

# CDS and the VO

# Virtual Observatory

- Framework for interoperable and efficient access to astronomical data and services
- e-Science for Astronomy
- Based on global standards
- co-ordination via IVOA



# Vision

- Archives and databases form a ‘digital sky’
- New possibilities via data discovery, efficient data access and interoperability

Driven by:

- Exploding data rates
- Multi- $\lambda$  science



# VxOs

Astronomical

Solar

Heliophysics

Geoscience

Planetary Science

Magnetosphere ...

- each one focused on domain specific needs

# CDS involvement

- Development of VO standards
- Leadership role in IVOA, EuroVO, VOFrance
- VO science tools and services
- VO science
- Science tutorials, outreach/education
- Assisting the Data Centre community to publish to the VO

# CDS approach to VO

- Participation in development of standards helps the CDS services
- As a major content provider we need to be involved
- Careful implementation of VO in CDS services alongside other access modes
- Use VO to foster innovation and collaboration

# Projects

- **EURO**  - European co-ordination
  - VOTech
  - DCA
  - AIDA
  - ICE

# IVOA

- **Leadership roles:**

**Genova** - Chair 2006-7, Vice-Chair 2005-6, DCP IG Vice chair 2004-7

**Ochsenbein** - VOTable Chair 2003-9

**Allen** - Apps IG/WG Chair 2005-8, CSP 2009-, Newsletter Editor, Secretary 2009-

**Preite-Martinez** - Semantics WG Chair 2005-8

**Derriere** - Semantics WG Chair 2008-

**Louys** - DMWG Chair 2007-11

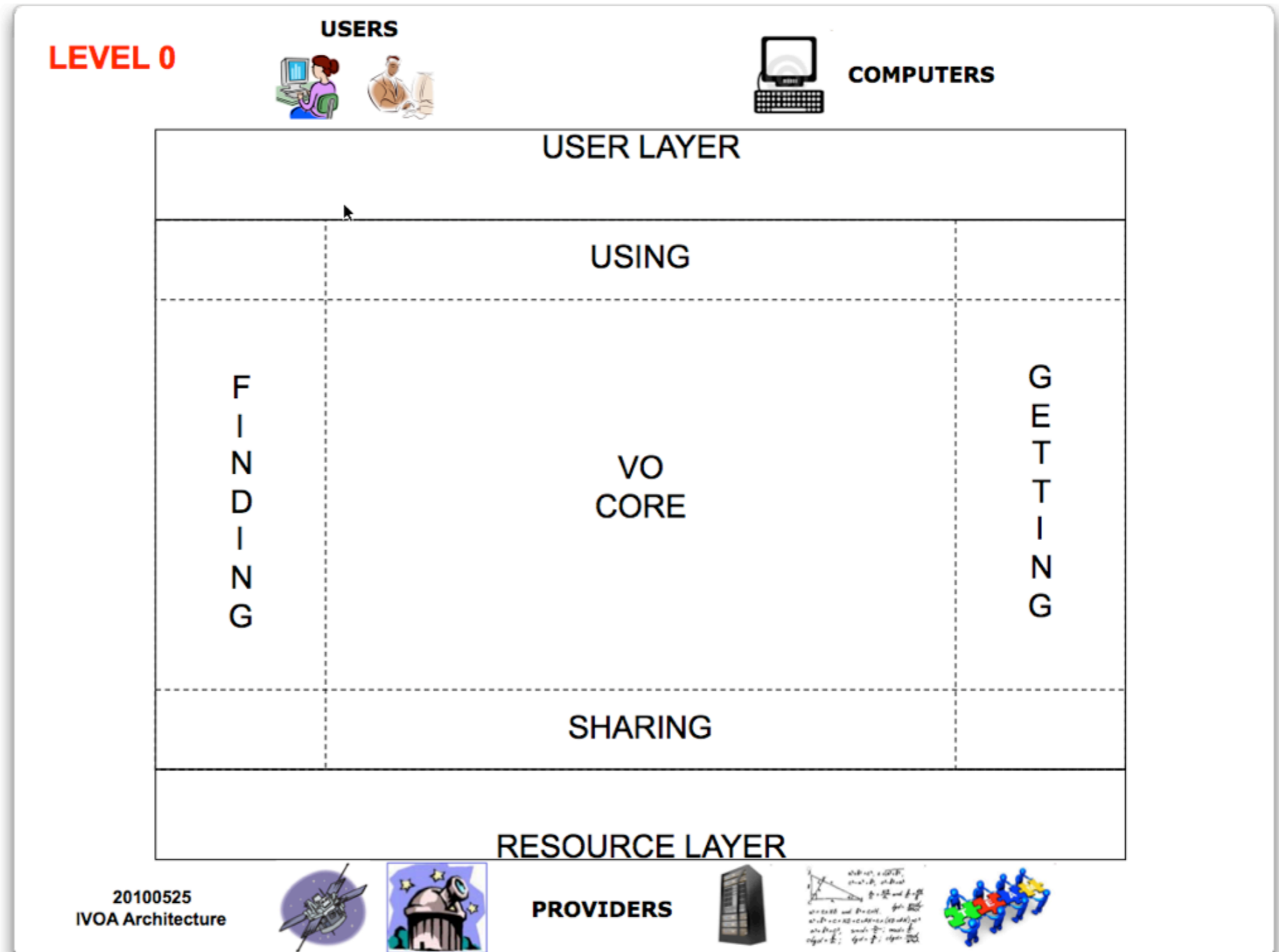
**Wozniak** - Theory WG Chair 2008-11

**Schaaff** - GWS WG Vice Chair 2011-



# IVOA - Architecture

Multi-level structure for understanding each component of the VO

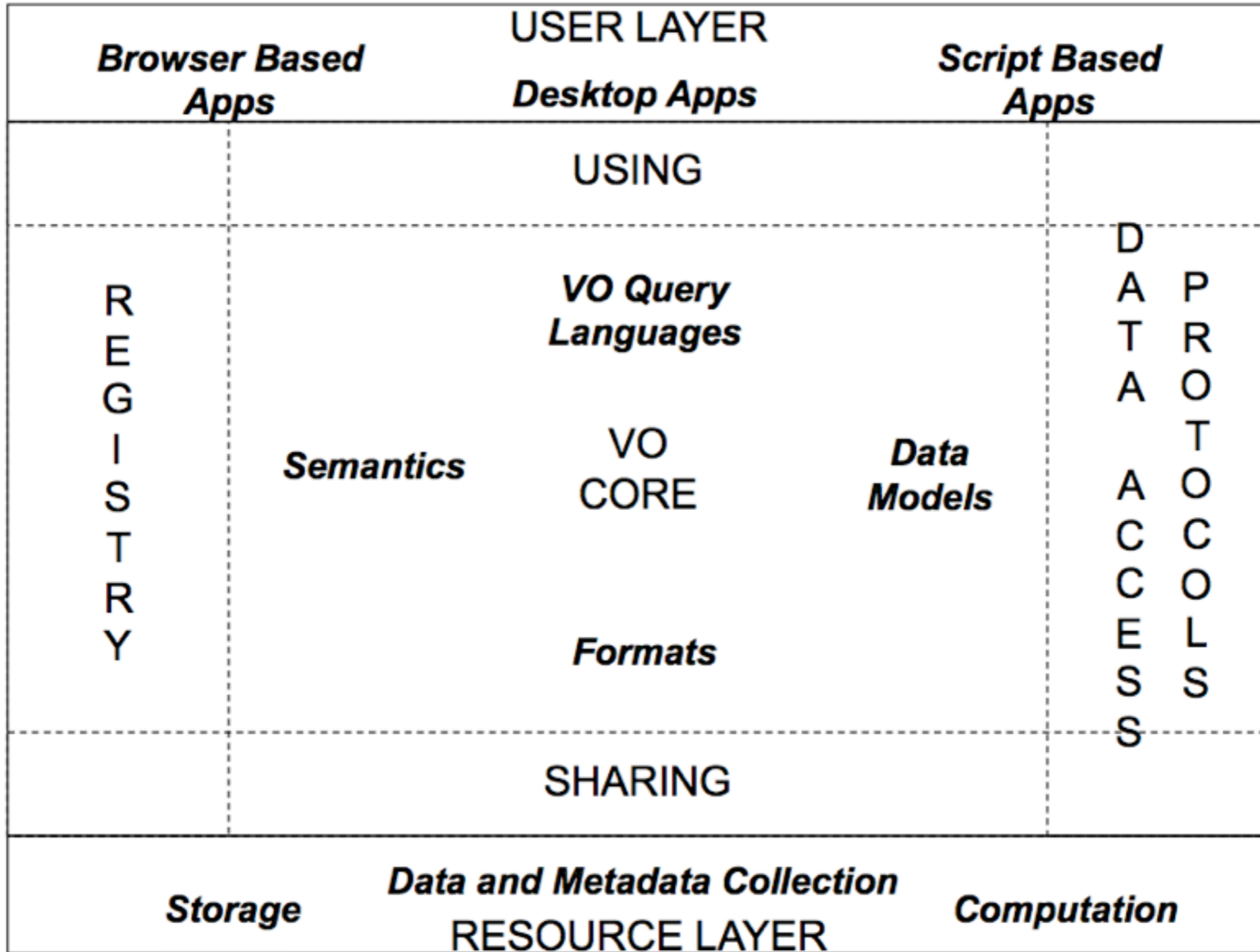


**LEVEL 1**

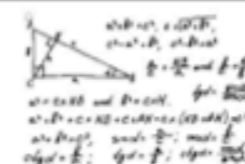
**USERS**



**COMPUTERS**



**PROVIDERS**



**LEVEL 2**

**USERS**

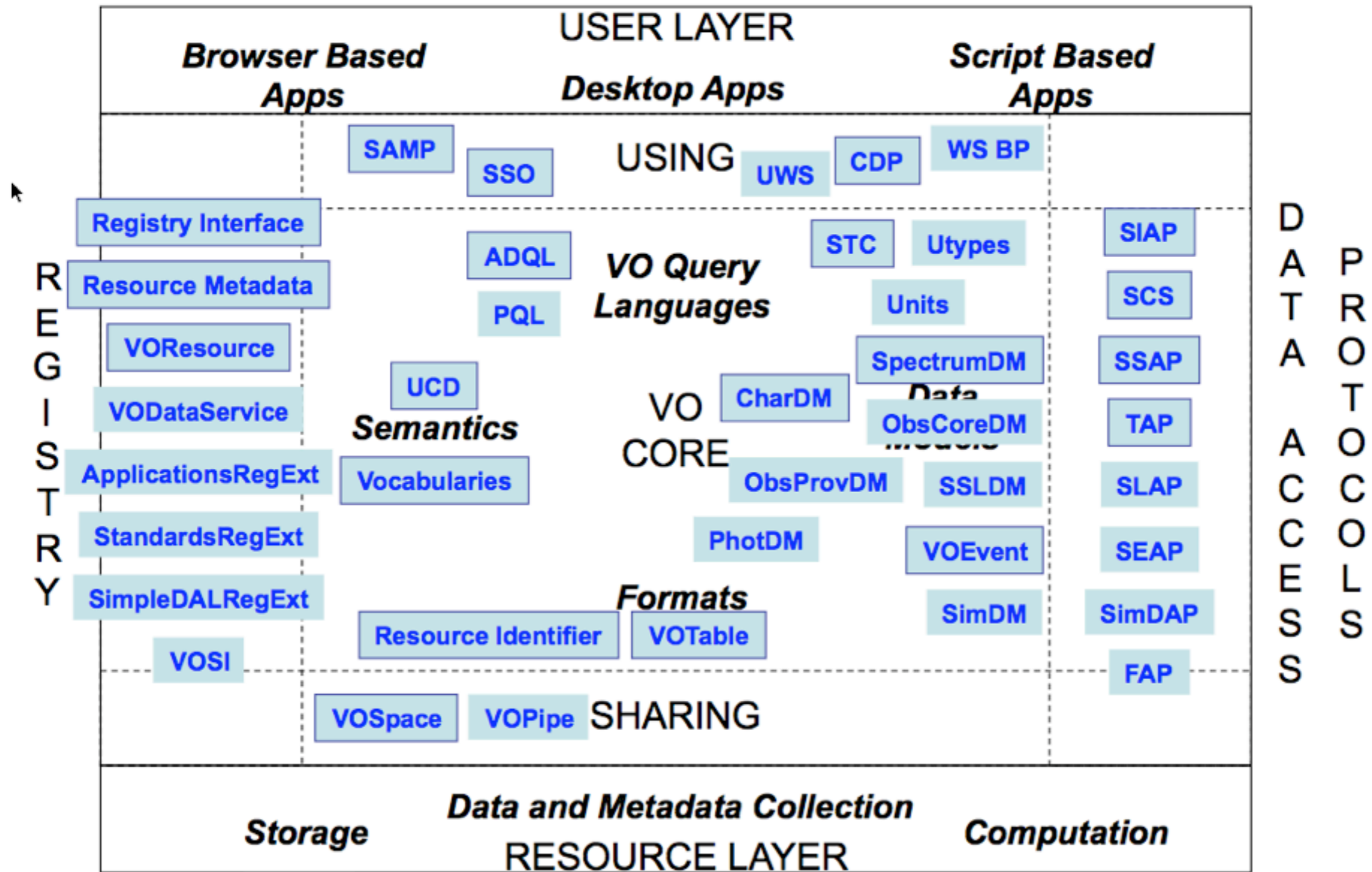


**COMPUTERS**

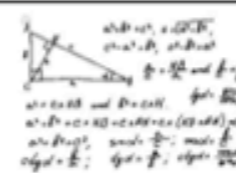


**REC**

InProgress



**PROVIDERS**



# Specific CDS contributions to IVOA standards

- VOTable
- Data models - Characterisation
- SAMP
- GWS
- ...
- see - list of IVOA standards 'signed' by CDS members

- One important aspect of CDS participation: test implementation alongside of standards development
  - ensures relevant and useable standards

# VO in CDS services

- VO Compliance in services
  - VO access alongside existing modes (Vizier example to follow)
- VO interoperability of tools (SAMP)
- Innovation (e.g. CDS Portal)

# VO standards used in VizieR web page interface



**Search Criteria**  
[Save in CDSportal](#)  
 Keywords    
 2mass  
 Tables  
 II/246  
 ..out  
 VII/233  
 ..xsc  
 II/241

**Preferences**  
 max: unlimited  
 VOTable  
 All columns  
 Compute  
 Distance  
 Distance (x,y)  
 Galactic  
 J2000  
 B1950  
 Ecl. J2000  
 default  
 Sort by Distance  
 No sort  
 Position in:  
 Sexagesimal  
 Decimal °  
 Mirrors  
 CDS, France

**Simple Target** **List Of Targets**  
 Target Name (resolved by [Sesame](#)) or Position:    
 J2000    
 Target dimension: 2 arcmin  
 Radius  Box size

**Simple Constraint** **List Of Constraints**    
 Query by [Constraints](#) applied on Columns (Output Order: + -)

Show	Sort	Column	Constraint	Explain (UCD)
<input checked="" type="checkbox"/>	<input type="radio"/>	RAJ2000	deg	(ra) Right ascension (J2000) ( <a href="#">pos.eq.ra;meta.main</a> )
<input checked="" type="checkbox"/>	<input type="radio"/>	DEJ2000	deg	(dec) Declination (J2000) (dec) ( <a href="#">pos.eq.dec;meta.main</a> )
<input type="checkbox"/>	<input type="radio"/>	errMaj	arcsec	(err_maj) Major axis of position error ellipse ( <a href="#">stat.error</a> )
<input type="checkbox"/>	<input type="radio"/>	errMin	arcsec	(err_min) Minor axis of position error ellipse ( <a href="#">stat.error</a> )
<input type="checkbox"/>	<input type="radio"/>	errPA	deg	[0,180] (err_ang) Position angle of error ellipse major axis (E of N) ( <a href="#">stat.error</a> )
<input checked="" type="checkbox"/>	<input type="radio"/>	2MASS	(char)	(designation) Source designation ( <a href="#">Note 1</a> ) ( <a href="#">meta.id;meta.main</a> )
<input checked="" type="checkbox"/>	<input type="radio"/>	Jmag	mag	<sup>(n)</sup> (j_m) J selected default magnitude ( <a href="#">Note 2</a> ) ( <a href="#">phot.mag;em_IR_J</a> )
<input type="checkbox"/>	<input type="radio"/>	Jcmsig	mag	<sup>(n)</sup> (j_cmsig) J default magnitude uncertainty ( <a href="#">Note 3</a> ) ( <a href="#">stat.error;phot.mag</a> )
<input checked="" type="checkbox"/>	<input type="radio"/>	e_Jmag	mag	<sup>(n)</sup> (j_msigcom) J total magnitude uncertainty ( <a href="#">Note 4</a> ) ( <a href="#">stat.error;phot.mag;em_IR_J</a> )
<input type="checkbox"/>	<input type="radio"/>	Jsnr		<sup>(n)</sup> (j_snr) J Signal-to-noise ratio ( <a href="#">stat.snr</a> )
<input checked="" type="checkbox"/>	<input type="radio"/>	Hmag	mag	<sup>(n)</sup> (h_m) H selected default magnitude ( <a href="#">Note 2</a> ) ( <a href="#">phot.mag;em_IR_H</a> )

VOTable

UCDs

# VizieR catalogues described in the Registry

The screenshot shows the EURO-VO Registry website. The browser address bar displays the URL: <http://registry.euro-vo.org/result.jsp?searchMethod=XPathQLSearch&select=%23ResourceType%23%3D%27Cat>. The search term "meganerdruns" is visible in the search bar. The page header features the EURO-VO logo and the text "AIDA Astronomical Infrastructure for Data Access". Below the header, there are navigation links for "The Euro-VO projects: VOTECH EuroVO-DCA EuroVO-AIDA". A sidebar on the left contains a list of resource types, with "Catalog Service (CDS)" highlighted. The main content area displays "Search Results" for the query. Three search results are visible, each with a title, IVOA identifier, and a brief description. The first result is "Results of obs with the 6-inch transit circle (Hammond+ 1927-1982) [I/100A]". The second is "Occultation Double-Star Observations (Evans 1983) [I/110]". The third is "Lowell Proper Motion Survey - Southern Hemisphere (Giclas+ 1978) [I/112]". Each result includes a "Published by" line and a "Published on" date. The bottom of the page features logos for "Member of IVOA" and "Powered by esa VO Virtual Observatory".

EURO-VO Registry :: Welcome

http://registry.euro-vo.org/result.jsp?searchMethod=XPathQLSearch&select=%23ResourceType%23%3D%27Cat

meganerdruns

School Wiki Google Translate CDS CDS Portal VizieR Facebook Google Maps

EURO-VO Registry :: Welcome

**EURO-VO**  
AIDA Astronomical Infrastructure for Data Access

The Euro-VO projects: VOTECH EuroVO-DCA EuroVO-AIDA

EURO-VO Registry

Search Resources

- Resource
- Organisation
- Authority
- Data Collection
- Service
- Registry
- Table Service
- Data Service
- Catalog Service
- Catalog Service (CDS)
- Cone Search (CS)
- Open Sky Node (OSN)
- Simple Image Access (SIAP)
- Proto Spectral Access (PSAP)
- Simple Spectral Access (SSAP)
- Simple Line Access (SLAP)
- Theoretical Spectral Access (TSAP)

Insert Resources

Update Resources

Validate Resources

EURO-VO Registry Resource Details

Member of

Powered by

### Search Results

1 -- 15 [ NEXT ]

**Results of obs with the 6-inch transit circle (Hammond+ 1927-1982)** [ CHECK | XML | EDIT | CLONE ]  
[I/100A]  
IVOA identifier: ivo://CDS.VizieR/I/100A [CatalogService] [ConeSearch]

This catalog is a compilation of seven catalogs of positions derived from observations with the six-inch transit circle of the U. S. Naval Observatory. The observations were obtained between 1911 and 1971 and were published in the catalogs: W210, W025, W150, W250, W350, W450, and W550. Proper motions and, in most catalogs, spectral types were added from other sources.

Published by: CDS on the 1997-12-09T10:25:36 and last updated on the 1997-12-09T10:25:36

**Occultation Double-Star Observations (Evans 1983) [I/110]** [ XML | EDIT | CLONE ]  
IVOA identifier: ivo://CDS.VizieR/I/110 [CatalogService]

This catalog contains data on 224 double stars observed photoelectrically during lunar occultations. The author cites the advantages of this method of double star detection as increased resolution, accuracy of the vector separations of roughly one-half arcsecond or better, and the opportunity to make photometric determinations of the magnitude differences between components. The vector separation is the true separation projected along a line perpendicular to the actual lunar limb. The catalog is a compilation of twelve years of observations from the literature (through roughly 1980). It is divided into three files. The first file, data1.dat, contains information on stars brighter than visual magnitude 6.7. The second, data2.dat, lists SAO catalog stars fainter than magnitude 6.7. The third file, data3.dat, contains data on faint stars with no SAO number. For these stars, data on their magnitudes or spectral types may be absent. In many cases there are multiple records per star, reflecting separate observations. The records are arranged by SAO number or other identifier, and contain visual magnitudes, spectral type, observing run number, a subjective grade of the probability of being double, the vector separation with computed error, position angle, and the lunar limb slope and its error. It also includes the magnitude difference between the components in (somewhat arbitrarily assigned) blue and red band passes. In the case of a triple star, the run number is repeated and the data for the triple given with magnitude differences from the brightest star.

Published by: CDS on the 1997-12-09T10:31:28 and last updated on the 1997-12-09T10:31:28

**Lowell Proper Motion Survey - Southern Hemisphere (Giclas+ 1978)** [ CHECK | XML | EDIT | CLONE ]  
[I/112]  
IVOA identifier: ivo://CDS.VizieR/I/112 [CatalogService] [ConeSearch]

This catalog contains a summary of the Lowell Proper Motion Survey for the southern hemisphere as completed to mid-1978. The catalog gives the position, motion, magnitude, and color of 2758 stars from the Lowell program.

Published by: CDS on the 1997-12-09T10:33:22 and last updated on the 1997-12-09T10:33:22

**Parallaxes and Proper Motions near SGP (Murray+ 1986) [I/129]** [ CHECK | XML | EDIT | CLONE ]  
IVOA identifier: ivo://CDS.VizieR/I/129 [CatalogService] [ConeSearch]

The catalog contains 6125 stars brighter than B-17.5, V-17.0 in the south galactic cap. The data have been obtained using the UK Schmidt telescope between 1975 and 1981. The plates were measured on the GALAXY machine at RGO. External errors of the parallaxes range between +/-0.012 and +/-0.017 arcsec according to magnitude. Internal proper motion errors range from +/-0.006 and +/-0.008 arcsec. In addition to the positions, proper motions, and parallaxes, the photometric data include B and V.

Published by: CDS on the 1997-12-09T10:48:39 and last updated on the 1997-12-09T10:48:39



# VizieR catalogues accessible via VOExplorer

VO Explorer - CDFS tables

Contents of CDFS tables - 53 resources

Publisher	IVOA-ID	Flag...	Title	Valida...
CDS	ivo://CDS.VizieR/J/ApJ/682/985		FIREWORKS photometry of GOODS CDF-S (Wuyts...	①
CDS	ivo://CDS.VizieR/J/MNRAS/371...		GOODS ELAIS-N1 24um flux densities (Rodighier...	①
CDS	ivo://CDS.VizieR/J/ApJ/697/13...		GOODS Ks-selected multiwavelength compilation...	①
CDS	ivo://CDS.VizieR/J/ApJ/666/863		GOODS MIPS early-type galaxies (Van Der Wel+, ...)	①
CDS	ivo://CDS.VizieR/VII/246		GOODS Morphological Catalog (Bundy+, 2005)	①
CDS	ivo://CDS.VizieR/J/ApJ/650/148		GOODS blue early-type galaxies (Lee+, 2006)	①
CDS	ivo://CDS.VizieR/II/261		GOODS initial results (Giavalisco+, 2004)	①
CDS	ivo://CDS.VizieR/J/A+A/504/751		GOODS-MUSIC catalog updated version (Santini+ ...)	①
CDS	ivo://CDS.VizieR/J/A+A/449/951		GOODS-MUSIC sample: multicolour catalog (Grazi...	①
CDS	ivo://CDS.VizieR/J/ApJ/689/687		GOODS-N spectroscopic survey (Barger+, 2008)	①
CDS	ivo://CDS.VizieR/J/A+A/454/423		GOODS-South Field VLT/FORS2 redshifts. II. (Van...	①
CDS	ivo://CDS.VizieR/J/A+A/478/83		GOODS-South Field VLT/FORS2 redshifts. III. (Van...	①
CDS	ivo://CDS.VizieR/J/A+A/434/53		GOODS-South Field redshifts (Vanzella+, 2005)	①
CDS	ivo://CDS.VizieR/J/ApJ/653/10...		Galaxies at 1.4 <- z <- 3.0 in GOODS-North Field...	①
CDS	ivo://CDS.VizieR/J/ApJ/600/L155		Gravitational lens in GOODS ACS fields (Fassnacht...	①
CDS	ivo://CDS.VizieR/J/AJ/127/3137		Hawaii redshifts in the ACS-GOODS region (Cowie...	①
CDS	ivo://CDS.VizieR/J/ApJ/606/L25		Hubble Ultra Deep Parallel Fields (Bouwens+, 20...	①
CDS	ivo://CDS.VizieR/J/ApJ/677/169		H(alpha) galaxies at z=0.84 (Villar+, 2008)	①

Information Table Metadata

### GOODS MIPS early-type galaxies (Van Der Wel+, ...)

Short Name J/ApJ/666/863 IVOA-ID ivo://CDS.VizieR/J/ApJ/666/863  
Resource Type CatalogService Created 2009-12-18 Validated ① by ivo://CDS.VizieR

Content Type catalog Subject galaxies, redshifts Level research  
We select galaxies with spectroscopic redshifts and early-type morphologies from Hubble Space Telescope Advanced Camera for Surveys (ACS) imaging from the Great Observatories Origin Deep Survey (GOODS; Giavalisco et al., 2004ApJ...600L..93G, Cat. 261>) in the Chandra Deep Field-South (CDF-S) and the Hubble Deep Field-North (HDF-N).  
[Further Information...](#)

Source Reference [2007ApJ...666..863V](#) (bibcode)

Footprint Service <http://cdsarc.u-strasbg.fr/viz-bin/w/Footprint?-gal&-z&&-s&sqrt&catid=16660863>  
Waveband Coverage optical, infrared  
[Show Table Metadata](#)

Service Rights public  
This resource describes an **Service**  
Interface Type Web Form Access URL <http://vizier.u-strasbg.fr/cgi-bin/VizieR-2?-source=J/ApJ/666/863>

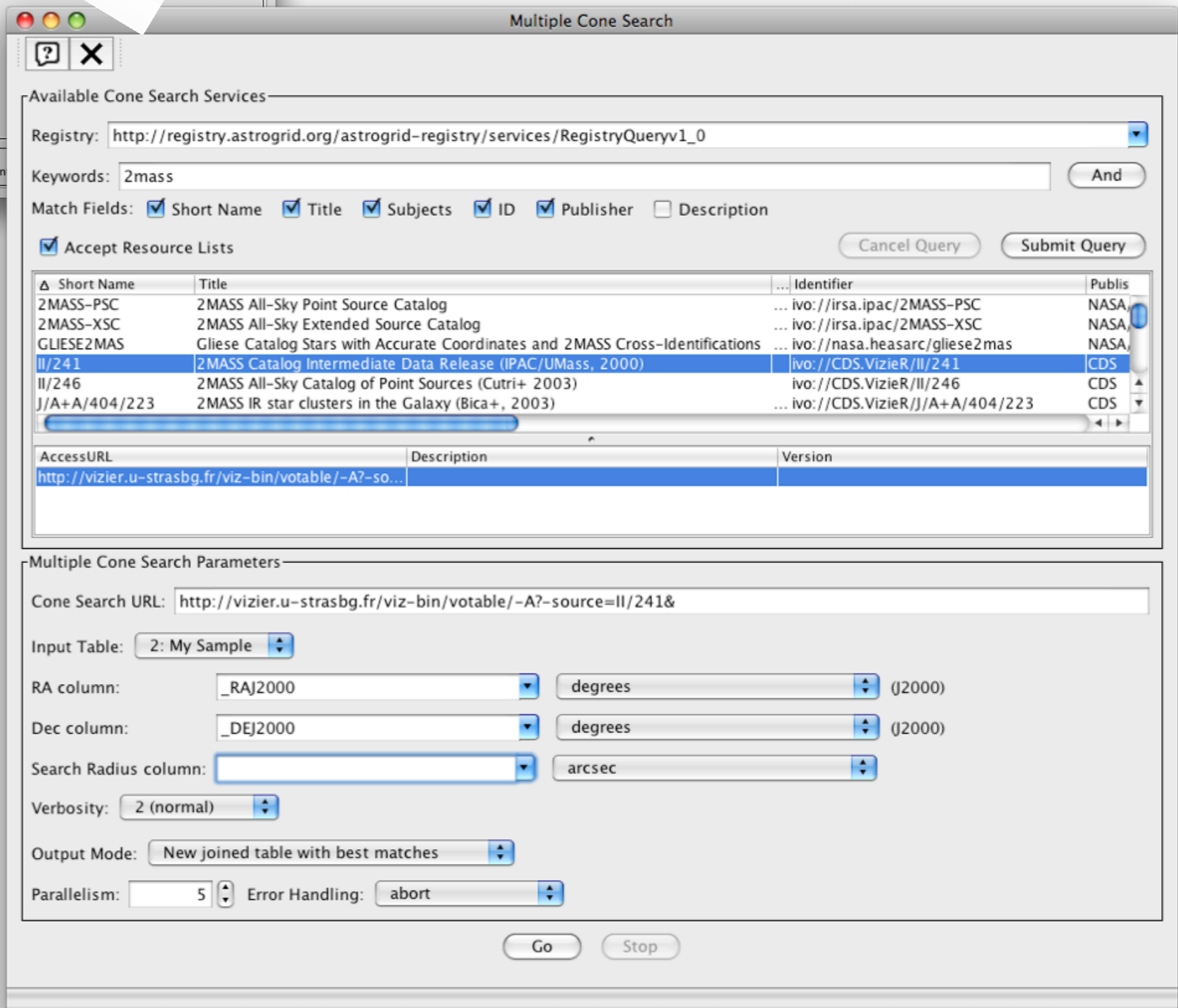
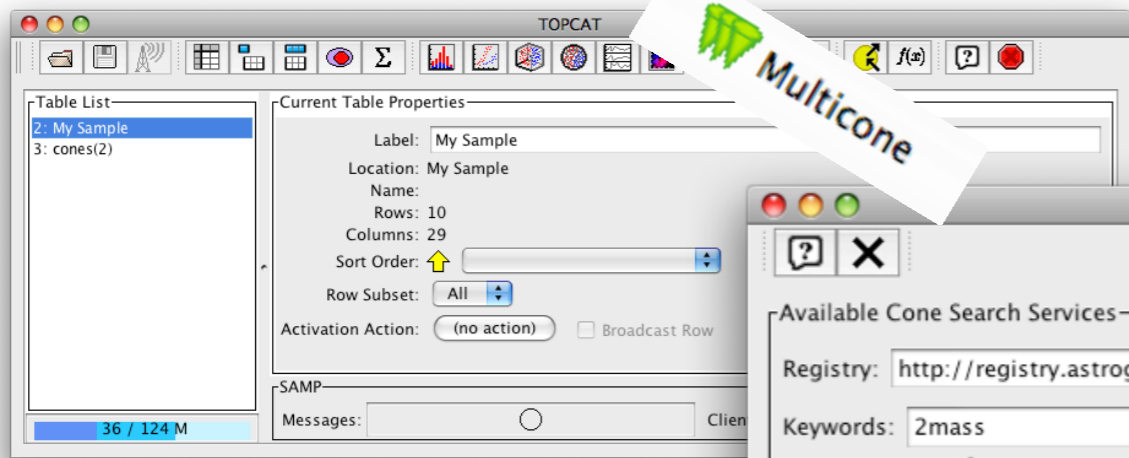
This resource describes an **Service**  
Interface Type Http Query Access URL <http://vizier.u-strasbg.fr/viz-bin/votable/-dtd/-A?-source=J/ApJ/666/863>  
Query Type get Result Type text/xml+votable

This resource describes a **Catalog cone search service**  
Verbose Parameter supported Maximum Search Radius 180.0 Maximum Results Returned 9999  
[Test Query](#) RA 0.0 Dec 90.0 SR 0.1

Interface Type Http Query Role std Access URL <http://vizier.u-strasbg.fr/viz-bin/votable/-A?-source=J/ApJ/666/863&>  
Query Type get Result Type text/xml+votable

Actions: Position Query, Multi Query, Web interface, Download...

About: Selection: CatalogService, Further Info, Publication, Email Curator



My Sample of objects

Registry: 2MASS from VizieR

Cone Search for each object

Table Browser for 4: cones(2)

	DEJ2000	Jmag	e_Jmag	Hmag	e_Hmag	Kmag	e_Kmag	rd_flg	bl_flg	cc_flg	extd_flg	mp_flg	Id_opt	Separation
1	54.3489	13.356	0.045	12.486	0.075	12.282	0.051	222	111	000	0	0		0.00184
2	69.6799	9.617		9.058	0.087	8.376	0.11	022	011	000	0	0		0.00085
3	40.86525	8.97	0.062	7.712	0.03	8.108	0.046	212	101	000	1	0	U	0.00087
4	39.06329	10.55	0.057	9.845	0.069	9.505	0.045	222	111	000	1	0		0.00062
5	69.81249	11.537	0.062	10.694	0.061	10.397	0.053	222	111	000	1	0	U	0.00062



Interactive Sky Atlas

Images

Catalogues

VO Access

All Sky

Scripting

and more...

Aladin v7.0

Location

Allsky opt Allsky IR DSS Simbad NED PPMX 2MASS

The Antennae Galaxies / NGC 4038-4039

SERC-I-DSS2.S572

2MASS... 1.957" x 1.857"

2MASS.J9903205\_J10690221 6.06

2MASS.H.9903205\_H10690221 5.98

RGB img 4.779 6.98 6.059

1.957" x 1.857"

1.957" x 1.857"

1.957" x 1.857"

1.957" x 1.857"

1.957" x 1.857"

1.957" x 1.857"

Fireworks Show in Collision of Antennae Galaxies (NGC 4038-4039)

Server selector

Others File Allsky all-vo FOV SExtractor Watch

Image servers

Aladin images

SkyView

UKIDSS

Sloan

DSS...

VLA...

Archives...

Others...

VO discovery tool

Target (ICRS, name) ngc 4039 Grab coord

Radius 14'

Servers  Images  Catalogs  Spectra Detailed list...

- Chandra X-Ray Observatory Data Archive
- The XMM-Newton Science Archive InterOperability System
- ESO Science Archive Image Service
  - BandPass: BB#B/123
  - BandPass: BB#I/203
  - BandPass: BB#Rc/162
  - BandPass: BB#U/50
  - BandPass: BB#V/89
- ST-ECF Hubble Legacy Archive Images
- Multimission Archive at STScI (MAST)

Press it to stop the processing => Stop it

Reset Clear SUBMIT Close ?

Catalog servers

- All VizieR
- Surveys
- Missions
- SimBAD
- NED
- SkyBot
- Others..

om 1/8x

sel / 4518 src 266Mb

# Some details on the access methods

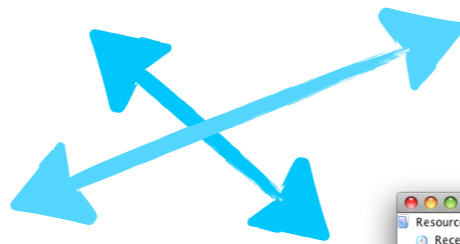
- Web interface
- SOAP
- ...?

# SAMP tool interoperability

Aladin

Topcat

The image displays three main software interfaces: Aladin (left), Topcat (top right), and SAMP (middle right). Aladin is a multi-panel astronomical image viewer. Topcat is a table browser showing a list of objects with columns for sequence number, QSO status, name, redshift (z), and magnitude (Vmag). SAMP is a meta-search interface showing a table list and current table properties.



The screenshot shows the VizieR web interface. It includes a search criteria section with a table of results. The table has columns for various astronomical parameters, with some values highlighted in red to indicate low quality results.

Full	r	RAJ2000	DEJ2000	RAJ2000	DEJ2000	2MASS	Imag	e	Hmag	e	Knag	e	Q
arcmin	"h:m:s"	"d:m:s"	deg	deg	deg	mag	mag	mag	mag	mag	mag	mag	mag
0.0013	00 05 08.814	+67 50 24.01	001.286724	+67.840004	00050881	+6750240	5.118	0.037	4.548	0.040	4.325	0.036	EE
0.2963	00 05 11.906	+67 50 20.66	001.299608	+67.839073	00051190	+6750206	12.855		12.546		13.413	0.096	UT
0.4365	00 05 06.253	+67 50 02.29	001.276055	+67.833969	00050625	+6750022	16.289	0.142	15.702	0.174	15.175	0.172	BC
0.6712	00 05 02.799	+67 50 02.62	001.261662	+67.834061	00050279	+6750026	16.686	0.164	15.917	0.174	15.593	0.209	CC
0.7036	00 05 12.170	+67 51 01.81	001.300709	+67.850502	00051217	+6751018	15.428	0.045	14.739	0.053	14.516	0.086	AA

The screenshot shows the VO Explorer - Chameleon interface. It displays a list of resources and detailed information for a specific resource titled "Cha X-ray sources & optical identifications (Alcala+ 1995)". The detailed view includes a description of the resource, its capabilities, and a table of data.

Flag	Title	Capability	Valida...	Date
1	Cha X-ray sources & optical identifications (Alcala+ 1995)		1	1997-12-09
1	New WTTs in the Chameleon complex (Alcala+ 1997)		1	1999-02-26
1	Proper motions of faint ROSAT WTT stars (Terranegra+ 1999)		1	1999-01-24
1	ROSAT All-Sky Survey: Chameleon Star Forming Region Study		1	2008-12-24

Web pages (VizieR)

VO Desktop

# Innovation: CDS Portal

CDS Portal

Target:

J2000 position for NGC 4039: 12 01 53.7 -18 53 08

**Object identifiers, measurements and bibliography for NGC 4039**

- Object type: Galaxy in Pair of Galaxies
- Morphological type: Sc
- [More SIMBAD data for NGC 4039](#)
- [1014 bibliographic references](#)
- [359 objects within 2'](#)
- [Display map around NGC 4039](#)
- [Display SimPlay interactive map around NGC 4039](#)
- [Related objects in bibliography:](#)

Number of bibliographic references for NGC 4039

**Images for NGC 4039**

- [Display region in Aladin \(Web Start\)](#)

Survey	Band	$\lambda$ ( $\mu\text{m}$ )	Size	Epoch	Resolution	Download
DENIS	I	0.79	12.5' x 12.4'	1996-03-30	0.9" / pixel	<a href="#">FITS</a>
DENIS	J	1.23	12.6' x 12.7'	1996-03-30	0.9" / pixel	<a href="#">FITS</a>
DENIS	K	2.16	12.6' x 12.7'	1996-03-30	0.9" / pixel	<a href="#">FITS</a>
2MASS	K	2.16	8.5' x 17.0'	1999-03-20	0.9" / pixel	<a href="#">FITS</a>
2MASS	H	1.65	8.5' x 17.0'	1999-03-20	0.9" / pixel	<a href="#">FITS</a>
2MASS	J	1.24	8.5' x 17.0'	1999-03-20	0.9" / pixel	<a href="#">FITS</a>
AAO	R	0.63	12.9' x 12.9'	1996-02-26	1.0" / pixel	<a href="#">JPEG</a> <a href="#">FITS</a>
SERC	I	0.80	12.9' x 12.9'	1996-05-25	1.0" / pixel	<a href="#">JPEG</a> <a href="#">FITS</a>

[Display color image](#)

**Catalogues for NGC 4039**

- [4 catalogues with 'NGC 4039' keyword](#)
- [146 catalogues around NGC 4039:](#)

Name	Description	Local density	Wavelength	Popularity	Coverage map
I/297 <a href="#">Query</a>	NOMAD Catalog (Zacharias+ 2005) <a href="#">[ReadMe]</a>	53	optical,IR	77	
J/A+A/443... <a href="#">Query</a>	NGC 4038/4039 broad and /narrow band photometry (Mengel+, 2005) <a href="#">[ReadMe]</a>	51	optical	27	
I/284 <a href="#">Query</a>	The USNO-B1.0 Catalog (Monet+ 2003) <a href="#">[ReadMe]</a>	51	optical	89	
I/305 <a href="#">Query</a>	The Guide Star Catalog, Version 2.3.2 (GSC2.3) (STScI, 2006) <a href="#">[ReadMe]</a>	49	optical	74	



# CDS Tools in VO schools/tutorials

- Heavy use of CDS tools/services in Euro-VO Science tutorials (VO Schools, VO Days)

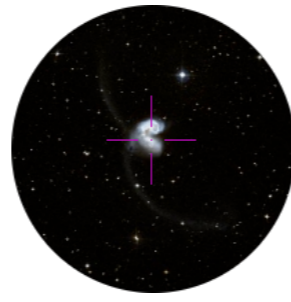
# Euro-VO Scientific Tutorials

## Fully developed example Science Cases

- **NEW** CDS Tutorial, (step-by-step) [Mar 2011] Uses the CDS Portal and Aladin
- **NEW** Study of the Coma Cluster, with a step-by-step description and a more expanded presentation; [Mar 2011] Uses Aladin and TOPCAT **VizieR**
- **NEW** A TOPCAT tutorial, with a section on multi SSA queries (step-by-step) [Mar 2011] Uses TOPCAT, SPLAT-VO
- H-alpha emitters in X-ray surveys (step-by-step) [June 2010] Uses Aladin and TOPCAT
- Proper motion of unstudied open clusters (step-by-step) [June 2010] Uses Aladin and TOPCAT
- A study of NGC1068 using TOPCAT for data retrieval (step-by-step) [Apr 2010; UPDATED Mar 2011] Uses Aladin, TOPCAT and SPLAT-VO
- Quasar candidates in selected fields (step-by-step) [Mar 2009; UPDATED Mar 2010] Uses VODesktop, TOPCAT, VO services, VOSED and VOSpec
- Classifying the SEDs of Herbig Ae/Be stars (step-by-step) [Jan 2010] Uses TOPCAT, VOSpec and VOSED **VizieR**
- The nature of a cluster of X-ray sources near the Chamaeleon star-forming region (step-by-step) [Jan 2010] Uses VODesktop, TOPCAT and Aladin **VizieR**
- Confirmation of a Supernova candidate (step-by-step) [2009, UPDATED Jan 2010] Uses Aladin, TOPCAT, SPLAT-VO or VOSpec **VizieR**
  - And a lighter version for undergraduate students [Apr 2010]
- Search for ULX sources (step-by-step) [Mar 2009; UPDATED Mar 2011] Uses Aladin and TOPCAT **VizieR**
- Study of Exoplanets (step-by-step) [Oct 2009] Uses the VizieR and Simbad services and TOPCAT
- Searching for Data available for the bright galaxy M51 (step-by-step) [Mar 2009, UPDATED Sep 2009] Uses Aladin, Simbad, VizieR, TOPCAT and VOSpec
- Discovery of Brown Dwarfs mining the 2MASS and SDSS databases (step-by-step) [Mar 2009] Uses Aladin, VizieR and TOPCAT
- The Pleiades open cluster (step-by-step) [Mar 2009] Uses Aladin and TOPCAT
- Using VOSpec: a VOSpec typical session (movie) [2009]
- From SED fitting to Age estimation: The case of Collinder 69 (step-by-step, includes illustrations) [2008] Uses VOSA
- Individual objects: 3C295 (step-by-step, includes illustrations) [2007, OUT OF DATE]
- IMF of massive stars (step-by-step, includes illustrations) [2007, OUT OF DATE]

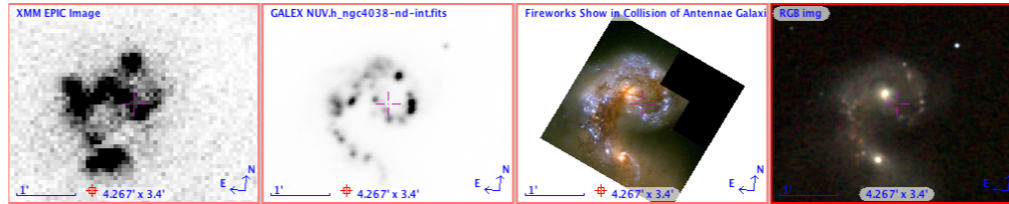


Single object search



*CDS VO  
Tutorial*

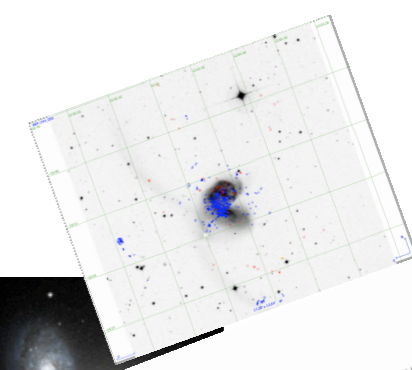
Find Multi- $\lambda$  data



Use catalogues to select a sample

Full	RAJ2000	DEJ2000	Arp	Name	RA2000	DE2000	Size	Or
	deg	deg			"h:m:s"	"d:m:s"	arcmin	
1	141.158	+49.357	1	NGC 2857	09 24 38	+49 21.4	5.2	E
2	244.075	+47.047	2	UGC 10310	16 16 18	+47 02.8	3.5	E
3	339.143	-2.905	3	MCG-01-57-016	22 36 34	-02 54.3	5.2	N
4	027.108	-12.382	4	MCG-02-05-50+A	01 48 26	-12 22.9	3.5	E
5	171.103	+3.327	5	NGC 3664	11 24 25	+03 19.6	2.6	N
6	123.310	+45.992	6	NGC 2537	08 13 14	+45 59.5	2.6	E
7	132.573	-16.577	7	MCG-03-23-009	08 50 17	-16 34.6	2.6	N
8	020.598	-0.875	8	NGC 0497	01 22 23	-00 52.5	3.5	S
9	123.748	+73.580	9	NGC 2523	08 14 59	+73 34.8	3.5	E
10	034.610	+5.653	10	UGC 01775	02 18 26	+05 39.2	2.6	E
11	017.240	+14.227	11	UGC 00717	01 00 22	+14 20.0	5.0	W

Script data and information retrieval for whole sample



```

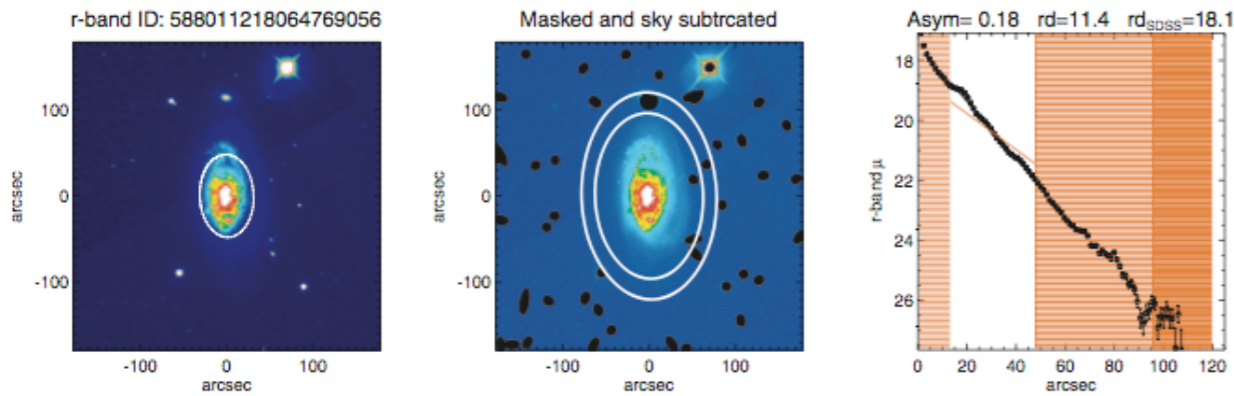
#AJS
reset
grid on
"ARP-$2_DSS" = get DSS.STScI(POSS2UKSTU_Red,15,15) $3
#"ARP-$2_Simbad" = get Simbad $3 5'
viz_logHST=get vizier(logHST) $3
viz_logESO=get vizier(logESO) $3
viz_logChandra=get vizier(logChandra) $3
sync
#export B/hst/hstlog /Users/allen/Desktop/Arp/Arp-
save /Users/allen/Desktop/Arp/Arp-$2_chart.png
/Users/allen/Desktop/Arp/Arp-$2_stack.a

```

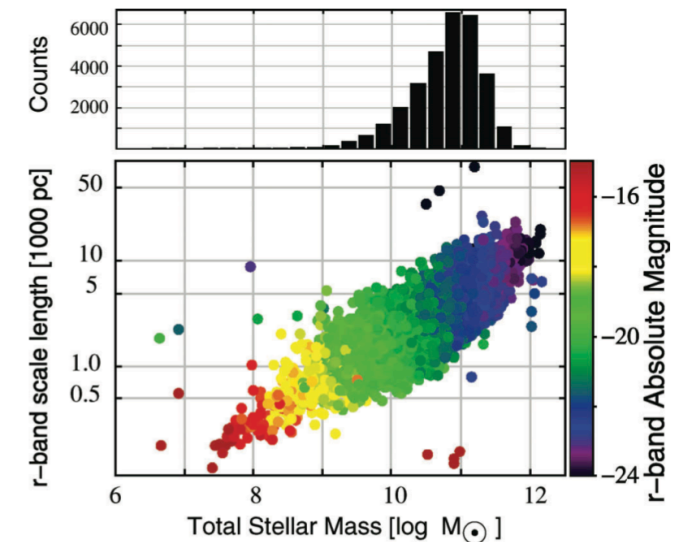
# VO Science

e.g. I.) Euro-VO Research Initiative

- SDSS, Skyview, Aladin, Topcat, IDL/GDL, VOSpace + Cluster System at CDS



×30374 →



Freeman law of galaxy disks confirmed for large sample out to  $z=0.3$

# Scalelength of disc galaxies

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## ABSTRACT

We have derived disc scalelengths for 30374 non-interacting disc galaxies in all five Sloan Digital Sky Survey (SDSS) bands. Virtual Observatory methods and tools were used to define, retrieve and analyse the images for this unprecedentedly large sample classified as disc/spiral galaxies in the LEDA catalogue. Cross-correlation of the SDSS sample with the LEDA catalogue allowed us to investigate the variation of the scalelengths for different types of disc/spiral galaxies. We further investigate the concentration and central velocity dispersion as indicators of morphological type, and are able to assess how the scalelength varies with respect to galaxy type. We note, however, that the concentration and asymmetry parameters have to be used with caution when investigating type dependence of structural parameters in galaxies. Here, we present the scalelength derivation method and numerous tests that we have carried out to investigate the reliability of our results. The average  $r_d$  disc scalelength is 3.79 kpc, with an rms dispersion of 2.05 kpc, and this is a typical value irrespective of passband and galaxy morphology, concentration and asymmetry. The derived scalelengths presented here are representative for a typical galaxy mass of  $10^{10.8 \pm 0.54} M_\odot$ , and the rms dispersion is larger for more massive galaxies. Separating the derived scalelengths for different galaxy masses, the  $r$ -band scalelength is  $1.52 \pm 0.65$  kpc for galaxies with total stellar mass  $10^9 - 10^{10} M_\odot$  and  $5.73 \pm 1.94$  kpc for galaxies with total stellar mass between  $10^{11}$  and  $10^{12} M_\odot$ . Distributions and typical trends of scalelengths have also been derived in all the other SDSS bands with linear relations that indicate the relation that connect scalelengths in one passband to another. Such transformations could be used to test the results of forthcoming cosmological simulations of galaxy formation and evolution of the Hubble sequence.

**Key words:** galaxies: structure.

## 1 INTRODUCTION

The exponential scalelength of a galaxy disc is one of the most fundamental parameters to determine its morphological structure as well as to model its dynamics, and the fact that the light distributions are exponential makes it possible to constrain the formation mechanisms (Freeman 1970). The scalelength determines how the stars are distributed throughout a disc, and can be used to derive its mass distribution, assuming a specific  $ML$  ratio. Ultimately, this mass distribution is the primary constraint for determining the formation scenario (e.g. Lin & Pringle 1987; Dutton 2009, and references therein), which dictates the galaxy's evolution. As the galaxy evolves, substructures such as bulges, pseudo-bulges, bars, rings and spiral arms may build up, and this will then considerably change the morphology of the host discs (Combes & Elmegreen 1993; Elmegreen et al. 2005; Bournaud, Elmegreen & Elmegreen 2007). The scalelength value is intimately connected to the circular velocity of the galaxy halo, which in turn relates closely to the angular momentum of the halo in which the disc is formed (Dalcanton, Spergel & Summers 1997; Mo, Mao & White 1998). Up to the last few years, cosmological simulations were limited to rather low resolution, were discs and spheroids were barely resolved, and generally limited to high redshifts, so reproducing realistic disc scalelengths for modern galaxies was clearly out of reach. The current simulations reach resolutions that allow resolving the discs from high redshift down to redshift zero, and subtle mechanisms changing the disc masses and scalelengths can be studied

# REVISITING THE SCALE LENGTH- $\mu_0$ PLANE AND THE FREEMAN LAW IN THE LOCAL UNIVERSE

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## ABSTRACT

We have used Virtual Observatory technology to analyze the disk scale length  $r_d$  and central surface brightness  $\mu_0$  for a sample of 29,955 bright disk galaxies from the Sloan Digital Sky Survey. We use the results in the  $r$  band and revisit the relation between these parameters and the galaxy morphology, and find the average value  $\langle \mu_0 \rangle = 20.2 \pm 0.7$  mag arcsec<sup>-2</sup>. We confirm that late-type spirals populate the lower left corner of the  $r_d - \mu_0$  plane and that the early and intermediate spirals are mixed in this diagram, with disk ellipticals at the top left corner. We further investigate the Freeman Law and confirm that it indeed defines an upper limit for  $\mu_0$  in bright disk galaxies with  $r_{\text{mag}} < 17.0$ , and that disks in late-type spirals ( $T \geq 6$ ) have fainter central surface brightness. Our results are based on a volume-corrected sample of galaxies in the local universe ( $z < 0.3$ ) that is two orders of magnitude larger than any sample previously studied and deliver statistically significant implications that provide a comprehensive test bed for future theoretical studies and numerical simulations of galaxy formation and evolution.

**Key words:** galaxies: evolution – galaxies: formation – galaxies: structure  
**Online-only material:** color figures

## 1. INTRODUCTION

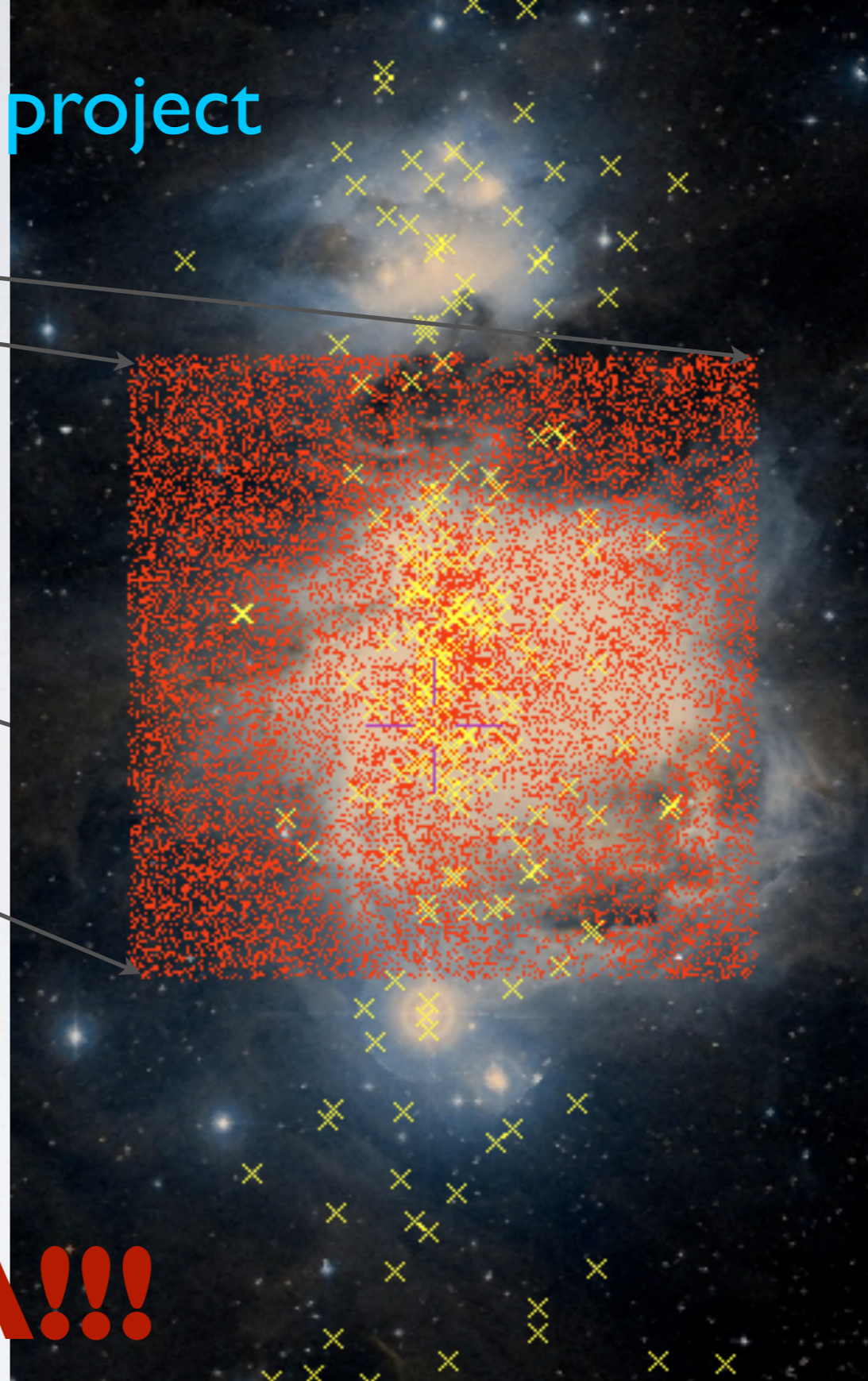
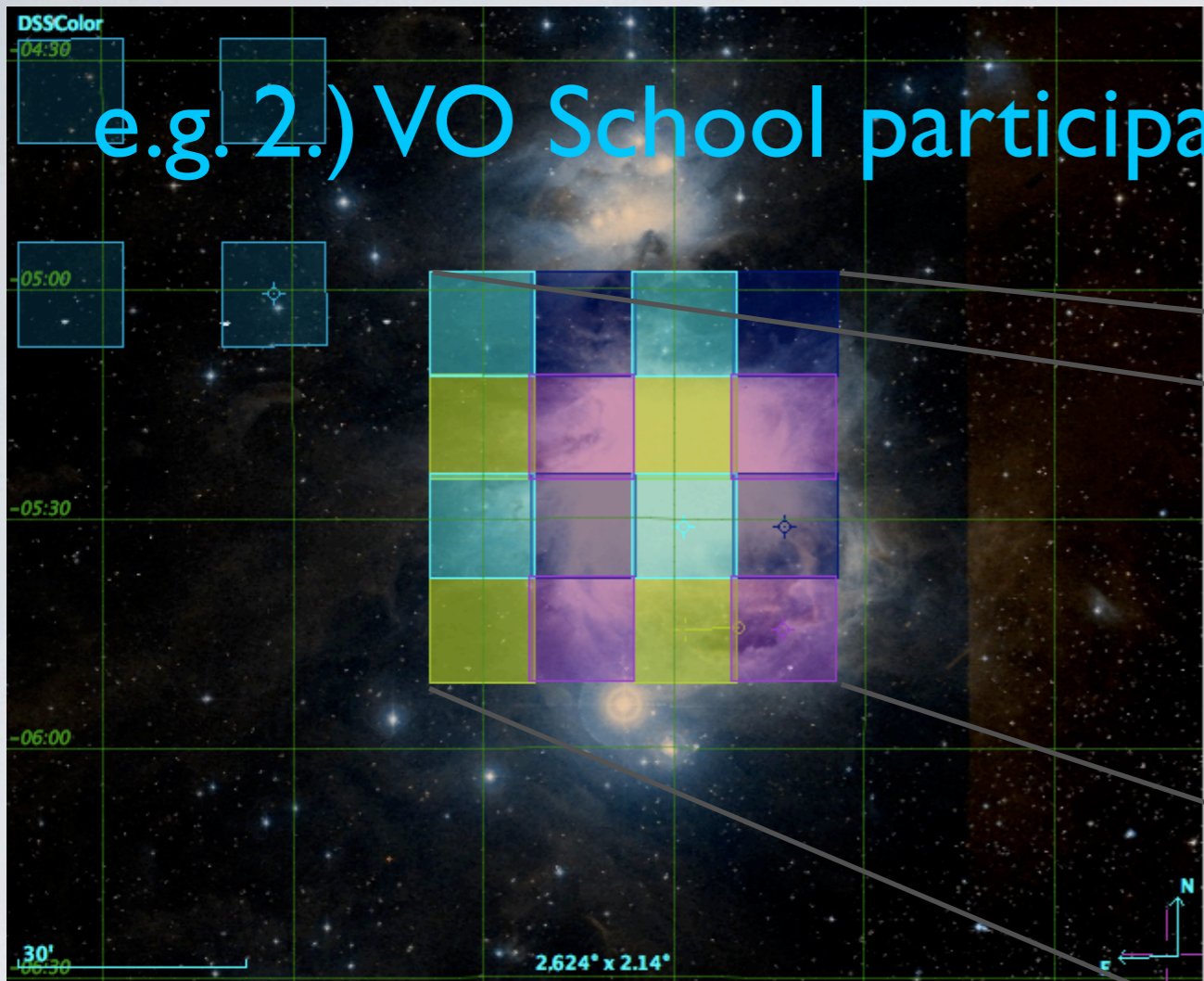
The current mainstream galaxy formation paradigm states that galaxy disks form within dark matter halos and that there is an intimate relation between the scale length  $r_d$  of the disk and that of the halo. The mass distribution of the disk is entirely set by the  $r_d$  and, for example, in the exponential case, 60% of its total mass is confined within two scale lengths and 90% within four scale lengths. Moreover, the angular momentum of the disk is set by  $r_d$  and the mass distribution of its host halo, and the fact that the angular momentum vectors are aligned suggests that there is a physical relation between the two. During the formation process, galaxy mergers and associated star formation and feedback processes play a crucial role in the resulting structure, however, the observed sizes of disks suggest that the combination of these physical processes indicate that galactic disks have not lost much of the original angular momentum acquired from cosmological torques (e.g., White & Rees 1978; Fall & Efstathiou 1980). The hierarchical and infall models predict comparable  $r_d$ , and in a cold collapse scenario (Vand 1959) since angular momentum is conserved, immediately after the collapse the gas is supported by rotation so that it quickly collects in the region where a disk forms with substantially higher rotation velocity than the halo is to form. A large  $r_d$  disk forms when the disk mass is smaller than the halo mass over the disk region, and vice versa: a small  $r_d$  disk forms when the mass of the disk dominates the mass of the halo in any part of the disk. The self-gravitating disk will also modify the shape of the rotation curve near the center of a galaxy (Gelato & Sommer-Larsen 1999) and the disk is then set to undergo secular evolution. The natural implication of this scenario is that the  $r_d$  dictates the life of a disk, and consequently, is a prime factor which determines the position of a galaxy on the Hubble sequence.

One prominent indicator for a smooth transition from spiral toward S0 and disk ellipticals is provided by the  $r_d - \mu_0$  diagram, where  $\mu_0$  is the central surface brightness of the disk, where spirals and S0s are mixed and disk ellipticals populate the upper left corner of this diagram (Kent 1985; Scorza & Bender 1995). Another instructive relation is the Freeman Law (Freeman 1970) which relates  $\mu_0$  to the galaxy morphological type. Although, some studies have found that the Freeman Law is an artifact due to selection effects (e.g., Disney 1976; Bothun 1981; Scorza & van den Bosch 1998), recent work has shown that proper consideration of selection effects can be combined with kinematic studies to explore an evolutionary sequence (e.g., van der Kruit 1987, 2002; de Jong 1996; Koda et al. 2000).

In the comparison between theory and observations, two issues complicate matters. On the theory side, mapping between initial halo angular momentum and  $r_d$  is not trivial, partly due to the fact that commonly the initial specific angular momentum distribution of the visible and dark component favors disks that are more centrally concentrated than exponential (e.g., de Jong & Lacey 2000; van den Bosch 2001). Observationally, comprehensive samples have yet not been studied, and the mixture of different species such as low and high surface brightness galaxies complicate the measurements of disk parameters (McGaugh et al. 1995; Graham & de Blok 2001).

Here, we analyze the  $r_d$  and  $\mu_0$  from an unprecedentedly large sample of bright disk galaxies in the nearby universe ( $z < 0.3$ ) using the Sloan Digital Sky Survey (SDSS) Data Release 6 (York et al. 2000; Adelman-McCarthy et al. 2008). As detailed in Fathi et al. (2010, hereafter F10), both parameters were robustly determined for 30,374 galaxies in the  $r$  band (only 29,955 used here as described in Section 2), whereas subsets of this sample are comparable to the one presented here. In the  $u$  band,  $r_d$  and  $\mu_0$  were robustly derived for a few hundred objects and therefore, not considered here. Throughout this Letter, unless otherwise stated, we use disk parameters in order to provide a comprehensive test bed for forthcoming cosmological simulations (or analytic/semi-analytic models) of galaxy formation and evolution.

## e.g. 2.) VO School participant project



1 fits file with 4 extensions x 4 points  
on sky x 2 filters x 13 epochs  
= 416 tables

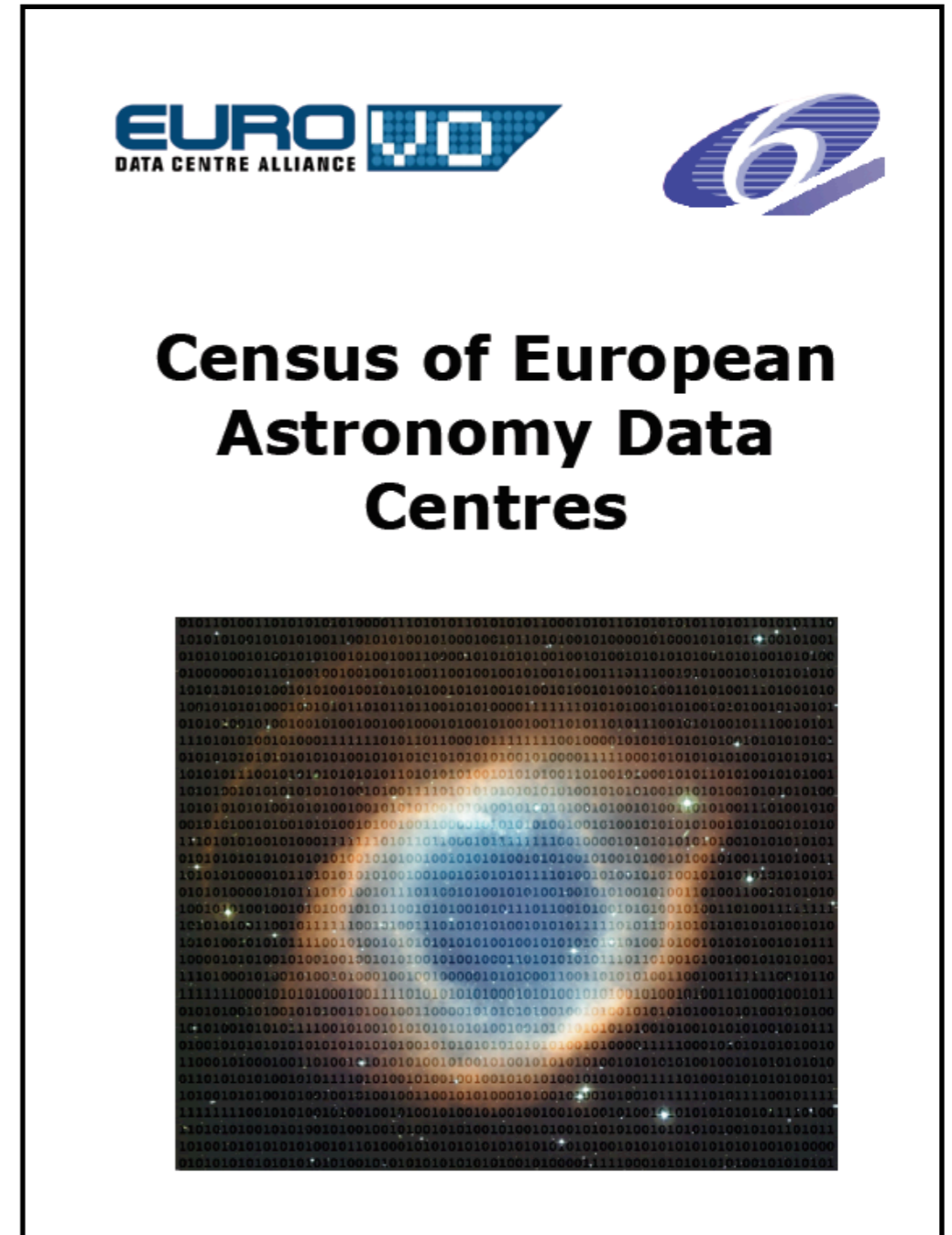
= **A LOT OF DATA!!!**

which sat on my laptop for more than 1 year... until... the VO School 2010!

# Assisting VO uptake

*CDS contributions to Data Centre Alliance project*

- Workshop tutorials
  - Scientific rationale
  - SAADA (w/L. Michel)
  - UCD tools
- Census



# Census summary

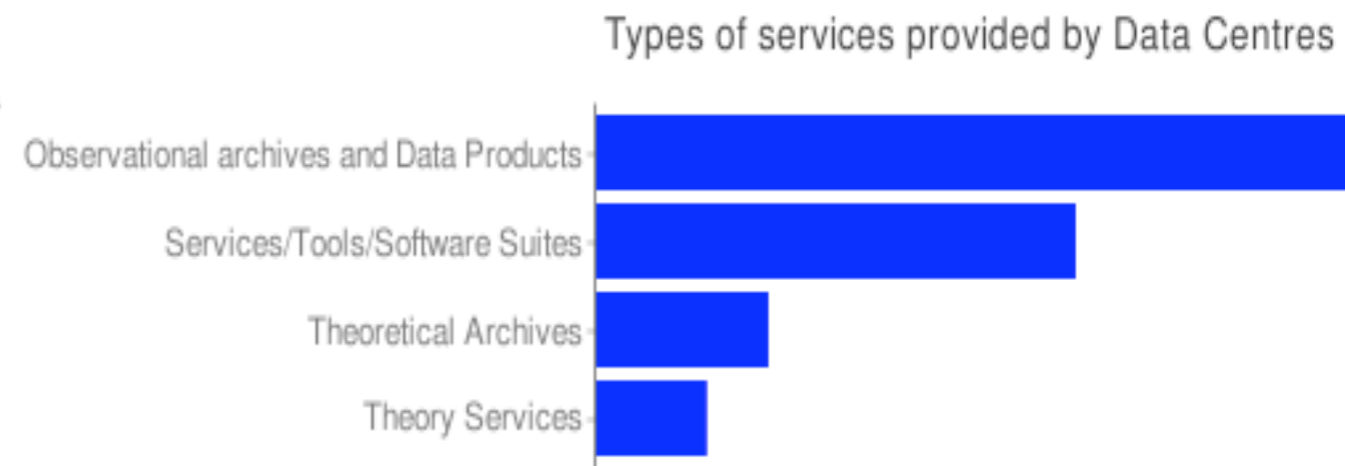
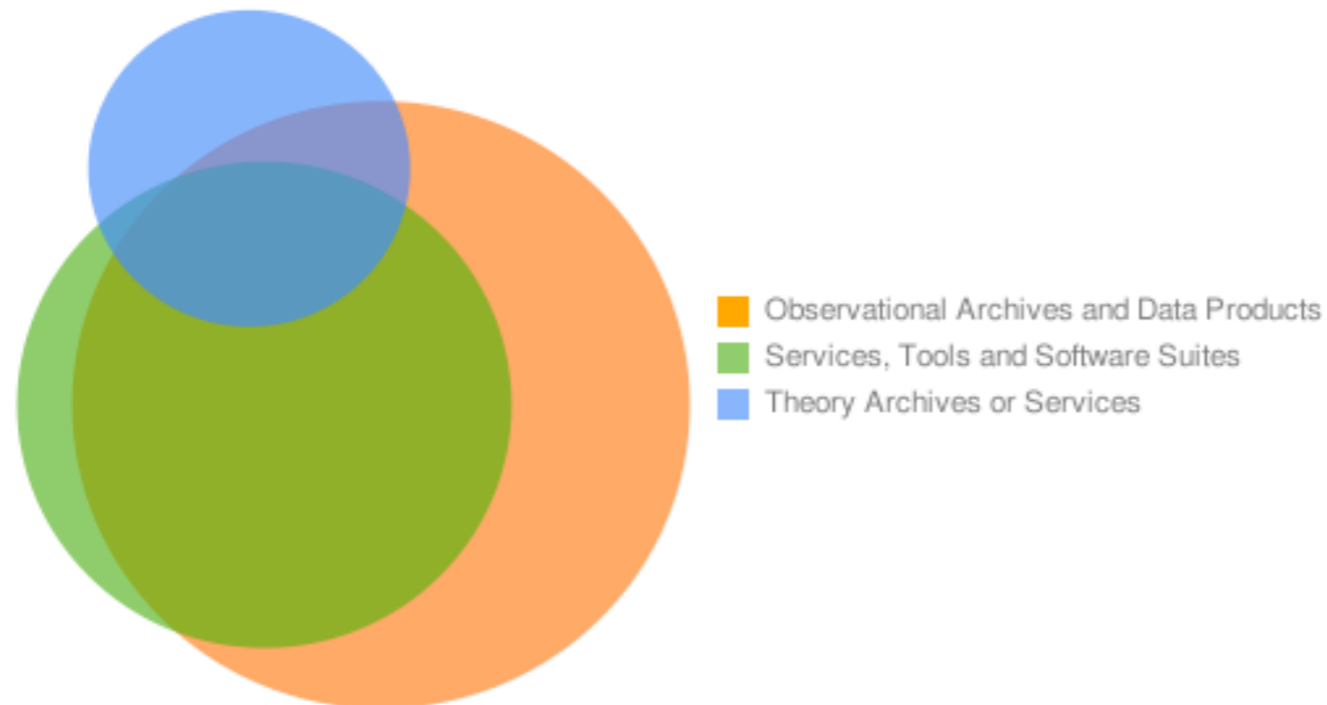
68 Data Centres

134 Observational Archives

66 'Service/Tool/Software Suite'

24 Theory Archives

8 Theory Services



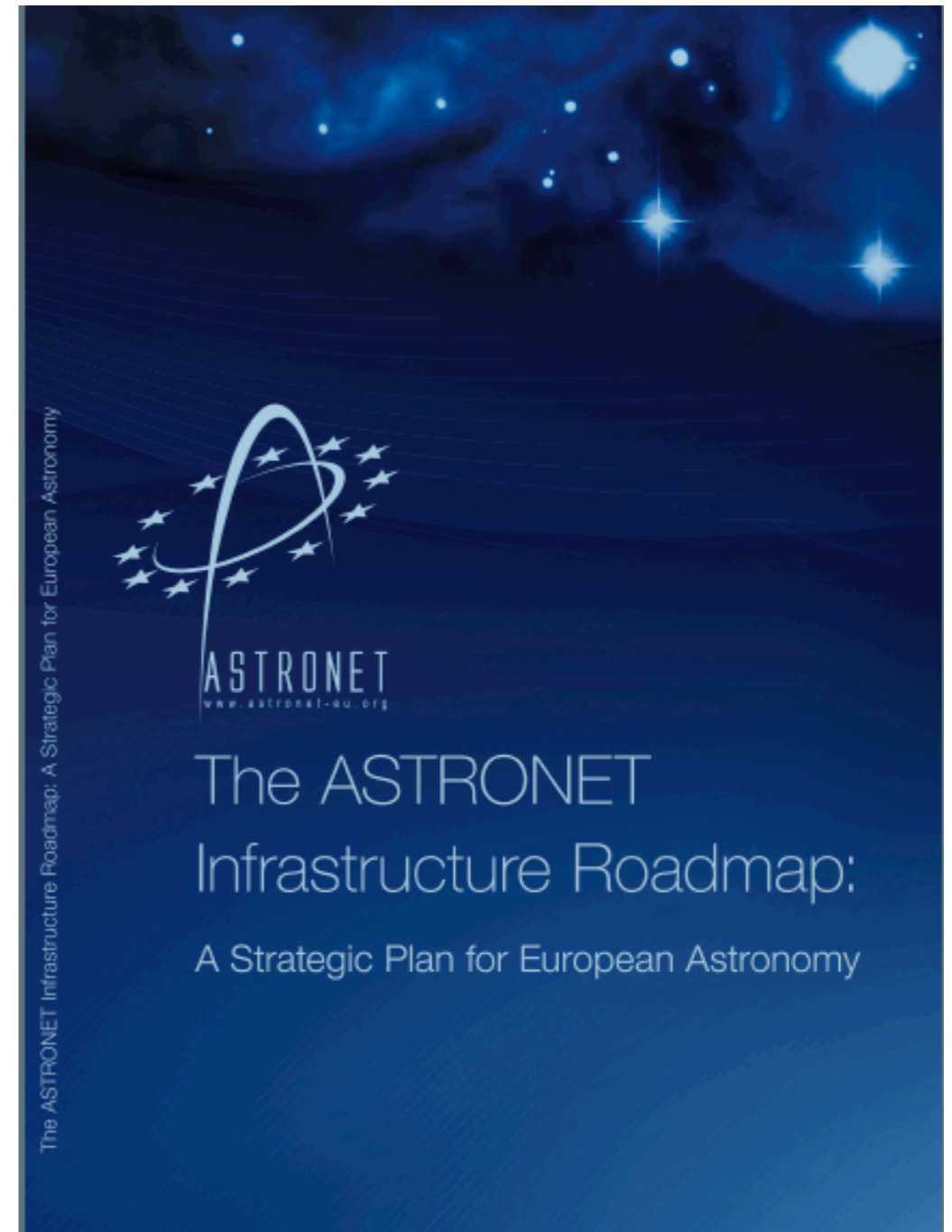
Diversity in terms of 'scale, content and function'

# Implications for VO

- Maintain coordination of VO developments with Data Centres
- Ensure VO publishing is not significantly more difficult than web publishing
- Accommodate diversity
- Increase emphasis on 'Science ready data'
- The census identifies Data Centres who will lead up-take of VO as Euro-VO moves into operational phase

# VO as Infrastructure

- VO in the ASTRONET Infrastructure roadmap
- recommendations for VO compliance
- community validation of VO approach



Panel D members: Allen, Padovani