

Virtuální observatoř – astronomie bez dalekohledů?

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Astronomie 21. století

- Exponenciální nárůst objemu dat
 - Multiobject fibers, IFU
 - CCD mozaiky
 - Kontinuální expozice TDI
- Pozorování s velkými přístroji v servisním režimu (VLT, Subaru)
- Queue Scheduling (HET, SALT)
- Bez přítomnosti PI astronoma
- Komplikované zpracování dat = automatické pipeline
- Robotické teleskopy (P60, Liverpool)

Teleskopy bez přítomnosti PI

- Klasický model PI – observing run se mění
- Úspory nákladů, efektivita – scheduler (SPICA)
- Keck , WYIN, VLT remote observing, RT
- Quick-look preview a eavesdropping
- Komplikované posouzení co je výsledkem
- pipeliney na gridech – automaticky do databáze
- Výsledek PI vidí až z DB na WWW
- Teleskop je databáze s velmi dlouhým přístupem“

Éra digitálních dat

- Multispektrální data (nová okna)
- syntéza údajů z různých zdrojů
- digitální data -archivy (IUE ULDA)
- 90. léta = web různé služby skyview, telnet
- různé formáty, jednotky, protokoly, GUI
- literatura = SIMBAD, ADS
- Integrace archivů = MAST, ESO, ING

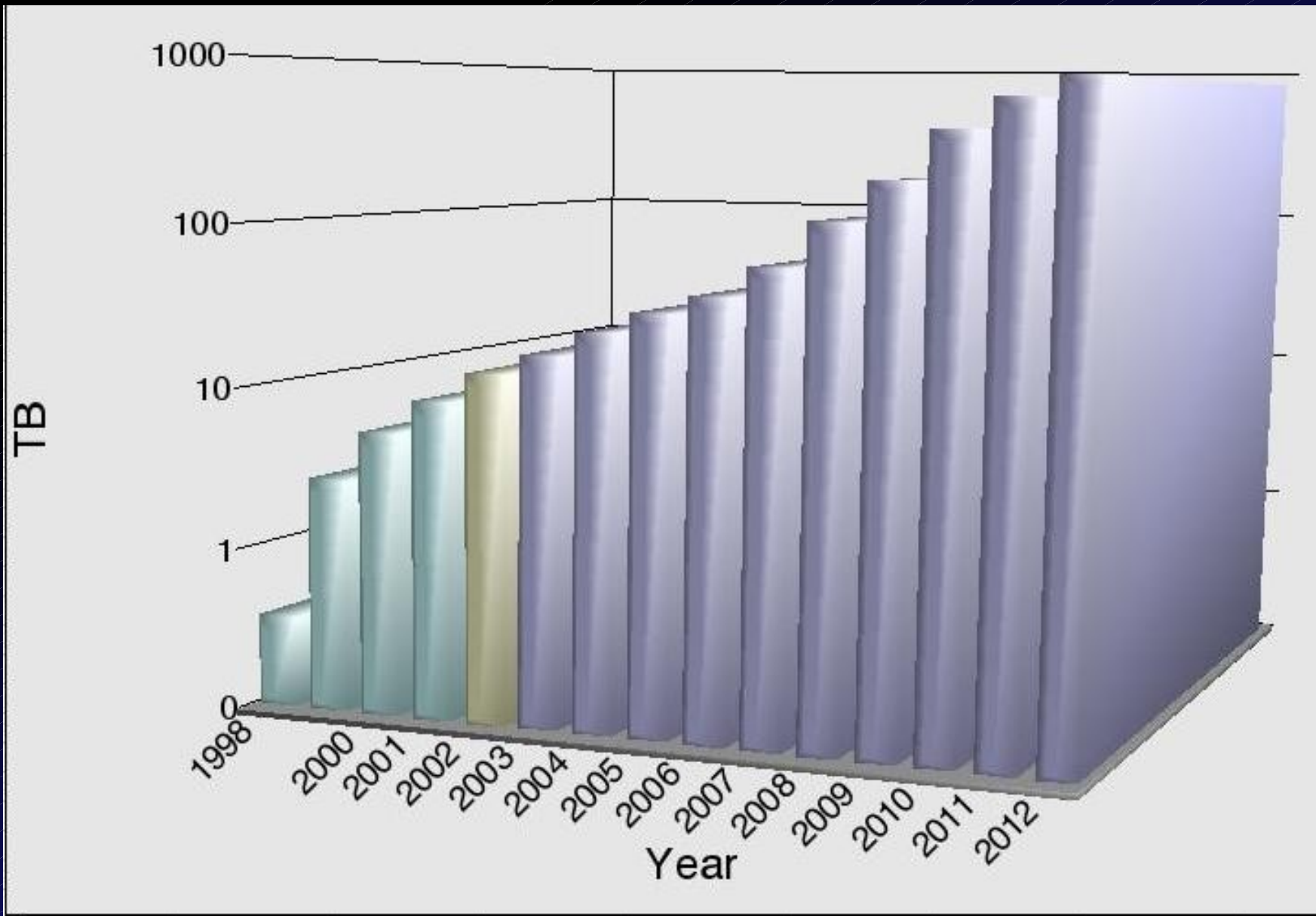
Demokratizace astronomie

- Digital divide (technologie ne, data ano)
- Data jealousy (pomine – psychologický efekt)
- Data pořízená a zpracovaná strojově – pocit že jsou nevlastní, proprietary period max rok
- Většina projektů-volné ihned
- Keck archiv – co veřejné (HIRES) je public
- Ale lavina dat
- Zdvojení každý rok (Moore 18měsíců)

Teorie – složité modely

- 3D simulace
- Plná MHD
- Velké simulace – data v TB, velké databáze na vstupu (linelisty, sítě modelů)
- Turbulence ISM ...
- N-částicové modely (celé galaxie, populace)
- Velkorozměrová struktura
- AI metody, NS, GA
- Vizualizace TB dat pomocí VR

Lavina dat



Počátky VO

- idea VO konec 2000
- propojení archivů
- jednotné rozhraní, datový formát pro přenos
- mnoho dat – distribuované zpracování
- GRID - fyzika elementárních částic
- multispektrální výzkum: radio---gama
- Výstupy simulací v NCSA
- Data pro SDSS – hlavní výzkum

Virtual Observatory : Key Definitions

- *“The Virtual Observatory will be a system that allows astronomers to interrogate multiple data centers in a seamless and transparent way, which provides new powerful analysis and visualization tools within that system, and which gives data centers a standard framework for publishing and delivering services using their data”.*
- Standardization of data and metadata, and of data exchange methods.
- Registry, listing available services and what can be done with them.

R.J.Hanisch, P.J.Quinn, in “IVOA – Guidelines for participation”

Principy VO

- Jednotný formát dat – VOTable, UCD
- transparentní přenos SOAP
- Web services (WS)
- VOregistry (jako DNS)
- MySpace (síťový home disk)
- protokoly (CGI services)
 - ConeSearch (hledání v kruhu na obloze)
 - SIAP (Simple Image Access Protocol)
 - SSAP(Simple Spectral Access Protocol)
 - SLAP(Simple Line Access Protocol)



VOTable :

```
<?xml version="1.0"?>
<!DOCTYPE VOTABLE SYSTEM "http://us-vo.org/xml/VOTable.dtd">
<VOTABLE >
  <DESCRIPTION>
    VizieR Astronomical Server: urania.iucaa.ernet.in          2002-10-04T05:20:16
    Explanations and Statistics of UCDs:                      See LINK below
    In case of problem, please report to:                    question@simbad.u-strasbg.fr
  </DESCRIPTION>
  <DEFINITIONS>
    <COOSYS ID="J2000" equinox="J2000" system="EQ_FK5"/>
  </DEFINITIONS>
  <INFO ID="Ref" name="-ref" value="VOTx11451"/>
  <RESOURCE name="V/105" ID="yCat_5105" >
    <DESCRIPTION>SKY2000 Catalog, Version 3 (Myers+ 2000)
  </DESCRIPTION>
  <TABLE ID="V_105_sky2v3r1" name="V/105/sky2v3r1" >
    <DESCRIPTION>The Sky2000 Version 2 Catalogue
  </DESCRIPTION>
    <FIELD datatype="int" width="6" name="HD" ucd="ID_ALTERNATIVE" >
      <DESCRIPTION>?Henry Draper &lt;III/135> number
    </DESCRIPTION>
    </FIELD>
    <FIELD unit="h:m:s" datatype="char" ref="J2000" name="RAJ2000" ucd="POS_EQ_RA_MAIN" arraysize="13" >
      <DESCRIPTION>Right ascension (J2000) hours
    </DESCRIPTION>
    </FIELD>
    <FIELD unit="d:m:s" datatype="char" ref="J2000" name="DEJ2000" ucd="POS_EQ_DEC_MAIN" arraysize="13" >
      <DESCRIPTION>Declination degrees (J2000)
    </DESCRIPTION>
  </TABLE>
</RESOURCE>
</VOTABLE>
```

☒ Display Data Of Selected Points

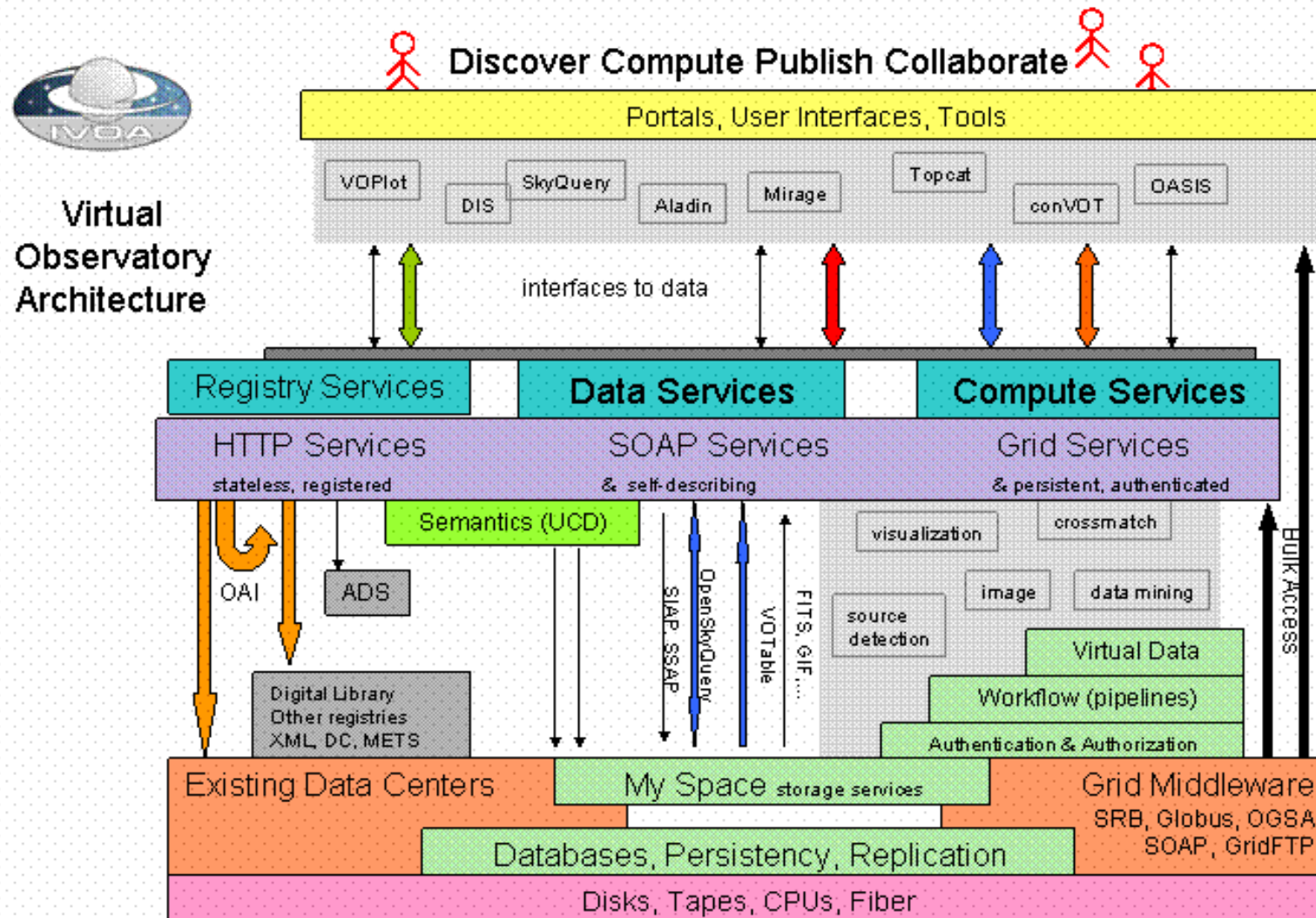
Close

Save As File

Technologie VO (SDSS)

- SDSS = SkyServer
- Skynode, SkyPortal (distribuované query mezi SkyNodey)
- OpenSkyQuery
- ADQL
- XMATCH, REGION
- VOspace – cache(WS, database, http put get)
- přenos dat nelze, pomalý - zpracování na místě
- VOEvent (alerty)

Architektura VO

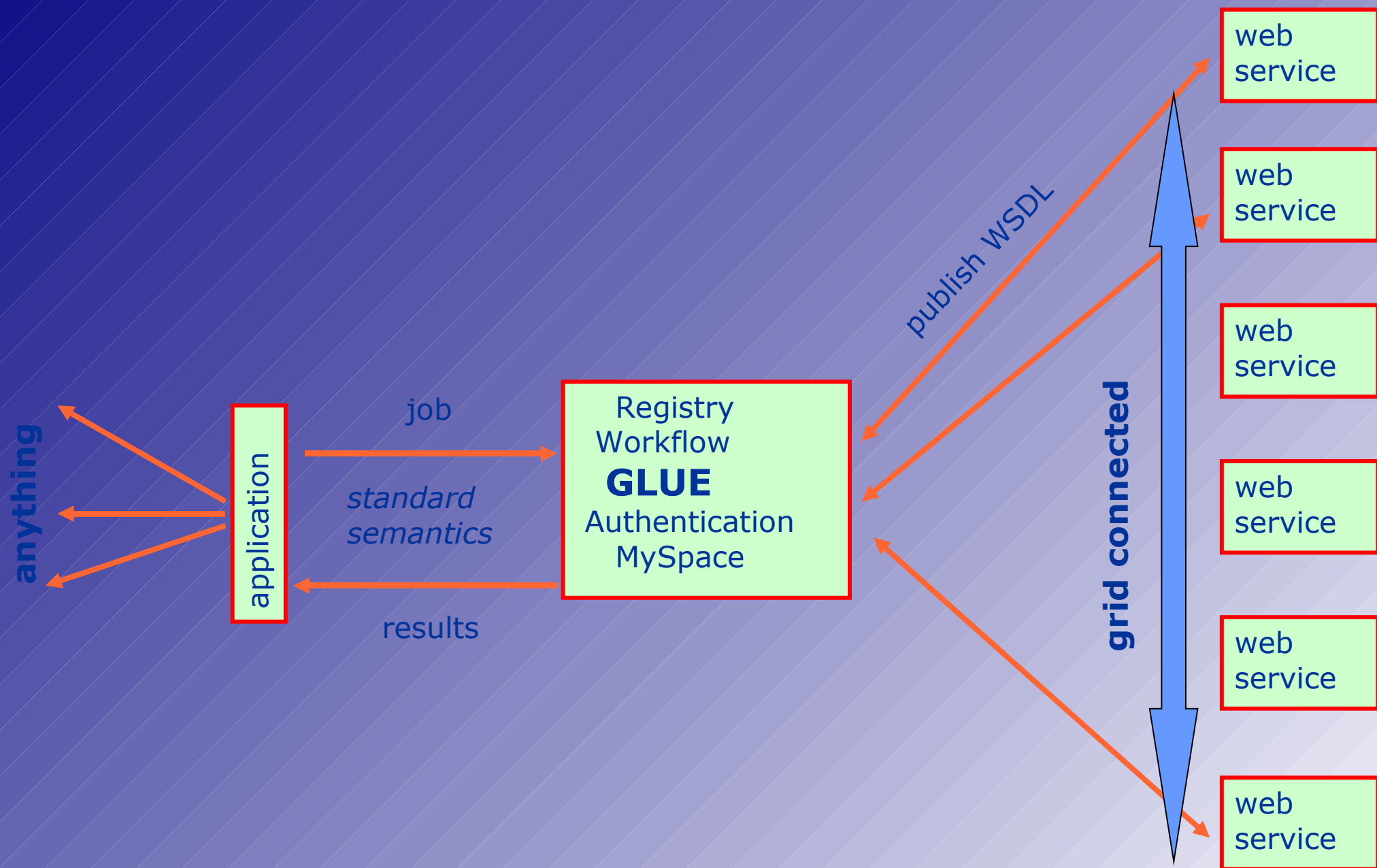
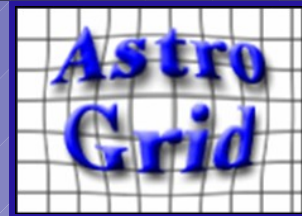


Grid : Key Definitions

- The **Grid** concept is “*coordinated resource sharing and problem solving in dynamic, multi-institutional virtual organizations*”
 - This sharing is, necessarily, highly controlled, with resource providers and consumers defining clearly and carefully just what is shared, who is allowed to share, and the conditions under which sharing occurs.
- A set of individuals and/or institutions defined by such sharing rules form what we call a **virtual organization** (VO ... VOrg)

Ian Foster, Carl Kesselmann, Steven Tuecke in “Anatomy of the Grid”

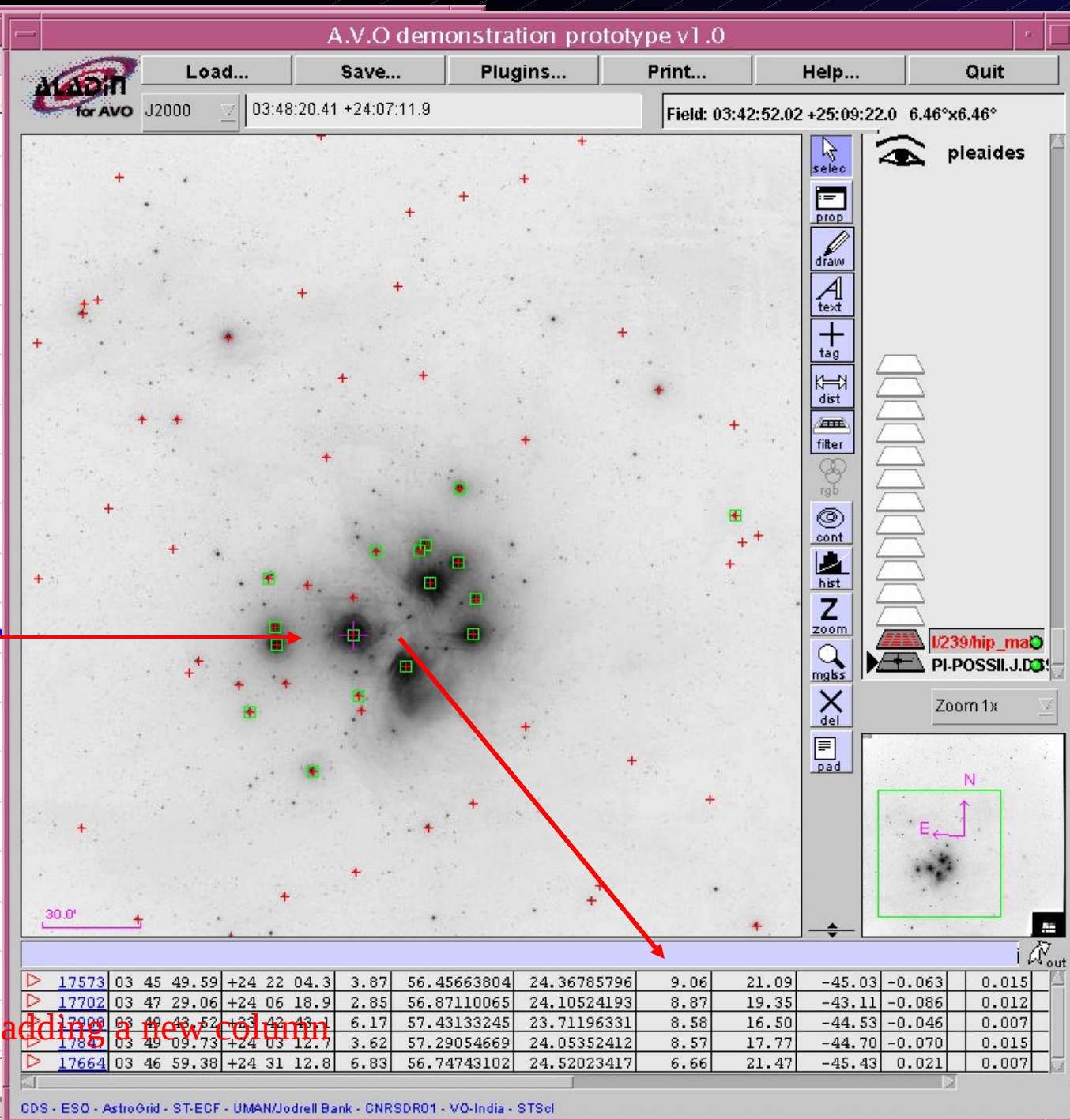
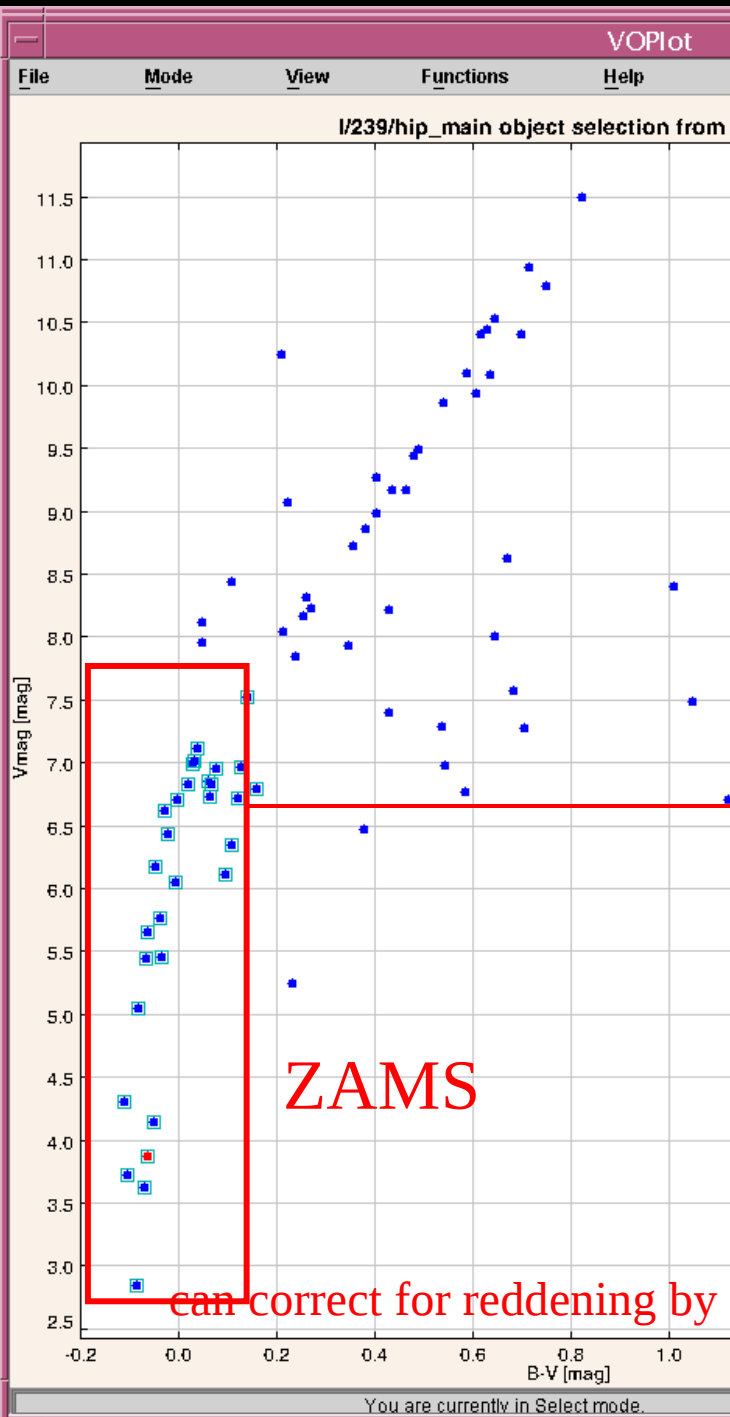
Virtual Observatory & Grid



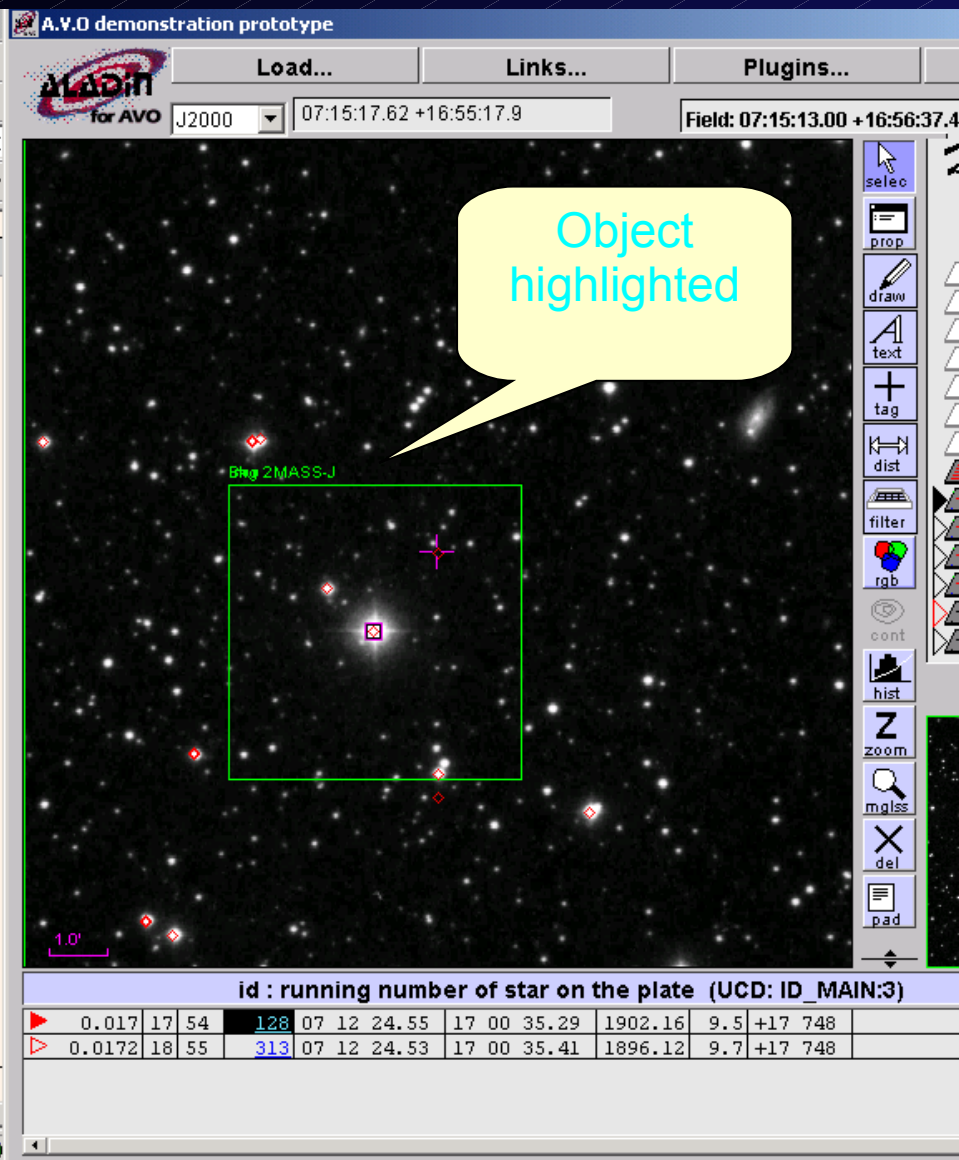
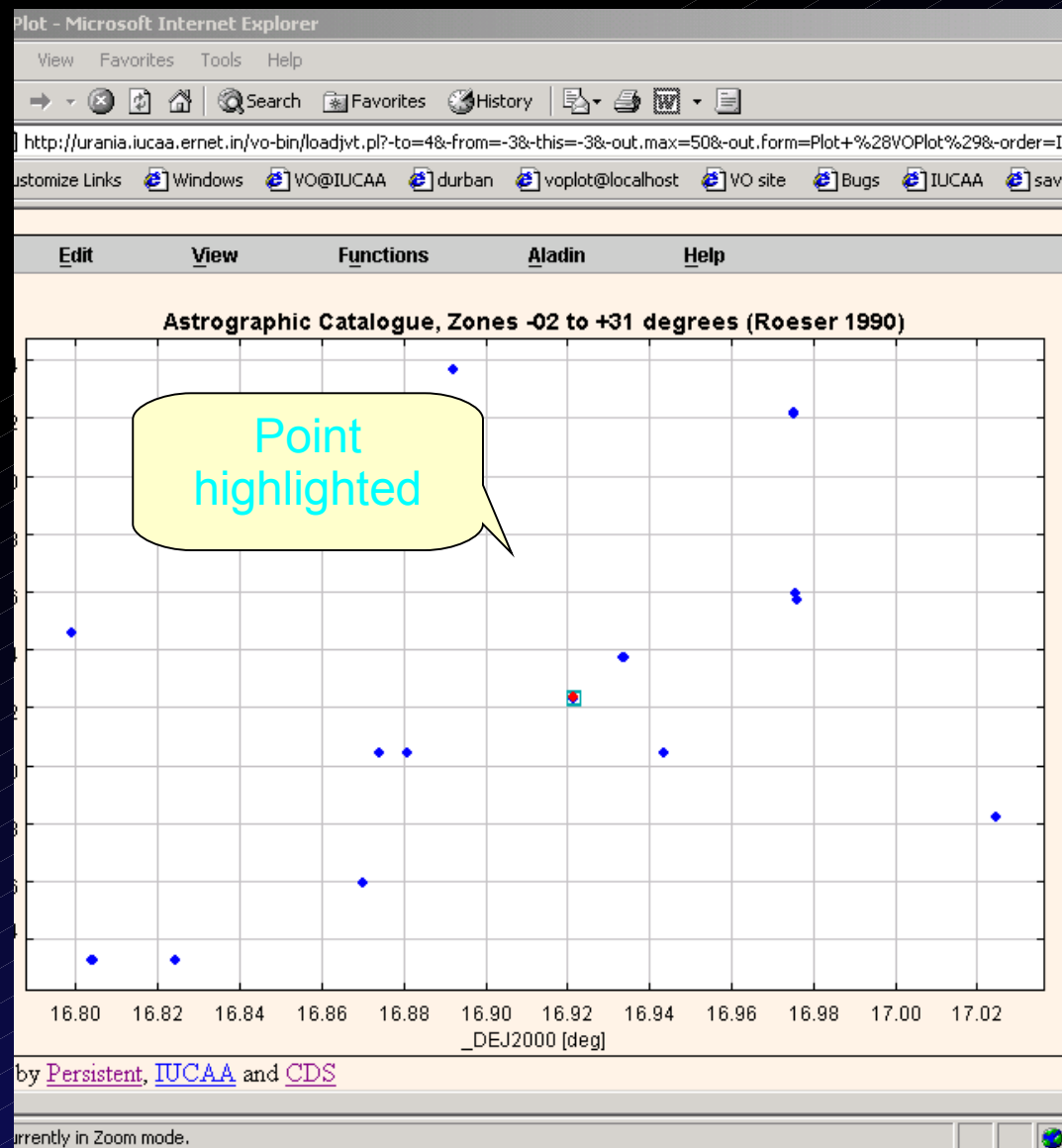
Nástroje VO-enabled

- Aladin
- VOPlot
- VOSpec
- SpecView
- SPLAT
- ViSiVio
- VOSED
- Sextractor – WESIX (Web Enabled Source Identification with Cross Matching)

Colour-magnitude diagram



VOPlot-Aladin interoperability



Building a query

AstroGrid Query Builder

The screenshot shows the AstroGrid Query Builder interface for SDSS Data Release 3 (AstroGrid DSA). The interface is divided into several panels:

- Chooser:** A sidebar on the left with tabs for Query, Parameter, XML, Info, and Security. The Query tab is selected.
- Tree:** A central panel showing the query structure. It includes a 'Select' clause with columns 'a.ra, a.dec, a.u, a.g, a.r, a.i, a.z, a.err_u, a.err_g, a.err_r, a.err_i, a.err_z, a.type', a 'From' clause 'PhotoObj as a', and a 'Where' clause with conditions 'a.ra Between 242.0 And 243.6' and 'a.dec Between 54.1 And 55.1'.
- Table Columns:** A table listing columns from the 'PhotoObj' table. The columns are: Name, UCD, Units, Type, and Description. The rows are: intmID, fieldID, parentID, specObjID, u, g, r, i, z, err_u, err_g, err_r, and err_i.
- Table Description:** A text box describing the 'PhotoObj' table: 'Maps all primary and secondary objects in the PhotoObjAll table to a view'.
- Selected table:** A list of tables in the database, including SpecLineNames, SpecZStatus, SpecZWarning, TiMask, Tile, TilingBoundary, TilingMask, TiledTarget, SpecObj, PhotoFamily, PhotoObj, PhotoPrimary, PhotoSecondary, SpecLine, SpecPhoto, Galaxy, and Sky.
- Query being built:** A dialog box titled 'Column References' with the text 'Insert 5 references into "Items"'. It has a 'Set Archive Definition..' button.

Annotations with arrows point to the following elements:

- Table Columns:** Points to the 'Table Columns' table.
- Table Description:** Points to the 'Table Description' text box.
- Selected table:** Points to the 'PhotoObj' table in the 'Selected table' list.
- Query being built:** Points to the 'Query' tab in the 'Chooser' sidebar.
- Dialog to insert selected columns into selected section of the query:** Points to the 'Column References' dialog box.
- List of tables in the database:** Points to the 'Selected table' list.

★ Non-expert
access pre-
2006

☼ Ready-made
FITS images

★ Aladin

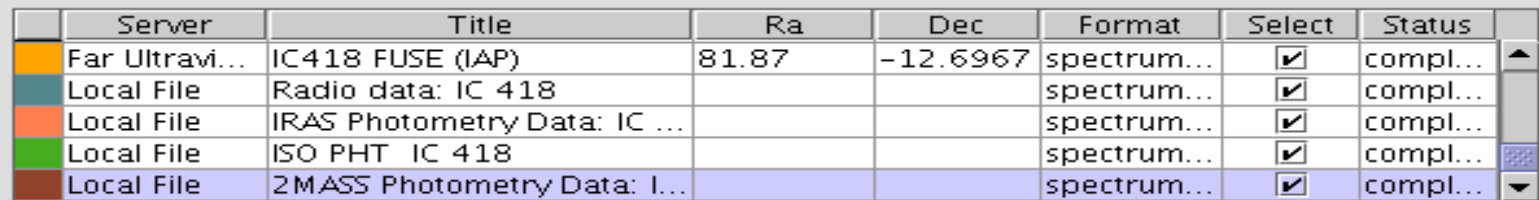
☼ Catalogues:

★ SpecFind

IR from warm dust in
remnant AGB shell
(IRAS, ISO, 2MASS)

Hot stellar emission
FUSE, IUE

Non-thermal nebular
radiocontinuum
(various - Vollmer
catalogue)



	Server	Title	Ra	Dec	Format	Select	Status
	Far Ultravi...	IC418 FUSE (IAP)	81.87	-12.6967	spectrum...	☒	compl...
	Local File	Radio data: IC 418			spectrum...	☒	compl...
	Local File	IRAS Photometry Data: IC ...			spectrum...	☒	compl...
	Local File	ISO PHT IC 418			spectrum...	☒	compl...
	Local File	2MASS Photometry Data: I...			spectrum...	☒	compl...

Teoretická VO (TVO)

- Metody VO (parametry v DB, SQL...) pro výzkum výsledků simulací, katalogy simulovaných objektů jako SDSS...
- Prohlížení simulačního prostoru podle různých os – parametrů, výřezy na oblasti...
- Virtuální vesmír (AstroGrid)
- Formování umělých galaxií, kulových hvězdokup – N částicové modely
- Srážky galaxií

CIELO VO implementation

CIELO-AGN is the first astrophysical line catalogue compatible with the (draft) *IVOA Line Data Model* and accessible through the (draft) *Simple Line Access Protocol*

SLAP Viewer Copyright ESAC, Spain

Server Selector

SLAP Services

- IASD
- LERMA
- NIST ATOMIC SPECTRA
- CIELO SLAP

Molecular line databases

Range of Search (m)

Wavelength Start 4411346184190677E-9 Wavelength End 4411346184190677E-9

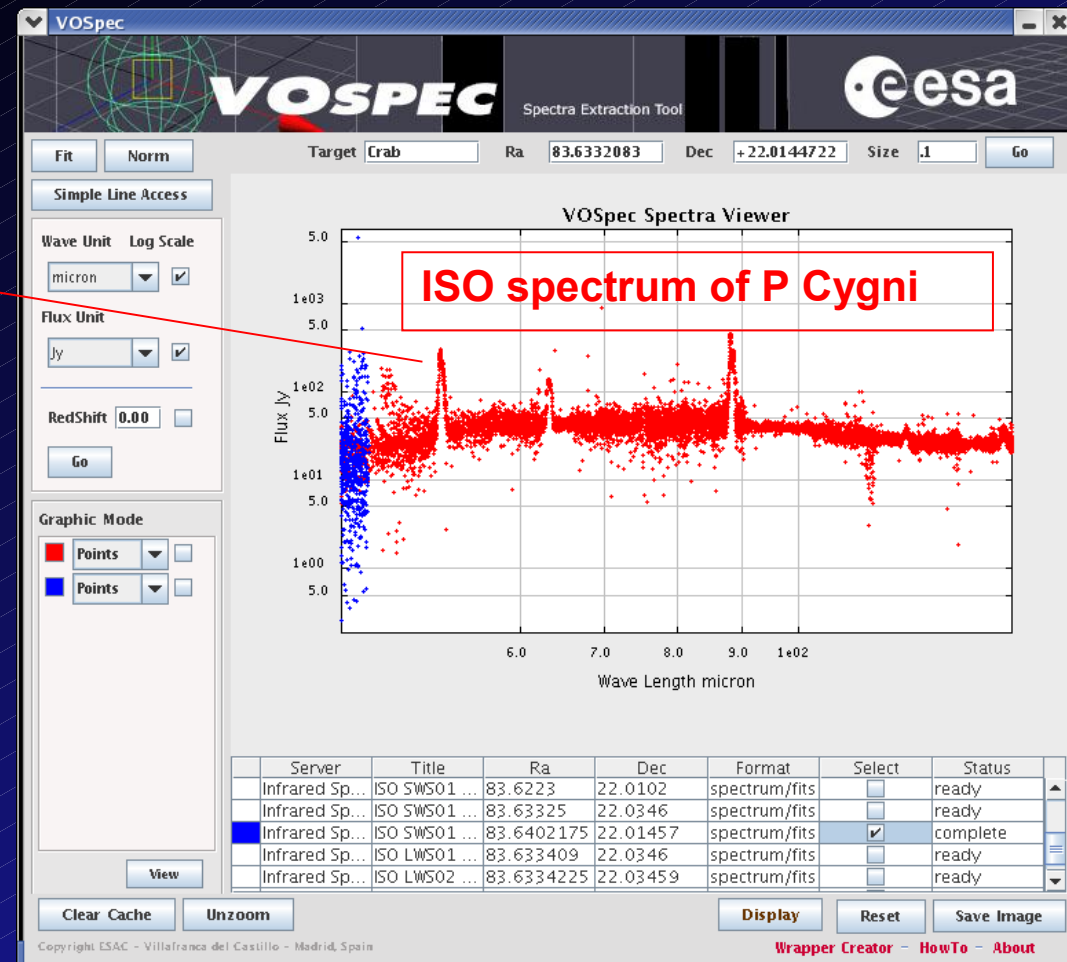
Reset

Slap Services Output

CIELO SLAP

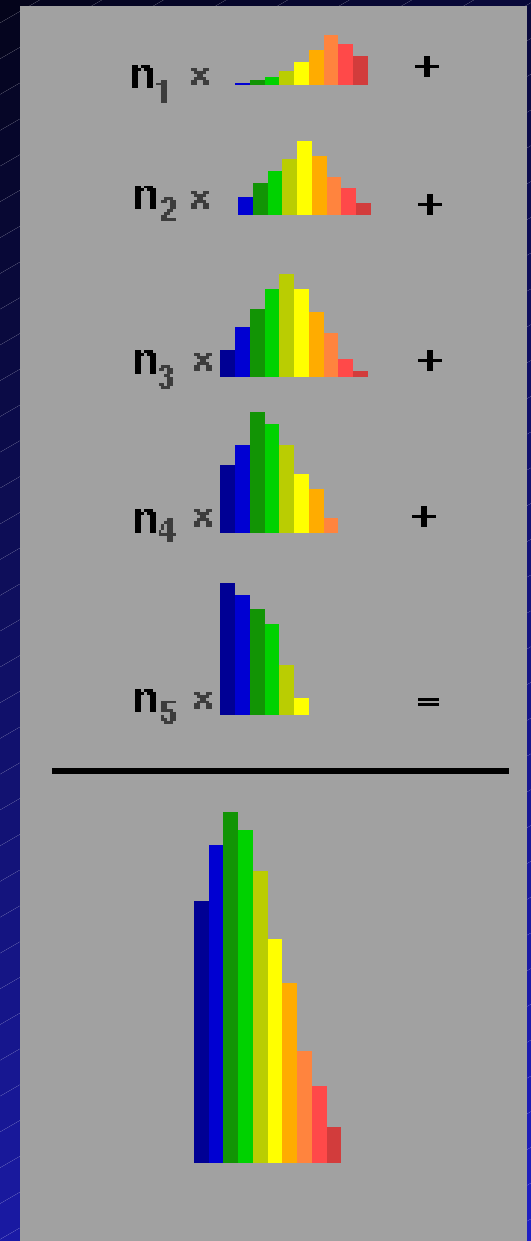
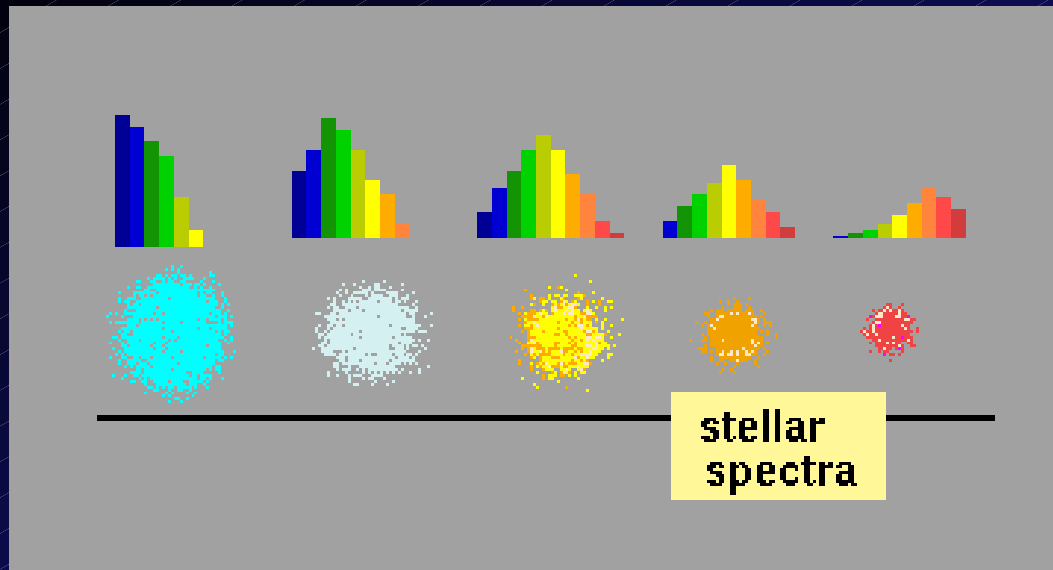
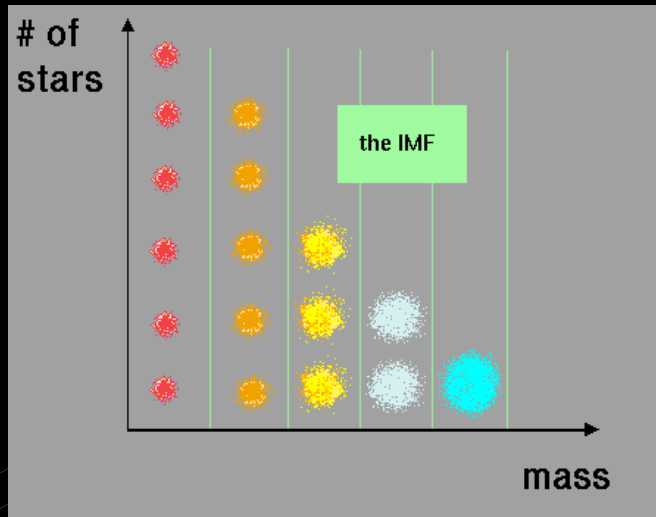
Idm:Line.wavelength	Idm:Source	Source.co...	Source.co...	Idm:Li...	Idm:...	Id...	Id...	Idm:...	I...
1.8627e-09	NGC1068	40.66963	-0.01328	1s_3p	1s2	1P1	150	OVII	...
1.7768e-09	NGC1068	40.66963	-0.01328	1s_4p	1s2	1P1	150	OVII	...
1.89671e-09	NGC1068	40.66963	-0.01328	2p	1s	2...	2...	OVIII	...
2.47793e-09	NGC1068	40.66963	-0.01328	2p	1s	2...	2...	NVII	...
2.21012e-09	NGC1068	40.66963	-0.01328	1s_2s	1s2	3S1	150	OVII	...
2.1602e-09	NGC1068	40.66963	-0.01328	1s_2p	1s2	1P1	150	OVII	...
2.18071e-09	NGC1068	40.66963	-0.01328	1s_2p	1s2	3P1	150	OVII	...

Close



(IVOA Line Data Model: Dubernet, Osuna et al., in preparation)
(Simple Line Access Protocol: Salgado et al., in preparation)

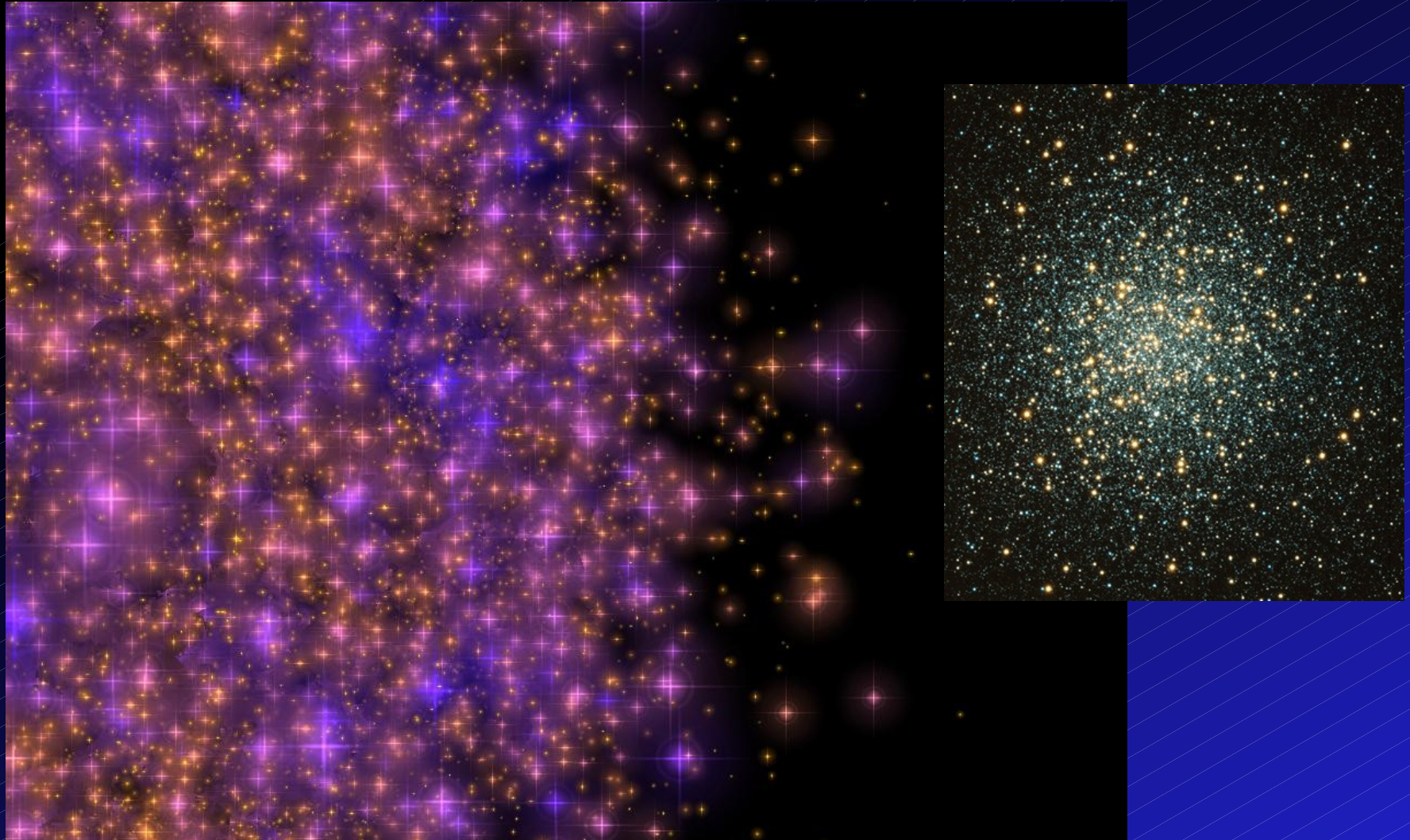
Stellar populations are modeled with synthesis models



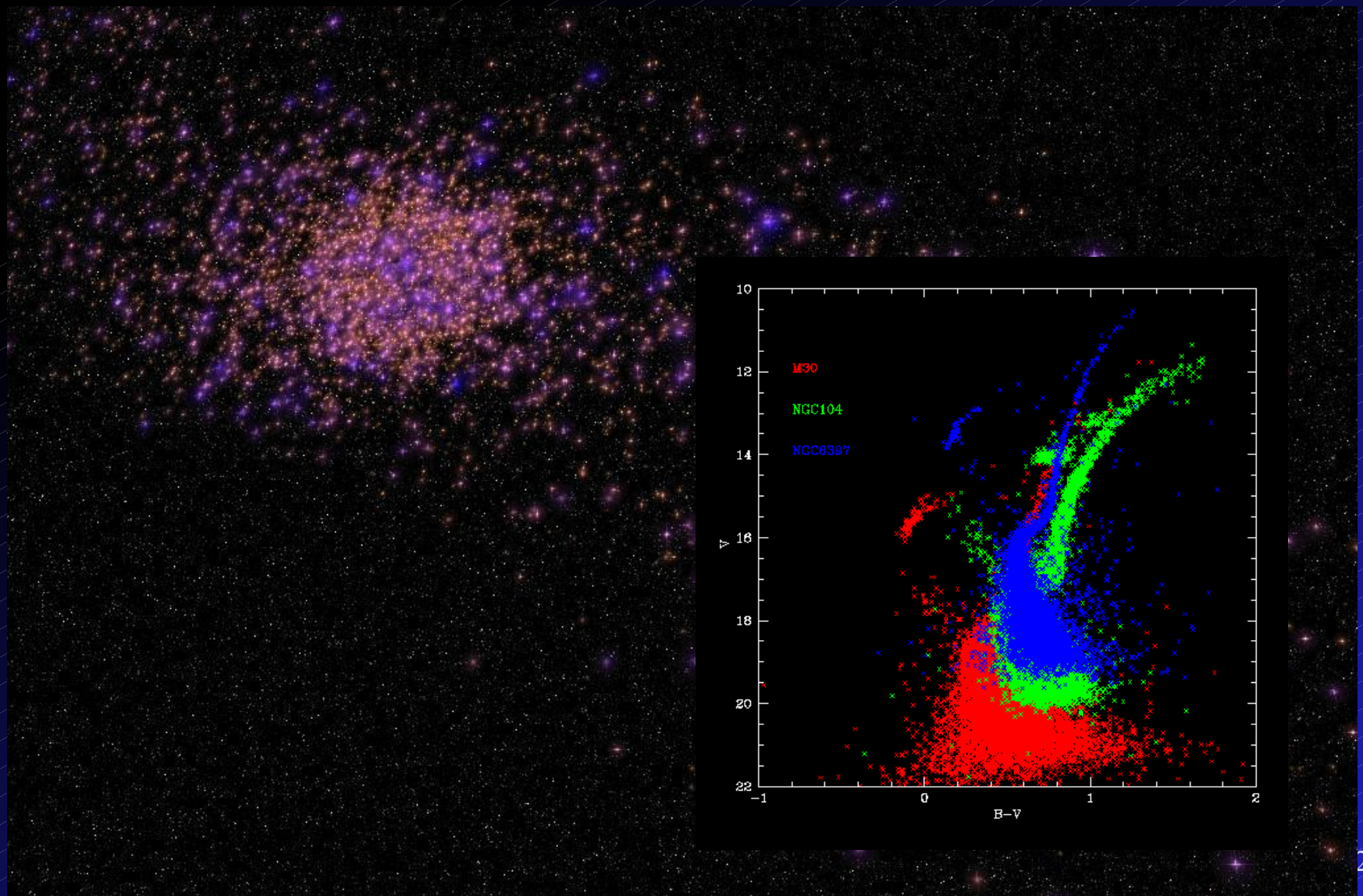
Virtuální dalekohled

- Výpočet na GRIDu (Superpočítači)
- Vizualizace dat ve 3D
- Konvoluce s PSF daného přístroje (přehlídky)
- Příslušné natočení , perspektiva
- Hledání vhodných podobností ve VO
 - Automaticky
 - χ^2 match
 - NN analýza

N Body Simulations of Globular Cluster Evolution

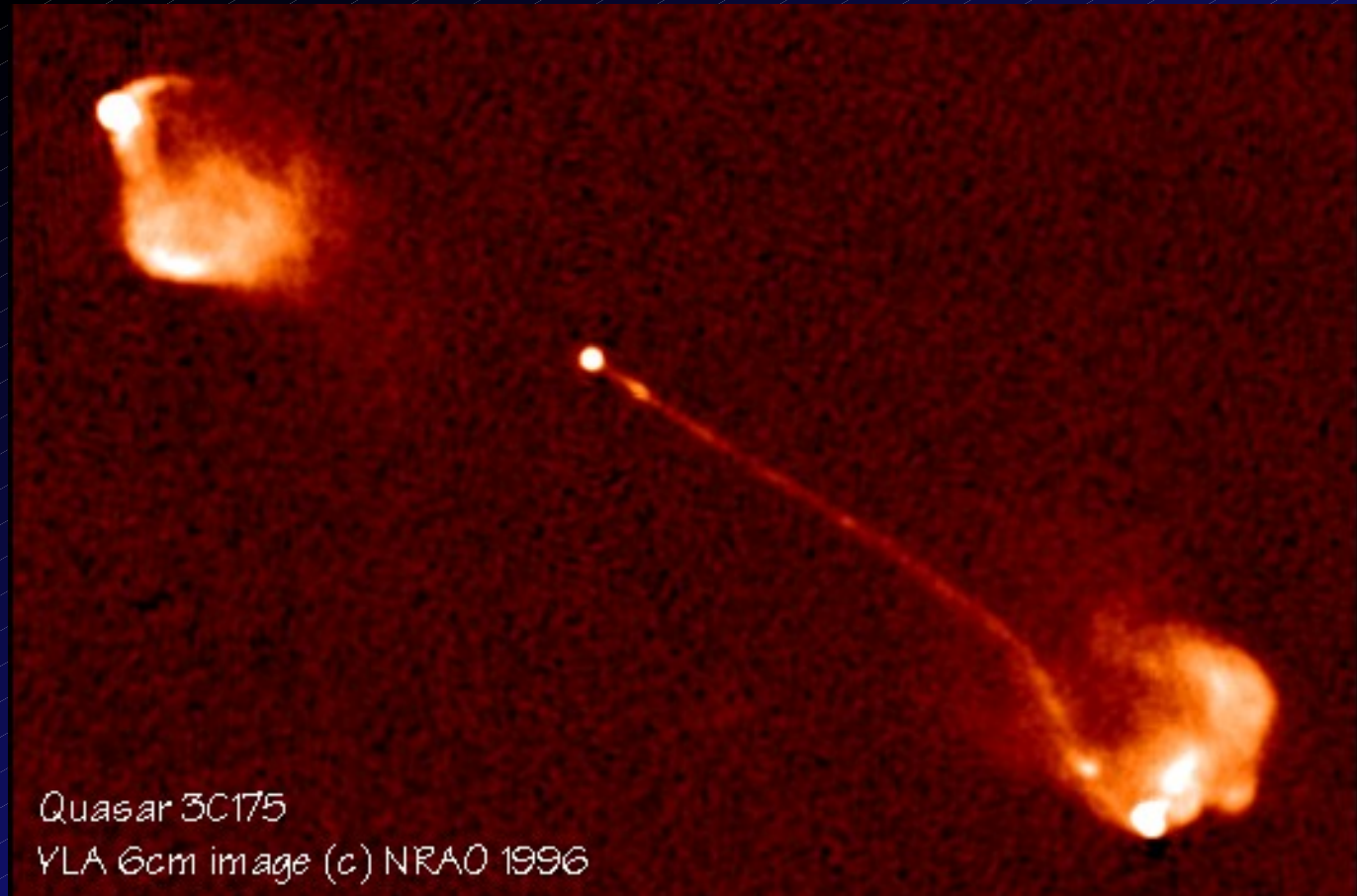


N Body Simulations of Globular Cluster Evolution

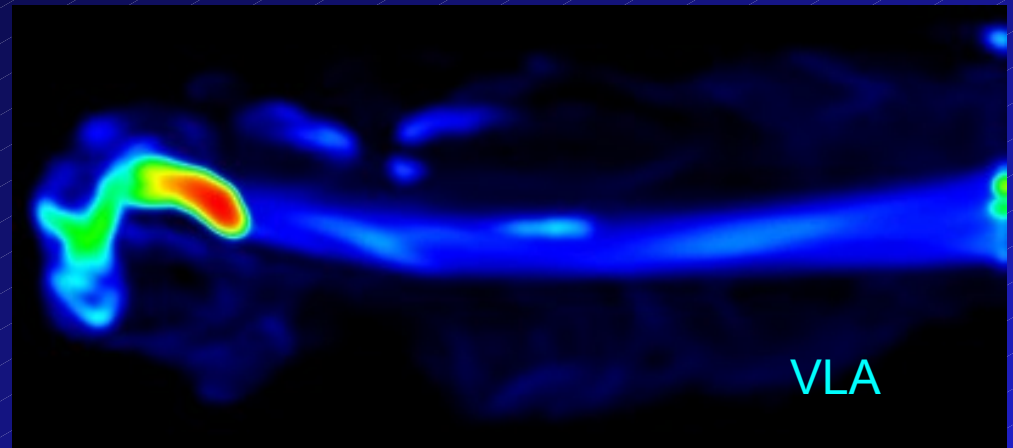
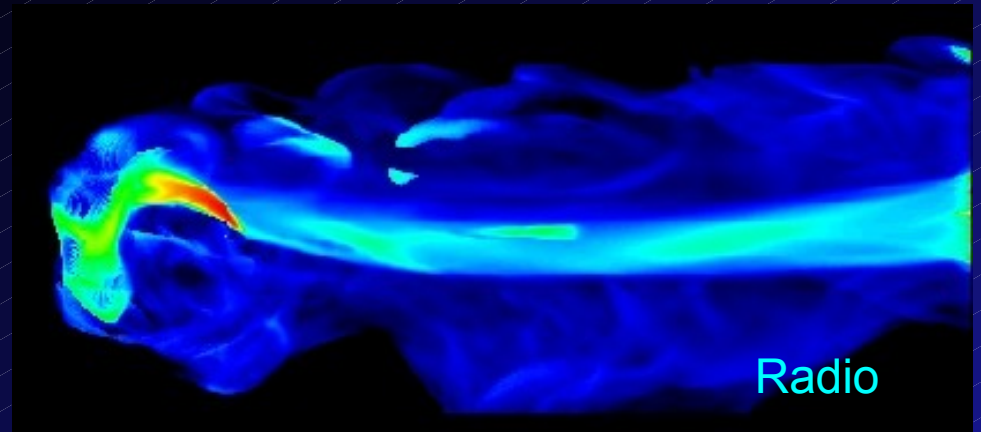
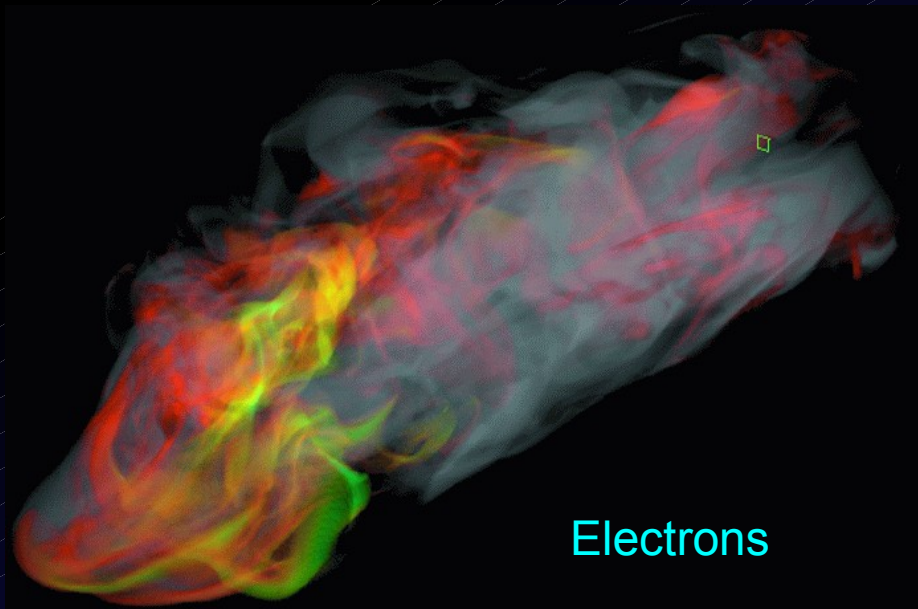


Collimated Outflows from AGN

- 3C 175

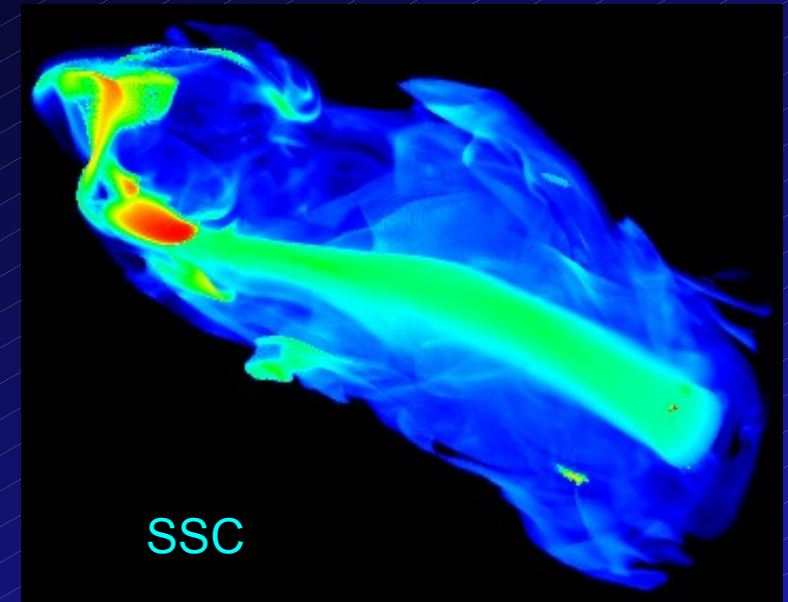
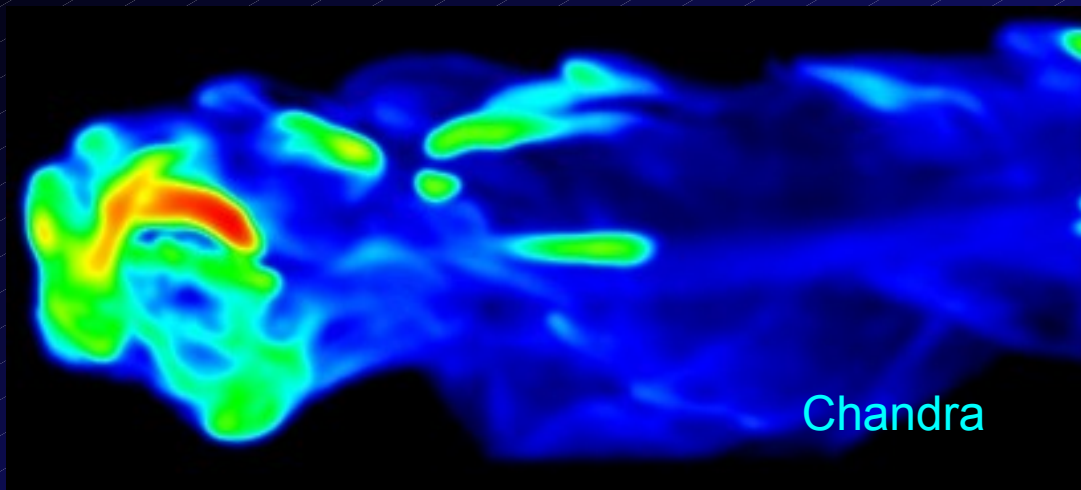
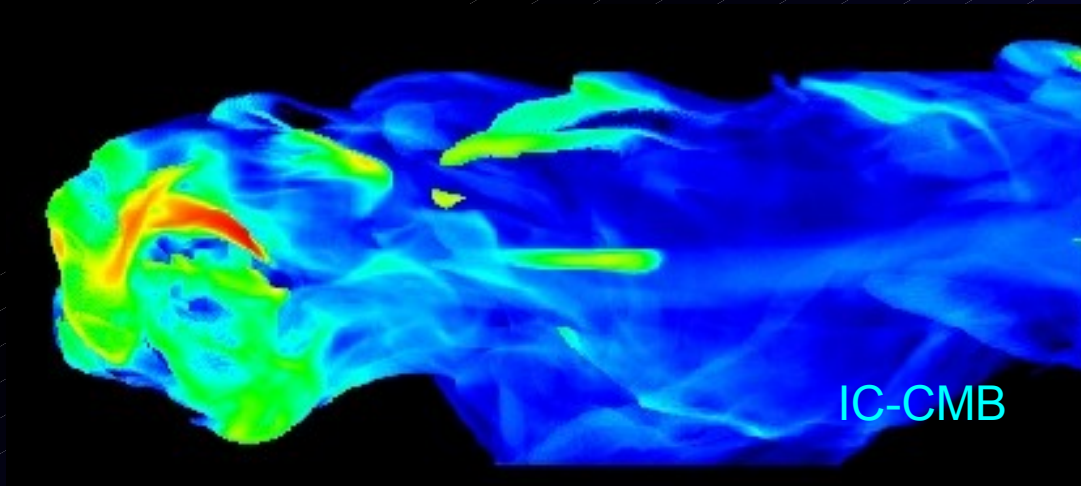


MHD Simulations of Collimated Outflows from AGN – Virtual Telescope Observations



Compare with
Radio
Archives

MHD Simulations of Collimated Outflows from AGN – Virtual Telescope Observations



Compare with
Chandra Archives

Věda především

- Nové objevy (publikace)
- Hledání vztahů
- Temná hmota ...
- Granty na VO (Astrovirtel 2001)
- Hledání vzácných objektů (BD, Obscured QSO)
- Vývoj hvězd a galaxií, star formation regions
- Kulové hvězdokupy
- Upřesnění Hubblový konst.

Ukázky aplikací

- Objevy hnědých trpaslíků (jako eps Ind)
- Přejít od AGB k PN (100 nových k 200 dosud známým pomocí VO)
- Světelné křivky pomocí AI
- SED (Spectrum Energy Distribution)
- Bolometrická jasnost
- Porovnání snímků (POSSI vs. POSSII) změny
- Modelování stelárních populací – spektra
- Sluneční oblasti – vlastnosti podle polohy

ImageComparer

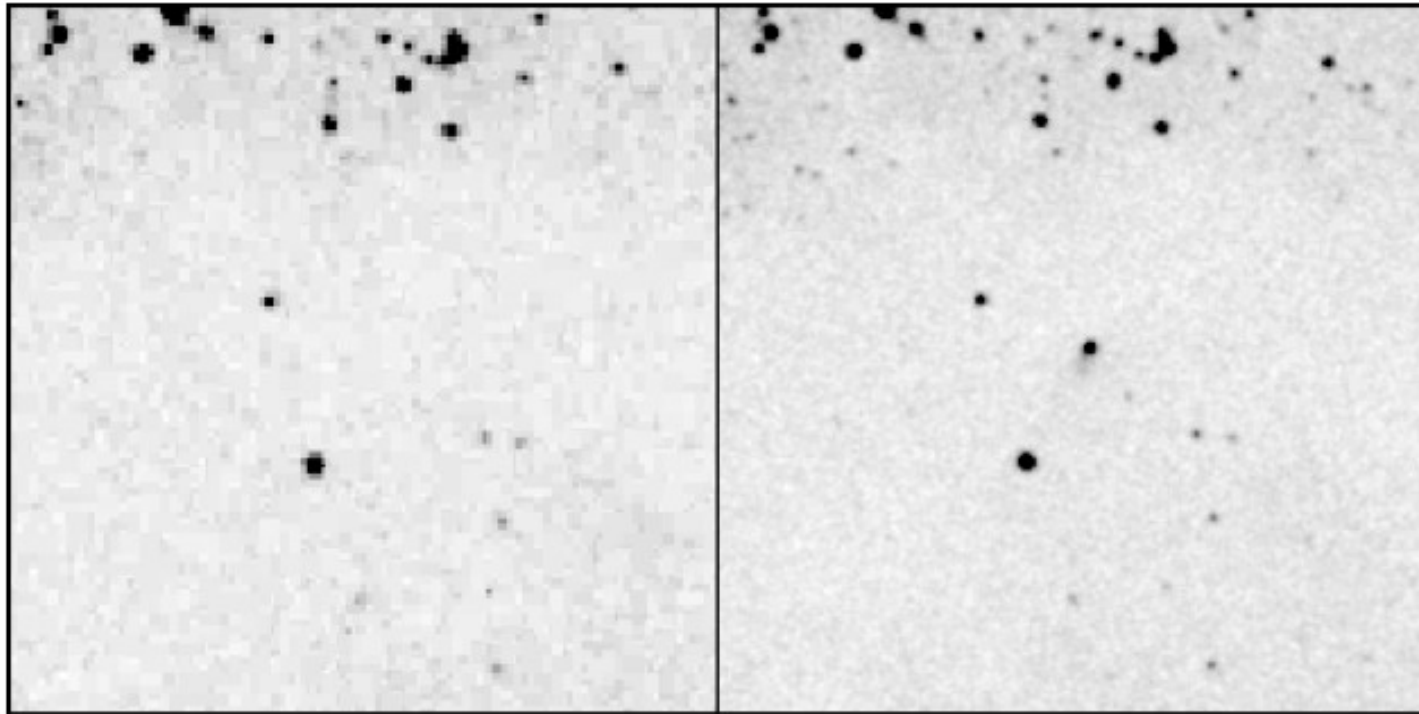
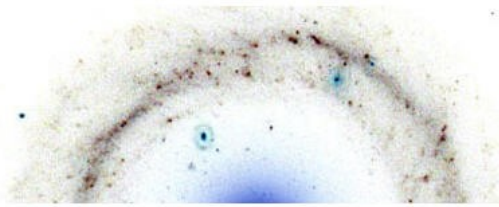


Fig. 3.— Red POSS-I and POSS-II images of Persson's Star. The left image was taken in October 1953, while the right image was taken in September 1991.

BDs discovered using VO



PROJECT

Brown Dwarf Search Science Prototype: Real-Time Cross Matching of Large Catalogs

[Standards](#)
[Software & Services](#)
[Publications](#)
[Prototypes](#)

[Internal Logos](#)

ABOUT NVO

[What is the NVO?](#)
[Science Objectives](#)

COMMUNITY

[Discussion Lists](#)
[International VO](#)
[VOForum](#)
[Metadata \(NCSA\)](#)
[Other Links](#)

PEOPLE

[Contact Us](#)
[Personnel](#)

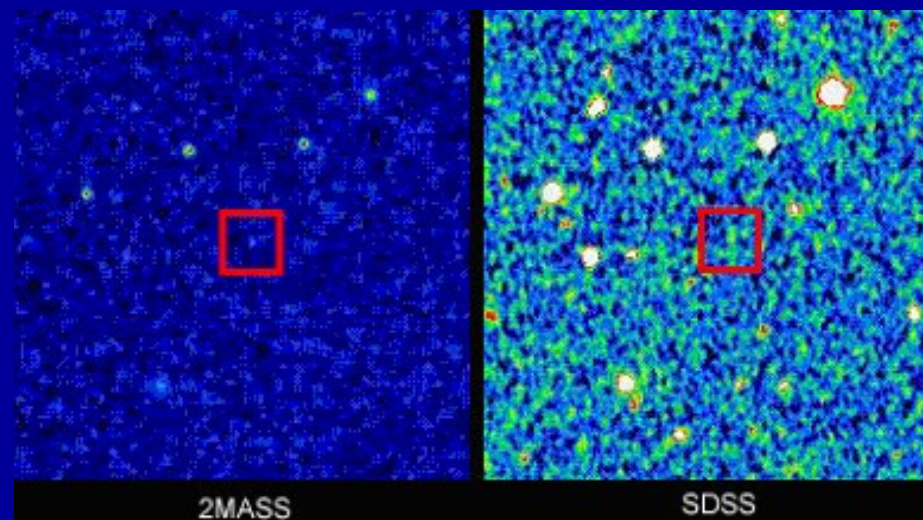
Scientific Motivation The search for brown dwarfs has been revolutionized by the latest deep sky surveys. A key attribute to discovering brown dwarfs is the federation of many surveys over different wavelengths. Such matching of catalogs is currently laborious and time consuming. This matching problem is generic to many areas of astrophysics.

Data Resources

- Sloan Digital Sky Survey (SDSS) Early Data Release (15 million objects)
- 2-Micron All Sky Survey (2MASS) 2nd Incremental Point Source Catalog (162 million objects)

What the VO Brings Today, doing the matching of these two large datasets is user-intensive and is replicated by many different users. Also, the correlation of these two datasets can take years of CPU time if not done correctly. The NVO brings two key aspects to

- **Filtering criteria:** z & J-only detections with $z - J > 2.75$
- *SDSS: 15M obj.*
- *2MASS: 160M obj.*
- *300000 objects in common.*



✓ *However, systematic searches using a VO methodology have not been performed so far.*

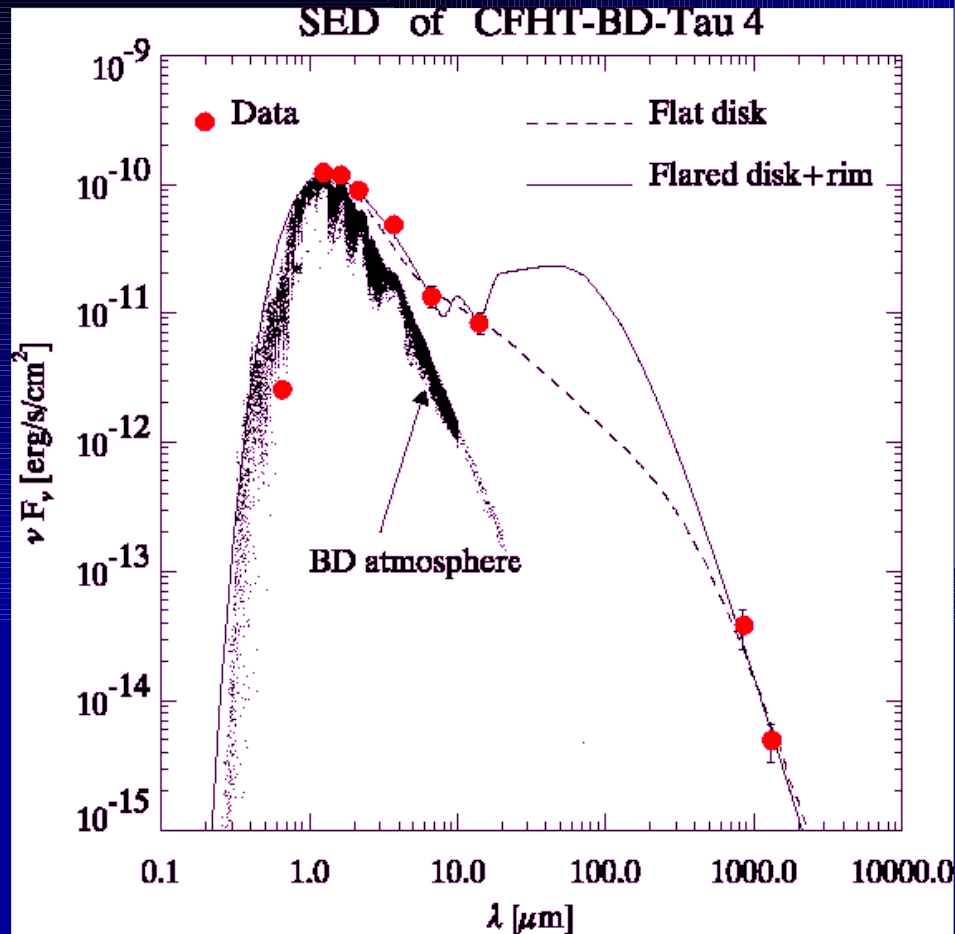
Discovering field BDs with 2MASS/DENIS

- Region surveyed:
 - ✓ RA: $300^\circ - 360^\circ$ / DEC: $-10^\circ / -34^\circ$
 - ✓ RA: $210^\circ - 270^\circ$ / DEC: $-1^\circ / -13^\circ$
- *10+8 potential candidates*
- Follow-up (IR imaging) already done. Analysis on-going.

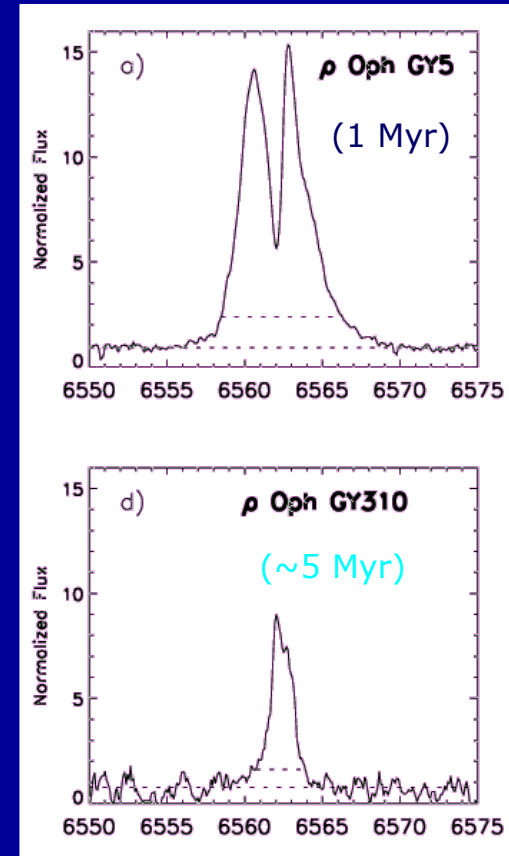
Discovering field BDs with 2MASS/SDSS

- Region surveyed:
 - ✓ RA: $300^\circ - 360^\circ$ / DEC: $0^\circ - 20^\circ$
- *Three potential candidates*, one of them already identified as BD (2004, AJ, 127, 3553)
- Follow-up (IR imaging) foreseen for the coming weeks.

The observational evidences

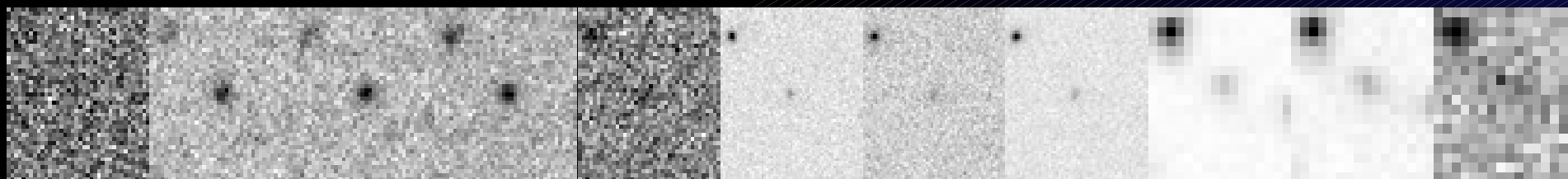


✓ A high percentage of BDs found in Star Forming Regions show IR excesses
→ Existence of disks.

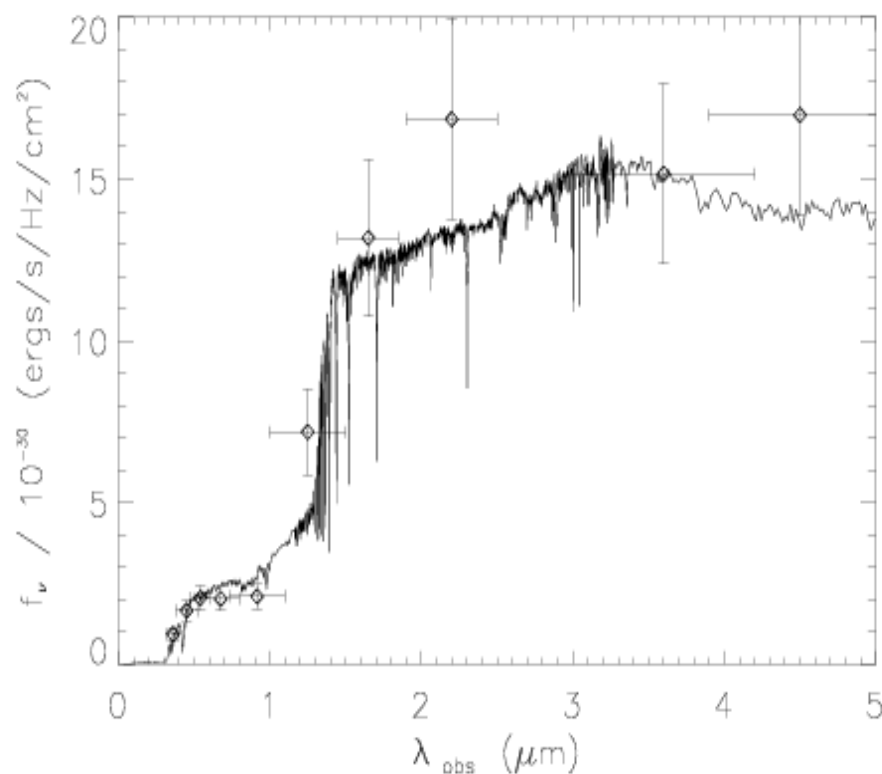


- ✓ H α double peak
Indicator of accretion. →
- ✓ Scenario compatible with a disk dissipation in a timescale similar to T Tauris.

Study Results



U B V R I J H Ks 3.6 μ m 4.5 μ m 5.8 μ m



$z_{\text{phot}} = 2.52$

Age = 500 Myr

Stellar mass = $9.9 \times 10^9 M_{\text{sun}}$

Reduced chi-sq = 1.04

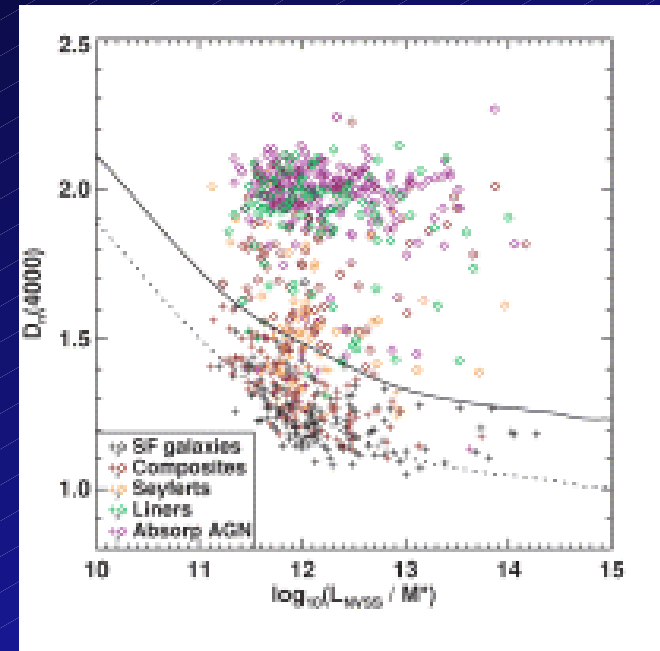
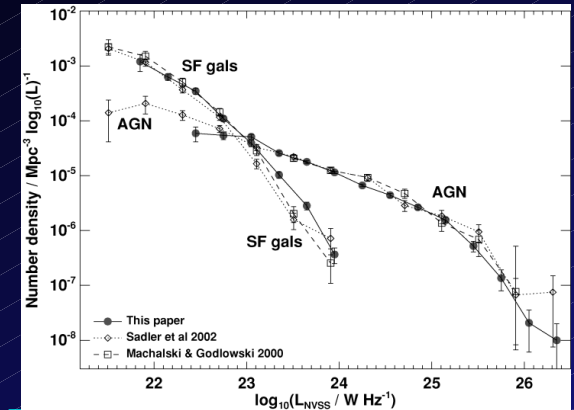
SFR current = $0.79 M_{\text{sun}} \text{ yr}^{-1}$

NVO Science – Some Examples

- Radio-Loud AGN in the SDSS

- Best et al. 2005

- Cross Match SDSS DR2, NVSS, FIRST
 - SDSS Spectral Data
 - 2712 Radio Galaxies
 - Radio Emission Due to AGN vs Star Bursts



NVO Science – Some Examples

- Is There an AGN – Starburst Connection?
 - (Heckman et al.2006)
 - Does a Common Accretion Torus Produce Both?
 - Both Phenomena Produce X-rays
 - Cross Correlate 80,000 X-ray Sources with > 500,000 Galaxies (with z) From SDSS DR4
 - Look for Common Hosts
 - Look for Evolution with Redshift

NVO Science – Some Examples

- Detecting Embedded Intermediate Mass Stars
 - (Kerton et al. 2006)
 - Star of 5-10 $M_{\odot}$ – At Boundary Between Solar Type and Very Massive Stars
 - Hence Crossover of Different Physical Processes
 - Young B Stars Buried in Molecular Clouds
 - Radio + mm Spectral Line Surveys + 2MASS, IRAS
 - Data Cube Analysis (x - y - λ)

NVO Science – Some Examples

- Merging Galaxies
 - (Allam et al. 2006)
 - Galaxy Mergers: Create Starbursts, Form Central CD's in Clusters, Feed AGN, Produce ULIRGS....
 - Optical (SDSS) Surveys Bias toward High SFR
 - IR Traces Mass Distribution (Red Stars)
 - Search 2MASS XSC (1.6M Galaxies)
 - Expect ~ 30,000 Merging Pairs
 - Do Multi Wavelength Followup

IVOA



Výhrady k VO

- Zaměřené na technologie a SW
- Kvalita dat – garbage in - garbage out
- Astronomové chtějí vědu především
- Kdo vlastní data – co s daty v PP při dotazu PI?
- Lidé se nebudou chtít lacino vzdát – data platidlo, prestiž, konkurenční výhoda
- Jak dát kredit ? Komu ?
- Kdo je autor článku ?????

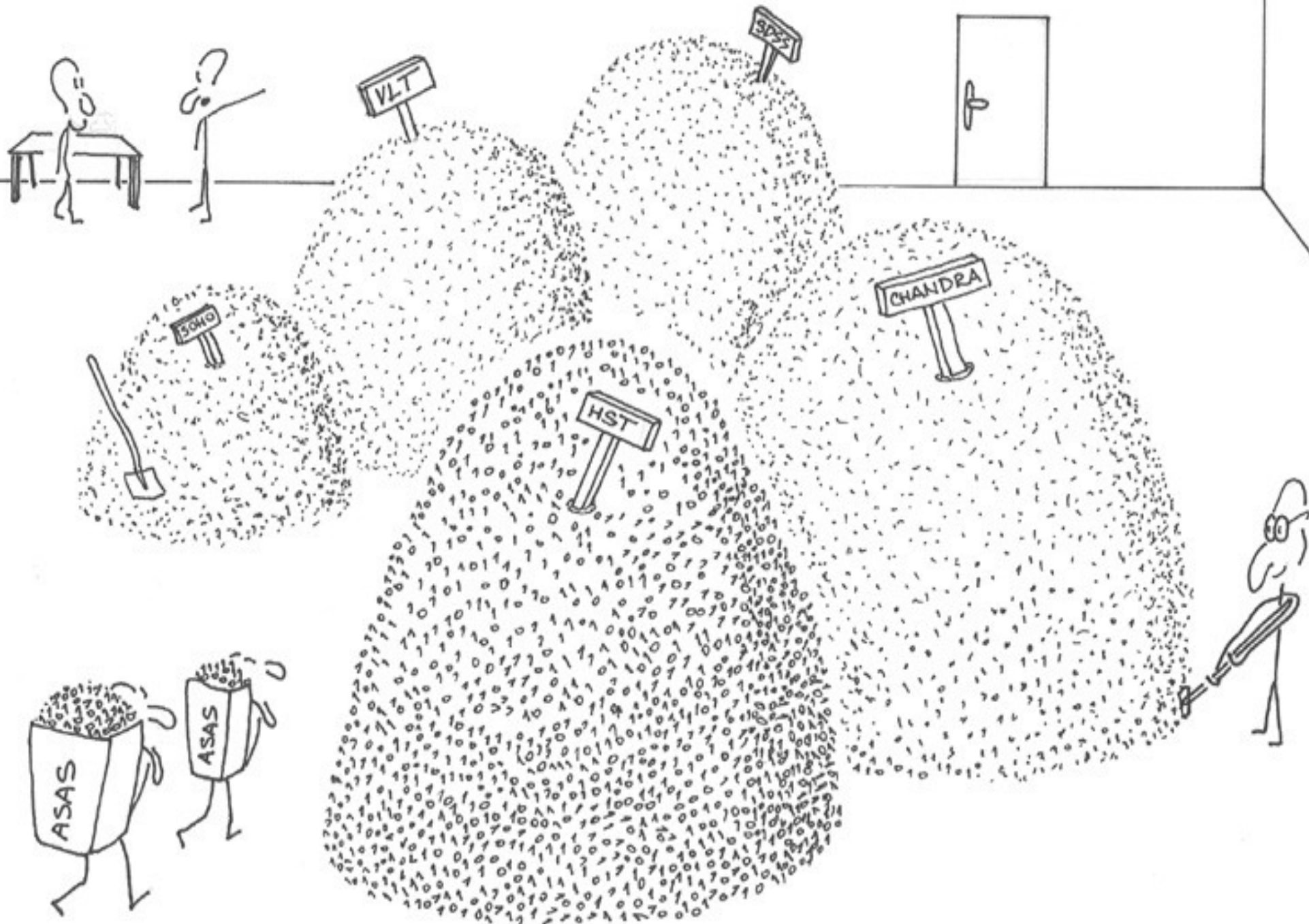
**Je báječné být u nové revoluce
v astronomii**

Zúčastnit se můžete i VY!

**Stačí jen Internet a rychlé PC
Veškerý SW i data jsou
ZDARMA!**

**Můžeme být plnohodnotnými
partnery po vstupu do ESO
(EURO-VO)**

VIRTUAL OBSERVATORY



The Digital Divide in Astronomy-

Immense databases, electronic archives of scientific periodicals are available free.

The latest research is available through preprints.

Virtual Observatory tools will make all this highly accessible and usable.

But-

*Many astronomers lack the bandwidth,
expertise and the environment to make use
of these riches...*

*There is resistance to the use of new
concepts and tools...*

There are reservations about exposing data...