

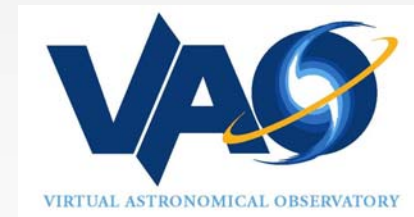
Science Initiatives of the US Virtual Observatory

Robert Hanisch
Space Telescope Science Institute
Director, Virtual Astronomical Observatory



US VO efforts

- National Virtual Observatory (NVO) development effort, 2001-08
 - \$14M, 17 organizations
 - NSF Information Technology Research program
- Virtual Astronomical Observatory (VAO) operational facility, 2010-2015
 - Funding is \$5.5M/year for five years, subject to annual performance review, 9 organizations
 - \$4M/year from NSF/AST
 - \$1.5M/year from NASA
 - Covers ~27 FTE over the nine organizations
- VAO is managed by the VAO,LLC (limited liability company) co-owned by AUI (operates NRAO and ALMA) and AURA (operates NOAO and STScI)
 - VAO has its own Board of Directors (J. Gallagher, chair)
 - R. Hanisch, director; B. Berriman, program manager, J. Lazio, project scientist, A. Szalay, technology advisor
 - G. Fabbiano, chair of Science Council





US VAO

http://www.usvao.org/

Directories News STScI Traffic Crosswords NWS Glenn Dale IVOA NVO Readability VAOTwiki

US VAO

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The Virtual Astronomical Observatory: Enabling Science

On May 15, 2010, the NSF and NASA announced a cooperative agreement to create a new research facility for astronomy: the Virtual Astronomical Observatory. The near-term goal of the VAO is to put useful and efficient tools in the hands of research astronomers as soon as possible. [more](#)

Research Initiatives

The VAO has identified eight major research initiatives that are of high priority. These are:

- ▶ A data discovery portal.
- ▶ Time series data analysis.
- ▶ Large-scale cross-match capability.
- ▶ Spectral energy distribution tools.
- ▶ Statistical analysis and data mining.
- ▶ Large-scale image display and visualization.
- ▶ Preservation and curation of data from journal articles.
- ▶ Integration of the desktop research environment with worldwide data sets and tools.

Near-Term Goals

Of these, the following four are scheduled for deployment in the first year of operation:

- ▶ An advanced portal for data search and discovery of global astronomical resources, and providing easy access to image visualization, maps of spatial coverage, and links to other web-based science applications.
- ▶ Generation and analysis of spectral energy distributions, including editing and visualization tools.
- ▶ Cross-match capabilities across catalogs containing up to one billion rows.
- ▶ On-line periodogram calculations and light-curve characterization tools for over 2.5 million time-series data sets.

What You Can Do Now

The VAO is one of a number of international projects integrating astronomy data access and electronic resources. You may explore current VO capabilities through a sample of tools and services now available:

[try the VO now](#)

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Science initiatives

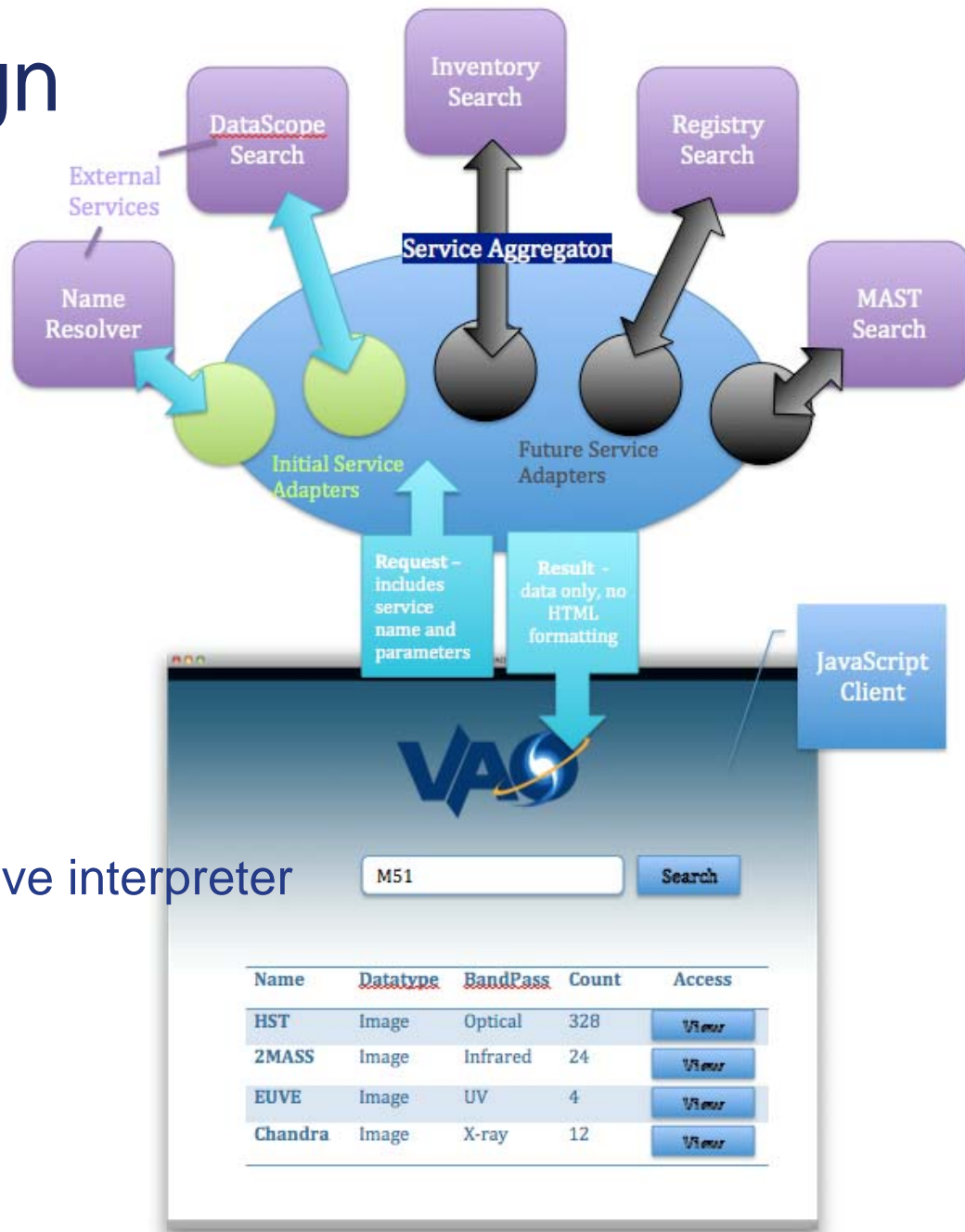
The VAO has selected seven science initiatives that were endorsed by the Science Council as providing maximal scientific impact in the astronomy community:

1. Development of a dedicated VAO Portal (Data Discovery Tool)
 2. Scalable cross-matching between catalogs of sources
 3. Building and analyzing spectral energy distributions (SEDs)
 4. Time domain astronomy: (a) Periodograms and light curve analyses; (b) Transient event services
 5. Data linking and semantic astronomy
 6. Desktop tool integration
 7. Data mining and statistical analysis
- These initiatives are complementary to VO applications and tools developed throughout the IVOA (Aladin, TOPCAT, VOSTat, etc.)
 - Exploit SAMP for applications interoperability





Portal design concept



context sensitive interpreter





Data discovery tool



Data Discovery

http://portal.usvao.org/portal/Mashup/Clients/Portal/DataDiscovery.html



Quick Search (fast for selected collections)

[About Search Options](#) | [Take the Tour](#)

Examples: [M101](#), [14 03 12.6 +54 20 56.7 r=0.2d](#), [more...](#)

Filters

datatype

<input type="checkbox"/>		Count
<input type="checkbox"/>	catalog	239
<input type="checkbox"/>	images	13

archive

<input type="checkbox"/>		Count
<input type="checkbox"/>	VIZIER	237
<input type="checkbox"/>	IRSA	14
<input type="checkbox"/>	Sloan	1

set

Quick Search: M101

252 Total Rows

MESSIER 101 (RA: 210.80227°, Dec: 54.34895°), radius: 0.2°

	Title	Total Records	Records Found
1	HST Archived Exposures Catalog	46137	91
2	Digitized Sky Survey (DSS)	7628	9
3	Data Inventory of Space-Based Obs, Ver 1.1	74821	9
4	PSCz catalog	18351	9
5	PSCz catalog	18411	9
6	The BMW-HRI source catalogue	29089	88
7	MAST Scrapbook	29291	86
8	Pulkovo catalogue of 58483 stars	58483	8
9	Absolute Proper motions of 59766 stars	59766	8
10	The 2E Catalogue	5948	8

HST Archived Exposures Catalog

Search Summary

Records Found When Searching M101: 91
 Data Type: Catalog

or: [Download Catalog Records](#)

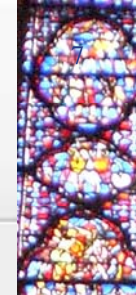
Resource Information

Archive: VIZIER
 Set: 'External'
 Notes: Period between 1993Dec to 1997Feb
 Total Records: 46137





Data discovery tool



Quick Search: M101

HST Archived Exposures Catalog: M101

91 Total Rows

MESSIER 101 (RA: 210.80227°, Dec: 54.34895°), radius: 0.2°

	ra	dec	Target	RAh	RAm	RAs	DE-	DEd	DEm	DEs	v3	fov	config
1	210.8497	54.35992	NGC5457-FLD1	14	3	23.94	+	54	21	35.7	8.5	SM93	WFPC2
2	210.8497	54.35992	NGC5457-FLD1	14	3	23.94	+	54	21	35.7	8.5	SM93	WFPC2
3	210.8497	54.35992	NGC5457-FLD1	14	3	23.94	+	54	21	35.7	8.5	SM93	WFPC2
4	210.8497	54.35992	NGC5457-FLD1	14	3	23.94	+	54	21	35.7	8.5	SM93	WFPC2
5	210.8497	54.35992	NGC5457-FLD1	14	3	23.94	+	54	21	35.7	8.5	SM93	WFPC2
6	210.8497	54.35992	NGC5457-FLD1	14	3	23.94	+	54	21	35.7	8.5	SM93	WFPC2
7	210.8497	54.35992	NGC5457-FLD1	14	3	23.94	+	54	21	35.7	8.5	SM93	WFPC2
8	210.8497	54.35992	NGC5457-FLD1	14	3	23.94	+	54	21	35.7	8.5	SM93	WFPC2
9	210.8497	54.35992	NGC5457-FLD1	14	3	23.94	+	54	21	35.7	8.5	SM93	WFPC2





Semantic discovery tool

Publications

Modeling and Fitting SED Data i... Publications

http://labs.adsabs.harvard.edu/semantic/publications.html

adsabs vao semantic browser

Directories Weather News STScI Traffic Crosswords NVO IVOA VAO Twiki Readability Bookmarks

adslabs NASA

Prototype ADSLabs/VAO Semantic Browser

Search Publications Objects Datasets Proposals My Stuff

Current Selection

Viewing all documents!

Search

(press ESC to close suggestions)

Publication Facets

Top Keywords

[astronomy infrared(38)] [astronomy uv(38)]
[astronomy x rays(410)] [black hole physics(31)]
[cd(40)] [cosmology observations(63)] [galaxies(202)]
[galaxies active(163)] [galaxies clusters(82)]
[galaxies elliptical lenticular%3Bcd(40)]
[galaxies evolution(71)] [galaxies intergalactic medium(40)]
[galaxies jets(53)] [galaxies nuclei(57)]
[galaxies photometry(58)] [galaxies quasars(60)]
[galaxies seyfert(47)] [galaxies starburst(49)]
[galaxy globular clusters(37)] [gravitational lensing(40)]

Top Authors

[Alexander, D(18)] [Bauer, F(19)]
[Birkinshaw, M(16)] [Brandt, W(33)]
[Cheung, C(15)] [Elvis, M(20)] [Fabblano, G(21)]
[Fabian, A(14)] [Garmire, G(19)] [Grindlay, J(17)]
[Hardcastle, M(18)] [Harris, D(15)] [Heinke, C(16)]
[Kneib, J(16)] [Koekemoer, A(20)]
[Murray, S(23)] [Rosati, P(19)] [Tozzi, P(19)]
[Worrall, D(19)] [Zezas, A(16)]

Paper Types

[science(387)]

Year of Publication

1990-2010

Object Facets

Object Types

[CIG ~{51}] [Galaxy ~{27}] [GinGroup ~{8}]
[GICl ~{16}] [GroupG ~{24}] [HMXB ~{16}] [IG ~{10}]
[LINER ~{17}] [LMB ~{18}] [LensedImage ~{11}]
[PartofG ~{13}] [Pulsar ~{11}] [QSO ~{23}]
[Radio ~{17}] [Region ~{63}] [SNR ~{25}]
[Seyfert ~{9}] [Seyfert 1 ~{41}]

< 1 2 3 ... 31 32 > displaying 1 to 20 of 630

The XMM-Newton Wide-field Survey in the Cosmos Field (XMM-COSMOS): Demography and Multiwavelength Properties of Obscured and Unobscured Luminous Active Galactic Nuclei (Link) [P]

"astronomy x rays" | "surveys" | "galaxies active"

Authors: Pello, R ; Kovac, K ; Maier, C ; Miyaji, T ; Mainieri, V ; Zucca, E ; Fiore, F ; Peng, Y ; Vergani, D ; Taniguchi, Y ; Leborgne, J ; Bolzonella, M ; Impey, C ; Merloni, A ; de Ravel, L ; Contini, T ; Le Floch, E ; Scoville, N ; Garilli, B ; Koekemoer, A ; Kneib, J ; Zamojski, M ; Aldcroft, T ; Cappelluti, N ; Iovino, A ; Vignali, C ; Aussel, H ; Civano, F ; Brusa, M ; Hao, H ; Zamorani, G ; Bardelli, S ; Elvis, M ; Ilbert, O ; Kampczyk, P ; Silverman, J ; Schinnerer, E ; Le Brun, V ; Iwasawa, K ; Tasca, L ; Tanaka, M ; Treister, E ; Comastri, A ; Gilli, R ; McCracken, H ; Capak, P ; Scodreggio, M ; Perez-Montero, E ; Lilly, S ; Kartaltepe, J ; Jahnke, K ; Mignoli, M ; Tresse, L ; de la Torre, S ; Lusso, E ; Salvato, M ; Bongiorno, A ; Lamareille, F ; Caputi, K ; Sanders, D ; Trump, J ; Finoguenov, A ; Le Fevre, O ; Fruscione, A ; Hasinger, G ; Capri, A ; Knobel, C

Year: 2010 BibCode:2010ApJ...716..348B Citations:182 more

The Stellar Mass Assembly of Galaxies from $z = 0$ to $z = 4$: Analysis of a Sample Selected in the Rest-Frame Near-Infrared with Spitzer (Link) [P]

"astronomy infrared" | "galaxies evolution" | "galaxies photometry" | "galaxies starburst"

Authors: Perez-Gonzalez, P ; Egami, E ; Zamorano, J ; Gil de Paz, A ; Gallego, J ; Pascual, S ; Donley, J ; Blaylock, M ; Barro, G ; Rieke, G ; Villar, V

Year: 2008 BibCode:2008ApJ...675..234P Citations:174 more

X-ray nature of the LINER nuclear sources (Link) [P]

"astronomy x rays" | "galaxies nuclei" | "galaxies active"

Authors: Dultzin-Hacyan, D ; Gonzalez-Martin, O ; Guerrero, M ; Masegosa, J ; Marquez, I

Year: 2006 BibCode:2006A&A...460...45G Citations:171 more

Chandra X-Ray Imaging of the Interacting Starburst Galaxy System NGC 7714/7715: Tidal Ultraluminous X-Ray Sources, Emergent Wind, and Resolved H II Regions (Link) [P]

"galaxies" | "galaxies starburst" | "galaxies interactions"

Authors: Struck, C ; Nowak, M ; Smith, B

Year: 2005 BibCode:2005AJ....129.1350S Citations:168 more

Multiwavelength Study of the Bright X-Ray Source Population in the Interacting Galaxies NGC 5774/NGC 5775 (Link) [P]

"stars binaries general" | "galaxies interactions" | "astronomy x rays" | "black hole physics"

Authors: Ghosh, K ; Gutierrez, C ; Foellmi, C ; Gandhi, P ; Saripalli, L ; Lopez-Corredoira, M

Year: 2009 BibCode:2009AJ....137.3263G Citations:168



TAP client: *Seleste*

seleste

Submit Open Save Clear Services Upload Jobs Form ADQL Guide Help

SDSS DR5 - Sloan Digital Sky Survey Data Release 5

Contents: fieldID

Select: top 100 rows

Output Columns: psfMagErr_g, run, rerun, camcol, fieldID, fieldID, pspStatus

Column Criteria:

Field.fieldID	=	Star.fieldID)
Star.psfMagErr_g	<	20)
Field.pspStatus	=	2)

Position Search: Star

Point
 Circle
 Box
 Region

contains column(s): ra dec

Center around: Target name Coordinates Other table

Name: Resolver: Simbad/NED

Radius: 1.0 arcmin

Sort Order: fieldID ASC

Name	Table	Primary Key	Datatype	Units	UCD	Description
psfMagErr_g	Star	false	real	mag	??	PSF flux error
fieldID	Field	false	integer		meta.id;meta.da...	Unique field identifier composed from [skyVersion,rerun,run,camcol,field]
pspStatus	Field	false	integer		meta.code	Maximum value of 'status' over all 5 filters

seleste

Help

Status	Start Date	End Date
Completed	2011-11-03T09:1...	2011-11-03T09:1...
Completed	2011-11-03T09:1...	2011-11-03T09:1...

Destruction: 2011-11-04T09:13:32

Quoted Time: 0

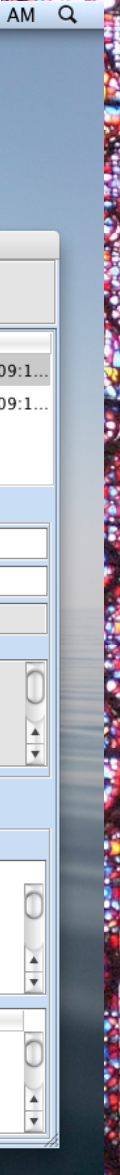
Quote:

Query: SELECT top 100 Star.psfMagErr_g, Star.run, Star.rerun, Star.camcol, Field.fieldID, Star.fieldID, Field.pspStatus FROM Star, Field WHERE ((Field.fieldID = Star.fieldID) AND

fieldID	pspStatus
87722981734023168	2
87722981734023168	2
87722981734023168	2
87722981734023168	2
87722981734023168	2

Units	UCD	Datatype
mag	??	real

run Unrecognised column with name 'run' smallint



TAP client: *Seleste*



seleste

Submit Open Save Clear Services Upload Jobs Form ADQL Guide Help

SDSS DR5 - Sloan Digital Sky Survey Data Release 5

Contents: fieldID

Select: top 100 rows

Output Columns: psfMagErr_g, run, rerun, camcol, fieldID, fieldID, pspStatus

Column Criteria: Field.fieldID, Star.psfMagErr_g, Field.pspStatus

Position Search: Circle

Center around: Name: Radius: 1.0

Sort Order: fieldID ASC

Name	Table	Primary Key	Datatype	Units
psfMagErr_g	Star	false	real	mag
fieldID	Field	false	integer	
pspStatus	Field	false	integer	

Jobs - seleste

Run Stop Update Delete Add Clone Remove Save Send Help

Service	Job ID	Status	Start Date	End Date
SDSS DR5 - Sloan Digital Sky Survey Data Release 5	-5f70c92b:132b5...	Completed	2011-11-03T09:1...	2011-11-03T09:1...
SDSS DR5 - Sloan Digital Sky Survey Data Release 5	-5f70c92b:132b5...	Completed	2011-11-03T09:1...	2011-11-03T09:1...

Parameters

Job ID: -5f70c92b:132b5735550:-1857 Destruction: 2011-11-04T09:13:32

Owner: Allotted Time: 0

Run ID: Quote:

Format: votable Query: SELECT top 100 Star.psfMagErr_g, Star.run, Star.rerun, Star.camcol, Field.fieldID, Star.fieldID, Field.pspStatus FROM Star, Field WHERE ((Field.fieldID = Star.fieldID) AND

Job Error

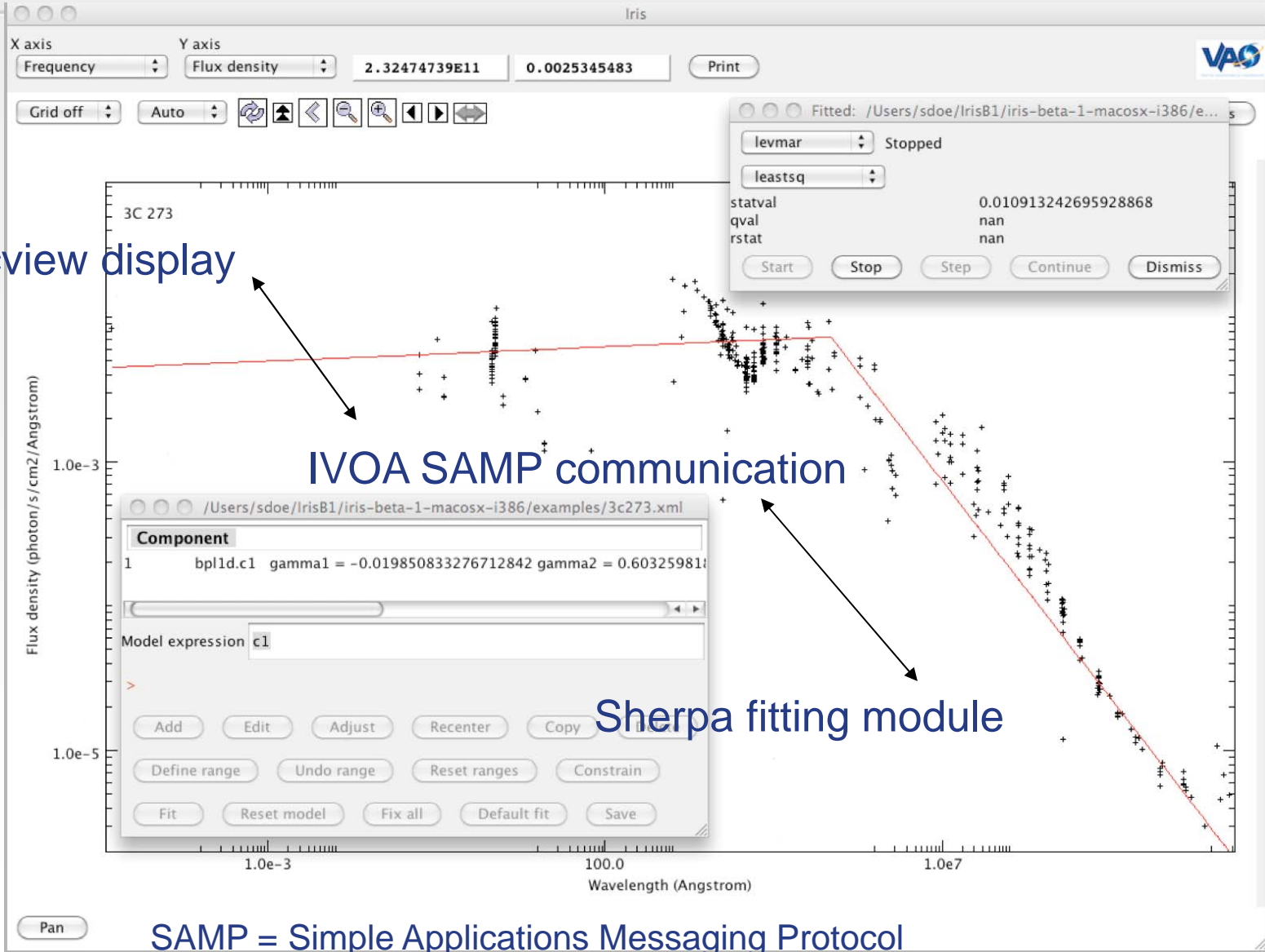
Results

100 rows found

psfMagErr_g	run	rerun	camcol	fieldID	fieldID	pspStatus
0.10899583	752	40	1	587722981734023168	587722981734023168	2
0.18907903	752	40	1	587722981734023168	587722981734023168	2
0.31558833	752	40	1	587722981734023168	587722981734023168	2
0.286404	752	40	1	587722981734023168	587722981734023168	2
0.20788214	752	40	1	587722981734023168	587722981734023168	2

Name	Description	Units	UCD	Datatype
psfMagErr_g	PSF flux error	mag	??	real
run	Unrecognised column with name 'run'			smallint

Spectral Energy Distribution tool.



Specview display

IVOA SAMP communication

Sherpa fitting module





SED tool: *Iris*

Sed Importer



Importer Online Help



Iris Online Help



Load SED



Launch Iris



SAMP status: connected

To Start, click on the "Load SED" button and start adding "segments" to the new SED.

A segment is a photometric point, a spectrum or an entire SED itself (i.e. any combination of photometric points and spectra).

You can add SED's from the NED SED Service.

You can also import SED segments from your local disk or a remote URL so that Iris (or other VO tools) can handle your data.

Since your files might not be standard SED's, you must provide some required information that will allow the segment to be used by VO tools.

If you use other VO tools, like Topcat or Aladin, you can use SAMP to "beam" a table from these applications to the SedImporter and import them into a standard SED.

After saving an SED file (either the entire SED you are building or a subset of the segments you imported), you can have IRIS load it by "broadcasting" it.

For more information, [click here](#) or on the Help icons.



SED Importer

Sed Importer

3c273

SED

ID:

Segments #:

Target Info

Name:

RA: DEC:

Interoperability

Accept tables from SAMP

Coords	Publisher	# Points
187.28, 2.0524	NASA/IPAC Extragalactic Database (NED)	459

Segments Operations

Click on the "Load SED" button and start adding to the new SED.

is a photometric point, a spectrum or an itself (i.e. any combination of photometric spectra).

and SED's from the NED SED Service.

to import SED segments from your local disk URL so that Iris (or other VO tools) can data.

Files might not be standard SED's, you must ne required information that will allow the

Load an input File

Location on Disk:

URL:

File Format:

Get an SED from the NED Service

NED Service

Target Name:

Change Endpoint

Endpoint:

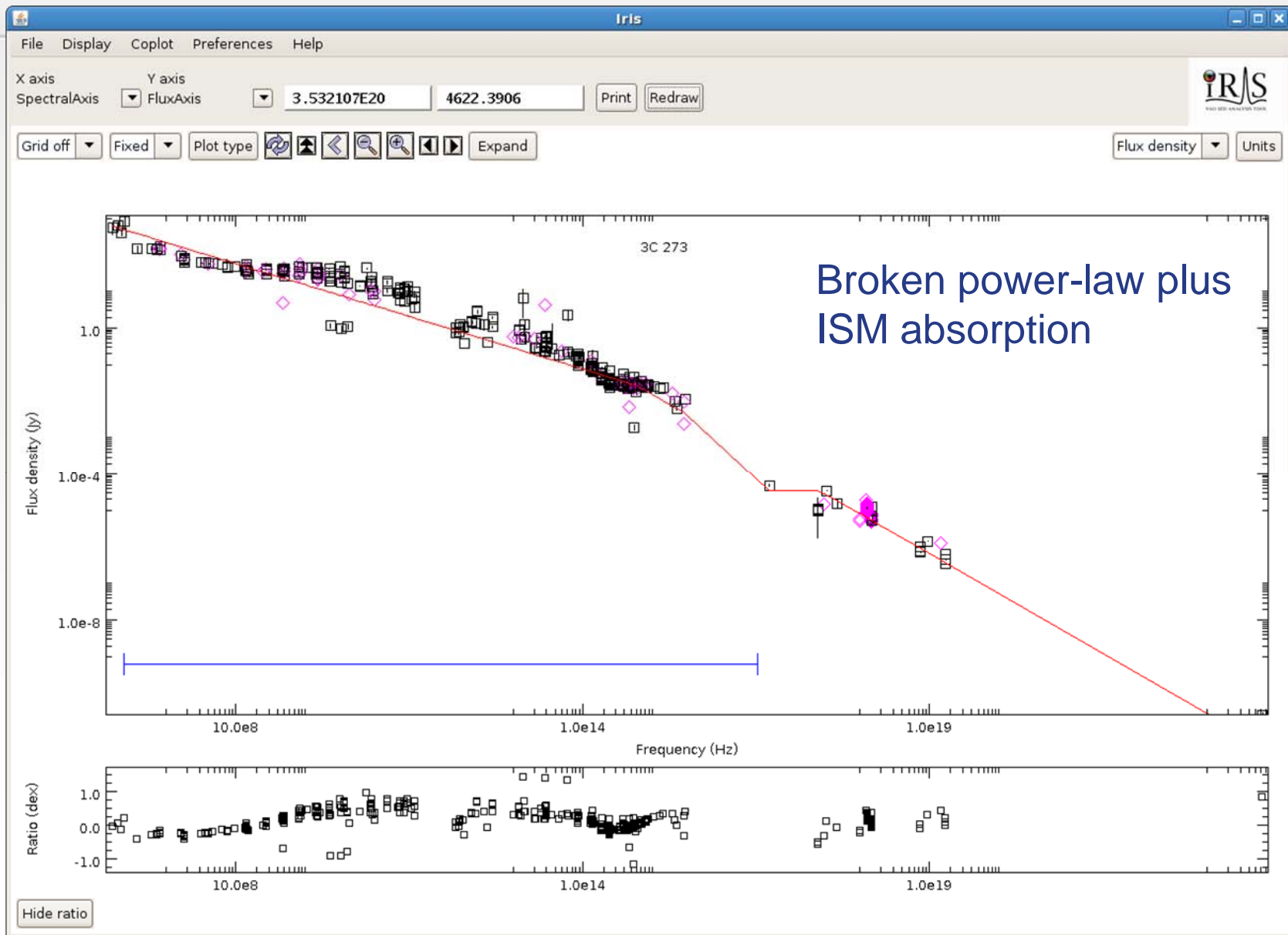

SAMP status: connected

For more info





SED fitting

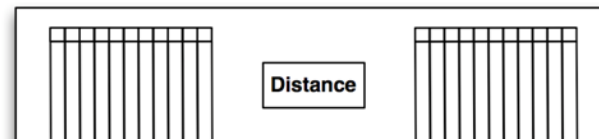


Cross-matching

Large-Scale Positional Catalog Cross-Comparison Web Service Overview

Data Sources: *User-uploaded table file* *VOSpace file or query* *DBMS catalogs (IRSA, CDS, HEASARC, etc.)* *Pre-built, large-scale catalog cross-comparisons**

Inputs:
HTTP GET submission




Cross Comparison

[\(alpha release notes\)](#)

The analysis and interpretation of multi-wavelength data in astronomy, especially from surveys, relies on the comparisons of source properties (flux, morphology) from different bandpasses, instruments and telescopes. The first step in such analysis is to perform a spatial cross comparison between source tables. Such tables may be on-line catalogs or subsets of such catalogs or may be user-supplied data in the form of table files. The focus of the project is to define a protocol for interacting with spatial cross comparison services and to provide a set of fast and extensible operational services that can be used easily and directly by astronomers. For some of the more obvious cross-comparison, general products will be pre-computed and served directly. [more...](#)

Select Data Source:

Upload a Table:



[Advanced Settings >](#)


Radius:

arcsec

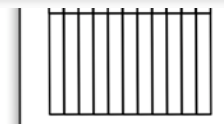


Select Data Source:

Select Catalog to Compare:



Output:
Returned table or VOSpace reference



Result Table:
Join table possibly filtered, sorted and with new composite columns.

Results:

Sent to user

Staged in VOSpace

Reused as input table for next comparison

* These cross-comparisons can be used as catalogs in their own right or as a short-cut to the cross-comparison process for common large-catalog comparisons



Time series integration/tools

HARVARD UNIVERSITY
TSC
 Time Series Center

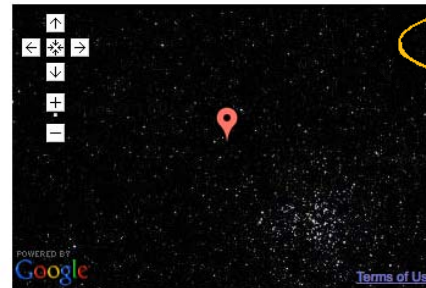
register | login CfA iig

Home Search Projects Surveys Publications People

Home > Search > Details

Details for MMT_M37 20001

RA 88.273967000 → hh:mm:ss
 Dec 32.693483000 → dd:mm:ss
 Survey MMT_M37
 Survey ID 20001
 Survey Field M37-1
 TSC ID 74787641
[Download light curves \(as JSON\)](#)



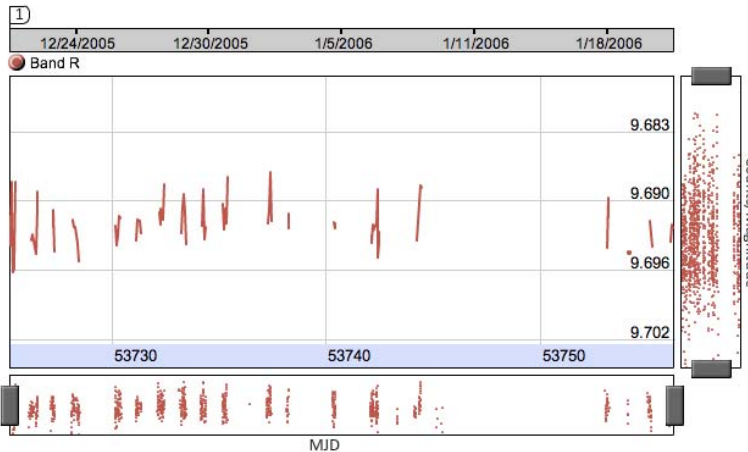
Star type:
 • PULS with period 0.055277000 days

$P = 0.055277$
 days

Lightcurves

Band	Start Time	End Time	TSC ID	Download
R	2005-12-21 04:10:26.68	2006-01-21 06:33:18.43	135482933	Download (as JSON)

Style: Edges Folding Auto-binning



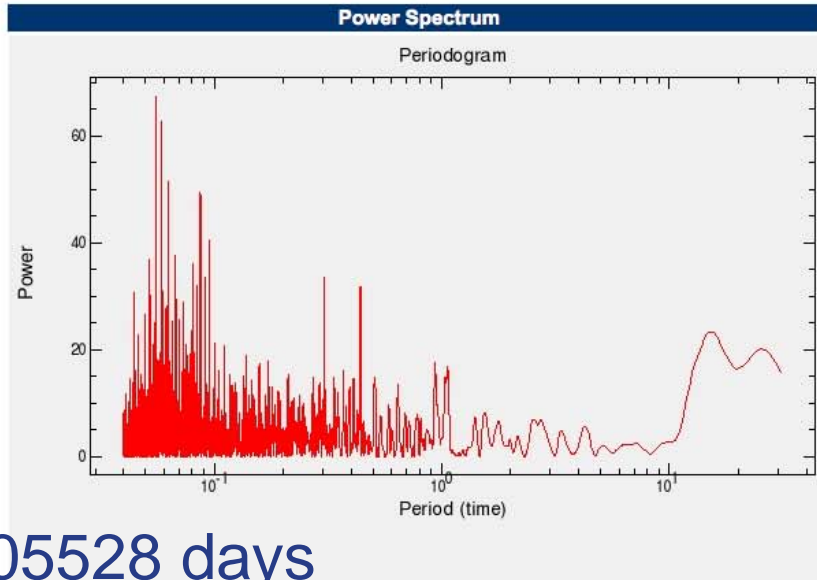


Time series integration/tools



- About Periodograms
- Changing Parameters
- Performance
- Troubleshooting
- Algorithms
- Parameters
- Periodogram Service
- News

NStED Periodogram Service



$P = 0.05528$ days

Download Periodogram (ASCII)

Rank	Period	Power	P-value	Link
1	0.055278	67.457128	0	Phased curve
2	0.058528	52.782253	0	Phased curve
3	0.062982	51.537318	0	Phased curve
4	0.086992	49.345746	0	Phased curve
5	0.095256	40.519022	0	Phased curve
6	0.067228	37.643664	0	Phased curve
7	0.052097	36.853611	1.47327e-12	Phased curve

The P-values above are computed for 13270 periods sampled, and an exponential power distribution is assumed.

Input		Current Values
<input type="button" value="Submit"/>		<input type="button" value="Reset"/>
Periodogram type	<input checked="" type="radio"/> Lomb-Scargle <input type="radio"/> BLS <input type="radio"/> Plavchan	Lomb-Scargle
Input file	ascii.tbl Number of points: 1327	<input type="button" value="View Time Series"/>
Time column	col1 Min: 53725.1739, Max: 53756.2731	col1
Data column	col2 Min: 9.6780, Max: 9.7028	col2
Constraint column	None	none

Adjustable Periodogram Parameters

The estimated time for processing is 15s

Period Sampling		
Period range	Min	0.040000
	Max	31.099210
Period step method	Fixed df	FixedDf
Fixed step size	0.00188170	0.00188170

Algorithm Settings

Output Options		
Number of peaks to return	50	50
Peak significance threshold (P-Value)	1	1

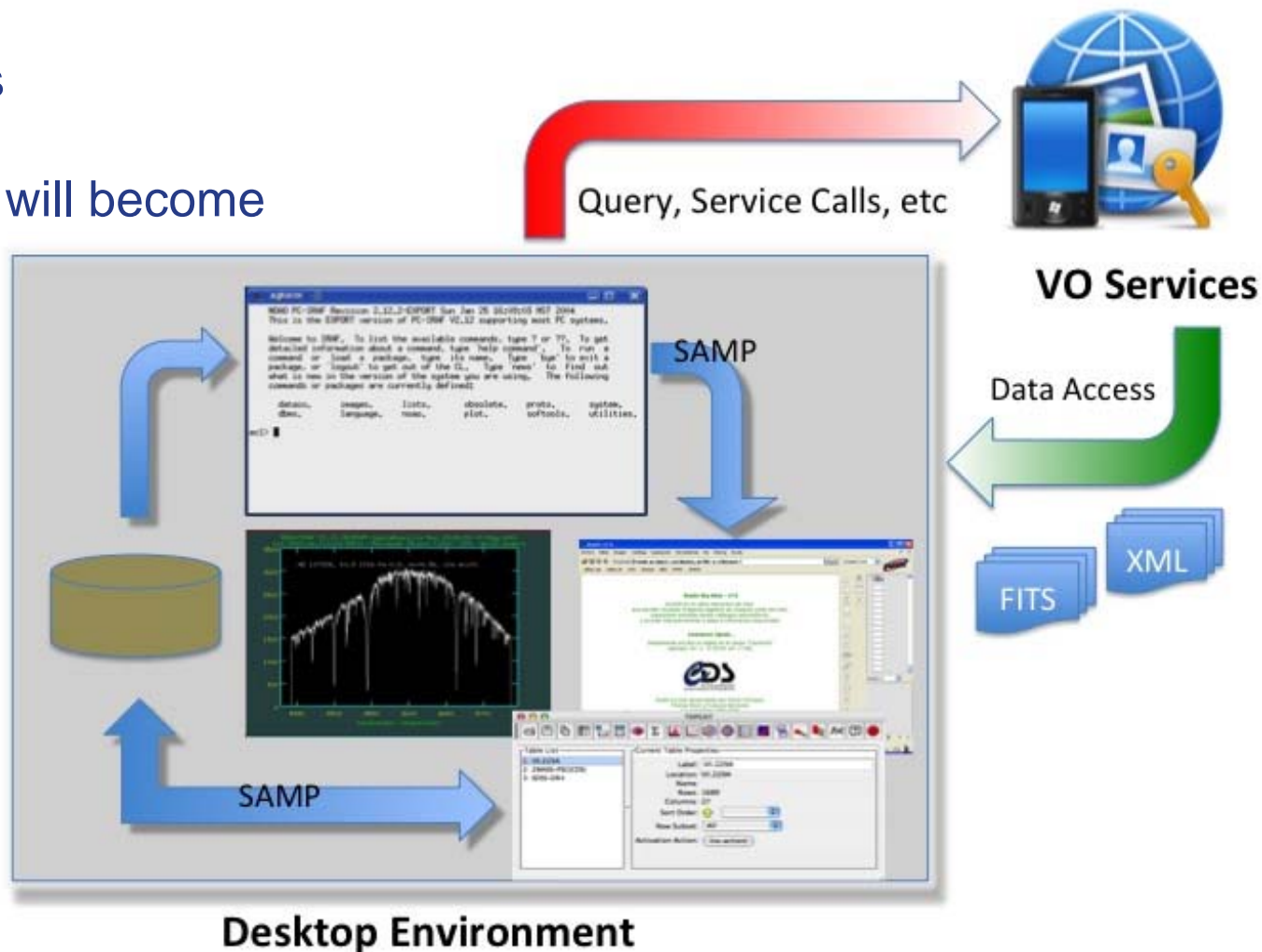


VO-IRAF integration

2000 registered IRAF users

~5000 total users

>700 IRAF tasks will become VO-aware



Data mining



DAta Mining & Exploration



we make science discovery happen

[Home](#) | [Cloud Services](#) | [Science](#) | [Technology](#) | [Machine Learning](#) | [Publications](#)

*GO to new DAMEWARE
beta app*

- News
- Release Notes
- Documentation
- Technical Support
- Test Resources
- F.A.Q.
- Who is who



Data Mining Web Application REsource (β rel)

DAMEWARE

Web Application REsource of DAME

<http://dame.dsf.unina.it>





Summary

- VAO has developed new research tools, which are now being released
- Introduction to the research community via AAS workshop and exhibit; VAO “community days”
- Goal is a “VO-web” of applications, utilizing tools from all international VO projects and from the user community
- Please visit demonstration table! Please join our e-mail list!



