

# Astrometry in the VO?

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Well... more “taking advantage” than “producing”...



Amelia Bayo  
Disclaimer: some slides shamelessly stolen  
from E. Solano, or B. Vollmer

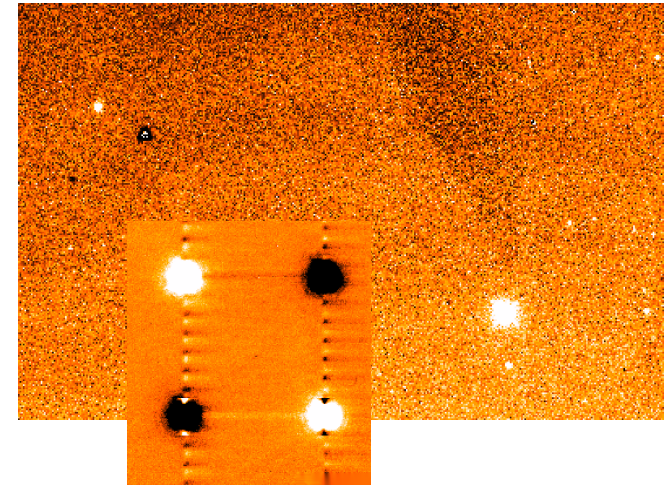
# Outline

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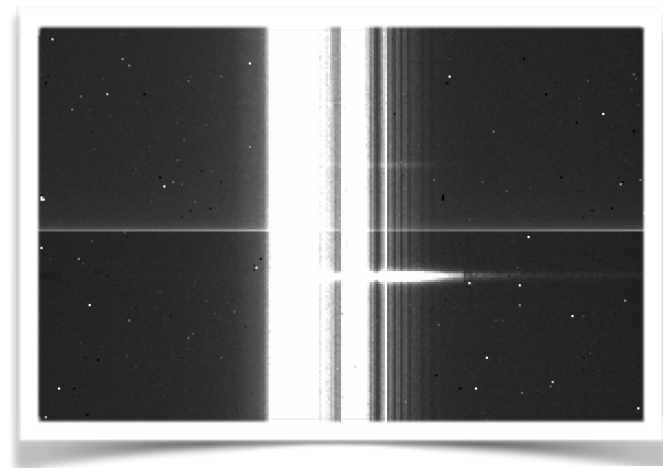
- What is that thing of the VO? Why would I need it?
- What kind of science cases related to astrometry have benefited from the VO initiative?
- Can I “do astrometry” in the VO?

# What are “Astronomical data”??

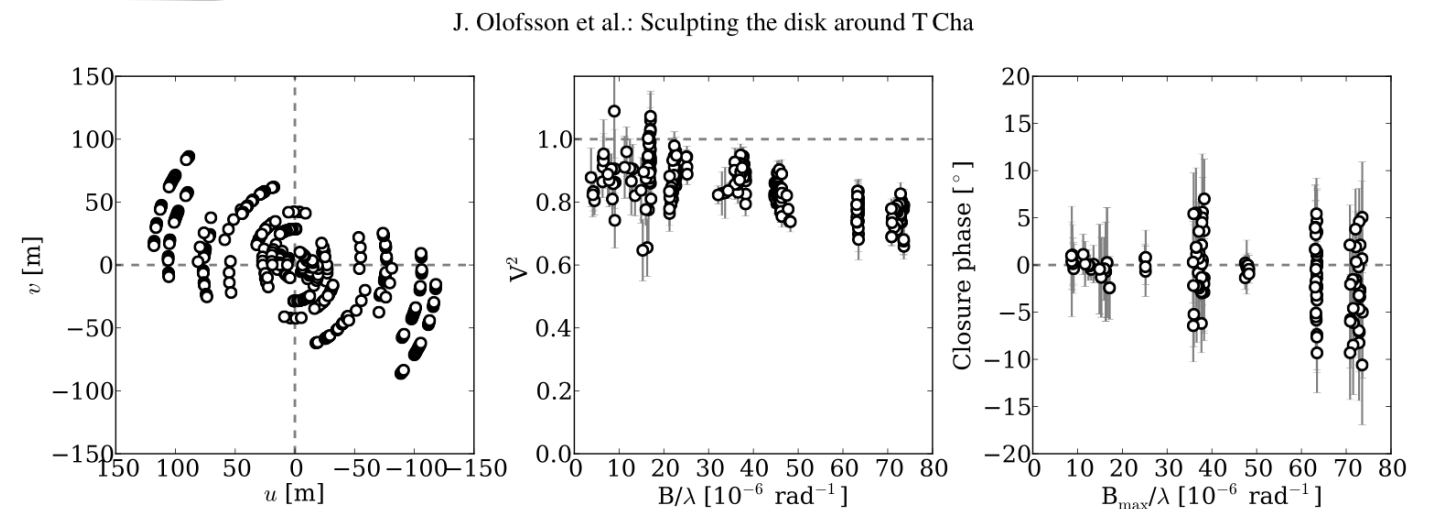
- Raw images



- 2-D spectra



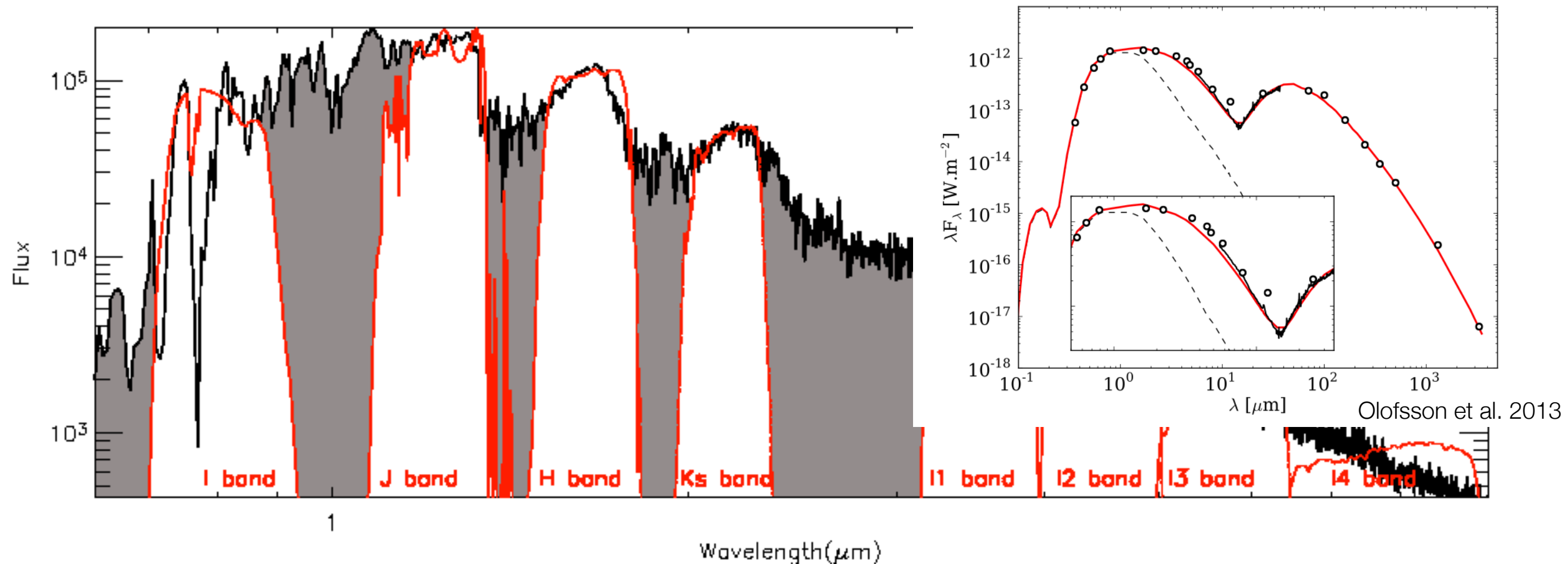
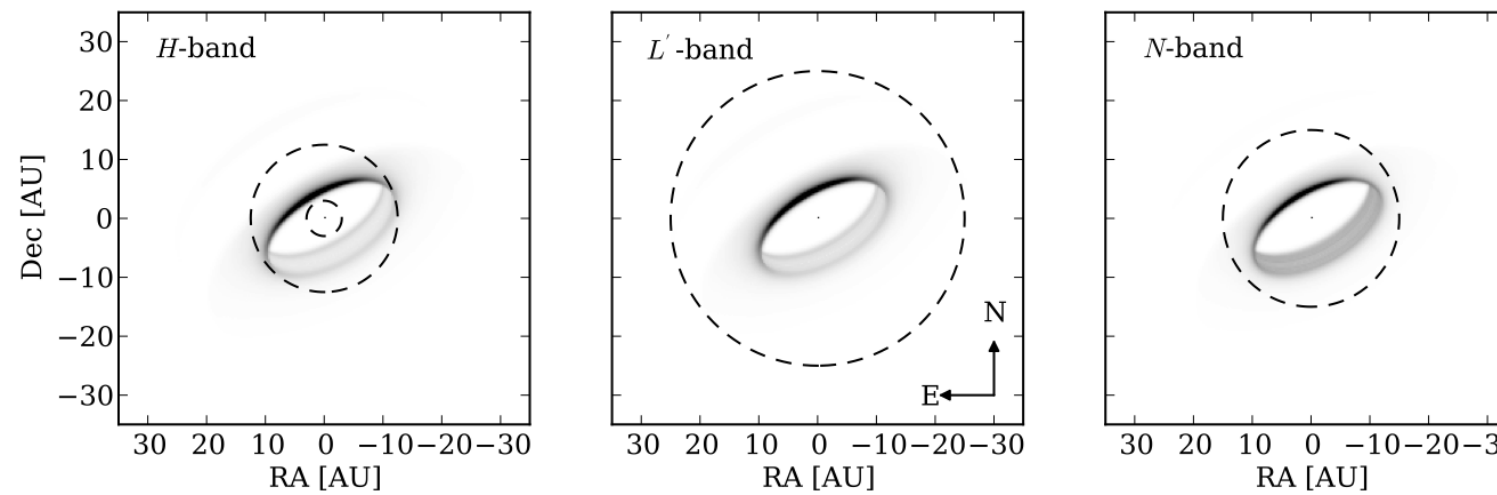
- A collection of visibilities from some interferometer?



- Theoretical models: predicted images, fluxes, spectra, low or high resolution simulations of structures, etc.

# What are “Astronomical

- Calibrated images with all metadata



- Theoretical predictions of stellar/population spectra (what resolution? high? extremely low, -SED-), of a functional form for the behavior of a multiple system, etc.



# What are “Astronomical data”??

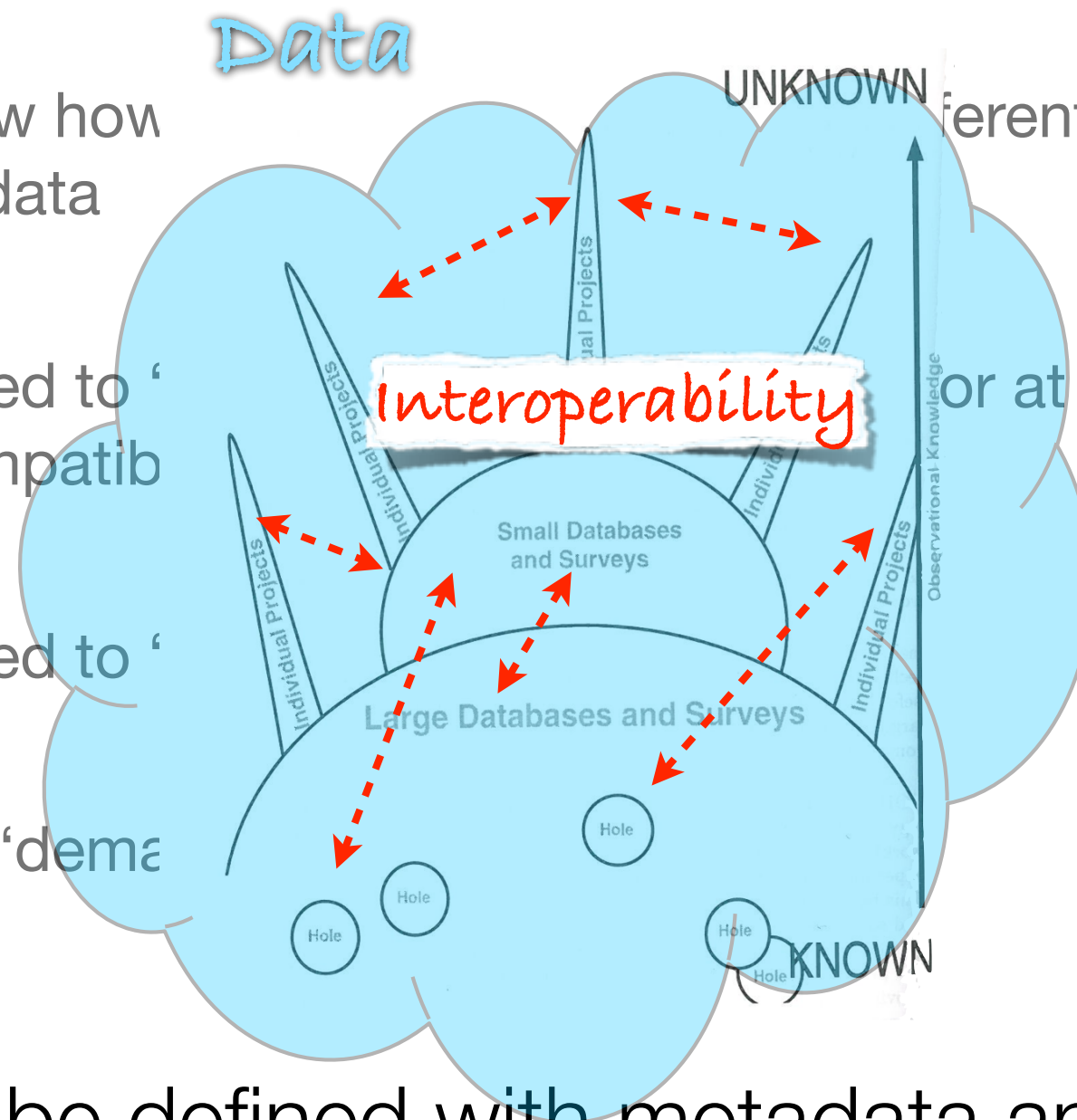
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- A catalog of parameters derived “directly” from one dataset, from several including literature, (line widths, velocities, strengths, integrated fluxes, periods, etc.).
- The results from some model fitting (not only derived parameters but goodness of the fit, etc.), some more “handwaving” or just general interpretation of the data in a broader context.
- Momentum maps, any kind of direct or “massaged” projections of a cube
- .....

All of the above!!!

# How do we deal with this mess??

- One needs to know how different kinds of data
- Data providers need to 'questions in a compatib
- Data providers need to 'to '
- Provided it to the "dema



Data needs to be defined with metadata and standardization is needed for this exchange to be efficient!

# Why do we need a “Virtual” Observatory?

“I want to know everything about vega”

**VizieR Service**

[Browsing through Catalogues](#) · [Output Preferences](#)

**Direct access to Catalogues from Name or Designation ([tips and examples](#))**

Clear

**Find catalogues or Data ([tips and examples](#))**

**Find catalogues among 7687 available**

Words matching author's name, word(s) from title, description, etc.

Select from **Wavelength**, **Mission**, and controlled **Astronomical** keywords:

Radio	ANS	AGN
IR	ASCA	Abundances
optical	BeppoSAX	Ages
UV	CGRO	Associations
EUV	COBE	Atomic_Data
X-ray	Chandra	BL_Lac_objects
Gamma-ray	CoRoT	Binaries:cataclysmic

**Target Name** (resolved by [Simbad](#)) or **Position**:

**Position in** ☒ Sexagesimal, or ☐ Decimal °

**Target radius:**

☒ Radius or ☐ Box size

**Search by Position across 7931 tables**


inds of  
ality

[Results](#)




Enter [Title Words](#) ☐ Require title for selection  
(Combine with: ☒ OR ☐ AND ☐ [simple logic](#) ☐ [boolean logic](#))

# Adding theoretical data: example

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Buscar en: ☒ la Web ☐ páginas en español ☐ páginas de España

La Web	Resultado
Sugerencia: <a href="#">Buscar sólo resultados en español</a> . Puede especificar el idioma de búsqueda en <a href="#">Preferencias</a>	
<a href="#">Kurucz 1993 Models</a>  - [ <a href="#">Traducir esta página</a> ]	
A list of solar metallicity stars of different spectral types and luminosity classes together with their closest <b>Kurucz model</b> spectrum is presented in Table ...	
<a href="http://www.stsci.edu/hst/observatory/.../k93models.html">www.stsci.edu/hst/observatory/.../k93models.html</a> - <a href="#">En caché</a> - <a href="#">Similares</a>	
<a href="#">Robert L. Kurucz</a>  - [ <a href="#">Traducir esta página</a> ]	
Some files taken from <b>Kurucz</b> CD-ROMs 1-26 are given for historical checks although many ...	
Molecules · Linelists · Opacities · Grids of <b>model</b> atmospheres ...	
<a href="http://kurucz.harvard.edu/">kurucz.harvard.edu/</a> - <a href="#">En caché</a> - <a href="#">Similares</a>	
<a href="#">Kurucz/Grids</a>  - [ <a href="#">Traducir esta página</a> ]	
CASTELLI: 2004 New grids of ATLAS9 <b>model</b> atmospheres (Castelli and <b>Kurucz</b> ) **THESE ARE THE PREFERRED <b>MODELS</b> ** *** 4 Nov 2008 ALL A*ODFNEW. ...	
<a href="http://kurucz.harvard.edu/grids.html">kurucz.harvard.edu/grids.html</a> - <a href="#">En caché</a> - <a href="#">Similares</a>	



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This is a copy of the  
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large and are  
write DVDs o  
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<sup>1</sup> Available via anonymous FTP from <ftp://calvin.physast.uga.edu/pub/NextGen> or via the WWW URL <http://dilbert.physast.uga.edu/~yeti>.



## Servidor no encontrado

Firefox no puede encontrar el servidor en dilbert.physast.uga.edu.

- Compruebe que no ha cometido errores al escribir la dirección, como **ww**.example.com en lugar de **www**.example.com
- Si no puede cargar ninguna página, compruebe la conexión de red de su ordenador.
- Si su ordenador o su red están protegidos por un cortafuegos o un proxy, cerciórese de que se le permite acceder a la Web con Firefox.

Reintentar

Table of Contents

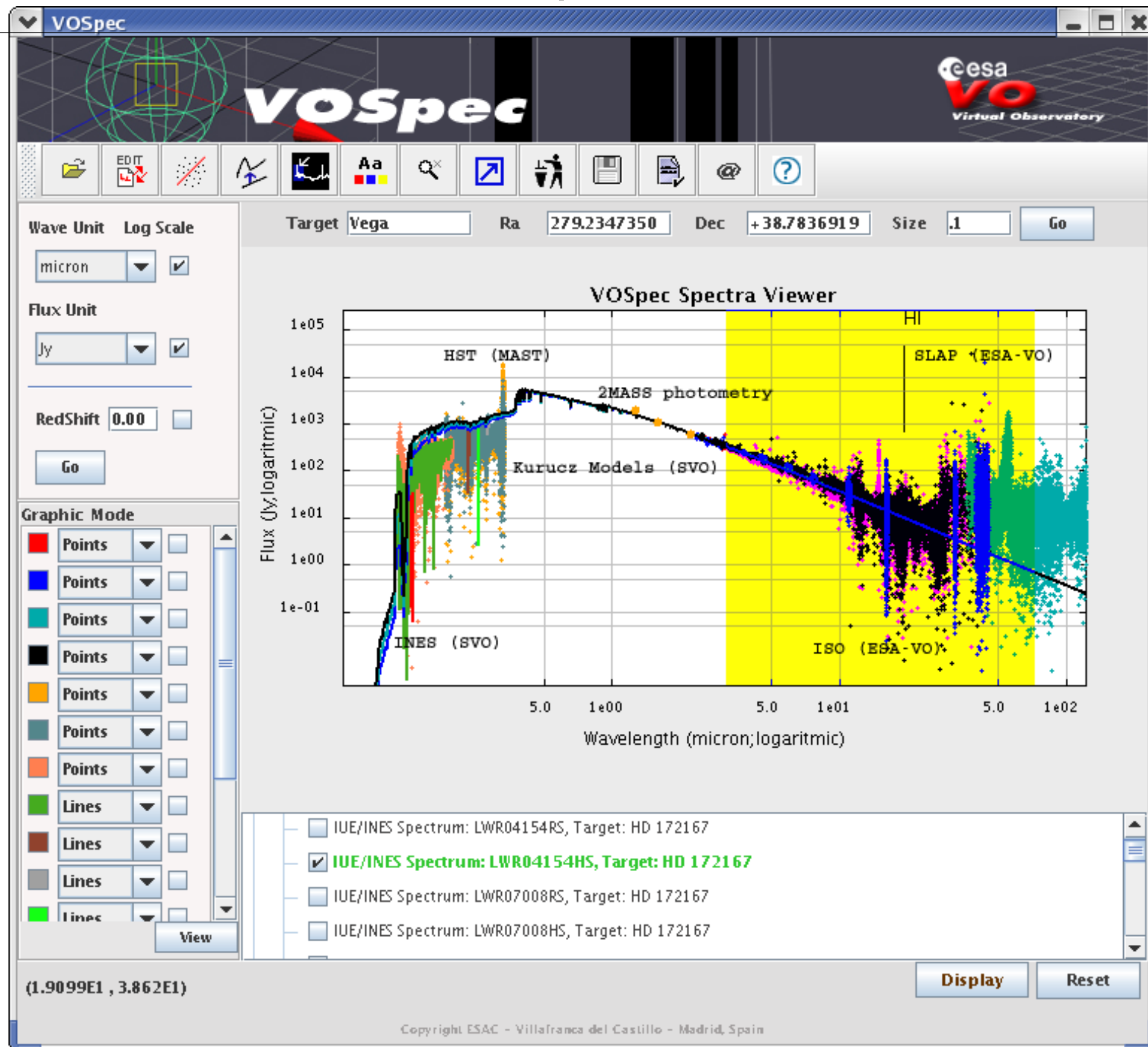
# Adding theoretical data: example

---

```
SDSC GRID  [+0.0]  VTURB 2.0 KM/S  L/H 1.25
PROGRAM READFLUX
C  SAMPLE PROGRAM READS THIS FILE ON UNIT 1
  DIMENSION Hnu(1221),HnuCONT(1221),WAVE(1221)
  CHARACTER*80 TITLE
  DO 11 ISKIP=1,22
11 READ(1,1)
C  wavelength in nm
  READ(1,1) WAVE
  1 FORMAT(10F10.2)
  DO 8 MODEL=1,500
C  ergs/cm**2/s/hz/ster
  READ(1,2,END=9) TITLE
  2 FORMAT(A80)
  PRINT 3,MODEL,TITLE
  3 FORMAT(I5,1X,A80)
  READ(1,4) Hnu
  READ(1,4) HnuCONT
  4 FORMAT(8E10.4)
  8 CONTINUE
  9 CALL EXIT
  END
```

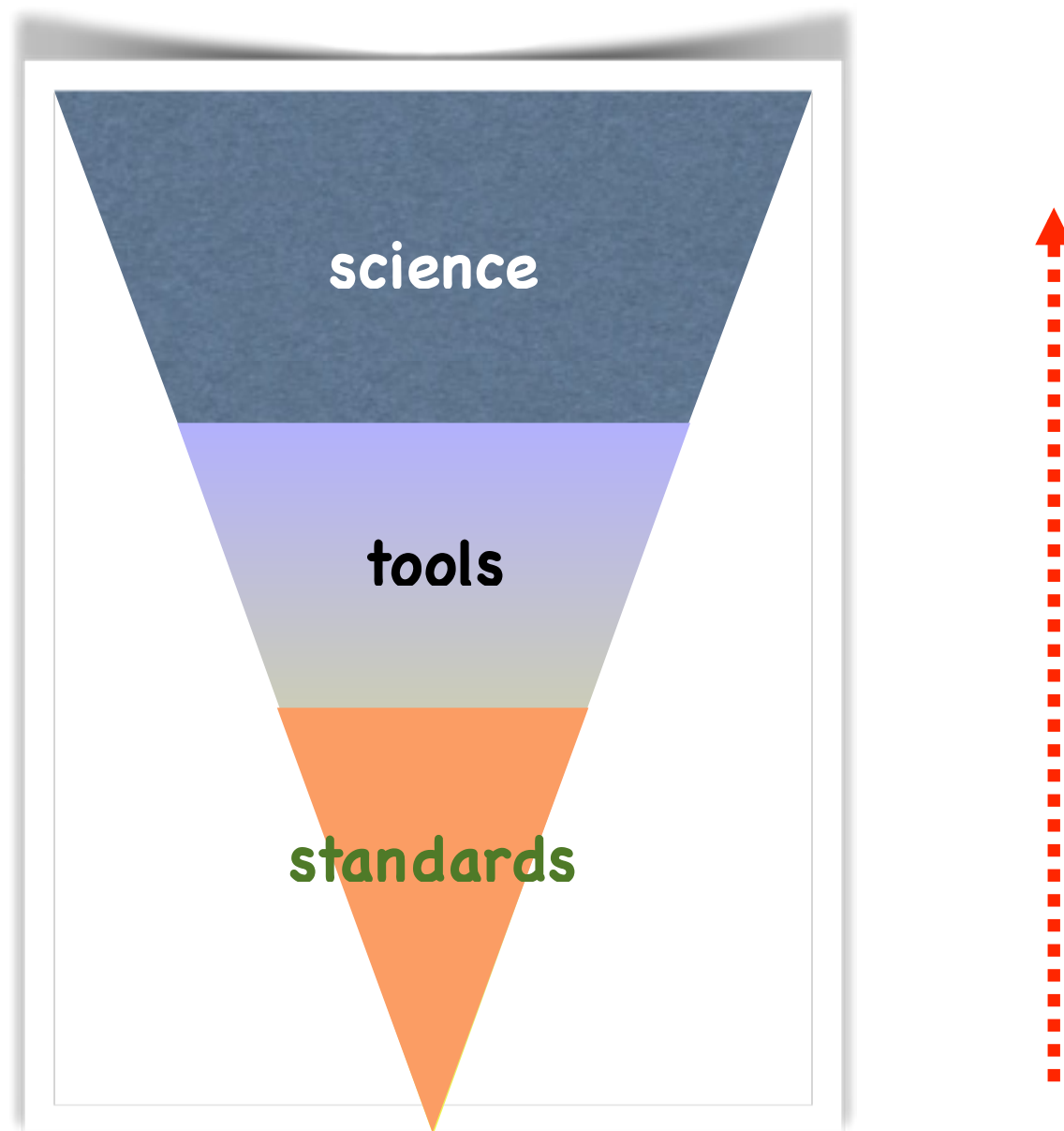
9.09	9.35	9.61	9.77	9.96	10.20	10.38	10.56
10.77	11.04	11.40	11.78	12.13	12.48	12.71	12.84
13.05	13.24	13.39	13.66	13.98	14.33	14.72	15.10
15.52	15.88	16.20	16.60	17.03	17.34	17.68	18.02
18.17	18.61	19.10	19.39	19.84	20.18	20.50	21.05
21.62	21.98	22.30	22.68	23.00	23.40	24.00	24.65

# Adding theoretical data: example with VO





# The VO approach



# Principles of the philosophy behind the VO

science

tools

```
SIMPLE = T /FITS
BITPIX = 16 /No.B
NAXIS = 2 /No.d
NAXIS1 = 1782 /Leng
NAXIS2 = 1786 /Leng
EXTEND = T /
DATE = '21/03/12' /Date
ORIGIN = 'CASB -- STScI' /Orig
PLTLABEL = 'SF02904' /Obse
PLATEID = 'A21Q' /GSSS
REGION = 'XP695' /GSSS
DATE-OBS = '1989/11/07' /UT d
UT = '#####' /UT t
EPOCH = 1.9898502197270E+03 /Epoc
PLTRAH = 5 /Plat
PLTRAM = 22 /
PLTRAS = 4.6105959333330E+01 /
PLTDECSN = '+' /Plat
PLTDECD = 10 /
PLTDECM = 5 /
PLTDECS = 3.0591079999998E+01 /
EQUINOX = 2.0000000000000E+03 /Juli
EXPOSURE = 7.0000000000000E+01 /Expo
BANDPASS = 35 /GSSS
PLTGRADE = 0 /Plat
PLTSKALE = 6.7199996948240E+01 /Plat
SITELAT = '+33:24:24.00' /Lati
SITELONG = '-116:51:48.00' /Long
TELESCOP = 'Palomar 48-in Schm' /Tele
CNPIX1 = 3294 /X corner (pixels)
CNPIX2 = 18277 /Y corner
DATATYPE = 'INTEGER*2' /Type of Data
SCANIMG = 'XP695_A21Q_01_00.PIM' /Name of original scan
SCANNUM = 1 /Identifies scan of the plate
DCHOPPED = F /Image repaired for chopping effects
```

From send mail ONLY to astro-ph <no-reply@arXiv.org>★

Subject astro-ph daily 39 new + 8 crosses received 151

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To astro-ph daily title/abstract distribution <rabbie@arXiv.org>★

Date: Fri, 20 Sep 2014 14:13:50 GMT (61kb)

Title: Representations of Time Coordinates in FITS

Authors: Arnold H. Rots, Peter S. Bunclark, Mark R. Calabretta, Steven L.

Allen, Richard N. Manchester, William T. Thompson

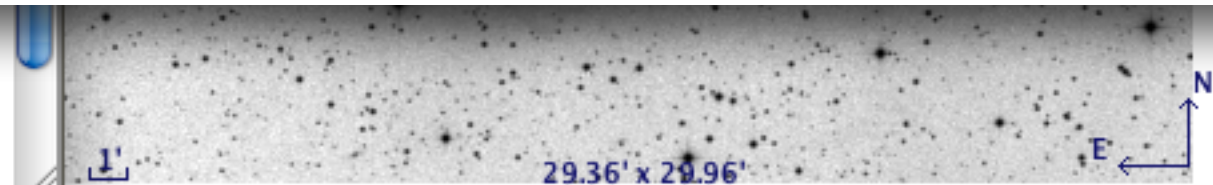
Categories: astro-ph.IM

Comments: FITS WCS Paper IV: Time. 27 pages, 11 tables

\\

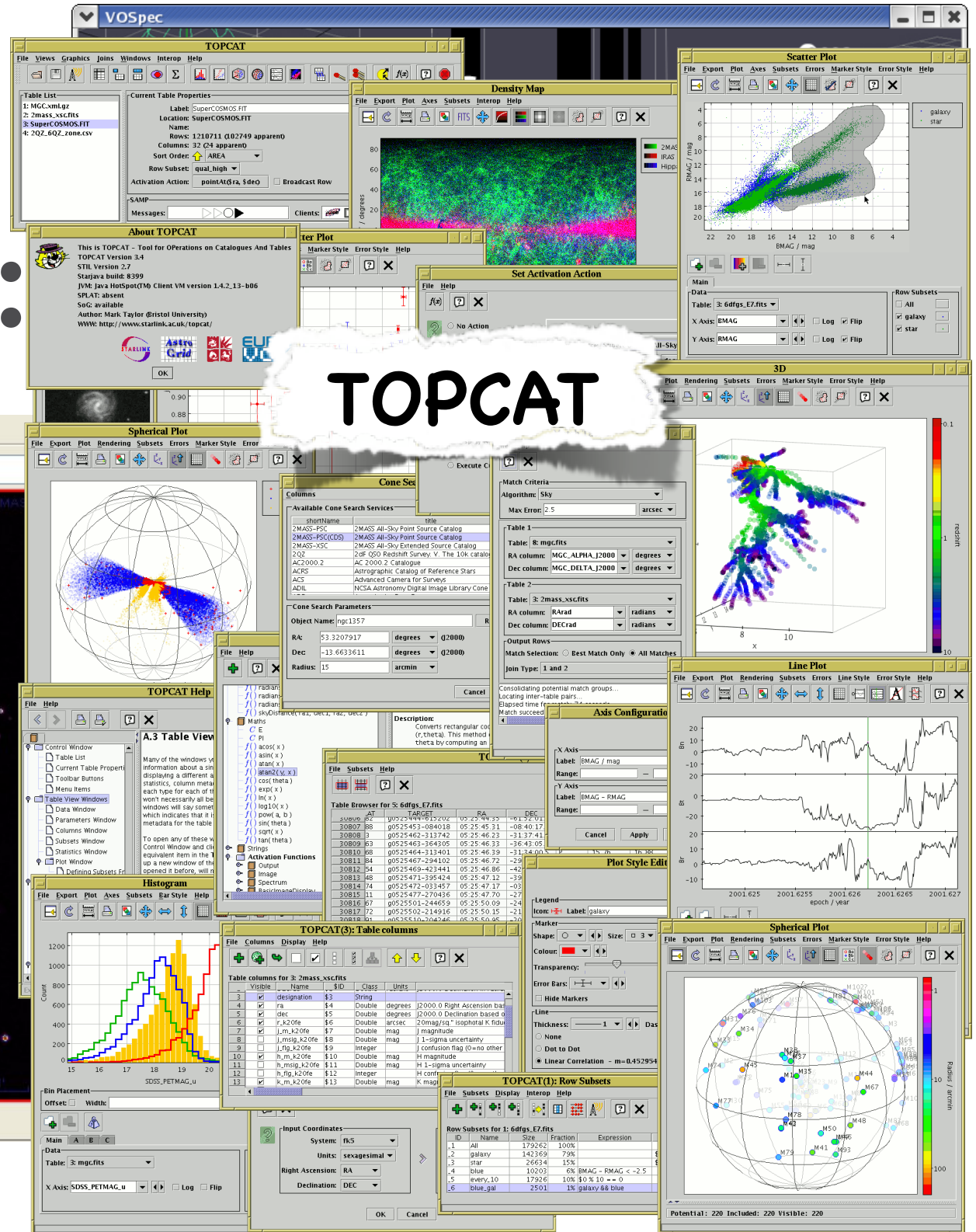
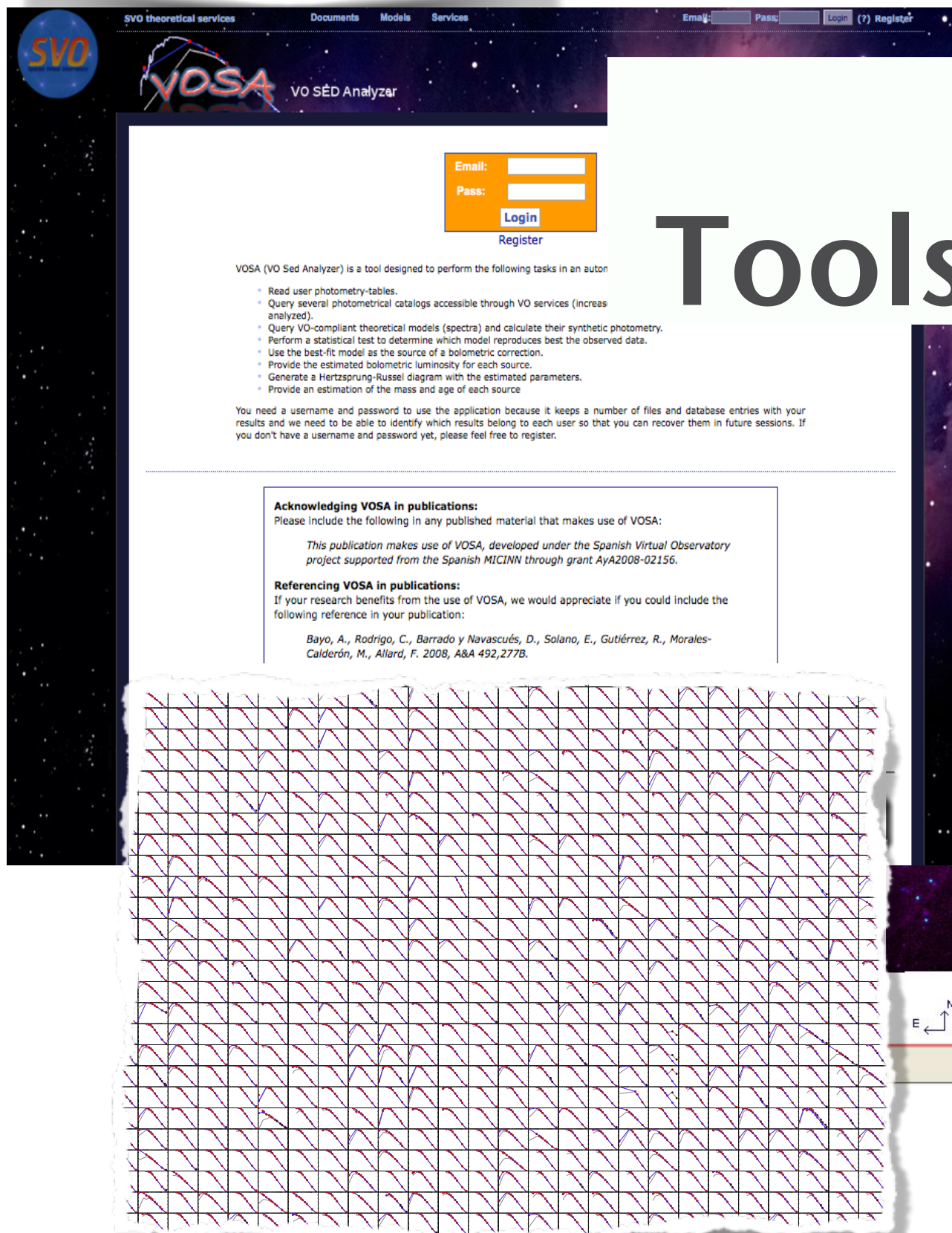
In a series of three previous papers, formulation and specifics of the representation of World Coordinate Transformations in FITS data have been presented. This fourth paper deals with encoding time. Time on all scales and precisions known in astronomical datasets is to be described in an unambiguous, complete, and self-consistent manner. Employing the well-established World Coordinate System (WCS) framework, and maintaining compatibility with the FITS conventions that are currently in use to specify time, the standard is extended to describe rigorously the time coordinate. World coordinate functions are defined for temporal axes sampled linearly and as specified by a lookup table. The resulting standard is consistent with the existing FITS WCS standards and specifies a metadata set that achieves the aims enunciated above.

\\ ( <http://arxiv.org/abs/1409.7583> , 61kb)





# Principles of the philosophy behind the VO



# Principles of the philosophy behind the VO: tools

## Applications/Services (alphabetical)

Aladin



AstroStat

CASSIS



CDS Cross-Match Service



Iris



Seleste



Skyview



SIMBAD



Specview



SPLAT



## Applications/Services (by function)

Search for Images: [Aladin](#), [Data Discovery Tool](#), [TOPCAT](#)

Search for Spectra: [VOSpec](#), [SPLAT](#), [Aladin](#), [Data Discovery Tool](#), [TOPCAT](#), [CASSIS](#)

Search for Catalogues/Tables: [Aladin](#), [Data Discovery Tool](#), [TOPCAT](#), [VizieR](#), [Xamin](#), [TAPHandle](#)

Image Visualisation: [Aladin](#)

Catalogue/Table Visualisation: [TOPCAT](#), [VOI](#)

Catalogue Cross-matching: [Aladin](#), [CDS Cross-Match Service](#), [TOPCAT/STILTS](#), [Cross-Comparison Tool](#)

Scatter, 3D plots and histograms: [TOPCAT](#), [VOI](#)

Statistics: [AstroStat](#)

Coverage Maps: [Aladin](#)

Table format conversion: [TOPCAT/STILTS](#), [VOI](#)

SEDs: [Iris](#), [VOSA](#), [VOSpec](#)

TAPHandle



TOPCAT/STILTS



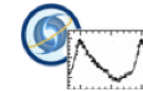
VAO Cross-Comparison Tool



VAO Data Discovery Tool



VAO Time Series Search Tool



VisIVO



VizieR



VOConvert

VOPlot



VOSA



VOSpec



Xamin

Other VO Compliant Tools:

[IRAF](#), [SAOImage DS9](#)

• May 2014 IVOA Newsletter now [available](#)



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**Time Series Search Tool**

Discover time-series data from three major archives & analyze them with the NASA Exoplanet Archive periodogram application.

AUG 15  
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# VOSat

[→ VAO Tools & Services](#)

- Data Discovery Tool** – Retrieve astronomical data about a given position or object in the sky.
- Iris: SED Analysis Tool** - Find, plot, and fit spectral energy distributions (SEDs) with this desktop application.
- Time Series Search Tool** – Discover time-series data from three major archives & analyze them with the NASA Exoplanet Archive periodogram application.
- Cross-Comparison Tool** – Perform fast positional cross-matches between an input table of up to 1 million sources and common astronomical source catalogs.
- VOClient** – Access the VO from Your Desktop.

[→ More News from the VO](#)

- ▶ [Montage BSD 3-Clause License](#)
- ▶ [IVOA Newsletter 012 – May 2014](#)
- ▶ [VO Client Release – Access the VO from Your Desktop](#)
- ▶ [Aladin v8](#)
- ▶ [Comet VOEvent Implementation Update](#)
- ▶ [CASSIS Spectrum Analyzer Update](#)
- ▶ [VisIVO Contest 2014](#)
- ▶ [VAO@AAS223](#)

▶ Science Service Monitor

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# Chile is part of this effort

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UTFSM

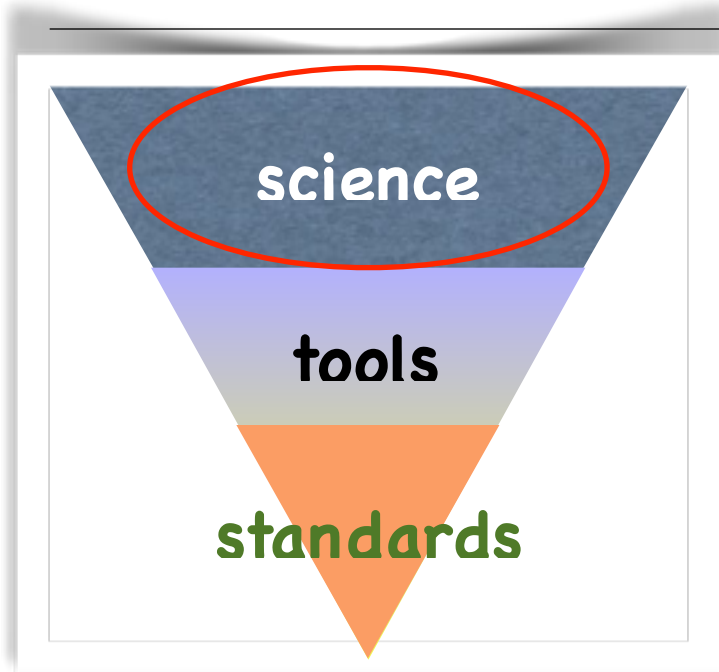
ASTROINFORMATIC



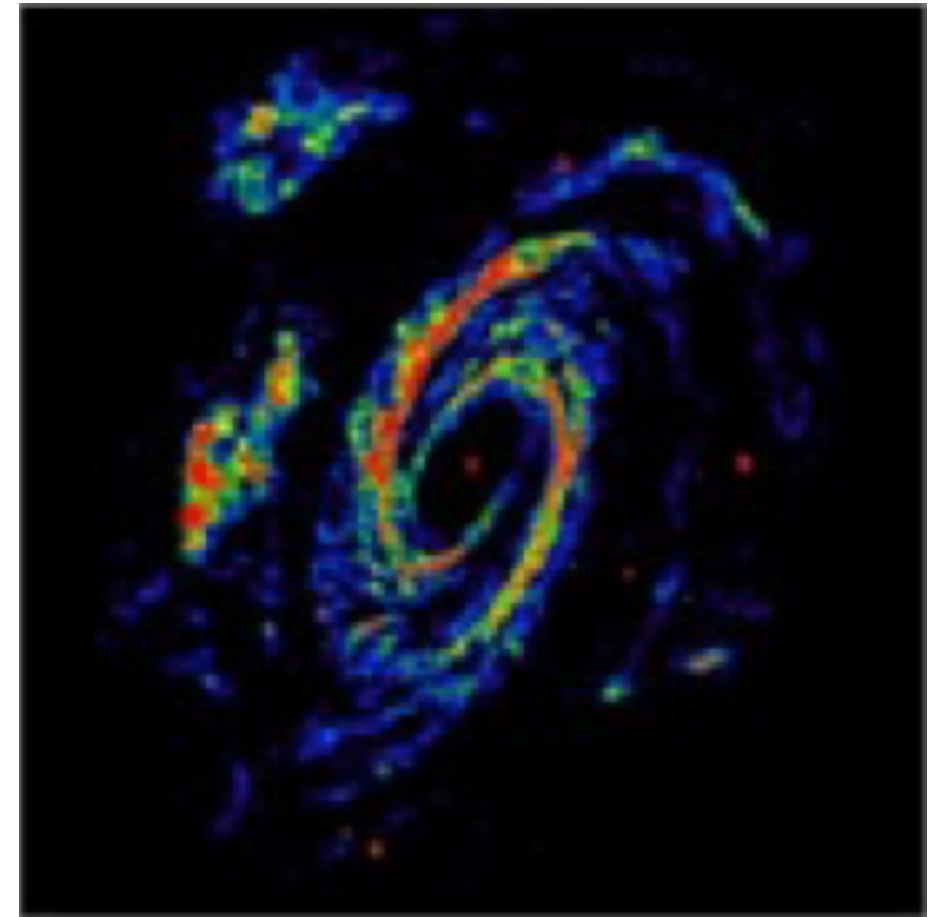
## What is CHIVO?

The Chilean Virtual Observatory (CHIVO) is a VO developed in Chile and it is one of many VO projects currently underway in the world. It was born out of the need to archive data that require large storage capacities and the need to develop new tools for the analyzing large volumes of data and better algorithms for intelligent processing of astronomical data, this due to the volumes of large scale data that will generate the astronomical observatories in Chile, mainly the ALMA project that will generate over 1TB of data per day, and in this form be to able to store the data in the

# Principles of the philosophy behind the VO



## Science:



- ☐ **Multiwavelength**
- ☐ **Exotic objects identification**



Does really anybody use the VO??

Disclaimer: I am not claiming to be complete or unbiased, in fact quite some part is a collection of my own experiences

# What do these papers “talk” about?

---

“H-index” of ~50 vs SDSS ~70 (to be taken with a pinch of salt,  
and I personally believe these comparisons are... not too smart)



galaxies stars surveys

parameters observational  
radio mining associations cosmology access system  
starburst instrumentation satellite open dynamics telescopes kinematics technology software  
catalogs galaxy rays clouds processes continuum stars  
base magnetics visualization archives  
elliptical stellar evolution infrared lenticular interphase  
solar resolution  
gamma identification  
medium micro-watching magnetosphere  
dwarfs development distances information astronomy interiors ism paleomagnetism  
photometry sunspots management universe halo extinction photometric peculiar field content  
magnetospheric activity satellites processing photometric dwarf  
spectroscopic geomagnetism gravitational mass  
clusters high image spectral planets boundary with  
systems cd  
abundances  
white aql formation micro telescope  
quasars sequence planetary function space numerical subdwarfs interaction  
bursts radio  
of  
interstellar large scale  
physics binaries  
structure observations grid brown-dwarfs  
x-rays early-type astrometry lensing  
individual statistical  
line low-mass on dome variables  
surface fit  
emission lines  
interferometric waves  
supernova regular  
cataclysmic

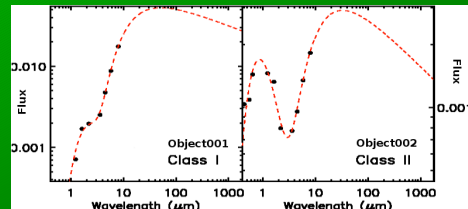






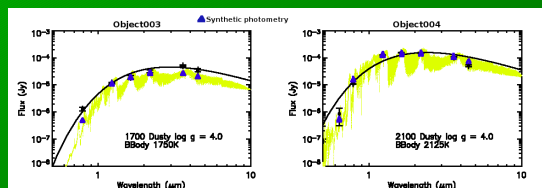
# Warning! self-promotion

Blackbody fittings (combinations, modified by different  $\beta$ )

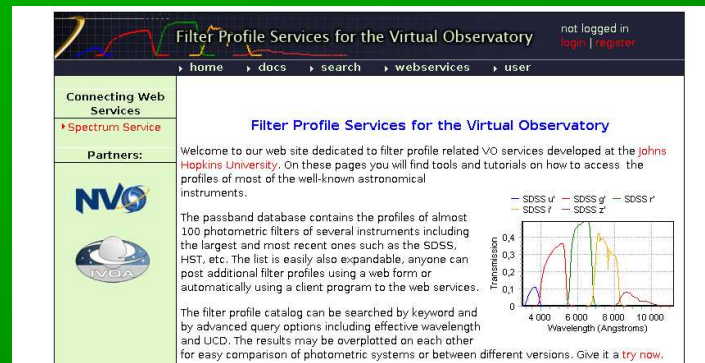


Under development

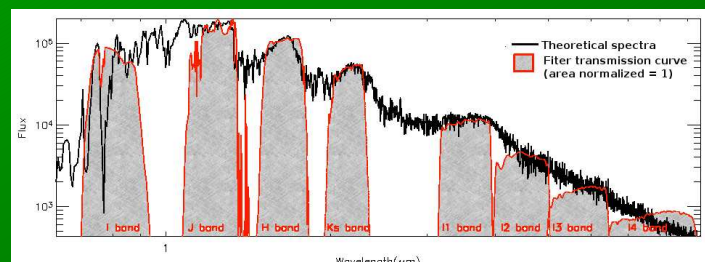
Synthetic photometry fittings



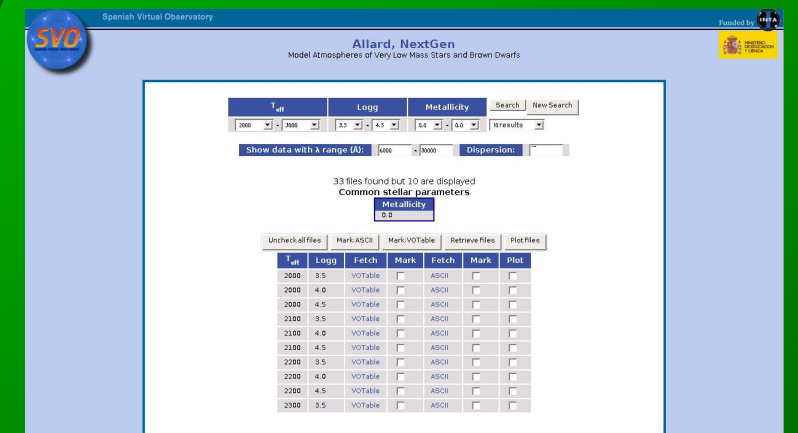
Filter selection.



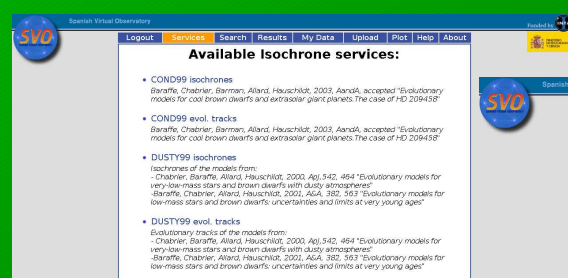
Filter+Synthetic spectra = Synthetic photometry.



Obtaining synthetic spectra.



Comparison with theoretical isochrones and evolutionary tracks.



Estimation of physical parameters.

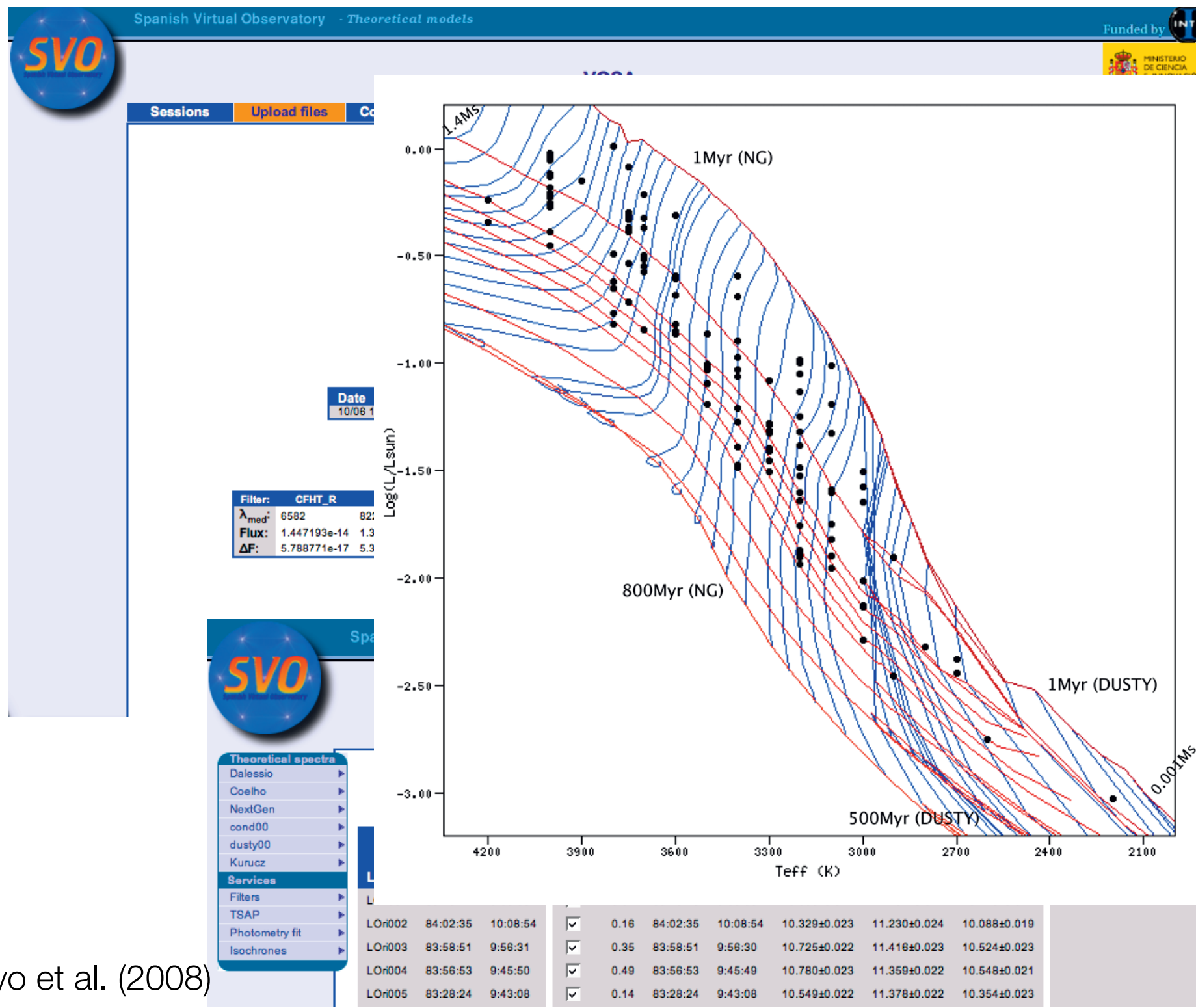
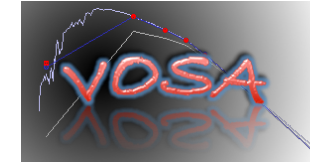
$$\log g = 4.44 + \log M(M_{\odot}) - 2 \log R(R_{\odot})$$

$$d(\text{pc}) = 2.26 \times 10^{-8} R_{*}(R_{\odot}) \sqrt{\left( \frac{F_{\text{Model}}}{F_{\text{Obs}}} \right)}$$

$$F_{\text{Obs}} = \left( \frac{MG}{gd} \right)^2 \sigma T_{\text{eff}}^4$$

Table Browser for 1: paramatal.2										
	Teff	logg	Flux	eFlux	R	eR	Mass	eM	L	
1	3600	5	1.710410E-10	1.697230E-12	2.13861	0.06686	16.05987	11.2083	0.8014	
2	3600	5	1.708030E-10	1.672630E-12	2.13861	0.07871	20.47713	14.0339	0.8544	
3	3700	5	1.551900E-10	1.650900E-12	2.14297	0.06938	16.67363	11.41119	0.7826	
4	3700	4	1.450400E-10	1.637350E-12	2.15135	0.07168	19.46413	13.31465	0.7257	
5	3900	4	1.640020E-10	1.630710E-12	1.98288	0.06072	1.42755	0.97104	0.82039	
6	3700	5	1.348800E-10	1.577020E-12	1.99795	0.0657	14.49332	9.9366	0.67475	
7	3700	5	1.428810E-10	1.428810E-12	1.76265	0.05723	12.39731	7.7333	0.58517	
8	3700	5	1.311830E-10	1.608590E-12	1.97632	0.06536	14.09522	9.67325	0.65622	
9	3600	5	1.064900E-10	1.138400E-12	1.59718	0.04096	9.26209	6.11476	0.53228	
10	3600	5	1.000710E-10	1.188710E-12	1.55356	0.04002	8.76366	5.88022	0.508	
11	3800	4,5	1.224400E-10	1.521800E-12	1.80466	0.05873	3.7393	2.5606	0.61249	
12	3900	4	1.144700E-10	1.254010E-12	1.65964	0.0552	0.99645	0.68905	0.57285	
13	3500	5	1.684920E-10	1.135840E-12	2.0025	0.05885	14.59552	10.03039	0.54274	
14	3600	5	9.737800E-11	1.135940E-12	1.52777	0.0481	8.4745	5.78179	0.48702	
15	3600	4,5	1.038000E-10	1.161380E-12	1.7175	0.04029	2.8572	1.8474	0.51934	
16	3600	5	0.999270E-11	1.093740E-12	1.7334	0.05859	10.90933	7.50322	0.45518	
17	3600	5	7.967800E-11	8.790500E-13	1.3768	0.04297	6.88344	4.69117	0.39552	
18	3600	5	8.697770E-11	9.98170E-13	1.6473	0.05075	10.43796	7.16434	0.43509	
19	3600	4	8.165770E-11	1.002540E-12	1.73725	0.06033	10.95788	7.56072	0.40488	
20	3200	5	8.422010E-11	1.138400E-12	2.11061	0.08053	16.7399	11.29175	0.4213	
21	3700	4	1.222900E-11	8.879330E-13	1.46106	0.04898	7.70311	5.13068	0.36129	
22	3600	4,5	7.684620E-11	8.500920E-13	1.59297	0.05308	2.91349	2.00052	0.38441	
23	3700	4,5	7.459300E-11	8.440400E-13	1.46634	0.04889	2.46889	1.69437	0.36345	
24	3600	5	7.362880E-11	1.027590E-12	1.55928	0.05422	8.82753	6.05176	0.36832	
25	3300	4,5	7.430700E-11	1.511960E-12	1.86414	0.07549	3.86886	2.80788	0.71669	
26	3300	4,5	7.383070E-11	9.415770E-13	1.6381	0.06872	3.96488	2.7669	0.69317	
27	3700	5	6.210810E-11	7.513100E-13	1.35671	0.04488	6.683	4.58495	0.31114	
28	3700	4,5	5.174840E-11	6.750930E-13	1.37119	0.04144	1.86255	1.25394	0.28897	
29	3600	4	6.010800E-11	7.688170E-13	1.4785	0.0469	0.73897	0.54577	0.31115	
30	3300	4,5	5.150980E-11	7.468890E-13	1.60827	0.05962	2.96973	2.05988	0.27666	
31	3300	5	5.362900E-11	7.594800E-13	1.43385	0.0506	1.64559	1.05049	0.2626	
32	3300	4,5	5.307200E-11	7.638000E-13	1.57546	0.05822	2.9468	1.86144	0.26489	
33	3300	5	5.398460E-11	9.062900E-13	1.39955	0.05198	7.11173	4.84787	0.25111	
34	3600	4	5.403300E-11	6.006010E-13	1.23563	0.04539	0.64789	0.44575	0.27034	
35	3300	4,5	4.603200E-11	5.988030E-13	1.46726	0.05405	2.4718	1.71794	0.23027	
36	3300	4	4.509000E-11	5.614370E-13	1.45217	0.05307	0.76566	0.53161	0.22556	
37	3300	4	4.862030E-11	6.414590E-13	1.60584	0.05051	0.93197	0.63388	0.24422	

# And VOSA came to life!





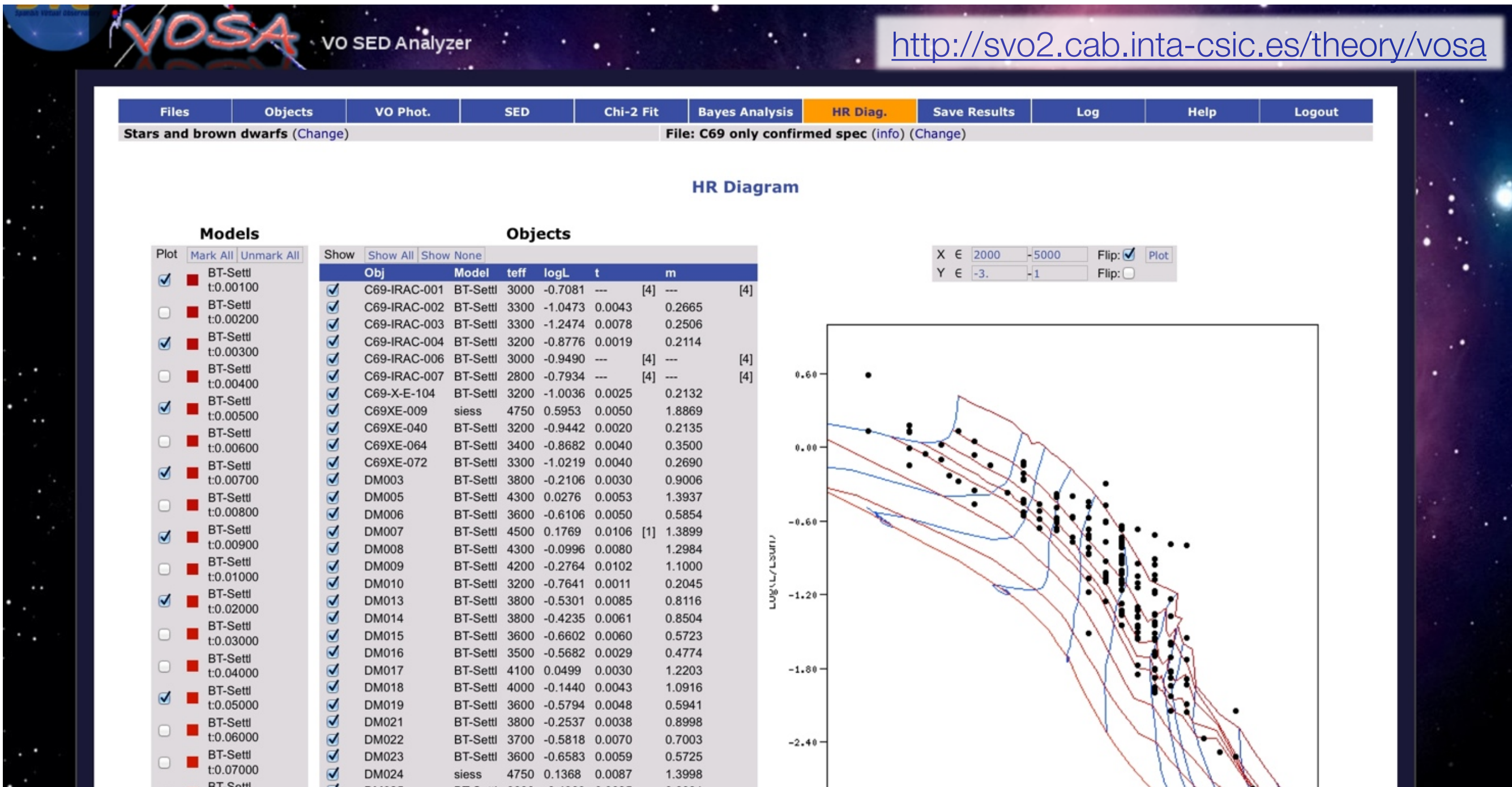
# And there was room for improvement

---

- “Limited to” / “conceived for” stars and brown dwarfs, what about older sources? and more massive? and ~~science-fiction~~ uhmm extragalactic studies?
- Reflected in the available collections of models: Kurucz, NextGen, COND, DUSTY and not many more
- Brute force fitting but no study of the relevance of the individual parameters to the fit
- No  $A_V$  estimation
- Not design to work with a single object (input format)
- Variety of catalogs offered but you can always do better and also look for more than photometry
- No Isochrone interpolation, make it even more VO!
- Anything else in the wish-list?



# VOSA 2: the new generation



~200 regular users, cited in ~ 50 papers

Bayo et al. (2008, 2014a subm.)

# Some examples: 2.- A product from “YOU”

- Data related:
- CDS wonders vs pain of getting, for example, IOP tables

```
04370+2559 (A, B) 2 4.3 \sim K3-M1 C A \gg B 20, 21
04385+2550 (A, B) 2 18.9 M0 C A \gg B 22, 2
CoKu Tau/3 (A, B) 2 2.05 M1 C A > B 1
CZ Tau (A, B) 2 0.32 M3 W A \sim B 1
DD Tau (A, B) 2 0.56 M3+M3 C A \sim B 1
DF Tau (A, B) 2 0.09 M0.5+M3 C A \sim B 1
DH Tau 2 15 M2+M2 C DH > DI 7, 8
DK Tau (A, B) 2 2.30 K9+M1 C A > B 1, 7
DQ Tau (A, B) 2 SB K5 C A \sim B 12
F04192+2647 (A, B) 2 23.3 \ldots \ldots A > B 23
F04297+2246 (A, B) 2 6.6 \ldots \ldots A > B 23
FM Tau 2 37.3 M2 C FM < V773 7, 8
FO Tau (A, B) 2 0.15 M2+M2 C A \sim B 1
FQ Tau (A, B) 2 0.76 M3+M3.5 C A \sim B 1, 17
FS Tau (Aa, Ab, B) 3 0.23 (Aa, Ab), 20 (A-B) M1+M4 (Aa, Ab) C Aa > Ab 1, 24
FV Tau (A, B) 2 0.72 K5+K6 C A \sim B, FV > FV/c 1
FX Tau (A, B) 2 0.89 M1+M4 C+W A > B 1, 6
FZ Tau 2 16.9 M0+K5 C FZ > FY 7, 8
GG Tau (A, B) 4 10.3 \ldots C A \gg B 1
GG Tau (Aa, Ab) 2 0.25 K7+M0.5 C Aa \gtrsim Ab 1
GG Tau (Ba, Bb) 2 1.48 M5.5+M7.5 C Ba > Bb 1
GH Tau (A, B) 2 0.31 M1.5+M2 C A \sim B 1
GI Tau 2 12.9 K6 C GI \sim GK 5, 6
GK Tau (A, B) 2 2.5 K7 C A \gg B 5, 6
GN Tau (A, B) 2 0.33 M2.5 C A \sim B 1, 26
Haro 6-37 (Aa, Ab, B) 3 2.62(A, B), 0.33 (Aa, Ab) K7+M1 C Aa > Ab, A > B 1, 11
HK Tau (A, B) 2 2.34 M1+M2 C A \gg B 1, 7
HN Tau (A, B) 2 3.11 K5+M4 C A \gg B 1
HP Tau (A, B) 2 0.017 K2 C A > B 7, 8, 15
IS Tau (A, B) 2 0.22 K7+M4.5 C+W A > B 1
IT Tau (A, B) 2 2.39 K3+M4 C A \gtrsim B 1, 6
RW Aur (A, B, C) 3 1.42 (A-BC), 0.12 (B-C) K1+K5 (A, B) C A > B \gg C 1, 10
T Tau (N, Sa, Sb) 3 0.70 (N-S), 0.1 (Sa-Sb) K0 C N \sim Sa \sim Sb 1, 3
UX Tau (A, B, C) 4 5.86 (A-B), 2.63 (A-C) K5+M2+M5 C+W+W A > B, A \gg C 1
UX Tau (Ba, Bb) 2 0.138 M2 W Ba > Bb 11
UY Aur (A, B) 2 0.88 M0+M2.5 C A \gtrsim B 1, 17
UZ Tau (A, Ba, Bb) 4 SB (A), 3.54(A-Ba), 0.37 (Ba-Bb) M1+M2+M2 C A > B, Ba \sim Bb 1, 13
V710 Tau (A, B) 2 3.17 M0.5+M2 C+W A \sim B 1
V773 Tau (AB, C, D) 4 SB (AB), 0.12 (AB-C), 0.24 (AB-D) K2+M0 (AB, C) W+C D > C > AB 1, 4
V807 Tau (A, Ba, Bb) 3 0.30 (A-B), 0.04 (Ba-Bb) K7+M3 C+W A > B, Ba \sim Bb 25, 1
V892 Tau (Aa, Ab, B) 3 0.06, 4.10 B9+M2 W Aa \sim Ab, A \gg B 16, 19
V955 Tau (A, B) 2 0.33 K5+M1 C A > B 1
VY Tau (A, B) 2 0.66 M0 W A > B 1
XZ Tau (A, B) 2 0.30 M3+M1.5 C B > A 1
ZZ Tau IRS 2 35 M4.5 C ZZ IRS > ZZ 2
ZZ Tau (A, B) 2 0.04 M3 C A \gtrsim B 9
```

TOPCAT(33): Table Browser				
Table for 33: J_A+A_560_A76_clusters				
ID	Name	Cat	GLON	
1	BH 131	(01),13	300.116	
2	[MCM2005b] 32	09	300.131	
3	BH 132	01	300.263	
4	VVV CL013	14	300.343	
5	[FSR2007] 1616	11	300.474	
6	[MCM2005b] 33	09	300.507	
7	Ruprecht 105	01	300.885	
8	G3CC 5	17	300.913	
9	[DBS2003] 77	05	300.966	
10	VVV CL015	14	300.967	
11	VVV CL016	14	300.984	
12	[DBS2003] 78	05	301.118	
13	VVV CL017	14,17	301.137	
14	[FSR2007] 1622	11	301.416	
15	G3CC 6	17	301.643	
16	NGC 4609	01	301.895	
17	G3CC 7	17	301.947	
18	Hogg 15	01	302.047	
19	VVV CL018	14	302.158	
20	[MCM2005b] 34	09	302.433	
21	[FSR2007] 1630	11	302.612	
22	[DBS2003] 79	05	302.64	
23	[DBS2003] 80	05	302.806	
24	Teutsch 109	02	303.652	
25	G3CC 8	17	303.927	
26	G3CC 9	17	304.002	
27	VVV CL019	14	304.805	
28	[MCM2005b] 35	09	304.845	
29	VVV CL020	14	304.87	
30	G3CC 10	17	304.887	
31	[DBS2003] 82	05	304.928	
32	[DBS2003] 131	05,17	305.259	
33	[DBS2003] 130	05	305.269	
34	VVV CL021	14	305.277	
35	[DBS2003] 132	05	305.321	
36	Danks 1	01,17	305.338	
37	VVV CL022	14	305.362	
38	[MCM2005b] 36	09	305.383	
39	Danks 2	01,17	305.392	
40	VVV CL023	14	305.438	



# Some examples: 2.- A product from “YOU”

*Asmus et al 2014*

TOPCAT(31): Table Browser

Table Browser for 31: TAP\_1\_sasmirala.objects

	name	raj2000	dej2000
1	3C 390.3	280.5375	79.77139
2	NGC 1275	49.95083	41.51167
3	NGC 6251	248.13333	82.53778
4	3C 305	222.33989	63.27055
5	NGC 5866	226.62292	55.76333
6	Mrk 266NE	204.57414	48.27806
7	Mrk 266SW	204.57213	48.27556
8	M51a	202.46958	47.19528
9	NGC 4258	184.73958	47.30389
10	Mrk 3	93.90167	71.0375
11	NGC 3147	154.22375	73.40083
12	4C +73.08	147.44108	73.23976
13	M81	148.88833	69.06528
14	UGC 5101	143.965	61.35306
15	NGC 3690E	172.14012	58.56294
16	NGC 3690W	172.12925	58.56131
17	NGC 3998	179.48375	55.45361
18	NGC 3982	179.11708	55.12528
19	NGC 3718	173.14542	53.06806
20	IRAS 08572+3915	135.10583	39.065
21	PKS 2158-380	330.32125	-37.77333
22	NGC 7130	327.08125	-34.95111
23	NGC 7172	330.50792	-31.86972
24	IC 1459	344.29417	-36.46222
25	NGC 7496	347.44708	-43.42806
26	NGC 7552	349.045	-42.58472
27	NGC 7582	349.59792	-42.37056
28	NGC 7590	349.72833	-42.23917
29	NGC 7314	338.9425	-26.05056
30	PKS 2354-35	359.25292	-34.75917
31	ESO 602-25	337.85625	-19.03444
32	MR 2251-178	343.52417	-17.58194
33	Mrk 915	339.19375	-12.54528
34	3C 445	335.95625	-2.10361
35	Mrk 926	346.18125	-8.68583
36	NGC 7592W	349.59084	-4.41574
37	ESO 297-18	24.655	-40.01139

Description

PKS 2158-380/MCG-6-48-13 is a radio-loud lenticular galaxy at a redshift of  $z = 0.0334$  ( $D \sim 149$  Mpc) with a Sy 2 nucleus [veron-cetty\_catalogue\_2010] and was first studied in detail by [fosbury\_very\_1982]. HST observations revealed three compact but resolved sources in the nucleus instead of one central source (total extend  $\sim 1$  arcsec  $\sim 0.7$  kpc; PA  $\sim 90^\circ$ ; [boyce\_faint\_1996, zirbel\_ultraviolet\_1998]). In addition, water maser emission was detected in this object [kondratko\_discovery\_2006]. No Spitzer data are available for PKS 2158-380, which was imaged with VISIR in the SIC filter in 2006 [van\_der\_wolk\_dust\_2010]. A compact MIR nucleus is weakly detected in the image. The low S/N prevents a quantitative analyses of the source morphology but the latter seems different than that seen in HST, as only one source was detected. Our nuclear photometry is consistent with the value in [van\_der\_wolk\_dust\_2010].

[boyce\_faint\_1996] P. J. Boyce, M. J. Disney, F. Macchetto, A. Boksenberg, J. C. Blades, and C. D. Mackay. [Faint object camera observations of complex nuclear structure in PKS 2158-380](#). *A&A*, **305** pp. 715, January 1996.

[fosbury\_very\_1982] R. A. E. Fosbury, A. Boksenberg, M. A. J. Snijders, I. J. Danziger, M. J. Disney, W. M. Goss, M. V. Penston, W. Wamsteker, K. J. Wellington, and A. S. Wilson. [Very extended ionized gas in radio galaxies. I - a radio, optical and ultraviolet study of PKS 2158-380](#). *MNRAS*, **201** pp. 991–1008, December 1982.

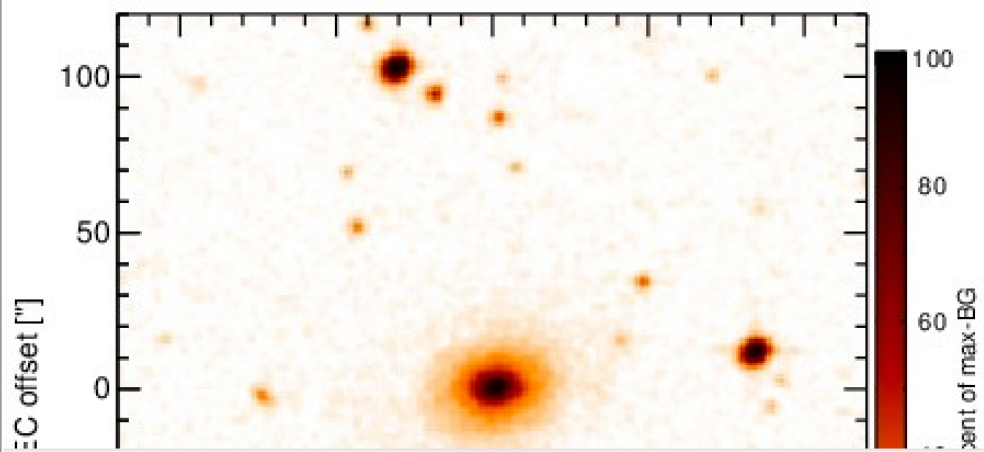
[kondratko\_discovery\_2006] P. T. Kondratko, L. J. Greenhill, J. M. Moran, J. E. J. Lovell, T. B. H. Kuiper, D. L. Jauncey, L. B. Cameron, J. F. Gómez, C. García-Miró, E. Moll, I. de Gregorio-Monsalvo, and E. Jiménez-Bailón. [Discovery of water maser emission in eight AGNs with 70 m antennas of NASA's deep space network](#). *ApJ*, **638** pp. 100–105, February 2006.

[van\_der\_wolk\_dust\_2010] G. van der Wolk, P. D. Barthel, R. F. Peletier, and J. W. Pel. [Dust tori in radio galaxies](#). *A&A*, **511** pp. 64, February 2010.

[veron-cetty\_catalogue\_2010] M.-P. Véron-Cetty and P. Véron. [A catalogue of quasars and active nuclei: 13th edition](#). *A&A*, **518** pp. 10, July 2010.

[zirbel\_ultraviolet\_1998] Esther L. Zirbel and Stefi A. Baum. [The ultraviolet continuum emission of radio galaxies. I. description of sources from the hubble space telescope archives](#). *ApJS*, **114** pp. 177, February 1998.

Images



URL: <http://dc.zah.uni-heidelberg.de/sasmirala/q/prod/qp/PKS%202158-380>

## Some examples: 3.-

---

A&A 525, A29 (2011)  
DOI: [10.1051/0004-6361/201015223](https://doi.org/10.1051/0004-6361/201015223)  
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**Astronomy  
&  
Astrophysics**

### **Identification of blue high proper motion objects in the Tycho-2 and 2MASS catalogues using Virtual Observatory tools**

F. M. Jiménez-Esteban<sup>1,2,3</sup>, J. A. Caballero<sup>4</sup>, and E. Solano<sup>1,2</sup>

- ✓ Bright objects with blue colors and high proper motions are rare on the sky  
The “usual suspects”: Nearby white dwarfs, hot subdwarfs, runaway stars or early type stars in nearby young moving groups

Important in many fields

- ✓ WDs are used as spectrophotometric standards
- ✓ Early-type stars in young moving groups are fundamental to understand the evolution of star-forming regions (closer → studies in greater detail)

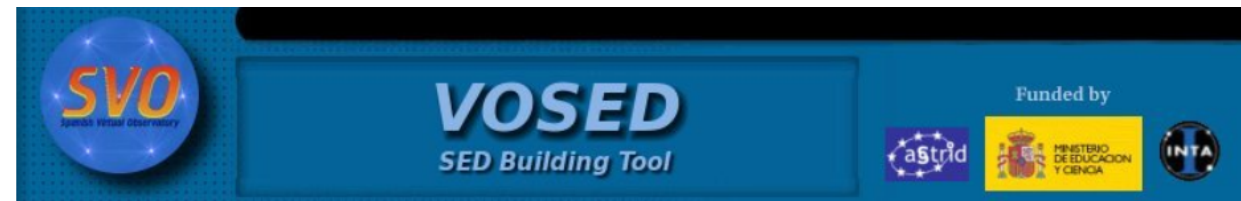
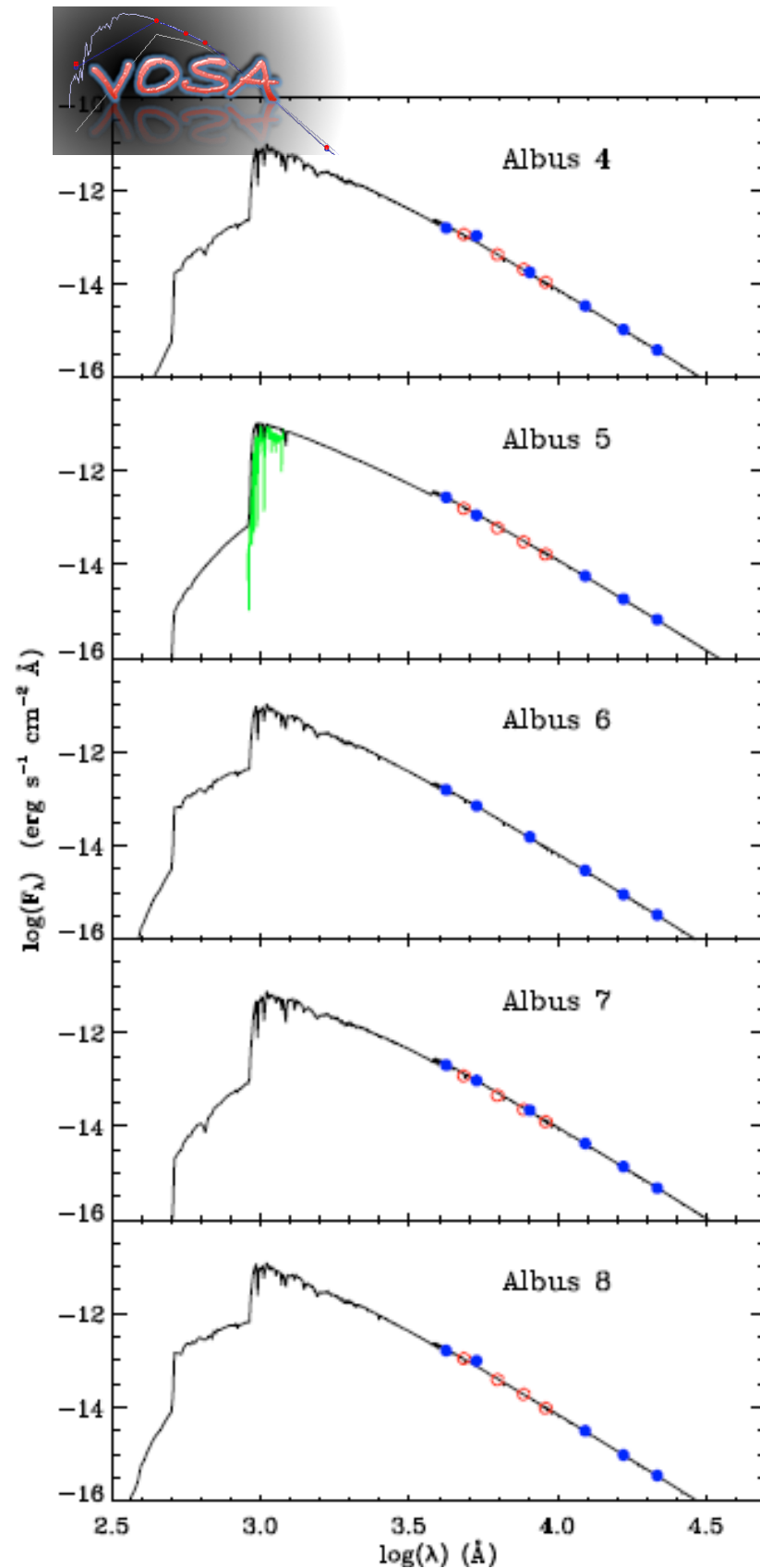
## Some examples: 3.-

A&A 525, A29 (2011)  
DOI: 10.1051/0004-6361/201015223  
© ESO 2010

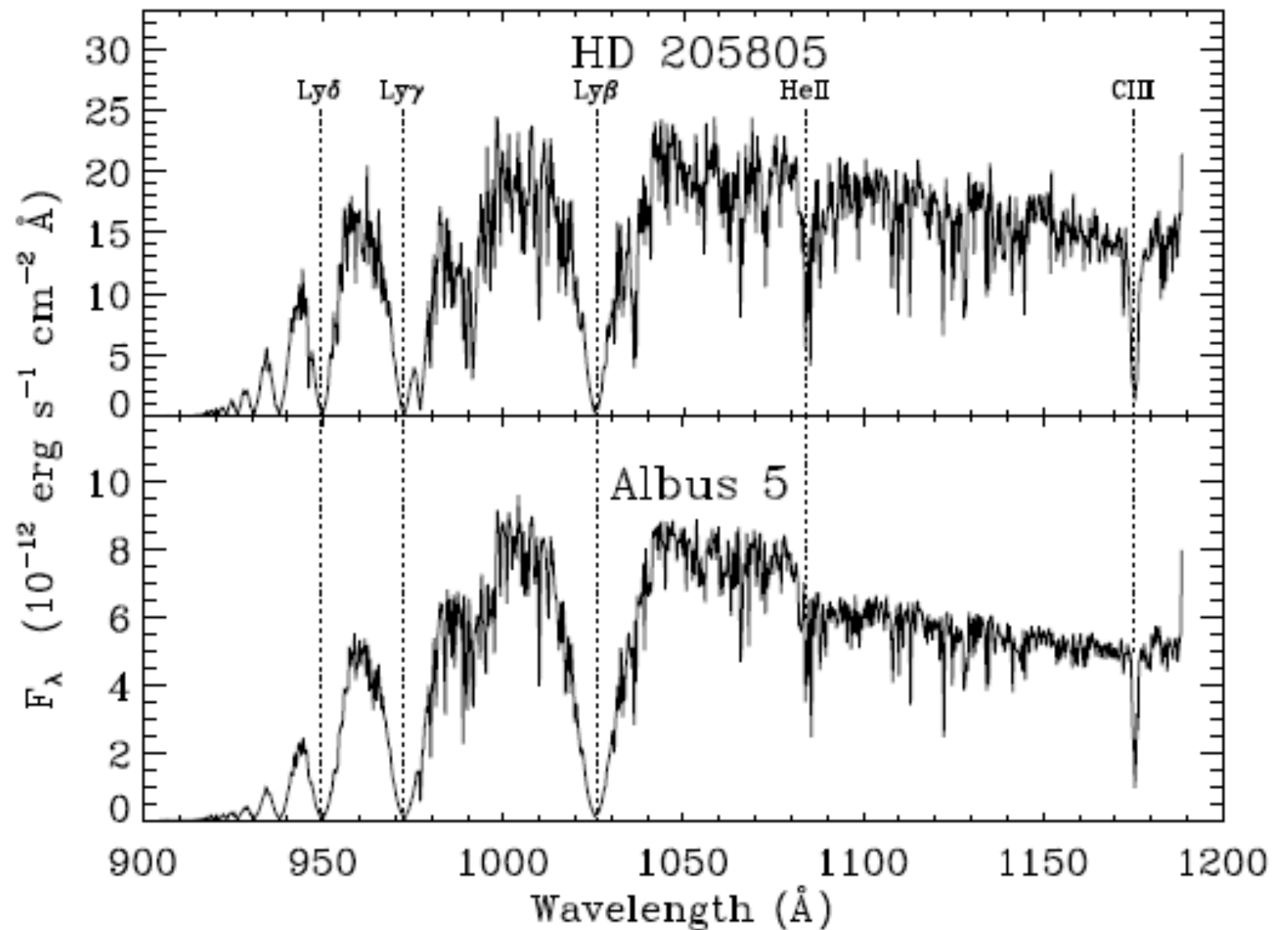
Astronomy  
&  
Astrophysics

### Identification of blue high proper motion objects in the Tycho-2 and 2MASS catalogues using Virtual Observatory tools

F. M. Jiménez-Esteban<sup>1,2,3</sup>, J. A. Caballero<sup>4</sup>, and E. Solano<sup>1,2</sup>



SED Building Tool: Search Form

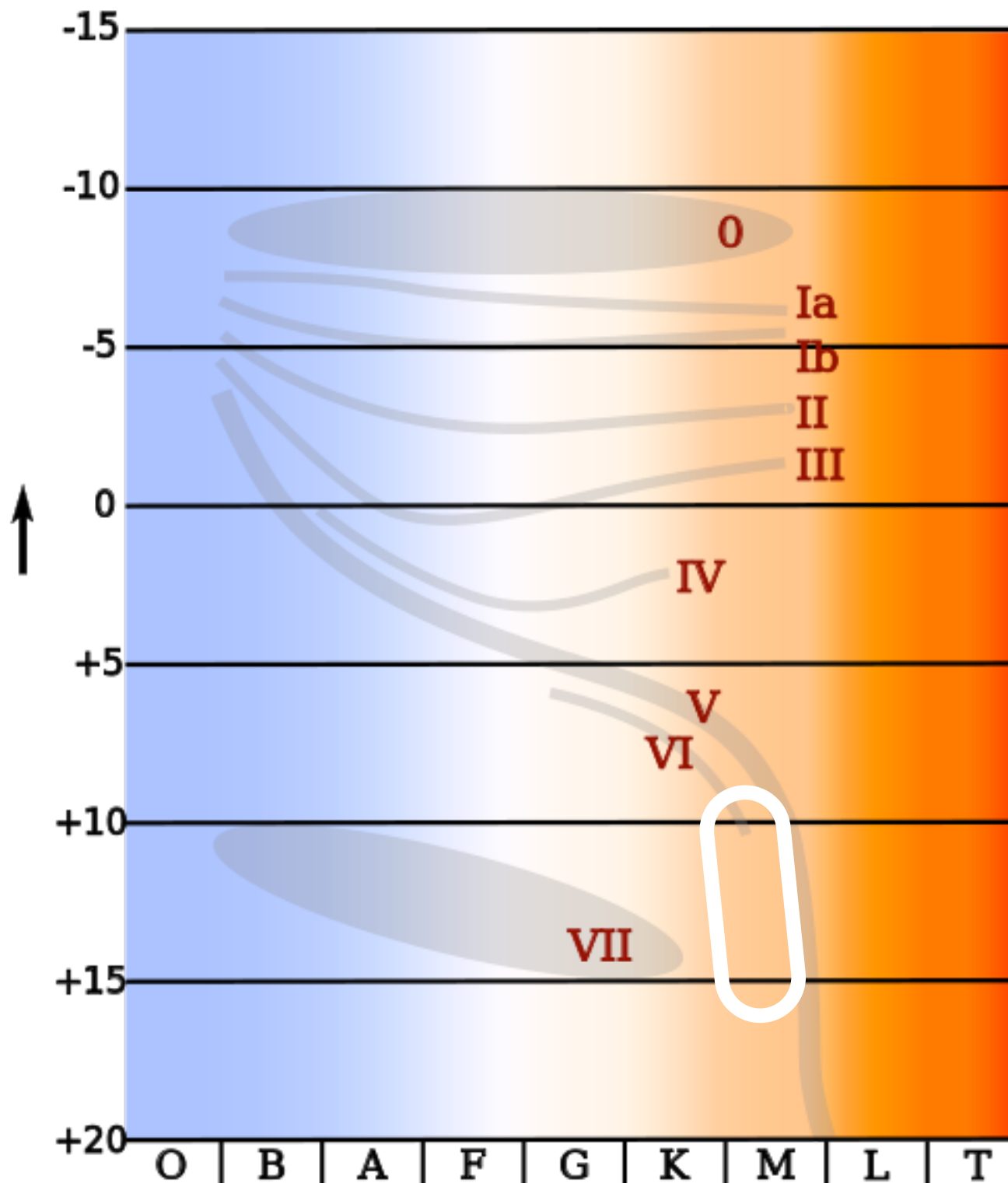


Some examples: 4.-

## New ultracool subdwarfs identified in large-scale surveys using Virtual Observatory tools ★ ★★

### Part I: UKIDSS LAS DR5 vs SDSS DR7

N. Lodieu<sup>1,2</sup>, M. Espinoza Contreras<sup>1</sup>, M. R. Zapatero Osorio<sup>3</sup>, E. Solano<sup>4,5</sup>, M. Aberasturi<sup>4,5</sup>, and E. L. Martín<sup>3</sup>



✓ Metal-poor dwarfs with spectral types later than M7

✓ Less lum. (act. hotter) than their solar met. counterparts

✓ Population II. Tracers of the galact. chem. history

✓ Rare objects: around 50 in 2011

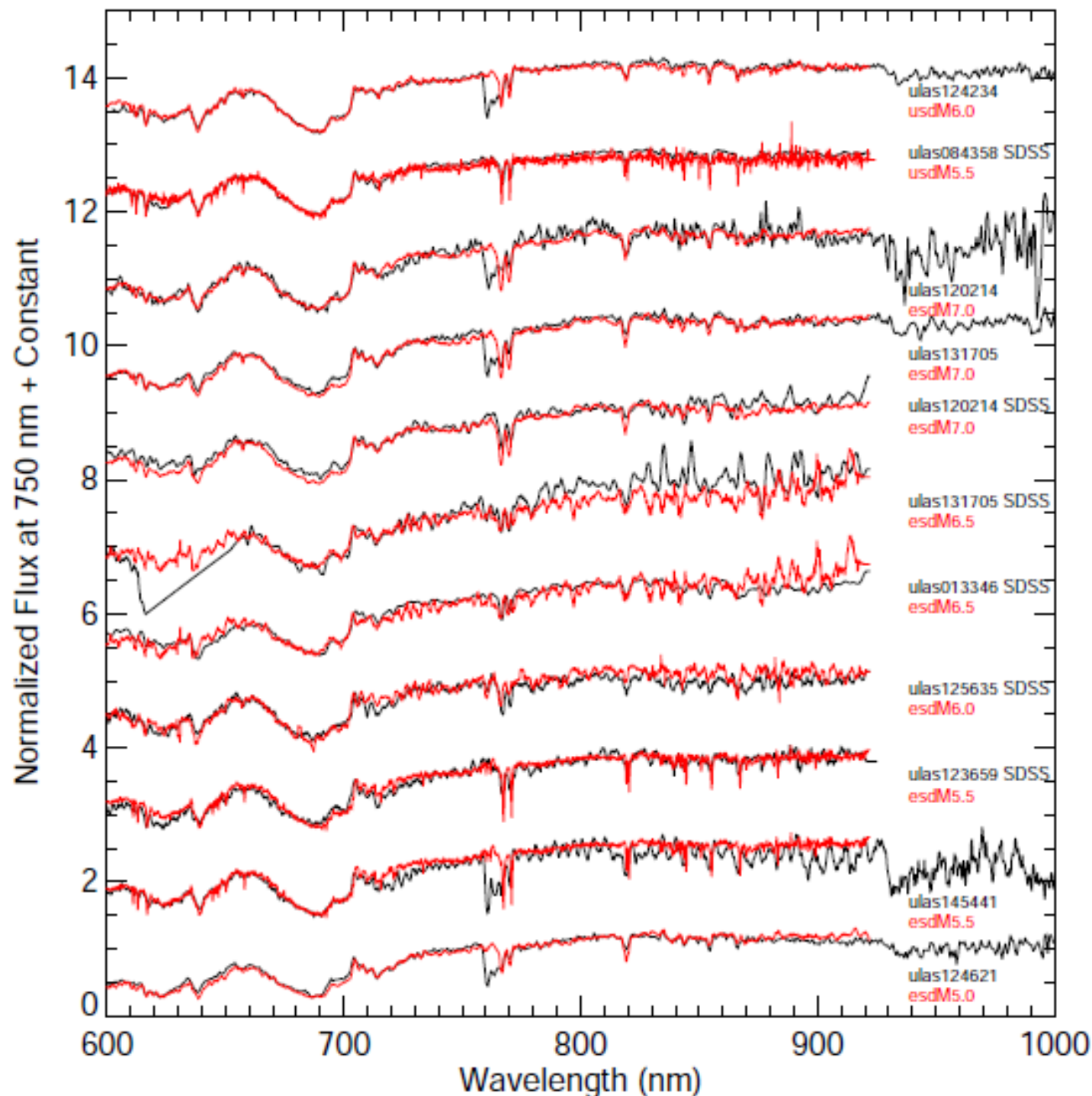


Some examples: 4.-

## New ultracool dwarfs identified in large-scale surveys using Virtual Observatory tools ★ ★★

### Part I: UKIDSS LAS DR5 vs SDSS DR7

N. Lodieu<sup>1,2</sup>, M. Espinoza Contreras<sup>1</sup>, M. R. Zapatero Osorio<sup>3</sup>, E. Solano<sup>4,5</sup>, M. Aberasturi<sup>4,5</sup>, and E. L. Martín<sup>3</sup>



✓ 20 new spectroscopically confirmed UCSDs

✓ > 80% success rate after proper motion refinement

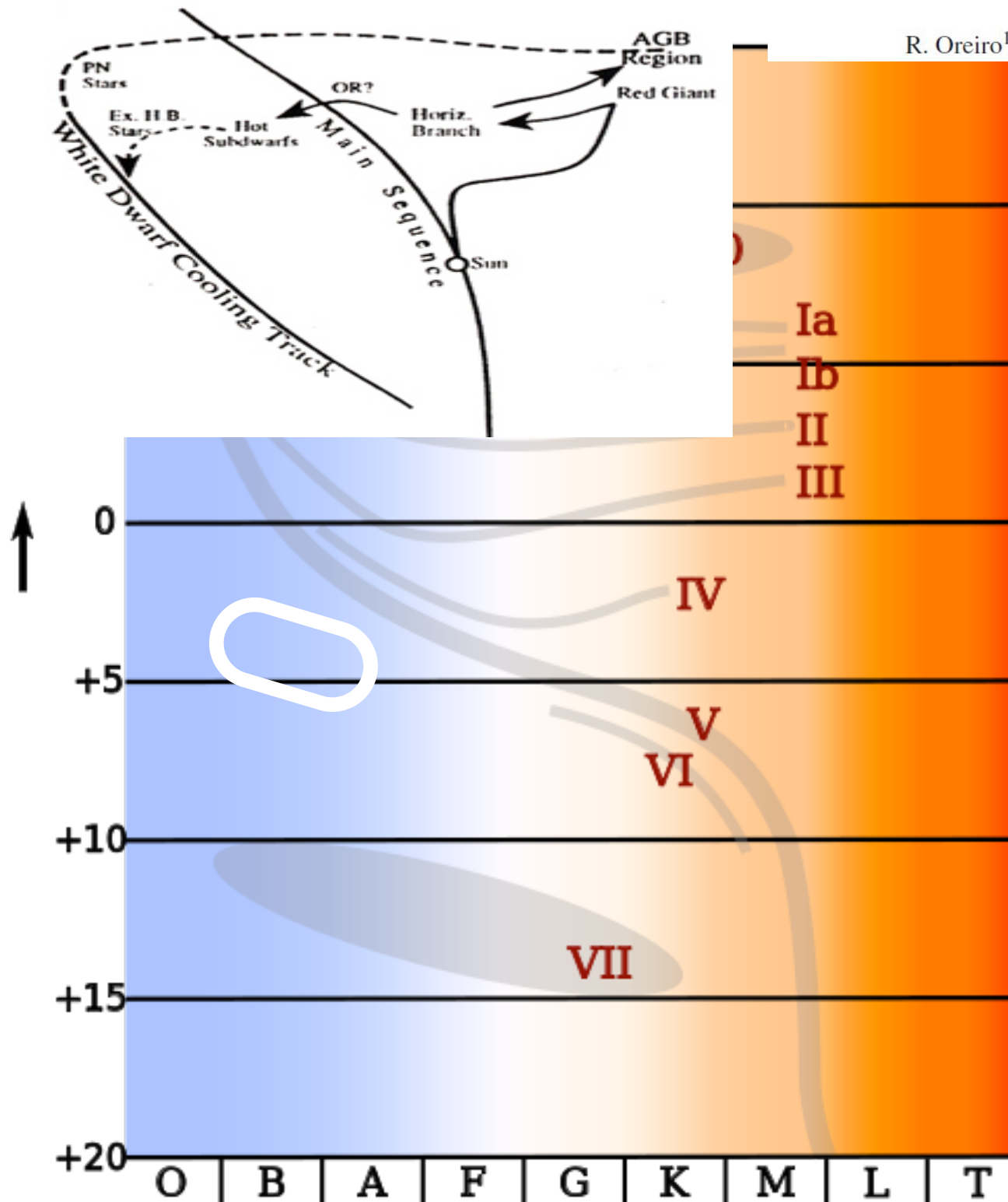


## Some examples: 5.-

A&A 530, A2 (2011)  
DOI: [10.1051/0004-6361/201016324](https://doi.org/10.1051/0004-6361/201016324)  
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### A search for new hot subdwarf stars by means of Virtual Observatory tools

R. Oreiro<sup>1</sup>, C. Rodríguez-López<sup>2,3</sup>, E. Solano<sup>4</sup>, A. Ulla<sup>3</sup>, R. Østensen<sup>5</sup>, and M. García-Torres<sup>6</sup>



✓ Uncertain origin

✓ Need of significant number of "bona-fide" hot sds. to perform statistical studies

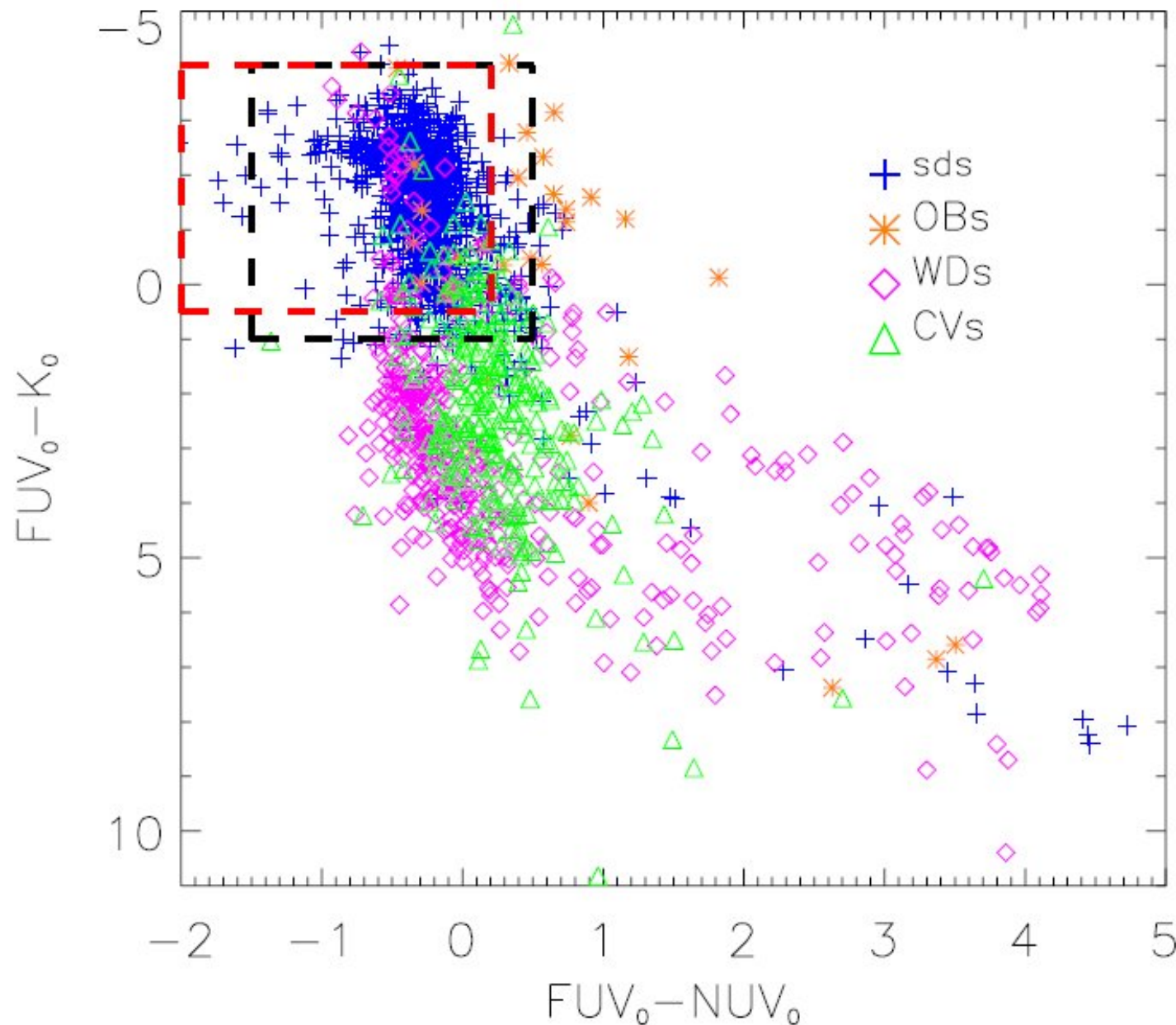
✓ Problems to identify them: High degree of contamination (WDs, CVs, OBs,...)

# Some examples: 5.-

A&A 530, A2 (2011)  
DOI: [10.1051/0004-6361/201016324](https://doi.org/10.1051/0004-6361/201016324)  
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## A search for new hot subdwarf stars by means of Virtual Observatory tools

R. Oreiro<sup>1</sup>, C. Rodríguez-López<sup>2,3</sup>, E. Solano<sup>4</sup>, A. Ulla<sup>3</sup>, R. Østensen<sup>5</sup>, and M. García-Torres<sup>6</sup>



Looking for blue targets?

X-match: GALEX-2MASS

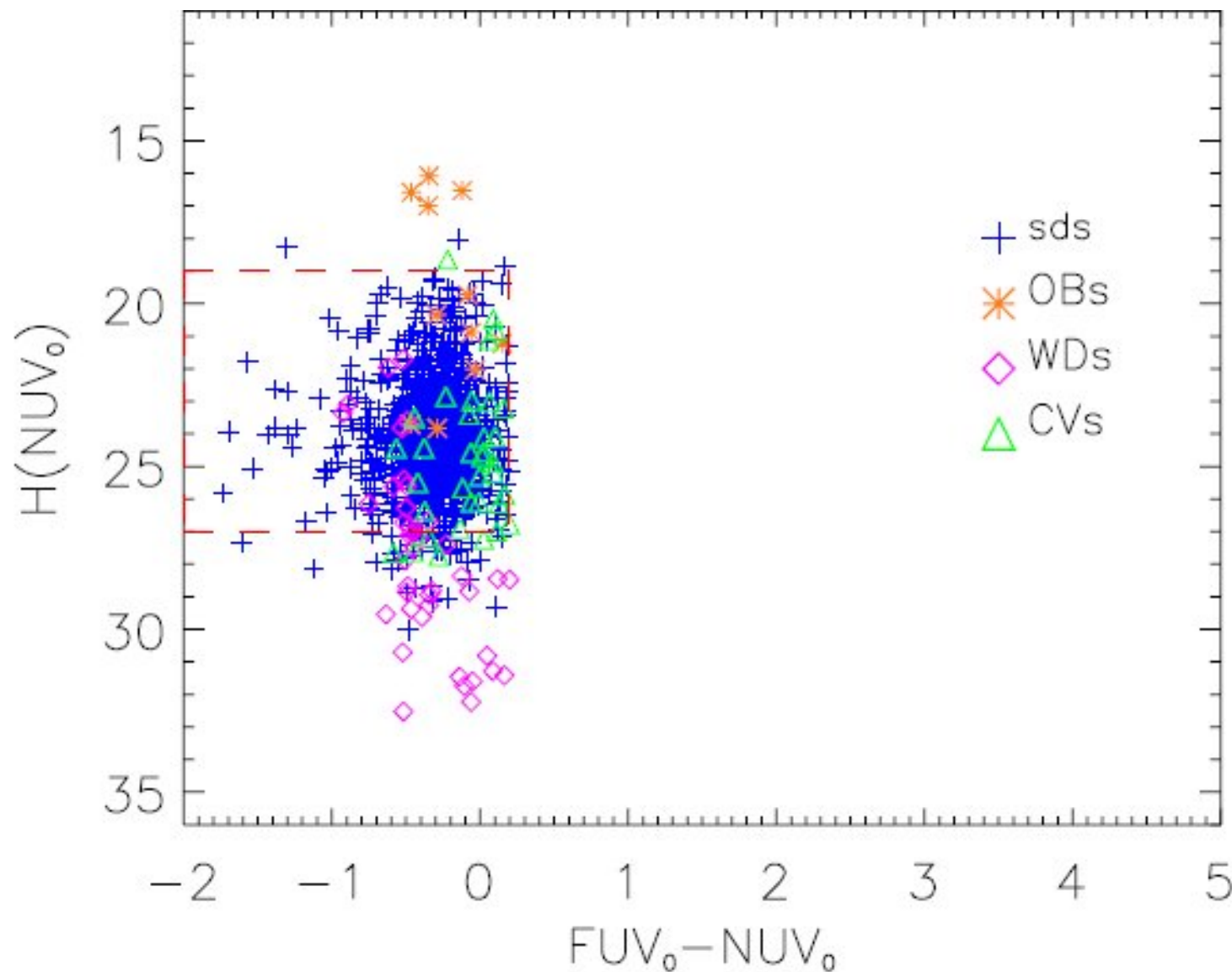
## Some examples: 5.-

A&A 530, A2 (2011)  
DOI: [10.1051/0004-6361/201016324](https://doi.org/10.1051/0004-6361/201016324)  
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Add SuperCosmos for ppm...



Remember the  
reduced ppm diagram?

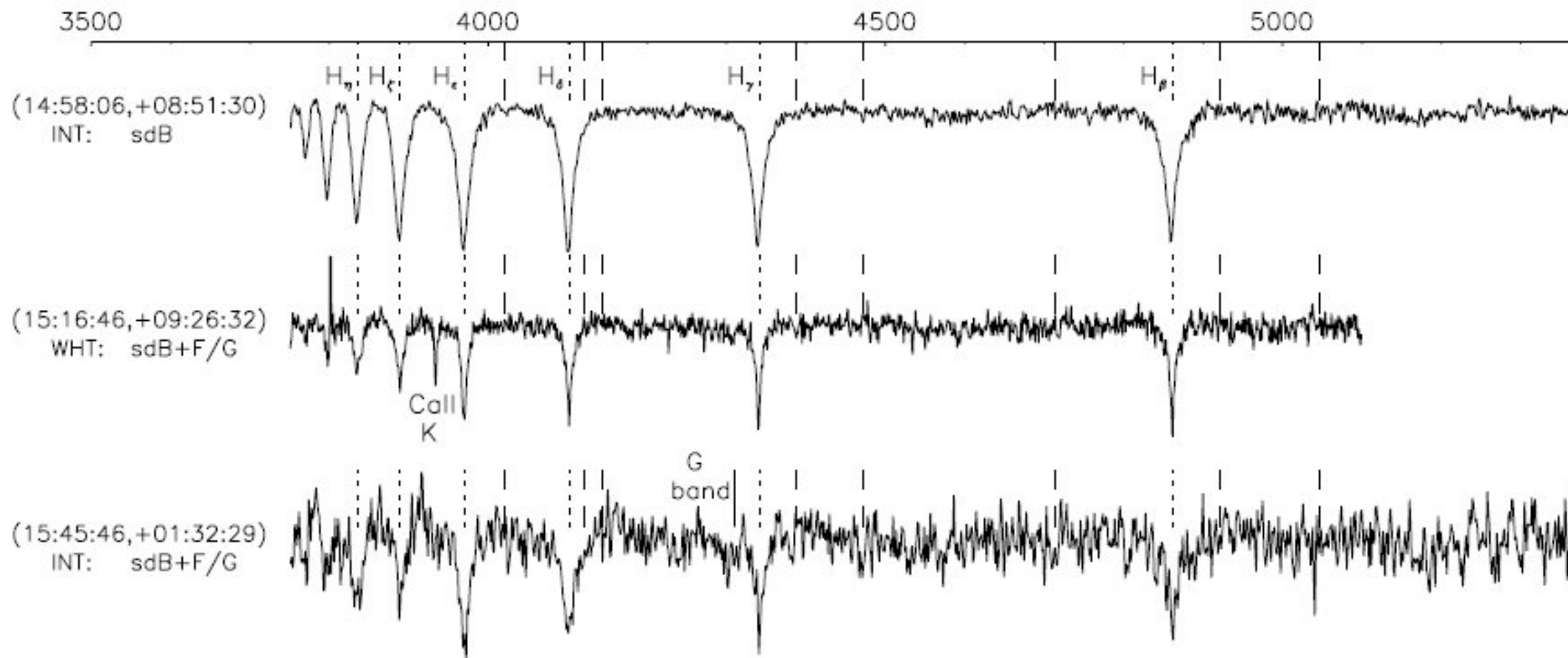


# Some examples: 5.-

A&A 530, A2 (2011)  
DOI: [10.1051/0004-6361/201016324](https://doi.org/10.1051/0004-6361/201016324)  
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**87% success rate!!**

OK, but are there tools for astrometrists in the VO?

Errrr... not really :( but some simple things can be done



# Aladin: astrometric calibration

The screenshot shows the GOLD Mine web interface, a Galaxy On Line Database Milano Network. The main display is a deep sky image with a central galaxy. A red circle highlights a specific point on the galaxy. The interface includes several control panels:

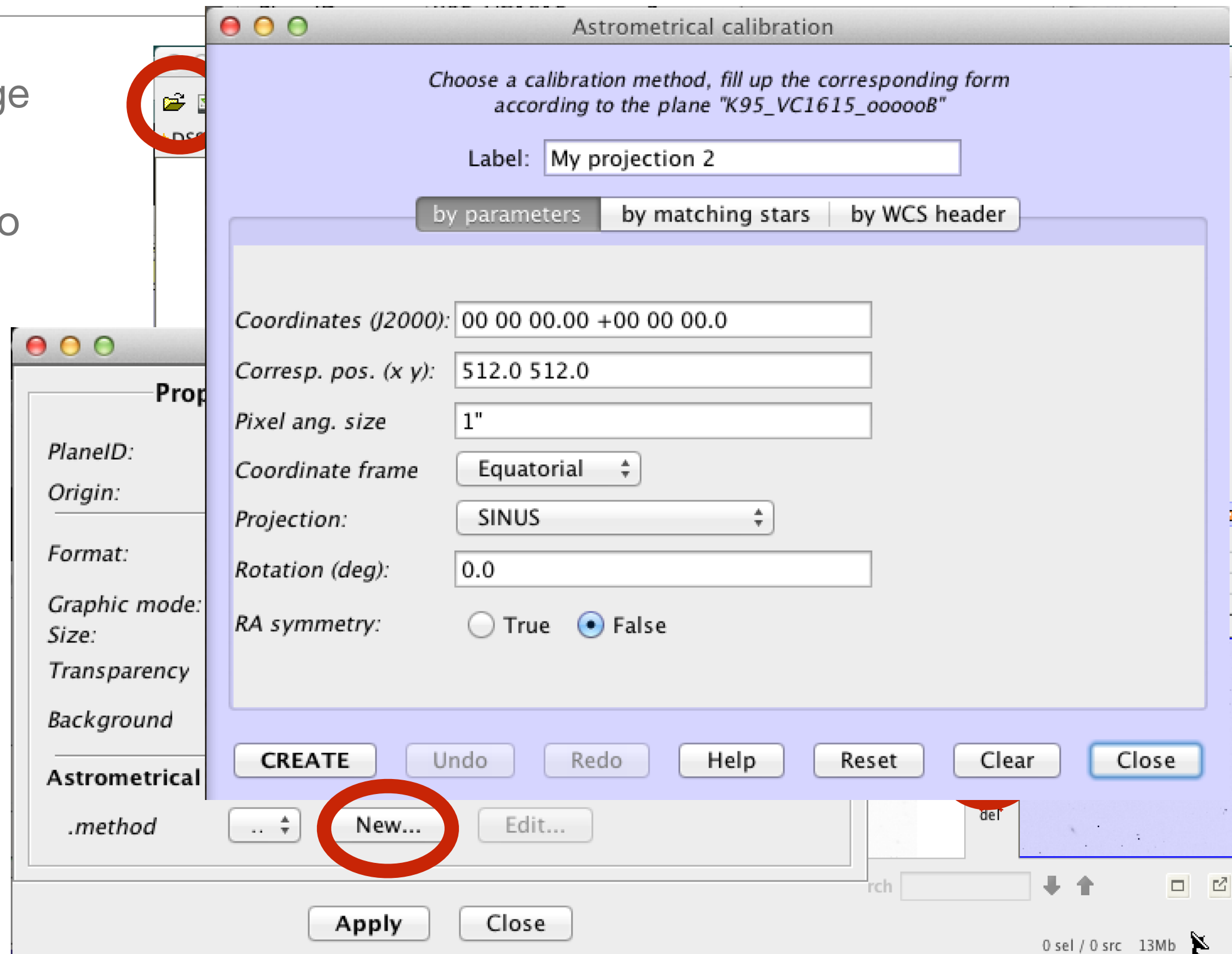
- goto**: Fields for galaxy name, coordinates (r.a., dec), cluster, and buttons for objects list, go, and animate.
- position**: Fields for r.a. (12:30:49.42), dec (+12:23:28.00), fov x (33.23 arcmin), fov y (18.00 arcmin), and a scale bar (2.13 arcmin).
- view**: A checkbox for "show targets in fov", a dropdown for "background image" (SDSS), and a "set" button.
- data**: A panel showing "No data selected" and buttons for "available data" and "get FOV data".
- images**: A table showing image availability for various filters.

The central image shows a deep sky field with a central galaxy. A red circle highlights a specific point on the galaxy. The text "Get some 'random' image" is overlaid at the bottom right.

filter	status
SDSS u	F
SDSS g	F
SDSS r	F
SDSS i	F
SDSS z	F
UKIDSS H	F
UKIDSS K	F
Misc	J

# Aladin: astrometric calibration

- Open the image
- Get header info
- Create a new astrometric calibration



# Aladin: astrometric calibration

- Include one object (coordinates and associated pixels) and pixel size

Astrometrical calibration

Adjust the following form according to the plane "K95\_VC16"

Label:

by parameters | by matching stars | by WCS header

NAXIS1 = 1024  
NAXIS2 = 1024  
CRPIX1 = 512.0  
CRPIX2 = 512.0  
EQUINOX = 2000.0  
CRVAL1 = 188.86012499999998  
CRVAL2 = 14.496305555555555  
CTYPE1 = RA---SIN  
CTYPE2 = DEC--SIN  
RADECSYS= FK5  
CD1\_1 = -2.777777777777778E-4  
CD1\_2 = -0.0  
CD2\_1 = -0.0  
CD2\_2 = 2.777777777777778E-4

MODIFY Undo Redo Help Reset Clear Close



# Aladin: astrometric calibration

- Load a calibrated image from the VO and a catalog to “anchor” the calibration

The screenshot displays the Aladin software interface with the 'Surveys in VizieR' dialog box open. The dialog box is titled 'Surveys in VizieR' and contains the following fields and controls:

- Target (XY im...):** 12 35 22.68 +14 30 16.9
- Survey:** 2MASS-PSC
- Radius:** 15.56'
- Buttons:** Info., Coverage (MOC), Grab coord, All columns (checkbox).

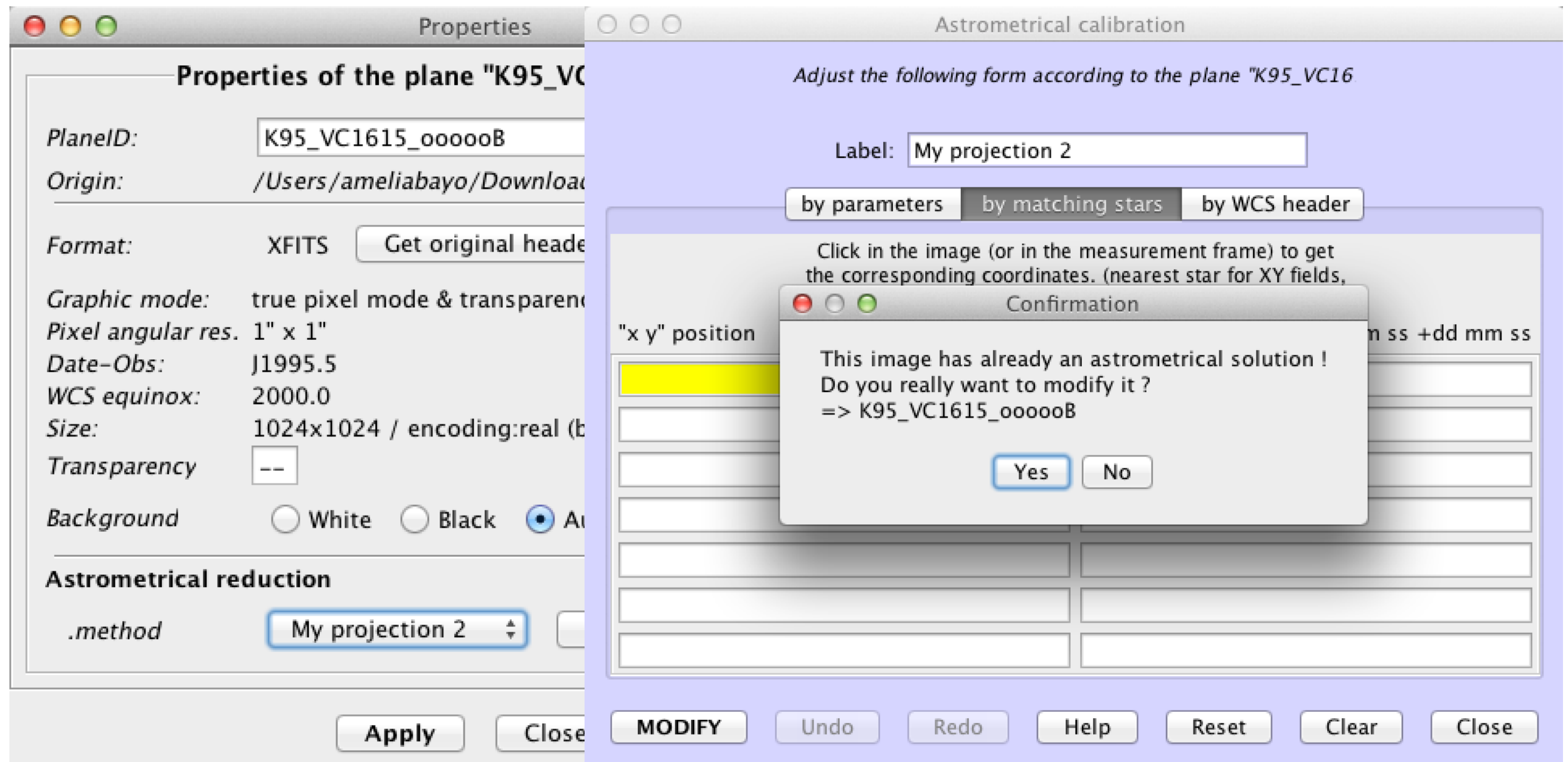
Below the dialog box, a table lists available surveys:

Name	Description	Nb of KRows
2MASS-PSC	The 2MASS Point Source and 2MASS6x catalogu...	470993
2MASX	The 2MASS Extended Source Catalogue (2003)	1648
AC2000.2	Astrographic catalog (mean epoch around 1900)	4622
AKARI	AKARI IRC (9/18um) and FIS (60-160um)all-sky...	1298
ALLWISE	ALLWISE Data Release (Cutri+ 2013)	747634
ASCC-2.5	All-Sky Compiled Catalog of 2.5M* (2003)	2501
B/DENIS	The DENIS database (3rd Release 2005 version)	355220
CMC14	The Carlsberg Meridian Catalog 14 (-30<Dec<...	95858
GALEX	GALEX-DR5 sources from AIS and MIS (2011)	77864
GLIMPSE	Spitzer's GLIMPSE catalogs (Galactic Plane)	104241
GSC-ACT	The HST Guide Star Catalog reduced on Tycho (...)	25242
GSC1.2	The HST Guide Star Catalog 1.2	25242
GSC2.2	The GSC II Catalog, Version 2.2.01 (obsoleted...	455851

The interface also shows various image and catalog servers on the left and right. The 'Image servers' list includes Aladin images, SkyView, UKIDSS, Sloan, DSS..., VLA..., Archives..., and Others... The 'Catalog servers' list includes All VizieR, Surveys, Missions, SIMBAD, NED, SkyBot, and Others... The 'Data Info Frame' at the top right displays the coordinates 980115N HI0640115.

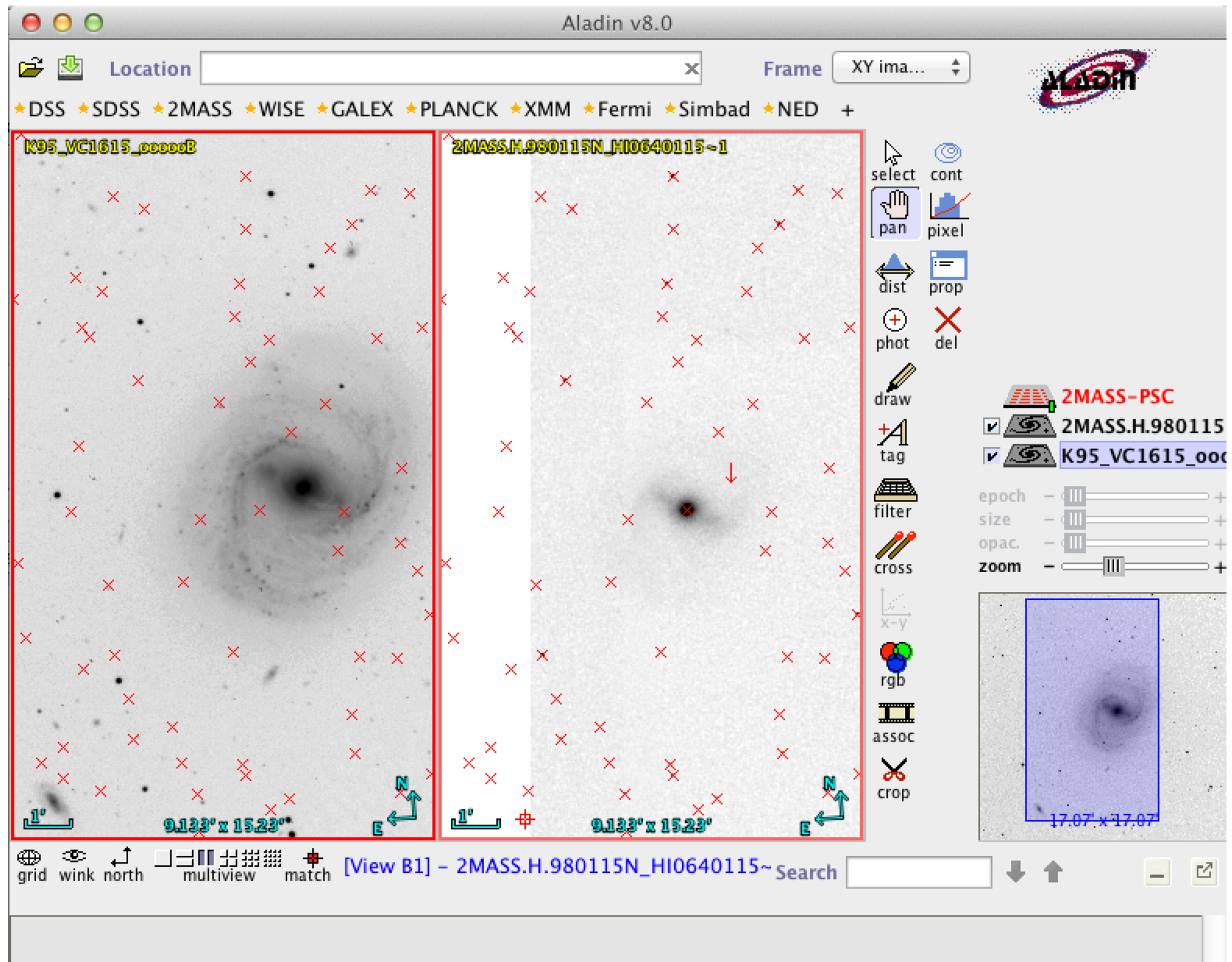
# Aladin: astrometric calibration

- Let's improve our "first calibration"



# Aladin: astrometric calibration

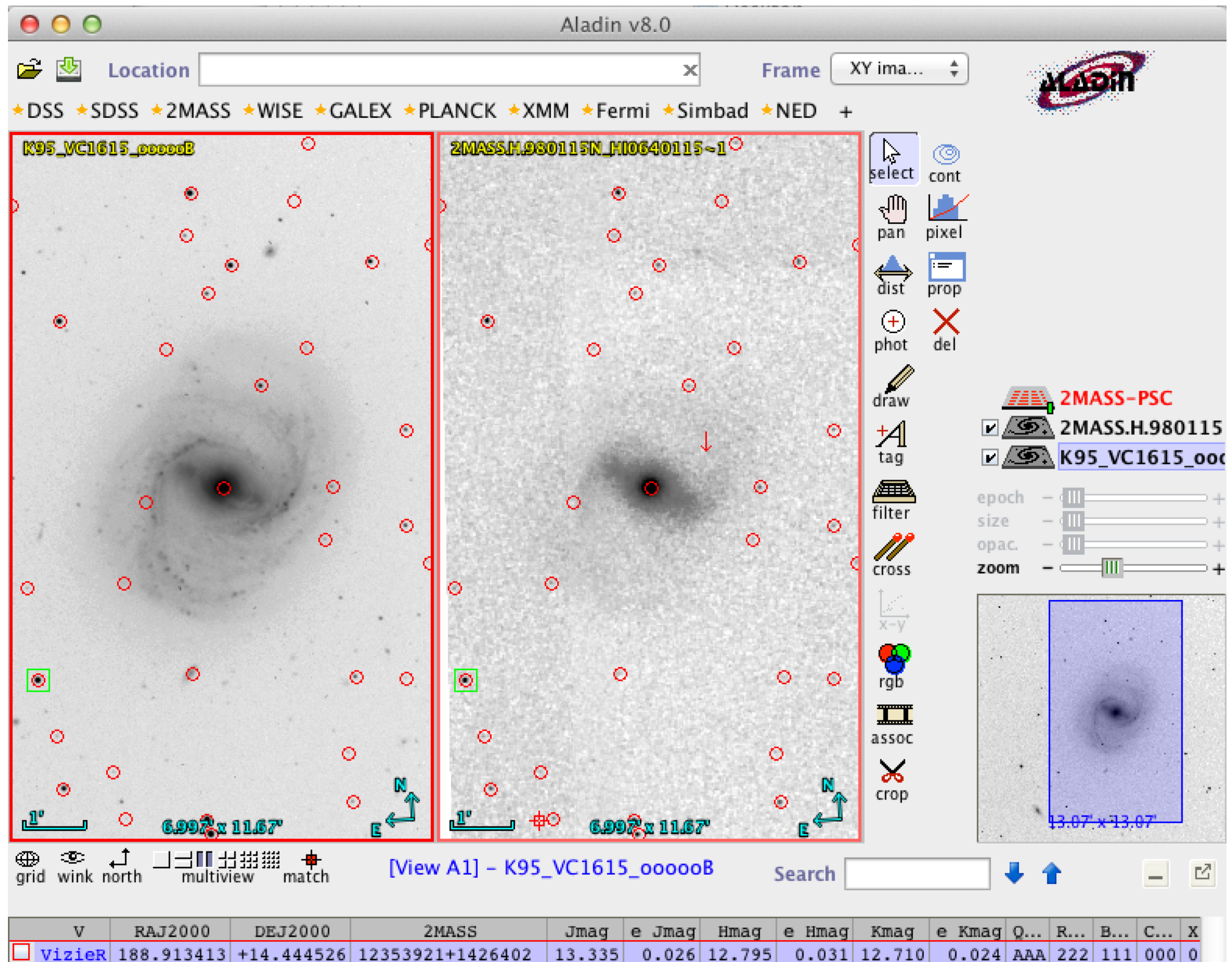
- Matching stars...





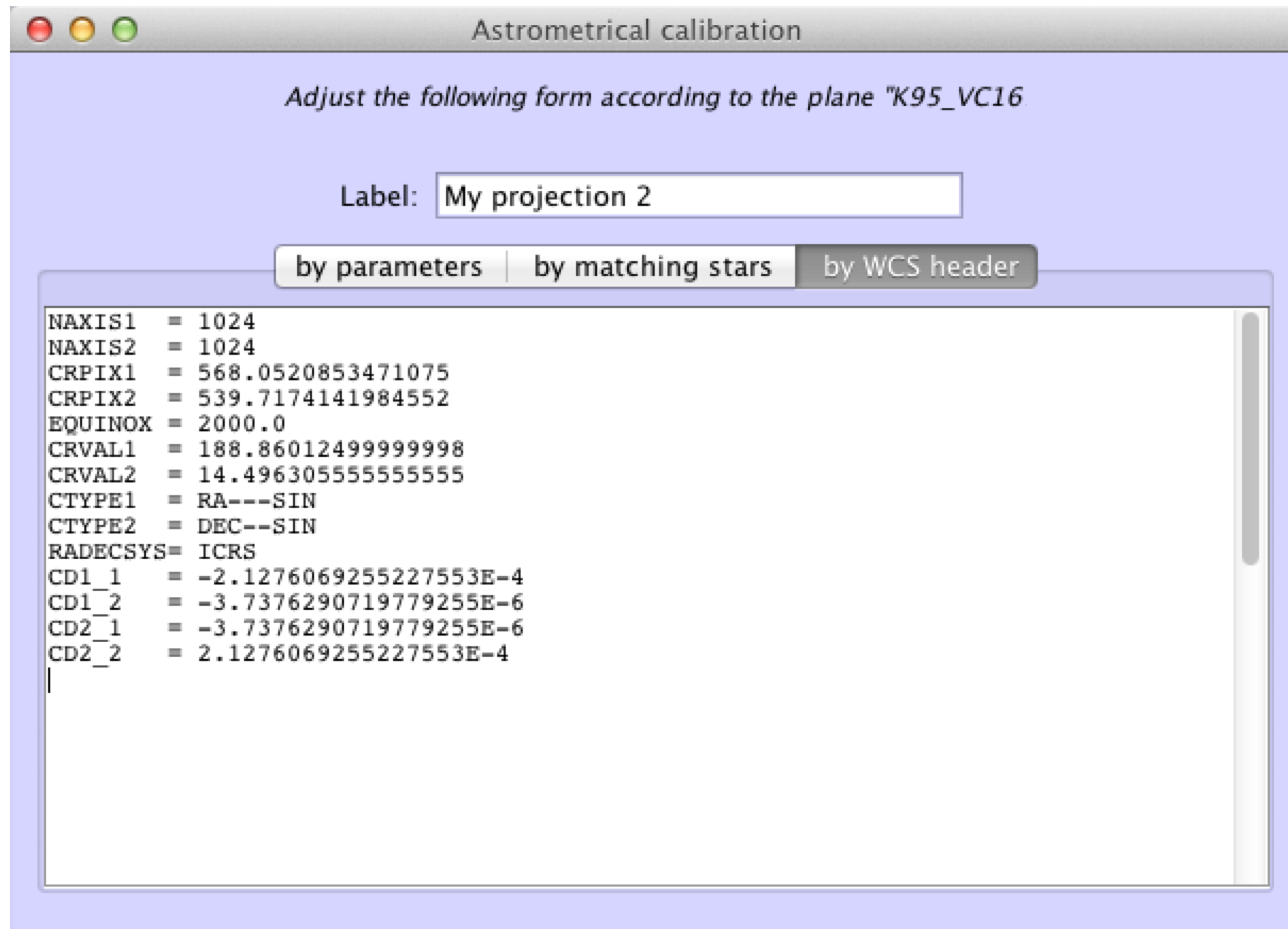
# Aladin: astrometric calibration

- Until we are happy...



# Aladin: astrometric calibration

- Something changed...



Astrometrical calibration

*Adjust the following form according to the plane "K95\_VC16"*

Label:

☐ by parameters ☐ by matching stars ☒ by WCS header

```
NAXIS1 = 1024
NAXIS2 = 1024
CRPIX1 = 568.0520853471075
CRPIX2 = 539.7174141984552
EQUINOX = 2000.0
CRVAL1 = 188.86012499999998
CRVAL2 = 14.496305555555555
CTYPE1 = RA---SIN
CTYPE2 = DEC--SIN
RADECSYS= ICRS
CD1_1 = -2.1276069255227553E-4
CD1_2 = -3.7376290719779255E-6
CD2_1 = -3.7376290719779255E-6
CD2_2 = 2.1276069255227553E-4
```

# Aladin: astrometric calibration

---

- Useful for a first quick look but problems... where do I start...
  1. What algorithm was used for the centering?
  2. Can I use J2000.0 catalogs without problems?
  3. “Slightly” manual, don’t you think?
  4. Imagine doing this for the FoV of the wide field imagers in VISTA, VST or the ESO 2p2?
  5. I could continue for a while...



# Thank you!...



... enjoy  
playing with  
the VO  
because it is  
useful but it  
is nowhere  
close to be  
perfect!