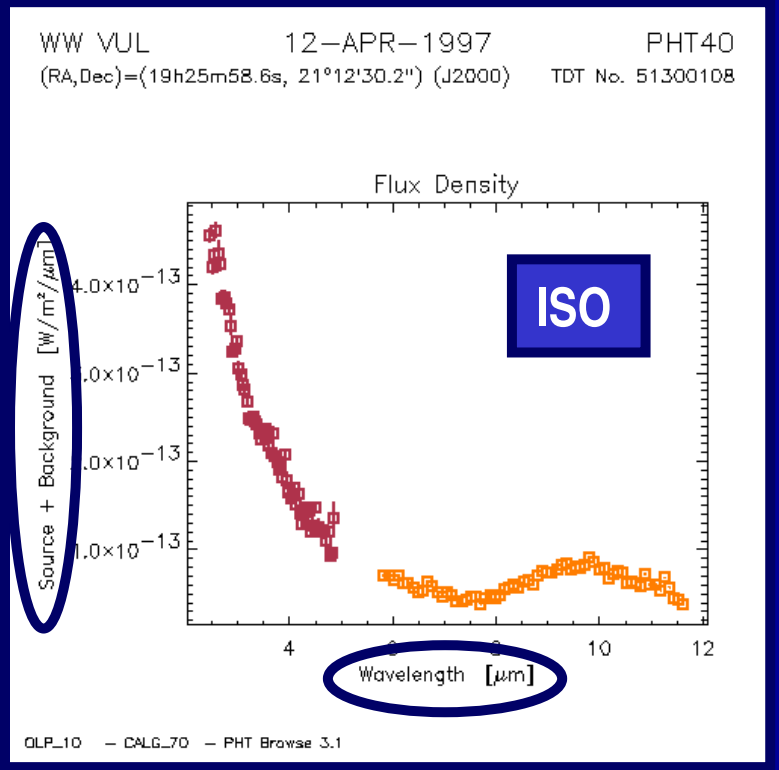
➲ VizieR: Contains more than 4000 astronomical catalogues consisting of one or several tables.

➲ Problem: as the catalogues come from many different sources, the original descriptions are very heterogeneous: "Give me all tables containing the V magnitude in the Johnson system: **144 different names for V Johnson.**

In the pre-VO era

- ✓ Different units both in wavelength and flux.
- ✓ Flux calibration of the photometric systems.





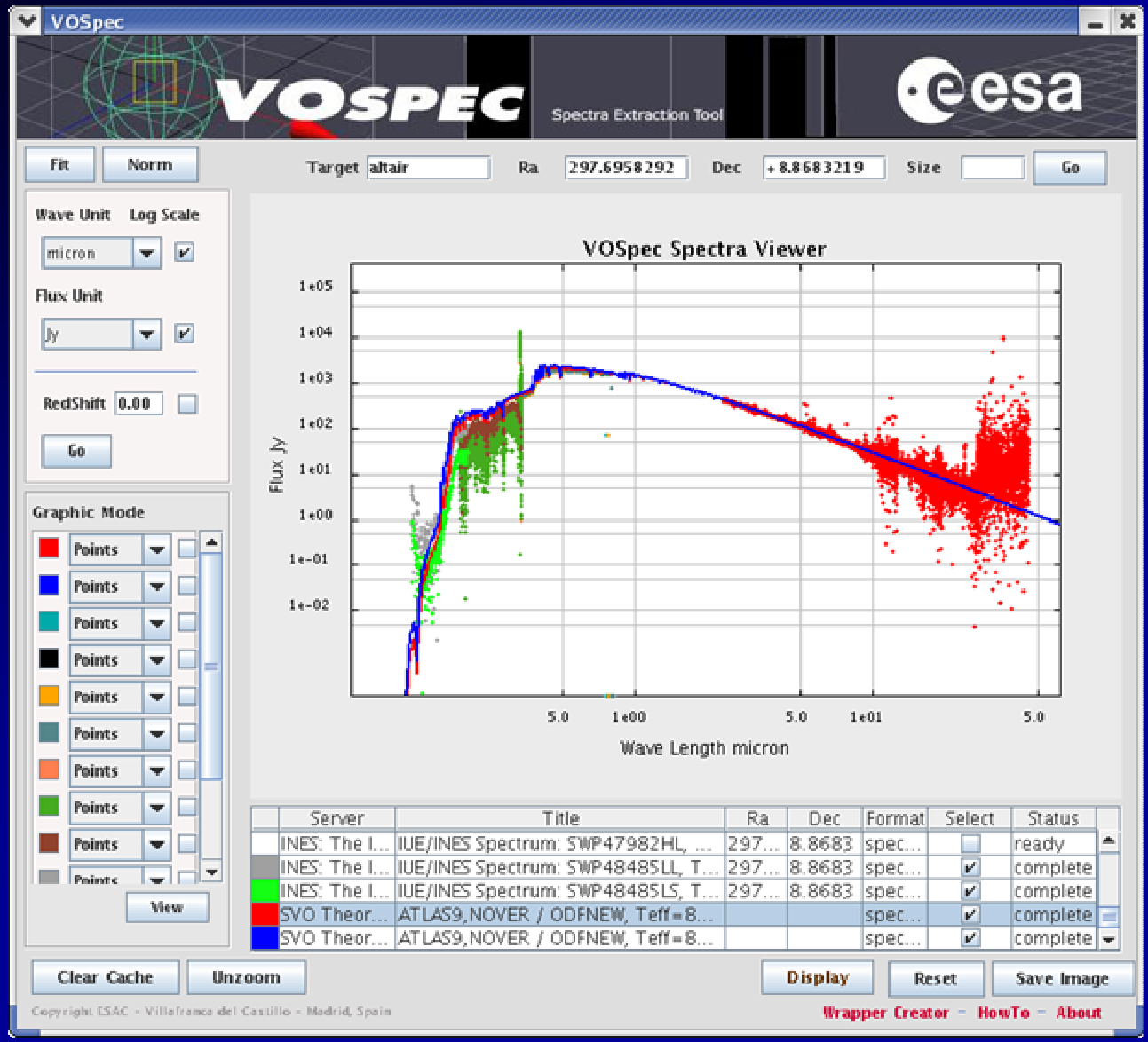
UBVRIJHK

- Wavelength: Å + μ
- Magnitudes!!!

Radio

- Wavelength: mm
- Flux: mJy

Using VO capabilities



The solutions provided by VO to solve the interoperability problem

- Agree and build standards.
  - Standard semantic: UCDs
  - Standard access protocols
  - Standard output formats
  - Standard data models
  - Automated discovery tools (registries)
- Uptake of standards by the data services.
- Development of a federation of astronomical data centres ("data grid").

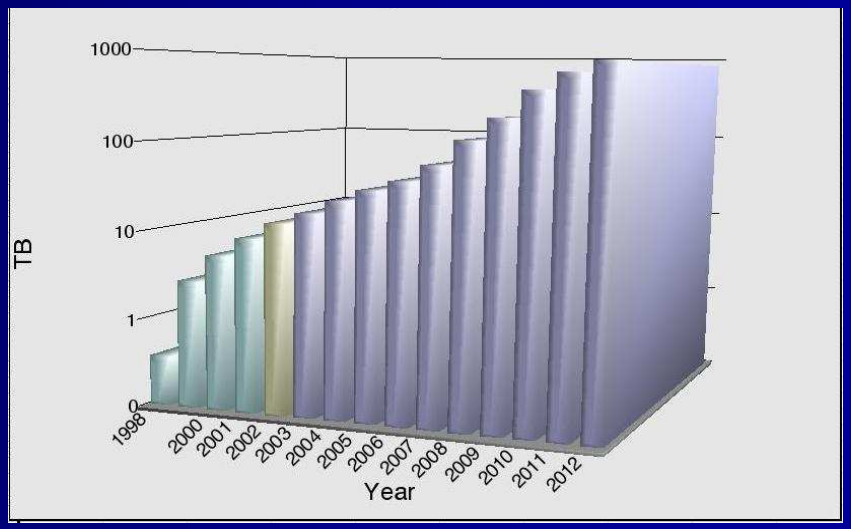
VO: a complementary approach

- The classical method has demonstrated to be quite inefficient when dealing with problems that require either:
  - ✓ Interoperability among data service and/or
  - ✓ Management of large volumes of data.

"large" really means LARGE

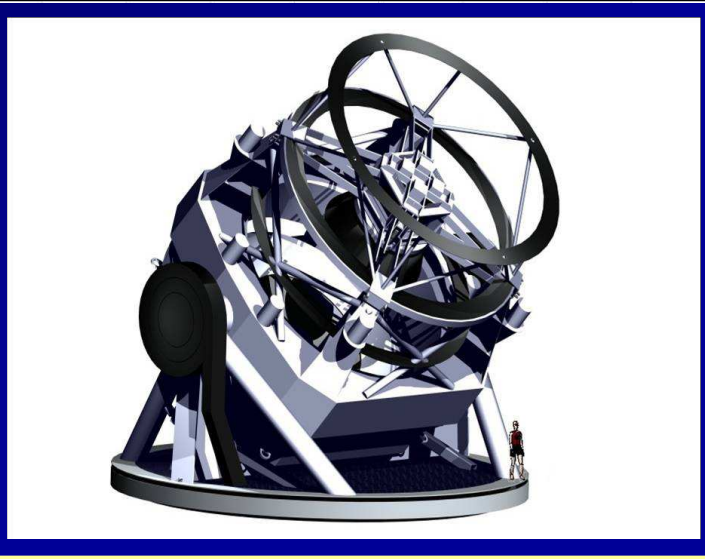
➢ Archive data are dramatically increasing.

✓ *ESO/ST-ECF Science Archive Facility holdings (x100 increase in the next 7 years)*

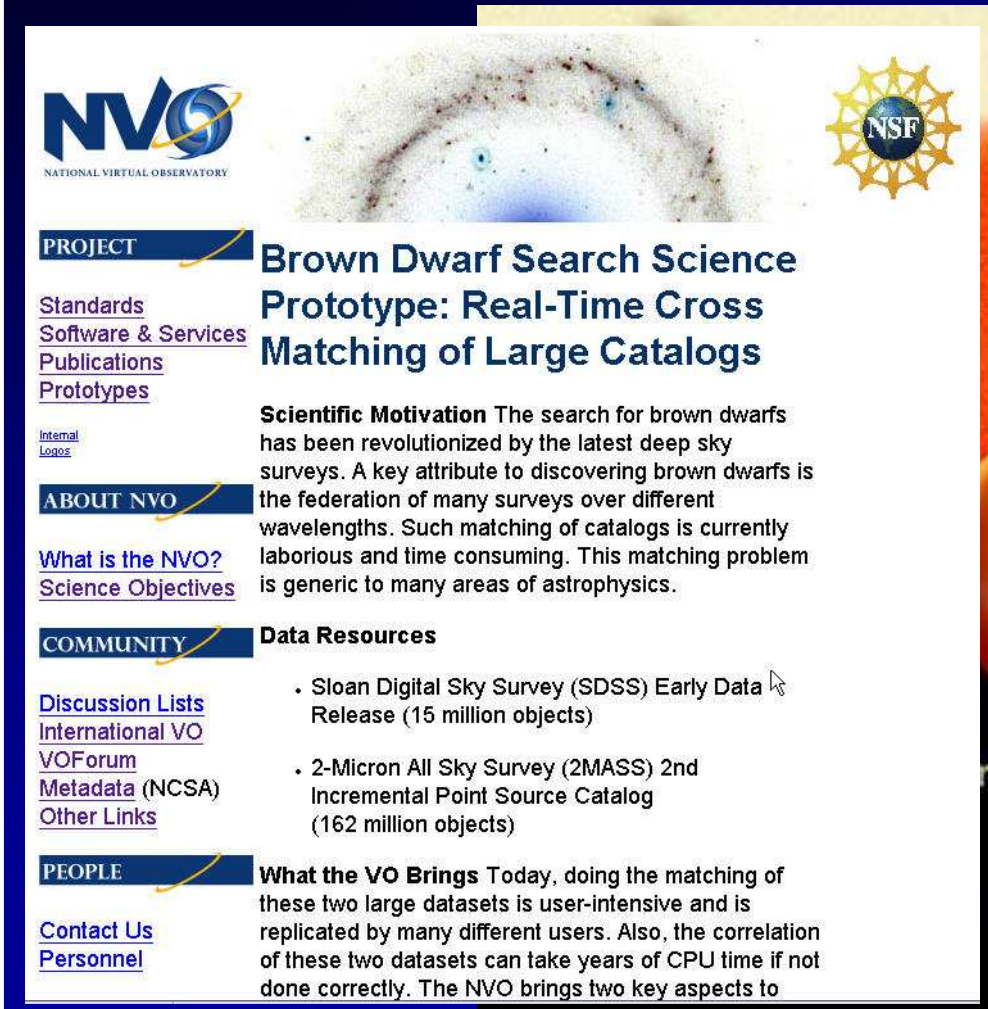


✓ *LSST*

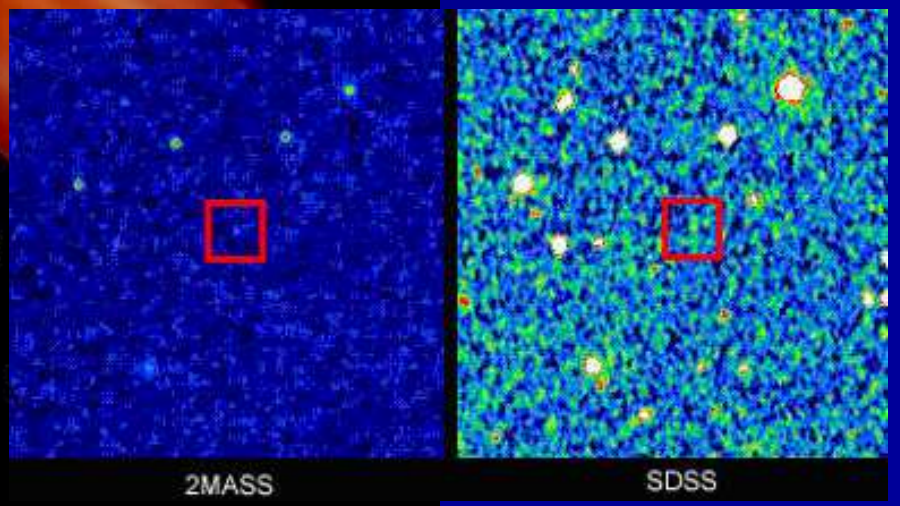
- It will scan the visible sky every few nights.
- Few TB/night. A factor of 1000 larger than current surveys.



Is it necessary to work with all this amount of information?



- **Criterio de filtrado:**
  Detecciones solamente en z y J con z- J > 2.75
- *SDSS: 15M obj.*
- *2MASS: 160M obj.*
- *300000 objetos en común.*



How to solve the problem of the data avalanche?

- Move from download to service paradigm
  - Leave the data where it is.
  - Operations on data (search, cluster analysis, etc) as services.
  - Ship the results not the data.

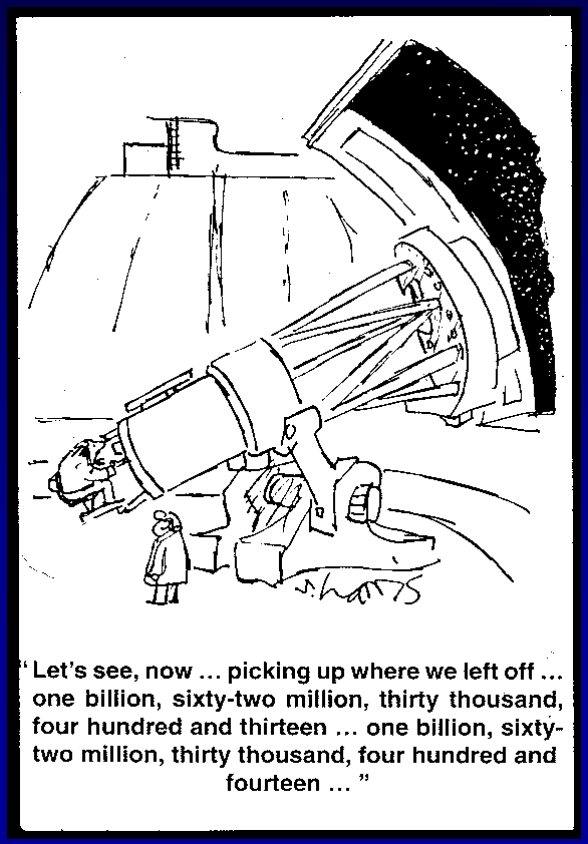
Requirements on data centres: computing

- Local resources:
  Supercomputers,
  PC farms

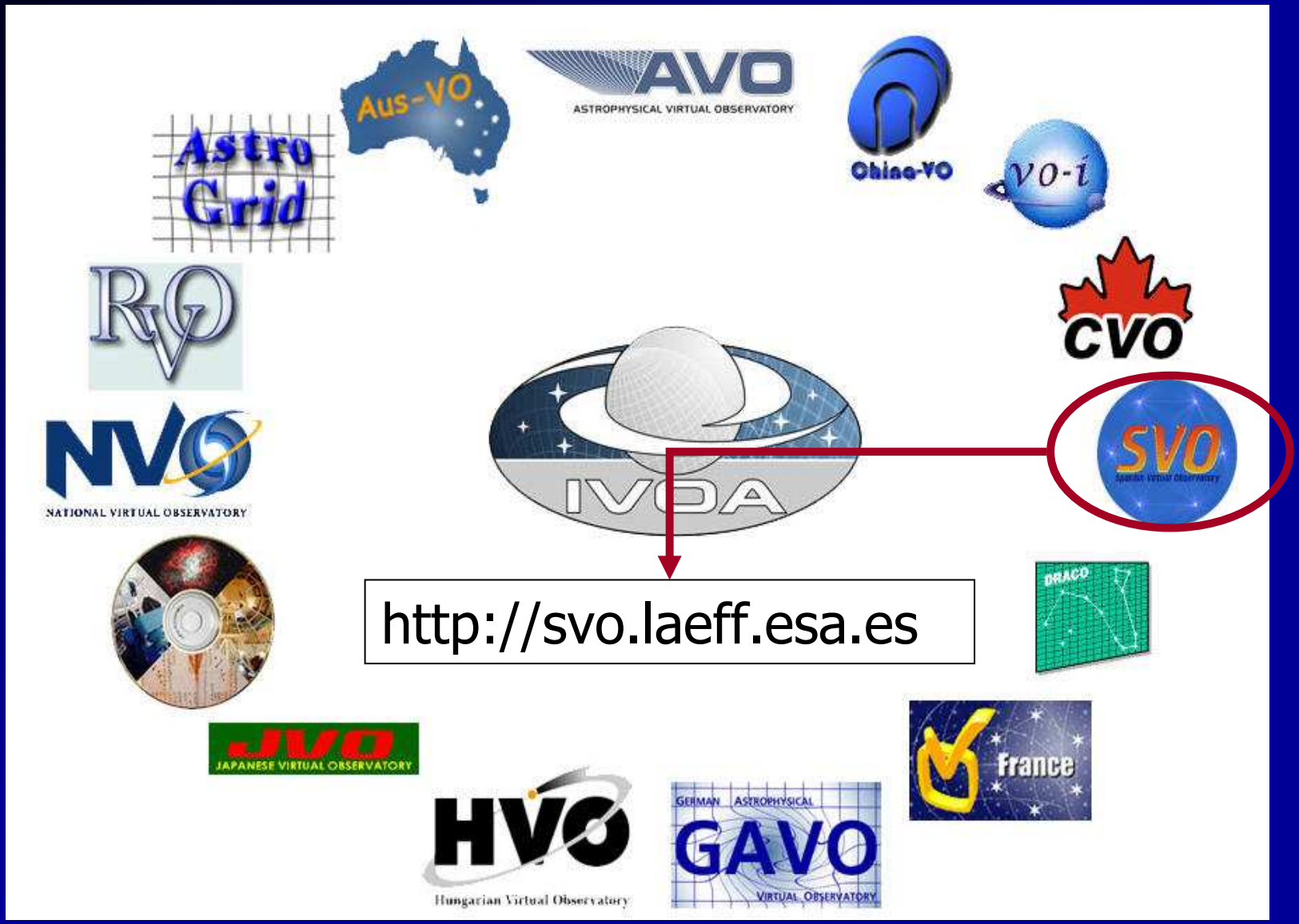
- Distributed computing:
  the GRID

Requirements on data centres: analysis tools

- Allow remote functionality as if they were local.
- ***Data mining:*** Key issue for VO and where the greatest scientific benefits are expected to come from.



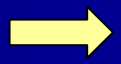
How is the VO structured?



The Spanish Virtual Observatory

- More than 60 people from 17 centres.

Conclusions

- VO is not science-fiction. It's a reality. 
- VO is an essential tool for multi-λ astronomy.
- VO is not only for people interested in handling large volumes of data. (e.g. "give me all spectra of A-type stars in a given range and with resolution > R).
- VO has crossed the non-return point: The biggest data providers (NASA, ESA, ESO, …) have understood the importance of this initiative and are already adapting their contents to VO requirements.
- The successfulness of VO from the scientific point of view strongly depends on the interaction with the scientific community.

From Demo to Real Science

- Extragalactic case: Discovery of 30 type 2 QSOs.

→ First refereed astronomical paper enabled via end-to-end use of VO tools and systems:

A&A 424, 545–559 (2004)
DOI: 10.1051/0004-6361:20041153

Astronomy & Astrophysics

Discovery of optically faint obscured quasars with Virtual Observatory tools

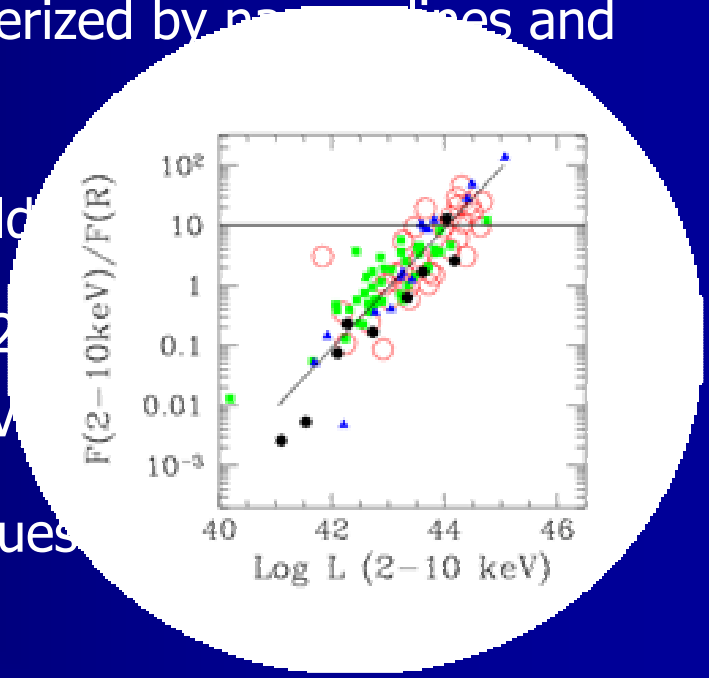
P. Padovani[1], M. G. Allen[2], P. Rosati[3], and N. A. Walton[4]

VO misconceptions

VO misconceptions

Discovering type 2 quasars

- Seyfert 2's high-power counterparts. Characterized by n[illegible]lines and hard X-ray emission (Lx > 1e44 erg/s).



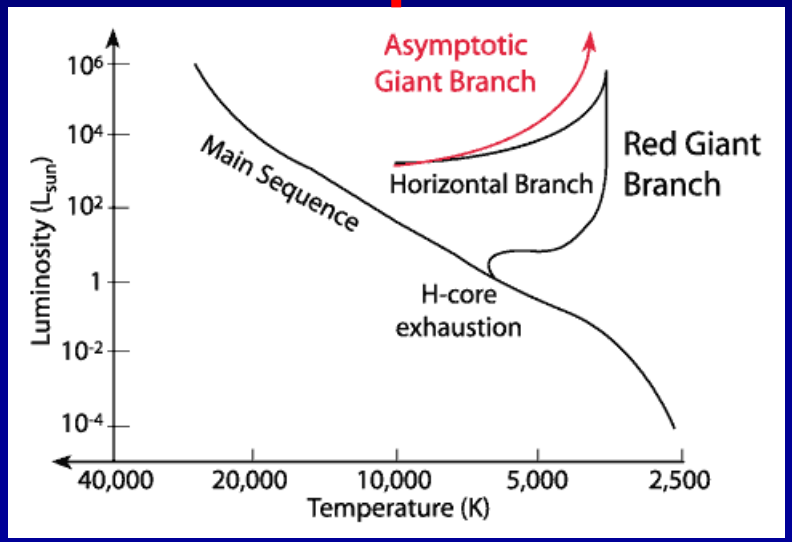
- Data: X-ray catalogue for the two GOODS field[illegible]
- Filtering: HR ≥ -0.2 for absorbed sources → 2[illegible]

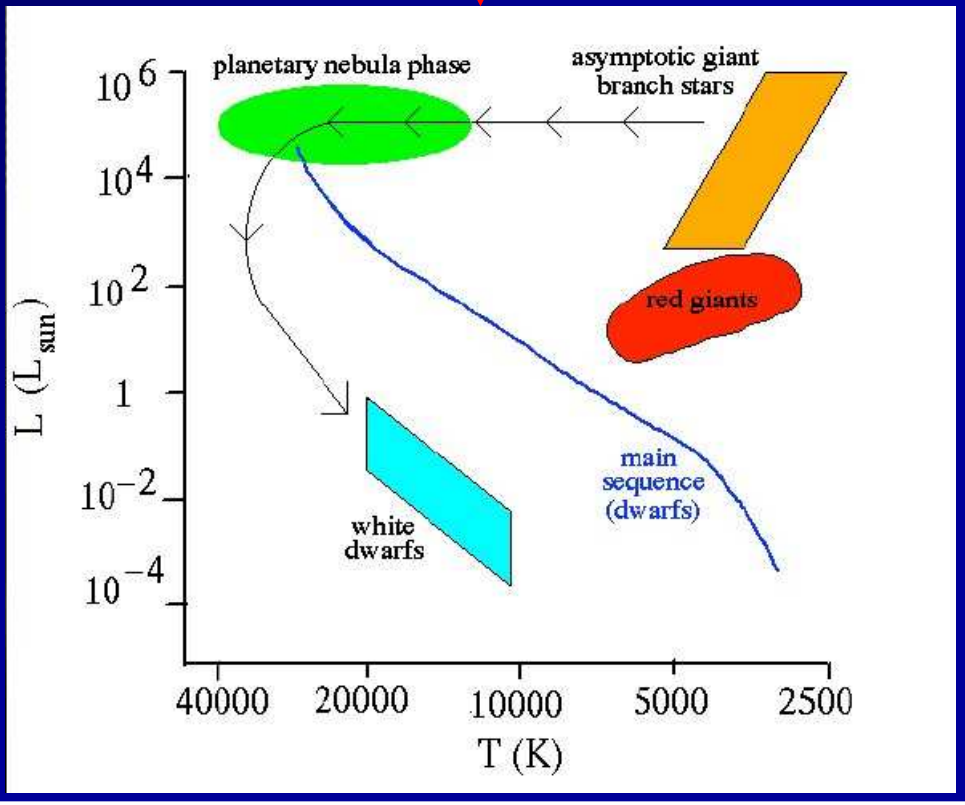
  HR=(H+S) / (H-S); H = (2.0 - 8.0 keV[illegible]
- Cross-matching with the GOODS ACS catalogues[illegible] counterparts → 168 matches.
- Data manipulation: X-ray power for unidentified sources derived from:

  Log L (2-10) = log f(2 – 10 keV) / f(R) + 43.05 (Fiore 2003).
- Results: 31 new QSOs 2 (only 9 sources previously known).

Scientific Demos: AGB stars to PNe

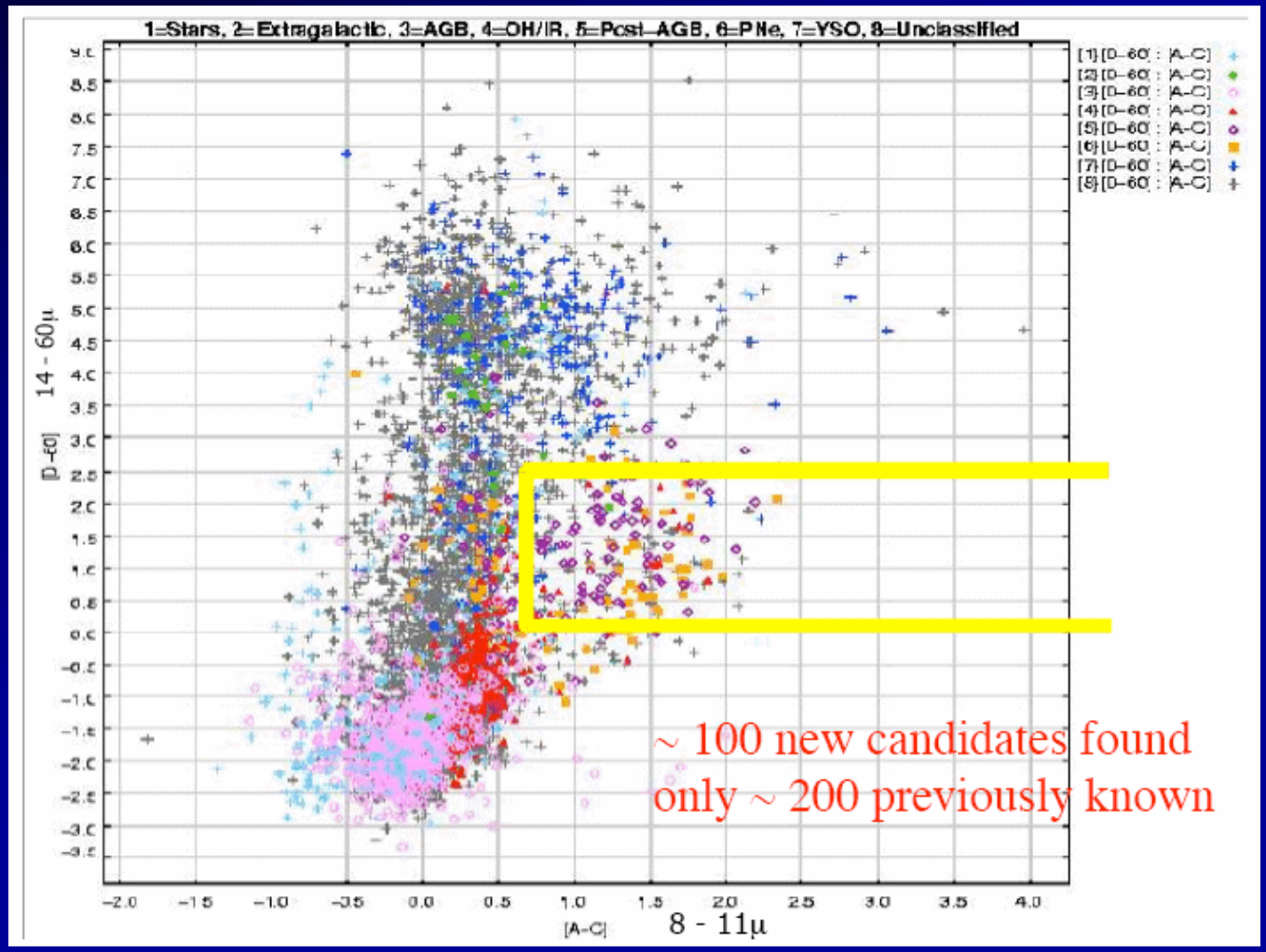
- Short transition times → Few objects in this phase.
- Stellar case for the AVO Demo 2005 (García Lario, Bayo, Sierra)
- GOAL: Identification of new candidates in the transition source.
- Many are heavily obscured in the optical by thick CS envelopes
- late evolutionary stages of low- and intermediate mass stars
- consequently, very faint in the optical
- IR data: MSX and IRAS catalogues.





AGB stars to PNe (II): Workflow

- Selection criteria: |b| ≥ 2 deg.
- Cross-matching with SIMBAD.
- Column manipulation
- Cross-matching with IRAS



AGB stars to PNe

VO gain: Efficiency

A spectroscopic atlas of post-AGB stars and Planetary Nebulae selected from the IRAS Point Source Catalogue. ⋆

O. Suárez[1], P. García-Lario[2], A. Manchado[3,4], M. Manteiga[5], A. Ulla[6], and S.R. Pottasch[7]

Abstract. We present low-resolution optical spectroscopy, finding charts and improved astrometric coordinates of a sample of 254 IRAS sources showing far infrared colours similar to those of well-known planetary nebulae. 106 sources are classified as post-AGB stars, 21 as "transition sources", and 36 as planetary nebulae, some of them strongly reddened. The large majority remained unidentified in the literature or were poorly known by the time when this spectroscopic survey started, some 15 years ago. Among the rest of sources in the sample, we were also able to identify 38 young stellar objects, 5 peculiar stars and 2 Seyfert galaxies. Up to 46 sources in our spectroscopic sample were found to show no optical counterpart, most of them are suggested to be heavily obscured post-AGB stars, rapidly evolving in their way to become planetary nebulae. A preliminary analysis of the distribution of post-AGB stars and PNe in the IRAS two-colour diagram is presented, as well as of their galactic latitude distribution. We also analyse the spectral type distribution of the post-AGB stars observed.

Key words. Planetary nebulae – stars: AGB and Post-AGB – infrared radiation – stars: mass loss