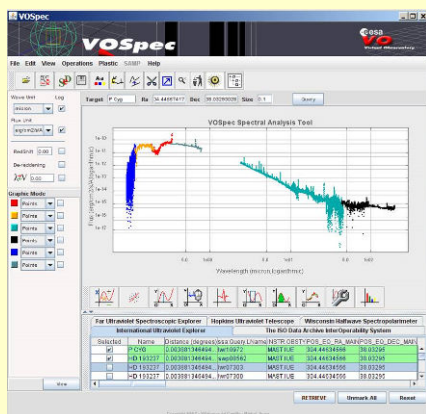




Virtual Observatory Science Gateways in Astronomical and Astrophysics

Christophe.Arviset@esa.int

Science Archives and Computer Engineering Unit
Science Operations Department
ESA/ESAC – Madrid, Spain



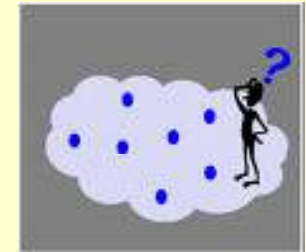


The VObs Concept for Astronomy

- ❑ WEB : all documents in the world inside your PC
- ❑ VObs : all astronomical data in the world inside your PC

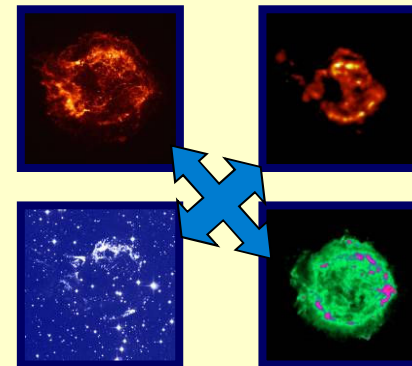
- ❑ What the VObs is NOT:

- A centralized database of all astronomical data
- A “monolith” software system
- A peer-to-peer system



- ❑ The VObs framework

- Agreed *standards*
- Inter-operable *data collections*
- Inter-operable *software modules*





VObs : What is needed ?

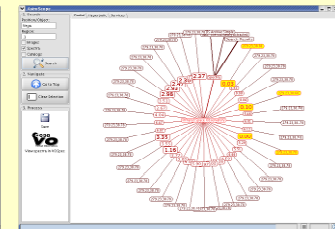
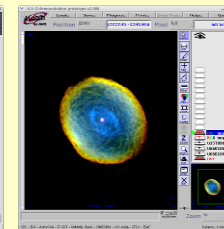
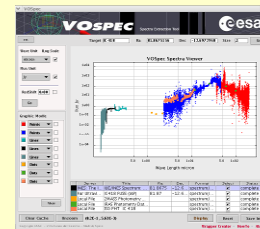
- ❑ Global standards
 - Transparent inter-operability for the end users

- ❑ Well funded data centres
 - Space agencies, Ground based telescope, Labs

- ❑ Working data services
 - Data and *Metadata* remains the key !

- ❑ VObs aware client tools and portals
 - Bring the data to the users

- ❑ VObs aware data mining services
 - New way of making science





Defining Standards for the A&A VObs

□ Working Groups defining interoperability standards for the VObs

- Data Access Layer
- Data Model
- VO Query Language
- Registry of VObs Resources
- VOTable
- Semantics
- Grid and Web Services



□ Strong involvement of Europe through

- National institutions
- International organizations (ESA, ESO)
- EC funded project – EuroVO AIDA



□ Link with other science communities

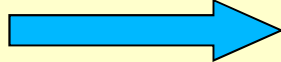
- Planetary, Solar Systems



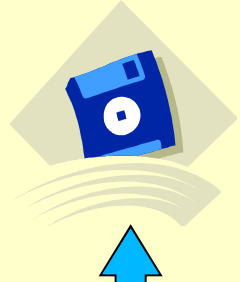
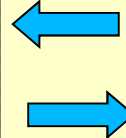
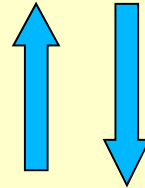
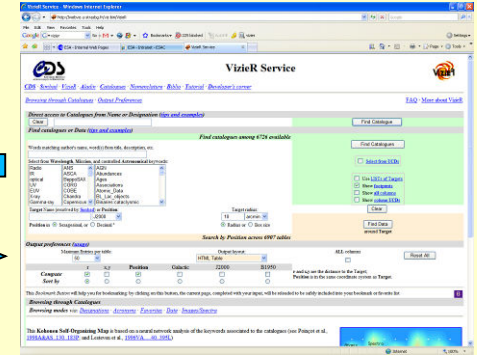
Publishing Data on the Internet

WEB SERVER

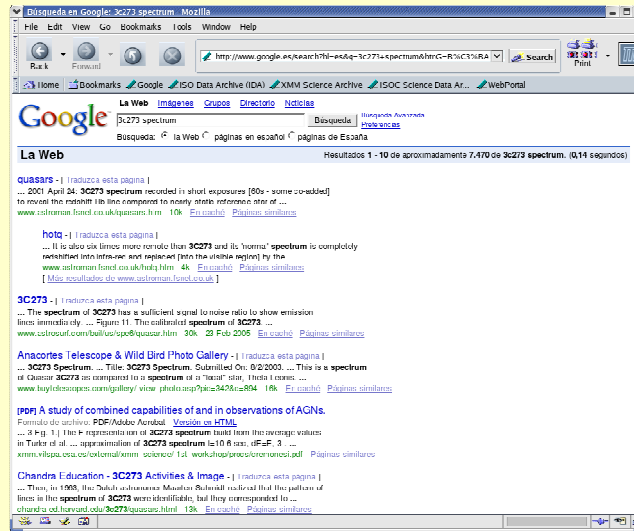
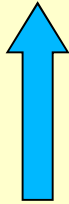
Publish Document



Robots makes Inventory Server



Create document





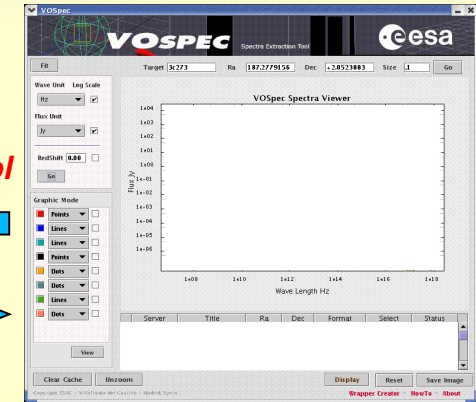
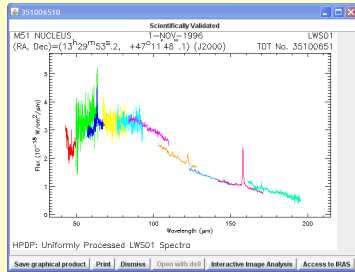
Publishing Data in the VObs

VObs Spectra SERVERS

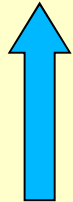
Create VObs Service

VObs Spectra Data Model

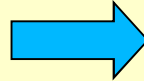
VObs Spectra Access Protocol



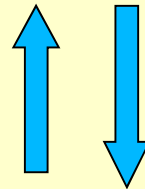
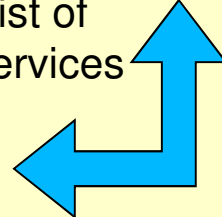
Produce Data



Register VObs Service



Find List of VObs Services



EURO VO
AIDA Astronomical Infrastructure for Data Access

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

Search Resources

Search Results 1 - 7

The ISO Data Archive InterOperability System (ISO SSAP) [XML | EDIT | CLONE]
IVOA Identifier: /ivo://nevis/iso [CatalogService] [ProtospectralAccess]
The Infrared Space Observatory (ISO) was the world's first true writing infrared observatory. Equipped with four highly sophisticated and versatile scientific instruments, it was launched by Ariane in November 1995 and provided astronomers world-wide with a facility of unprecedented sensitivity and capabilities for a detailed exploration of the universe at infrared wavelengths. The two spectrometers (SWS and LISIS), a camera (DISCAM) and an imaging photo-spectrometer (ISOPHOT) jointly covered wavelengths from 2.5 to around 240 microns with spatial resolutions ranging from 1.3 arcseconds (at the shortest wavelengths) to 90 arcseconds (at the longer wavelengths). Its 60 cm diameter telescope was cooled by superfluid liquid helium to temperatures of 2.4 K.
Published by: European Space Agency on the 2005-08-02T00:00:00 and last updated on the 2009-04-08T12:00:00

Epic Spectra SSAP of the SSC Interface for the XMM/Newton Catalogue [XML | EDIT | CLONE]
[XCATDBI:SSA]
IVOA Identifier: /ivo://xcatdbi/2xmnm/epicssa [CatalogService] [ProtospectralAccess]
XMM/Newton is the incremental second catalogue of serendipitous X-ray sources from the European Space Agency's (ESA) XMM-Newton observatory. The catalogue has been constructed by the XMM-Newton Survey Science Centre (SSC) on behalf of ESA. 96176 EPIC spectra related to this catalogue have been made available. Spectra returned by the service are not calibrated but are returned with calibration files.
Published by: Observatory of Strasbourg, SSC Team on the 2006-10-07T00:00:00 and last updated on the 2009-06-29T20:48:18Z

XMM-NewtonMasterLogPublicArchive [XMM] [CHECK | XML | EDIT | CLONE]
IVOA Identifier: /ivo://heasarc/xmm/master [CatalogService] [CmsSearch]
This is the XMM-Newton Master Catalog and Public Archive table which has been created from information supplied to the HEASARC by the XMM-Newton Project. It is periodically updated as necessary. This database table contains the list of observations which have already been made by the XMM-Newton observatory, as well as those which are scheduled to be made in the near future (usually a few weeks to a month ahead of the present). It does not contain observations which are scheduled to be performed further in the future (see the ESA XMM-Newton Advanced Observations Plan at: http://xmm.vilspa.esa.eu/center/xmm_observ_adv_obs_plan.shtml)
Illumination: /ivo://heasarc/xmm/master/log_public_archive_gain_observed_for_this_log does it contain accepted observations which have not yet been scheduled. The list of all accepted XMM-Newton observations, including a number of ones which are unlikely to ever be carried out, such as accepted priority C targets, is available in the XMM/Newton table. This table includes entries for both pointed data and for data obtained during space-swift slews. The slew observations all have obid values beginning with the digit 9 and, because they were not made at a fixed position, lack any positional information such as RA and Declination. Some XMM-Newton observations for which the archived data has become publicly available as indicated by the public_obs parameter value, i.e., the proprietary period has expired, are not currently available at the HEASARC. Such cases will have values of 'N' for the data_in_heasarc parameter. These datasets in most cases are available at the ESA XMM-Newton Data Archive at: [http://xmm.vilspa.esa.eu/ftp/](http://xmm.vilspa.esa.eu/ftp/http://xmm.vilspa.esa.eu/ftp/) For much more detailed information on the XMM-Newton instruments and their operation, please refer to the XMM-Newton User Handbook at: <http://heasarc.gsfc.nasa.gov/docs/xmm/uhb/>

Euro-VO Registry of VObs resources

VObs Science Gateway

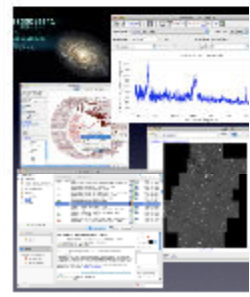


The Euro-VO projects: [VOTECH](#) [Euro-VO](#)

Science

Software

- [Recipes User Manual](#)
- [Scientific Workflows](#)
- [AIDA Research Initiative](#)
- [Scientific Papers](#)
- [Science Advisory Committee](#)



Application / Version (in alphabetical order)	
Aladin v6.011 (September 2009)	
Datascopes v2.1 (March 2007)	
Montage	
Octet	
Open SkyQuery	
SkyView	
SPLAT 3.9.0 (May 2009)	
Specview 2.14.4 (August 2009)	
TOPCAT/STILTS 3.4-3/2.0-4 (July 2009)	
VisIVO 1.5.7.1 (May 2009)	
VOConvert 1.0 (June 2006)	
VODesktop 1.3 (June 2009)	
VOEventNet	
VOPlot 1.5 (May 2009)	
VOSTat 1.1 (November 2008)	
VOSA 1.0.2 (March 2009)	
VOSED 1.3 (July 2009)	
VOServices (Footprint, Spectrum, Filters, ...) 2.1.0.0	
VOSpec V5.5 (September 2009)	
WCSFixer	

Functionality
Search for Images: Aladin, Datascope, SkyView, VODesktop
Search for Spectra: Aladin, Datascope, SPLAT, Specview, VOServices, VOSpec
Search for Catalogues: Aladin, Datascope, TOPCAT, VODesktop
Image visualisation: Aladin, SkyView
Spectra visualisation: SPLAT, Specview, VOServices, VOSpec
Catalogues visualisation: Aladin, TOPCAT, VOPlot
Cross-correlation: Aladin, Open SkyQuery, STILTS, TOPCAT
Scatter, 3D plots and histograms: TOPCAT, VOPlot
Statistics: VOSTat
Footprint Service: Aladin, VOServices
Table format conversion: TOPCAT, VOConvert
Filter curves: VOServices
SED building: VOSA, VOSED, VOSpec
Fixing WCS: Aladin, WCSFixer

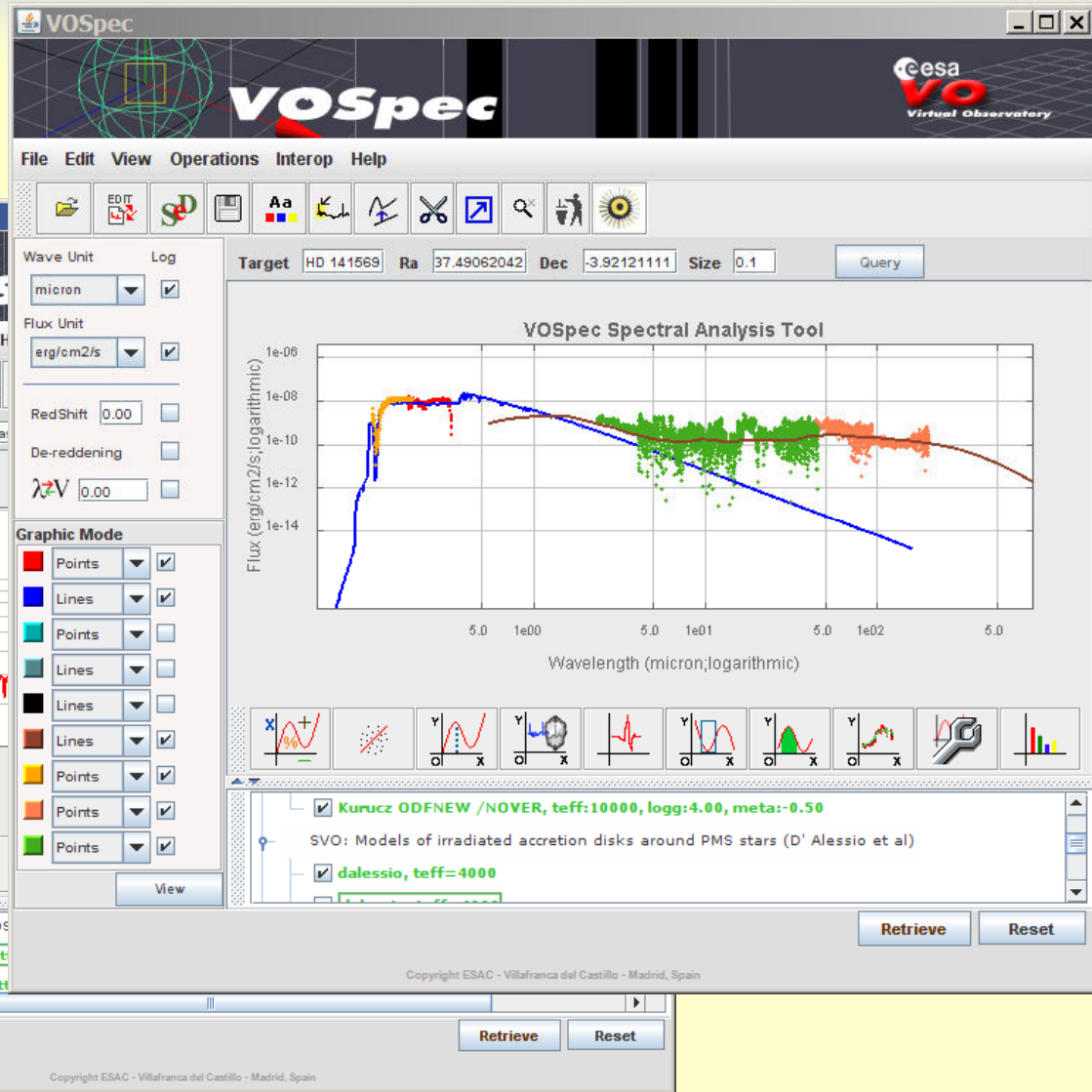
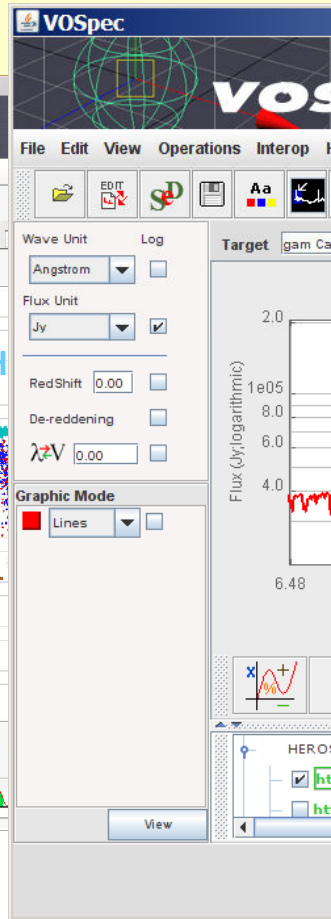
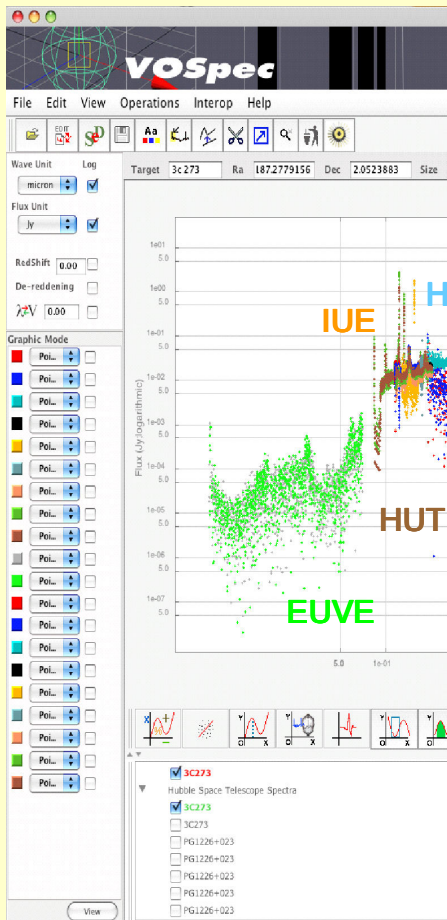
Other VO-compliant tools	
DS9: Image visualisation	
GOSSIP: SED fitting	
Mirage: Table visualisation	
VirGO: Search for Images and Spectra	
Browse the Registries	
EURO-VO Registry	
AstroGrid Registry	
NVO Registry	
Manuals, Tutorials, How-tos	
Aladin User manual	
Datascopes how to	
Montage help	
Open SkyQuery help	
SkyView documentation	
Specview examples	
SPLAT documentation	
STILTS documentation	
TOPCAT documentation	
VisIVO how to	
VODesktop how to	
VOSpec User manual	

<http://www.euro-vo.org/pub/fc/software.html>



ESA VOSpec : Spectral Analysis Tool

Multi-wavelength spectral analysis tool developed by ESA-VO





Aladin (CDS)

- ❑ Interactive software sky atlas
- ❑ Visualize digitized astronomical images,
- ❑ Superimpose entries from astronomical catalogues

Aladin v6.0

File Edit Image Catalog Overlay Tool View Interop Help

Location: 07:18:58.50 -13:17:09.0 ICRS Pixel: 10159 full

NGC2359

logHST UCAC2 Simbad SDSS DR7 r SERC.ER-DSS2.6 RGB img SERC.ER-DSS2.6 SERC.J-DSS1.62

Zoom 1/2x

OTYPE (14 items)

MAIN ID	OTYPE	RA	DEC	COO ...	COO ...	C...	PMRA	PMDEC	B	V
ND-A2.0 0750-03882...	X	07 18 13.68	-13 24 03.0						18.1	
S 07143-1315 AB	**	07 18 55.30	-13 25 51.0	3000	3000	5			9.6	9
C 5407-1067-1	Star	07 18 58.11	-13 17 10.3	45.13	32.19	0	4.4	0.6	11.03	11
C 5407-2513-1	Star	07 19 16.91	-13 21 28.7	64.95	58.44	0	-1.8	-3.6	11.6	11
811 I-88	Em*	07 18 58.50	-13 17 09.0							

simbad - OTYPE - Object type

Aladin script commands for advanced usage [Tool>Script console]

94 sel / 432 src 39Mb

Aladin v6.0

File Edit Image Catalog Overlay Tool View Interop Help

Location: 00:42:04.20 +41:11:41.0 ICRS Pixel: unknown full

Filter2 UCAC2 HST F606W Mosaic F606Wa F606Wb F606Wc RGB img GaleX FU GaleX NU

Zoom 1/2x

TYC1	TYC2	T	pmRA	pmDE	Bmag	Vmag	HIP	RA (ICRS)	DE (ICRS)
2801	1169	1	7.8	-4.2	12.375	11.865	11.80523889	40.83714611	
2805	39	1	-2.1	-4.5	11.466	9.430	11.83447778	41.29891750	
2805	26	1	-6.7	-1.7	12.603	12.405	11.83851111	41.59899500	
2805	412	1	12.3	-6.6	13.385	12.159	11.88197917	41.64164778	
2801	1384	1	10.6	-4.1	11.576	10.841	11.88240278	41.10554667	
2805	507	1	6.2	-2.8	12.686	10.833	11.90623472	41.50409500	

TIP: In the crowded regions, move the catalog plane under the image plane

233 sel / 233 src 279Mb

US NVO DataScope



Data found(376)
 No data (5397)
 Errors(30)
 Waiting(0)
 100% complete

Position:m31
 Resources/hits: 5803/344330
 Cache age:19.472 hours

- [Summary](#)
[Resources](#)
[Data Table](#)
[No Data](#)
[Still Processing](#)
[Errors](#)
[Help](#)

Matching Resources

These resources had data in the specified region. Click on the

checkbox to select the data for download or analysis.
name to view the catalog data and select files.
? to see the metadata for the resource.

When the number after the name is given as *nn/mm* you have selected *nn* of the *mm* files indexed in that resource. Click on the resource name to select files within such resources. Download selected resources from the Summary tab.

<input type="checkbox"/> Major Multiwavelength Services					
<input type="checkbox"/>	<input type="checkbox"/> NED(images) (0/136) ?	<input type="checkbox"/> NED(sources) (1490) ?	<input type="checkbox"/> Simbad (4291) ?	<input type="checkbox"/> SkyView (0/39) ?	
<input type="checkbox"/> Images (Data in one or more FITS files)					
<input type="checkbox"/> Multi	<input type="checkbox"/> CADC (0/3177) ?	<input type="checkbox"/> CADC/HST (0/452) ?	<input type="checkbox"/> DSS ESO (0/8) ?	<input type="checkbox"/> HST/SIAP/PREVIEW (0/445) ?	<input type="checkbox"/> MAST Scrapbook (0/129) ?
	<input type="checkbox"/> MAST-Scrapbook (0/80) ?				
<input type="checkbox"/> Optical	<input type="checkbox"/> CADC/CFHT (0/2710) ?	<input type="checkbox"/> DSS (0/1) ?	<input type="checkbox"/> DSS1B (0/1) ?	<input type="checkbox"/> DSS1R (0/1) ?	<input type="checkbox"/> DSS2 (0/3) ?
	<input type="checkbox"/> HAlpha (0/1) ?	<input type="checkbox"/> HST Previews (0/734) ?	<input type="checkbox"/> NEAT (0/1) ?	<input type="checkbox"/> NOAO (0/168) ?	
<input type="checkbox"/> Radio	<input type="checkbox"/> GB6 (0/1) ?	<input type="checkbox"/> NVAS (0/46) ?	<input type="checkbox"/> NVSS (0/1) ?	<input type="checkbox"/> VLSS (0/1) ?	<input type="checkbox"/> WENSS (0/1) ?
<input type="checkbox"/> Infrared	<input type="checkbox"/> 2MASS (0/3) ?	<input type="checkbox"/> 2MASS ASKY AT (0/18) ?	<input type="checkbox"/> 2MASS QL (0/18) ?	<input type="checkbox"/> CADC/IRIS (0/4) ?	<input type="checkbox"/> IRAS (0/4) ?
	<input type="checkbox"/> IRIS (0/4) ?	<input type="checkbox"/> ISSA (0/4) ?	<input type="checkbox"/> LGA (0/3) ?	<input type="checkbox"/> MSX (0/4) ?	<input type="checkbox"/> SFD100m (0/1) ?
	<input type="checkbox"/> SFDdust (0/1) ?				
<input type="checkbox"/> UV	<input type="checkbox"/> EUVE (0/4) ?	<input type="checkbox"/> GALEX (0/2) ?	<input type="checkbox"/> GALEX_Atlas (0/2) ?	<input type="checkbox"/> GalaxFar (0/1) ?	<input type="checkbox"/> GalaxNear (0/1) ?
	<input type="checkbox"/> HST.maoz_atlas (0/1) ?	<input type="checkbox"/> UIT (0/15) ?	<input type="checkbox"/> WFC (0/2) ?		
<input type="checkbox"/> X-ray	<input type="checkbox"/> Chandra (0/250) ?	<input type="checkbox"/> HRI (0/1) ?	<input type="checkbox"/> PSPC1 (0/1) ?	<input type="checkbox"/> PSPC2 (0/1) ?	<input type="checkbox"/> PSPC2cnt (0/1) ?
	<input type="checkbox"/> PSPC2exp (0/1) ?	<input type="checkbox"/> RASS (0/1) ?	<input type="checkbox"/> RASS3 (0/3) ?	<input type="checkbox"/> RASSALL (0/3) ?	<input type="checkbox"/> ROSAT SIA (0/899) ?
<input type="checkbox"/> Other	<input type="checkbox"/> CADC/JCMT (0/11) ?	<input type="checkbox"/> HST/SIAP/PREVIEW (0/445) ?	<input type="checkbox"/> ISO SIAP (0/34) ?	<input type="checkbox"/> XMM-Newton SIAP (0/34) ?	<input type="checkbox"/> voparis (2) ?
<input type="checkbox"/> Lists of Observations (Data in one VOTable)					

US NOAO VObs Portal



>sky< time xmatch siap query cart log in

persistence: on

contents
tutorial
faq
email us

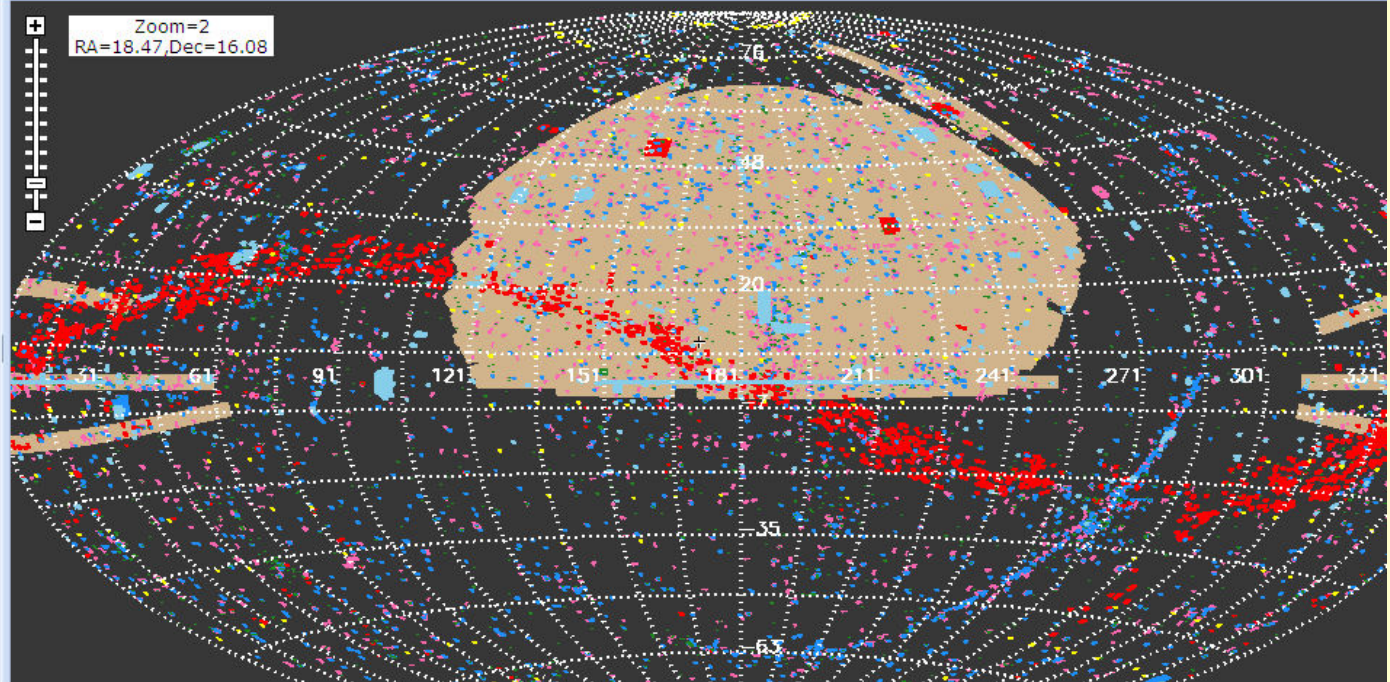
NOAO VO Portal v6.0.4
A web application for the VO

- Description
- Add a Marker and Crossmatch
- Zoom to Object, Region or Sky Coordinate
- Display and Search by Archive

- Cart
- SDSS
- CHANDRA
- NSA
- XMM
- HST
- INT
- GALEX

Search

Search Region on the Sky:
0.00 < RA < 360.00
-90.00 < DEC < 90.00



Current coordinate format: decimal degrees
Add selected rows to cart | View selected rows in VOPlot | See Data Grid as VOTable

(0) + - ! *	URL ⁱ	Preview ⁱ	Live Query ⁱ	RA ⁱ	Dec ⁱ	Filter ⁱ	Obs. Date ⁱ	Telescope ⁱ	Survey ⁱ	Instrument ⁱ	Archive ⁱ	Seeing ⁱ	Depth ⁱ	Exp. Time ⁱ
<input type="checkbox"/>	Retrieve	Preview	Search	153.151993	11.3709002	r prime Mosaic	unknown	KPNO 4.0 meter tel	Deep Ecliptic	CCDMosaThin1	NSA	1.4	23.7	300.0
<input type="checkbox"/>	Retrieve	Preview	Search	153.151993	11.2203999	r prime Mosaic	unknown	KPNO 4.0 meter tel	Deep Ecliptic	CCDMosaThin1	NSA	1.4	23.6	300.0
<input type="checkbox"/>	Retrieve	Preview	Search	153.151993	11.0683002	r prime Mosaic	unknown	KPNO 4.0 meter tel	Deep Ecliptic	CCDMosaThin1	NSA	1.4	23.6	300.0
<input type="checkbox"/>	Retrieve	Preview	Search	153.151993	10.9177999	r prime Mosaic	unknown	KPNO 4.0 meter tel	Deep Ecliptic	CCDMosaThin1	NSA	1.4	23.4	300.0
<input type="checkbox"/>	Retrieve	Preview	Search	152.848999	11.3625002	r prime Mosaic	unknown	KPNO 4.0 meter tel	Deep Ecliptic	CCDMosaThin1	NSA	1.4	23.5	300.0
<input type="checkbox"/>	Retrieve	Preview	Search	152.848007	11.2117004	r prime Mosaic	unknown	KPNO 4.0 meter tel	Deep Ecliptic	CCDMosaThin1	NSA	1.4	23.6	300.0
<input type="checkbox"/>	Retrieve	Preview	Search	152.848007	11.0591002	r prime Mosaic	unknown	KPNO 4.0 meter tel	Deep Ecliptic	CCDMosaThin1	NSA	1.4	23.9	300.0

UK AstroGrid VODesktop



VO Explorer - LEDAS

File Edit View Resource Window Help

- Resource Lists
 - Examples
 - Radio & X-ray
 - IR Redshift
 - Recent Changes
 - Solar
 - VOEvent
 - ROE Holdings
 - XMM-DR5
 - X-ray clusters
 - 2mass-2xmm-DR6
 - LEDAS+XMM
 - test
 - Copy of test
 - XMM at ROE
 - XMM-DR6
 - LEDAS
 - all XMM

Actions

- Query
- About

Selection: CatalogService

- Further Info
- Email Curator

Astroscope - 482 Cat. Object Services

File Edit View History Result Window Help

Search for

- Cat. Objects Images
- Spectra Timed Data

At

Position (RA,Dec) or Object Name

210.802125,+54.348083

Search Radius (degs/arcsecs)

0.010000

Degrees Sexagesimal

Navigate

Search

Go To Top Clear Selection

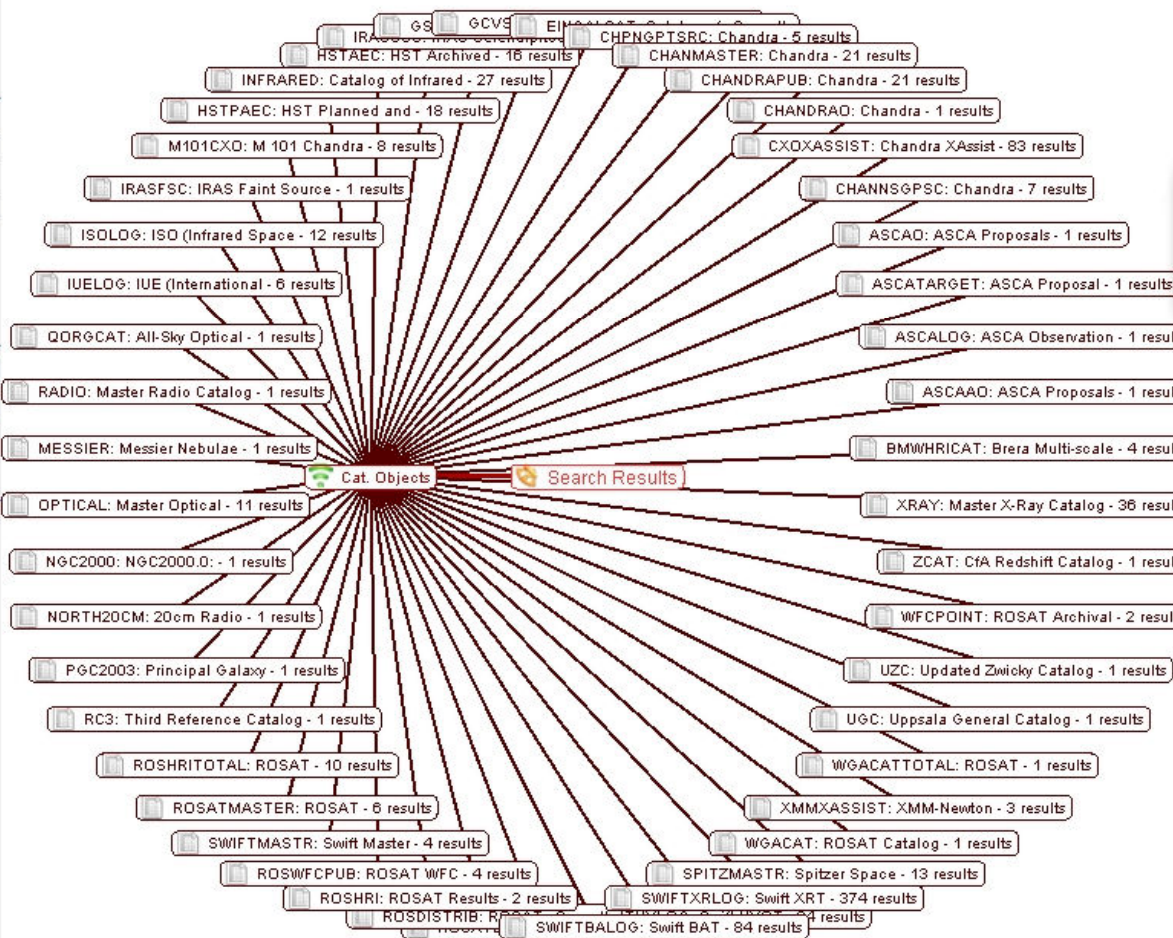
Process

Actions

- View
- Download...

About

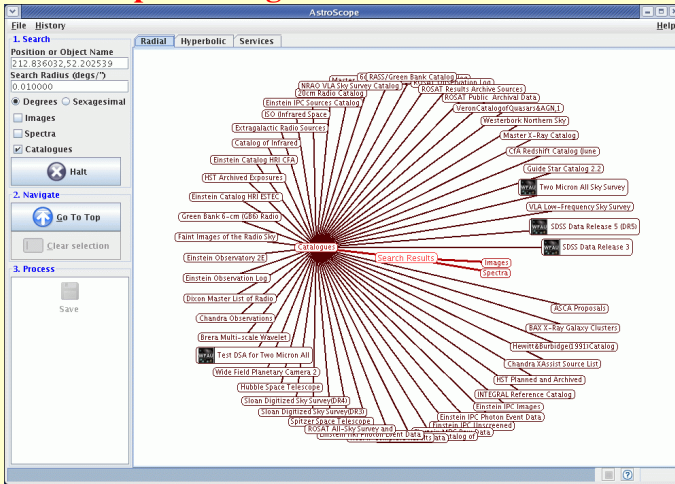
application/x-votable+xml



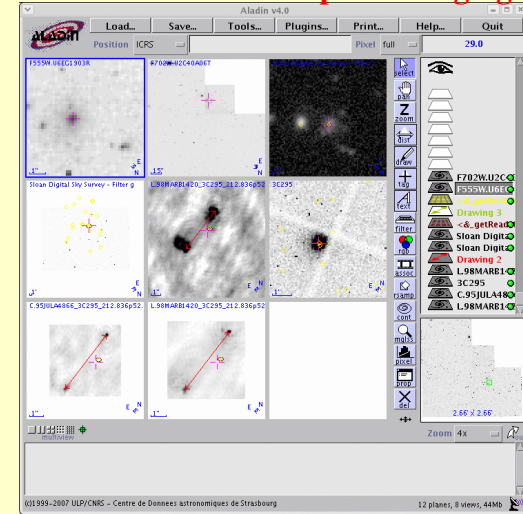
The power of applications interoperability in the VObs



AstroScope: catalogue search

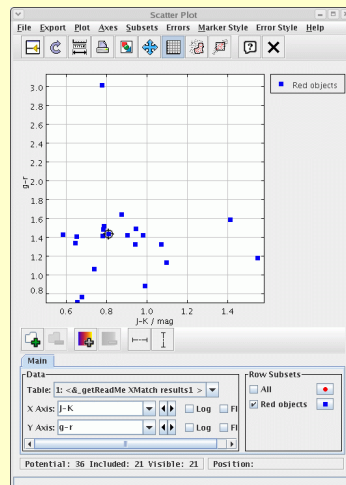


Aladin: multipanel imaging

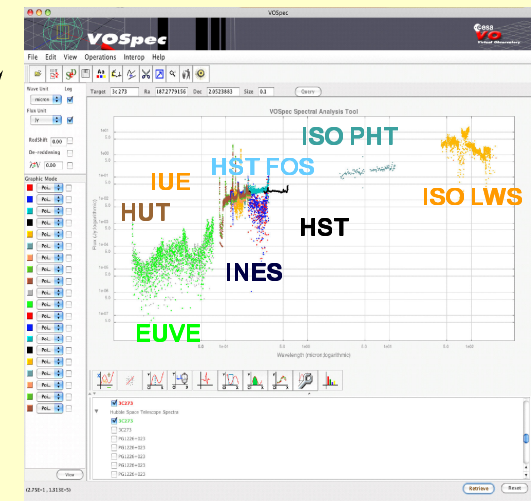


(SAMP)
Simple Application
Messaging Protocol

TOPCAT: tabular data plotting/manipulation



VOSpec: generation of SEDs





New "players" in the game ?

The screenshot shows the Google Earth interface with the 'Hubble Studies' collection selected. A context menu is open over the 'Hubble's Largest Galaxy Port' thumbnail. The menu options are:

- Name: Hubble's Largest Galaxy Port
- Information
- Imagery
- Virtual Observatory Searches
 - NED
 - SDSS Search
 - NVO Directory/Catalog Search
- Set as Foreground Imagery
- Set as Background Imagery
- Properties
- Copy Shortcut

The main view shows a large, detailed image of a galaxy. The interface includes a search bar, a toolbar, and a sidebar with 'Places' and 'Layers' sections. The 'Layers' section is expanded to show 'Sky Database' and various sky-related layers. The bottom of the interface features a 'Look At' section with a dropdown menu set to 'Sky' and 'Digitized Sky Survey (Optical)', an 'Info' icon, and a 'Image Crossfade' slider. The bottom right corner shows a compass, a map of the constellation Ursa Major, and coordinates: RA: 14h01m26s, Dec: 54:22:00.



Conclusions

- ❑ VObs requires international standards for interoperability between astronomical resources
- ❑ Data Centres remain the key as they provide data, metadata and services
- ❑ VObs Science Gateways bring these transparently to the end users enabling new Science !

- ❑ Special thanks to VObs applications developers and scientists

