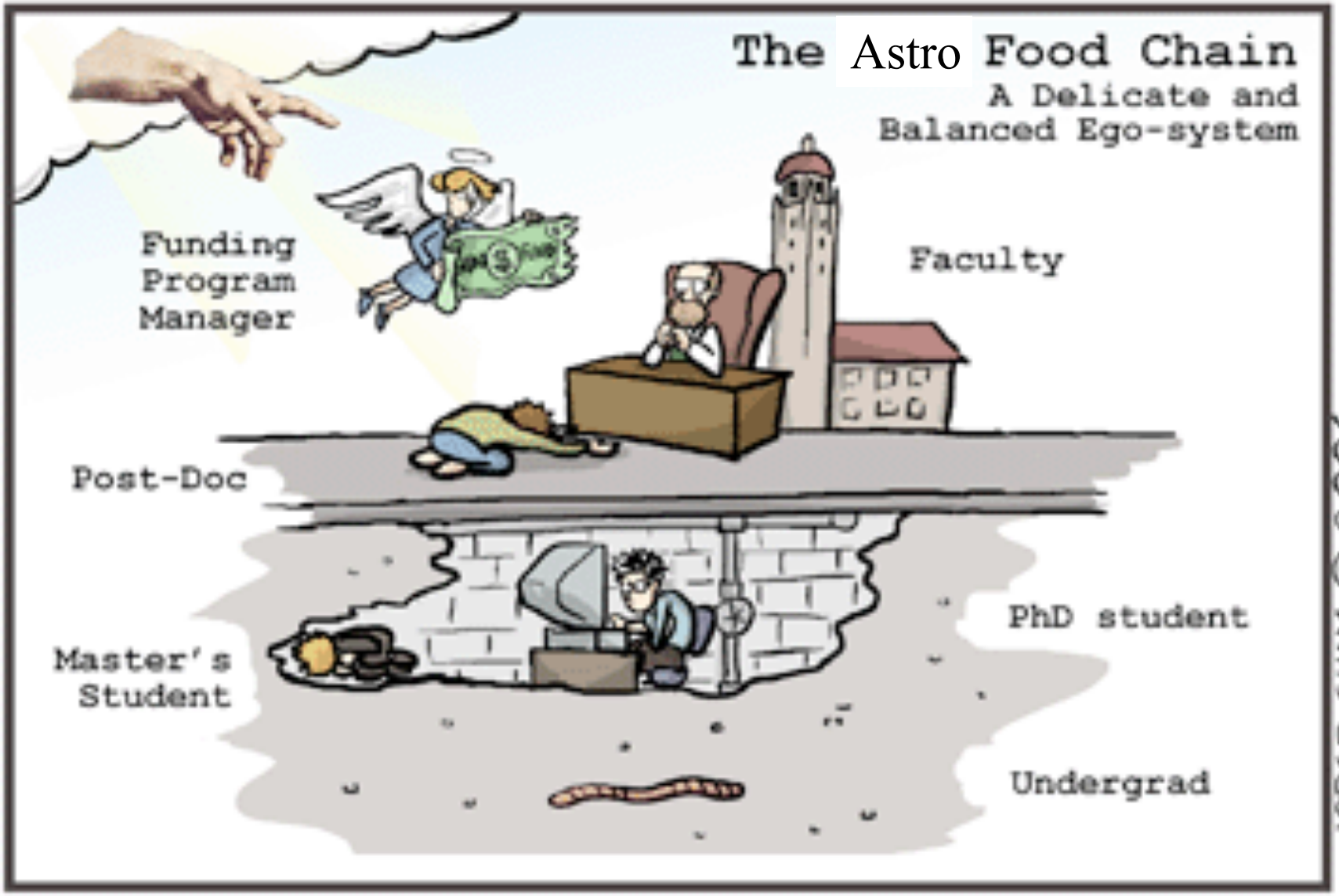
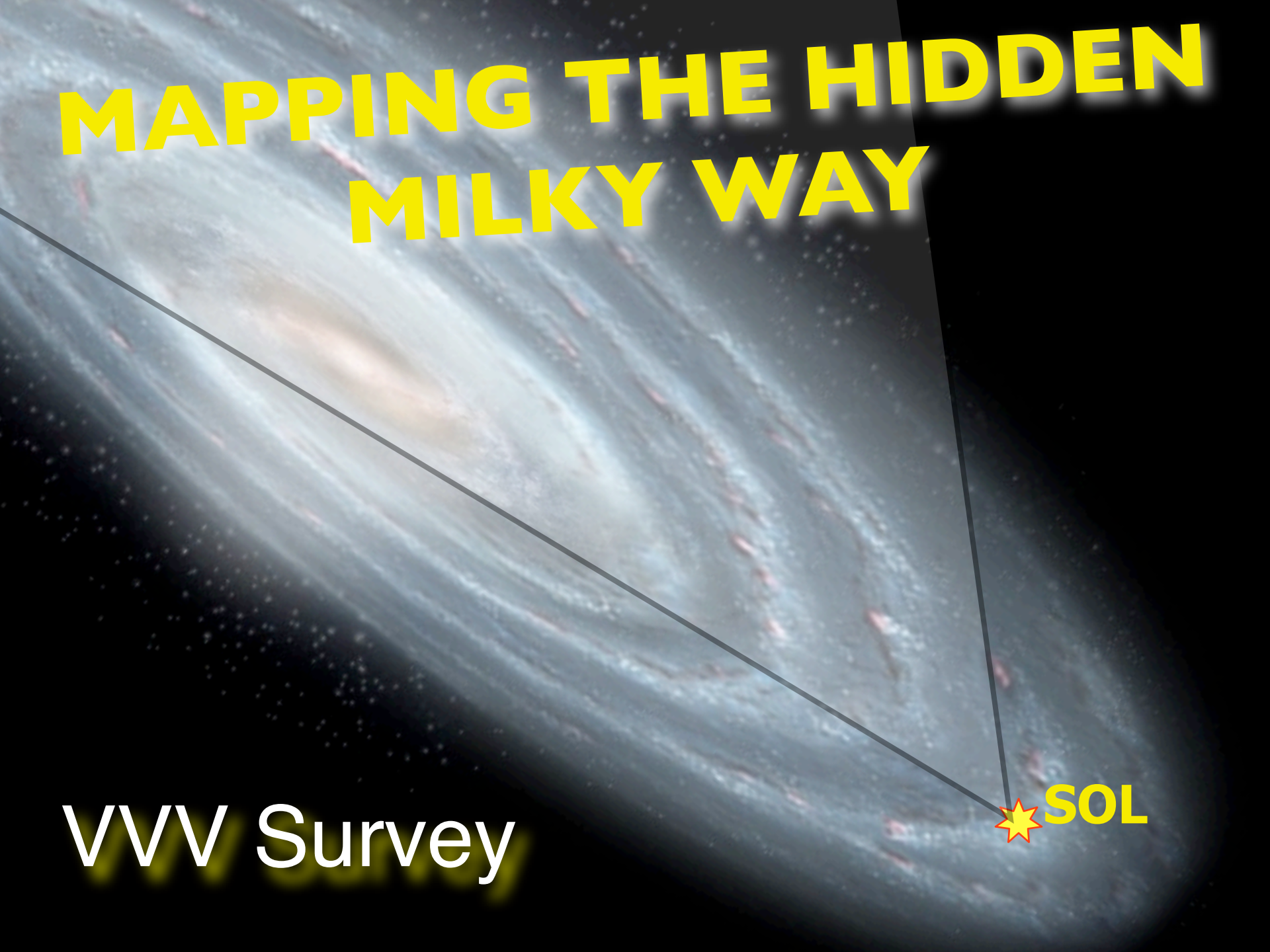


Back to Astronomy


MAPPING THE HIDDEN MILKY WAY
SOL
VVV Survey

how did the
Milky Way form

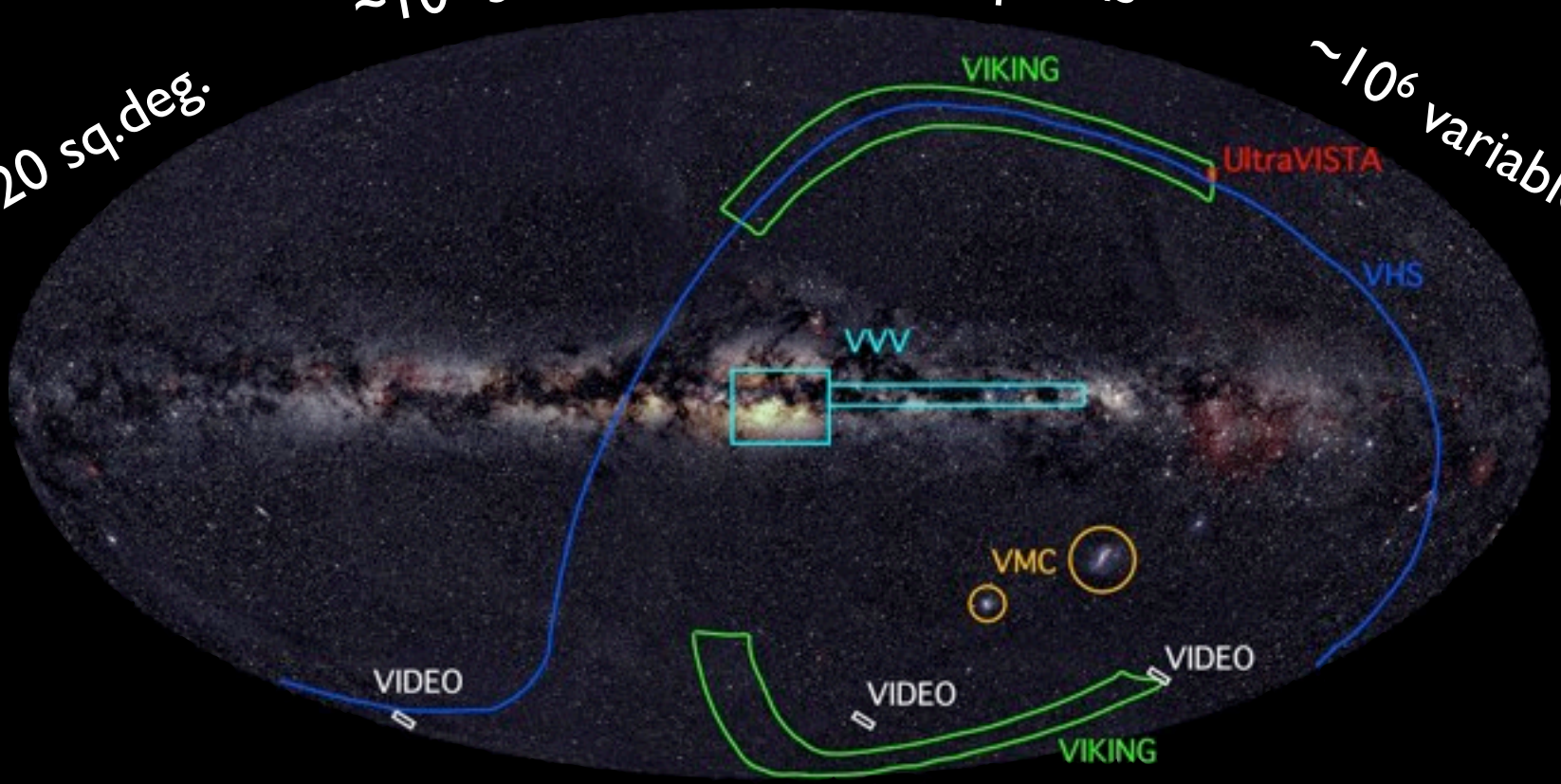
VISTA PUBLIC SURVEYS

520 sq.deg.

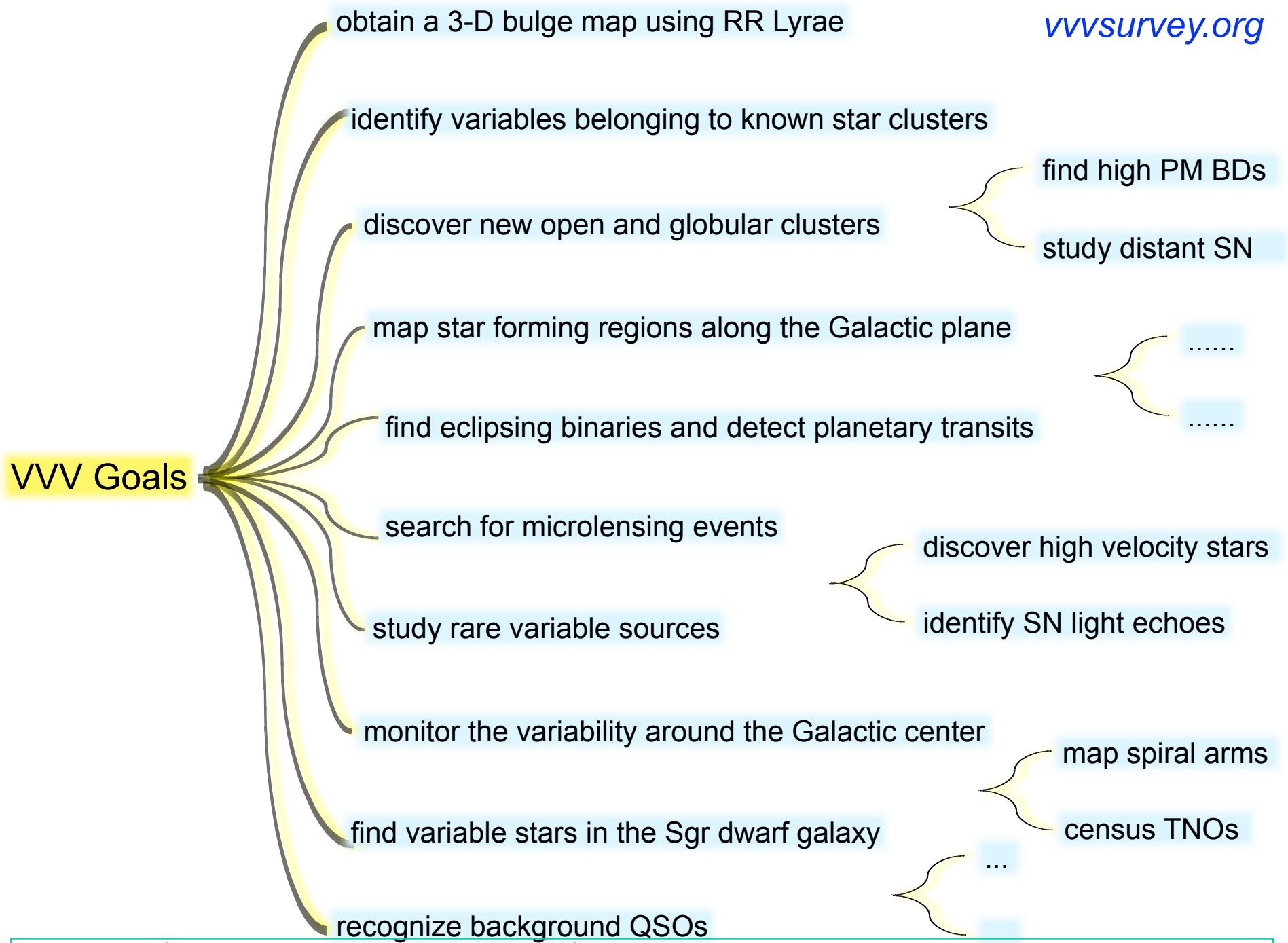
~10^9 stars

~100 epochs

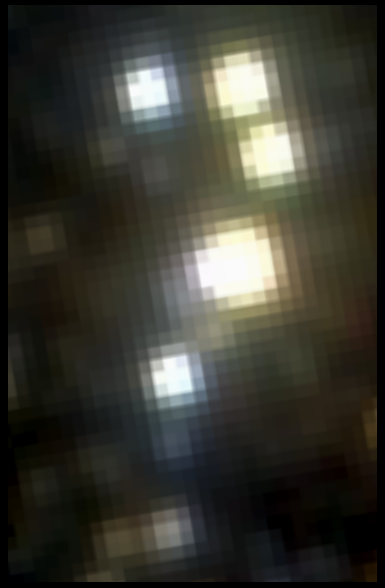
~10^6 variables



vvvsurvey.org

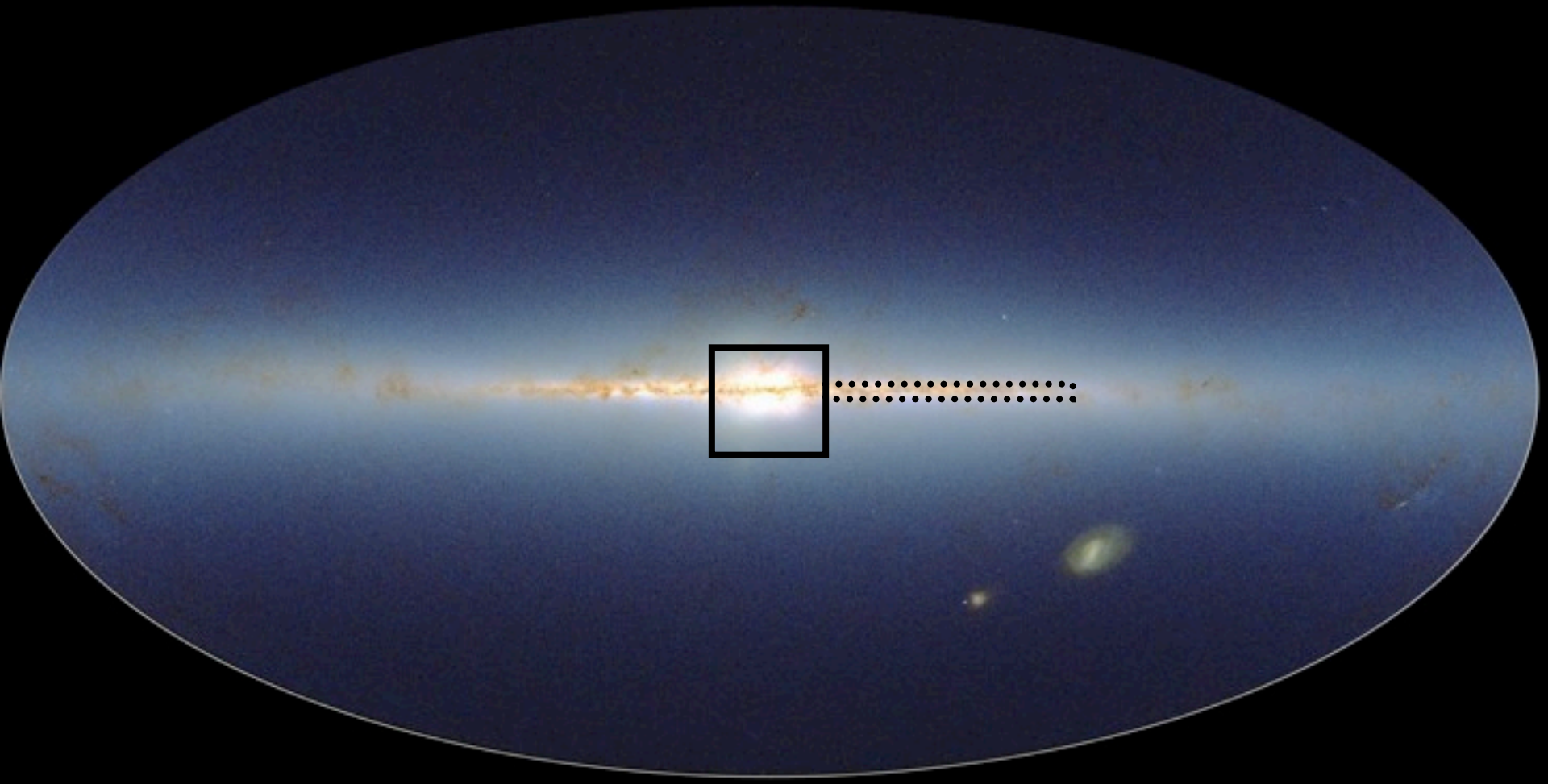


what is the 3-D structure of the inner MW



vvvsurvey.org

- 2-D MW maps are not sufficient, need 3-D
- a single snapshot is not sufficient, need time coverage

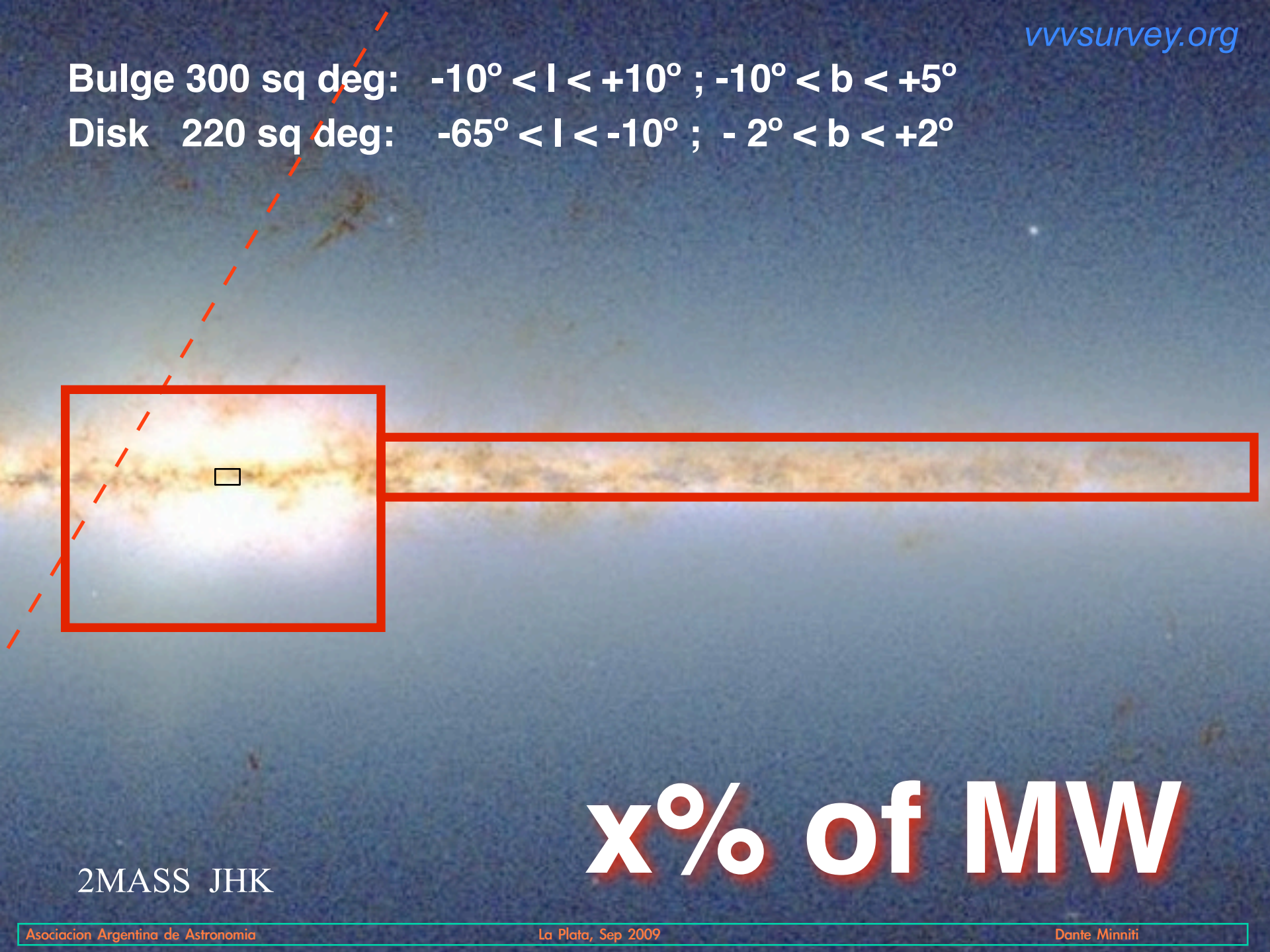


2MASS JHK

vvvsurvey.org

Bulge 300 sq deg: $-10^\circ < l < +10^\circ$; $-10^\circ < b < +5^\circ$

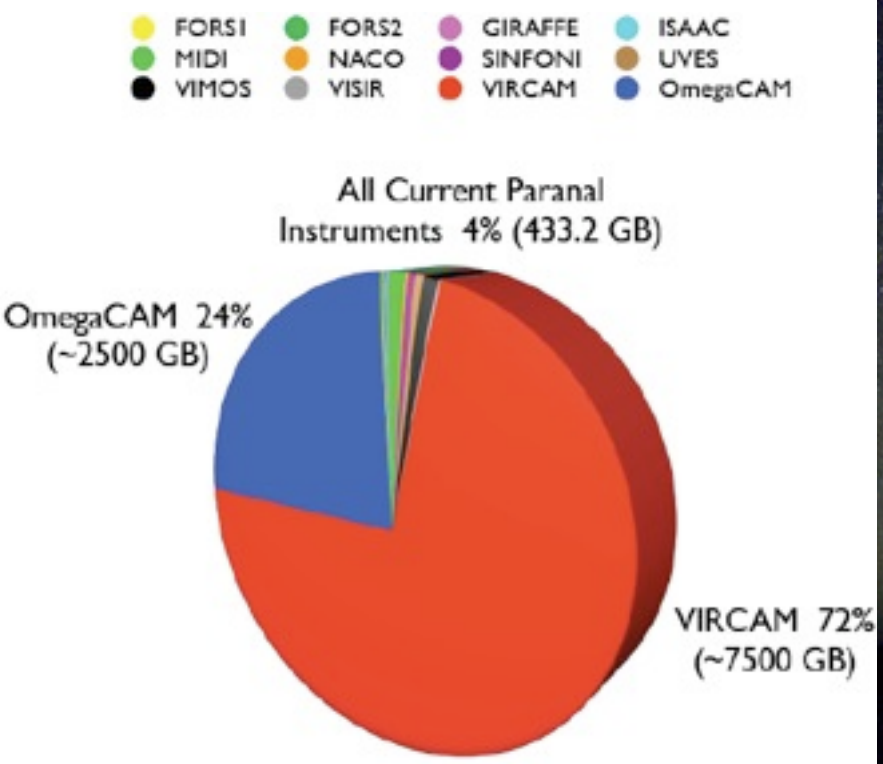
Disk 220 sq deg: $-65^\circ < l < -10^\circ$; $-2^\circ < b < +2^\circ$



2MASS JHK

x% of MW

Expected monthly dataflow: raw calibrations and science frames

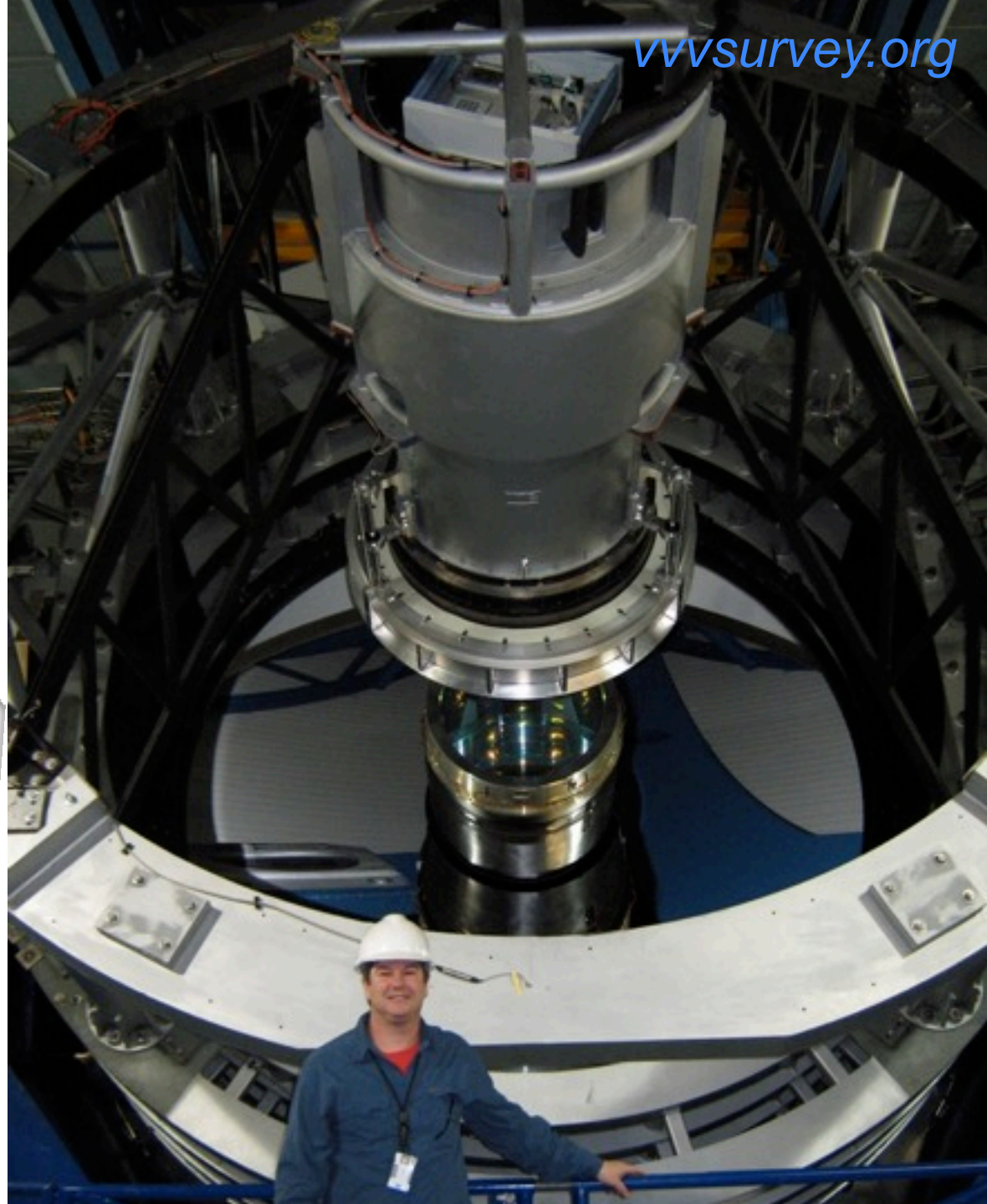


from Magda Arnaboldi (EDT)

VISTA and the VLTs at Paranal

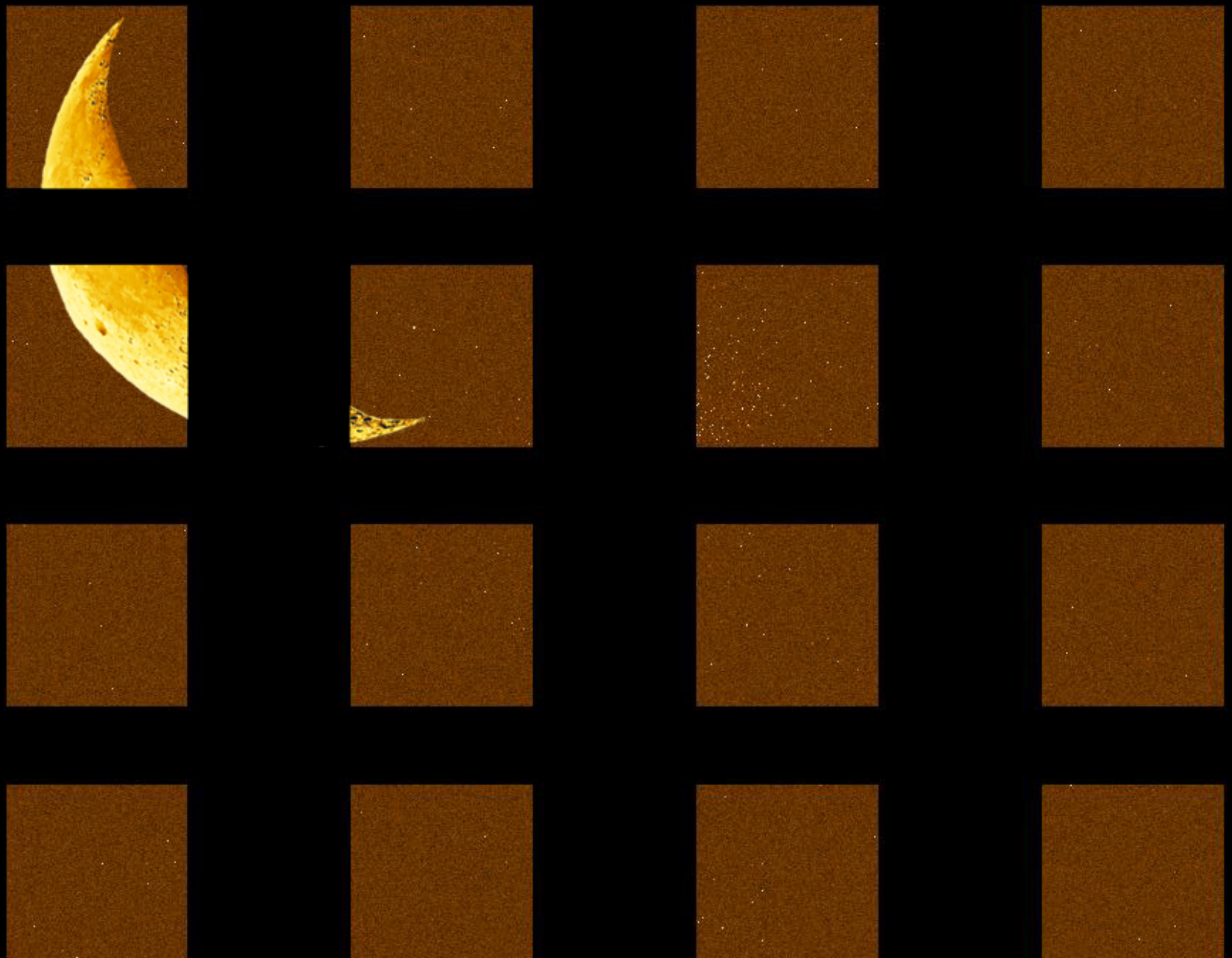
VISTA TELESCOPE AT ESO PARANAL

4.1 m telescope
f3.25 focus
fov 1.5 sqdeg



VISTA Near-IR Wide Field Camera

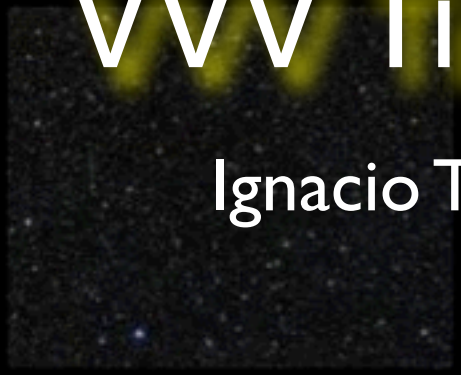
vvvsurvey.org



VVV Tiles

Ignacio Toledo

vvvsurvey.org



b271

b372

b322

b274

b323

SV

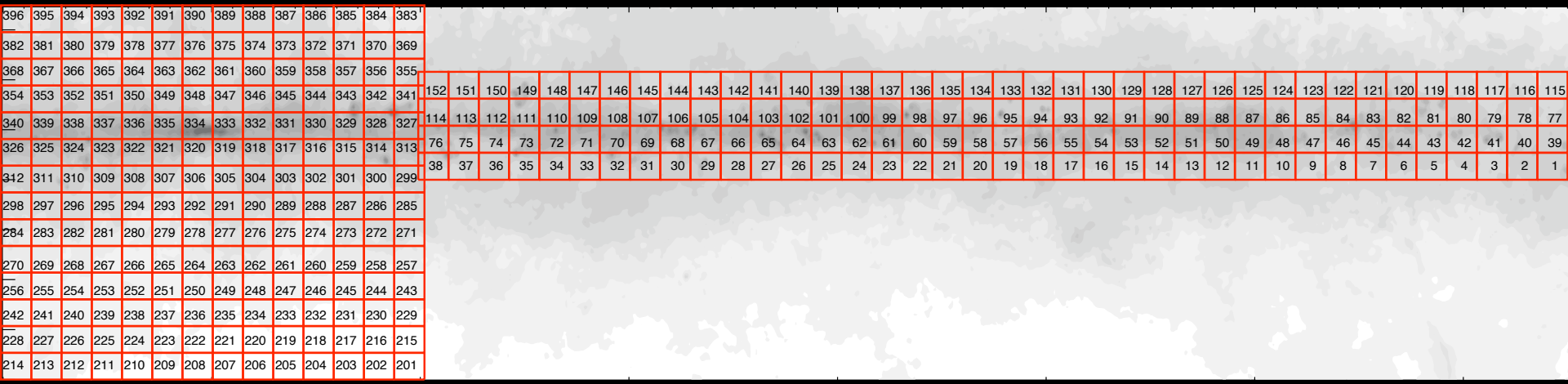
b349

d003

d014

VVV Year 1

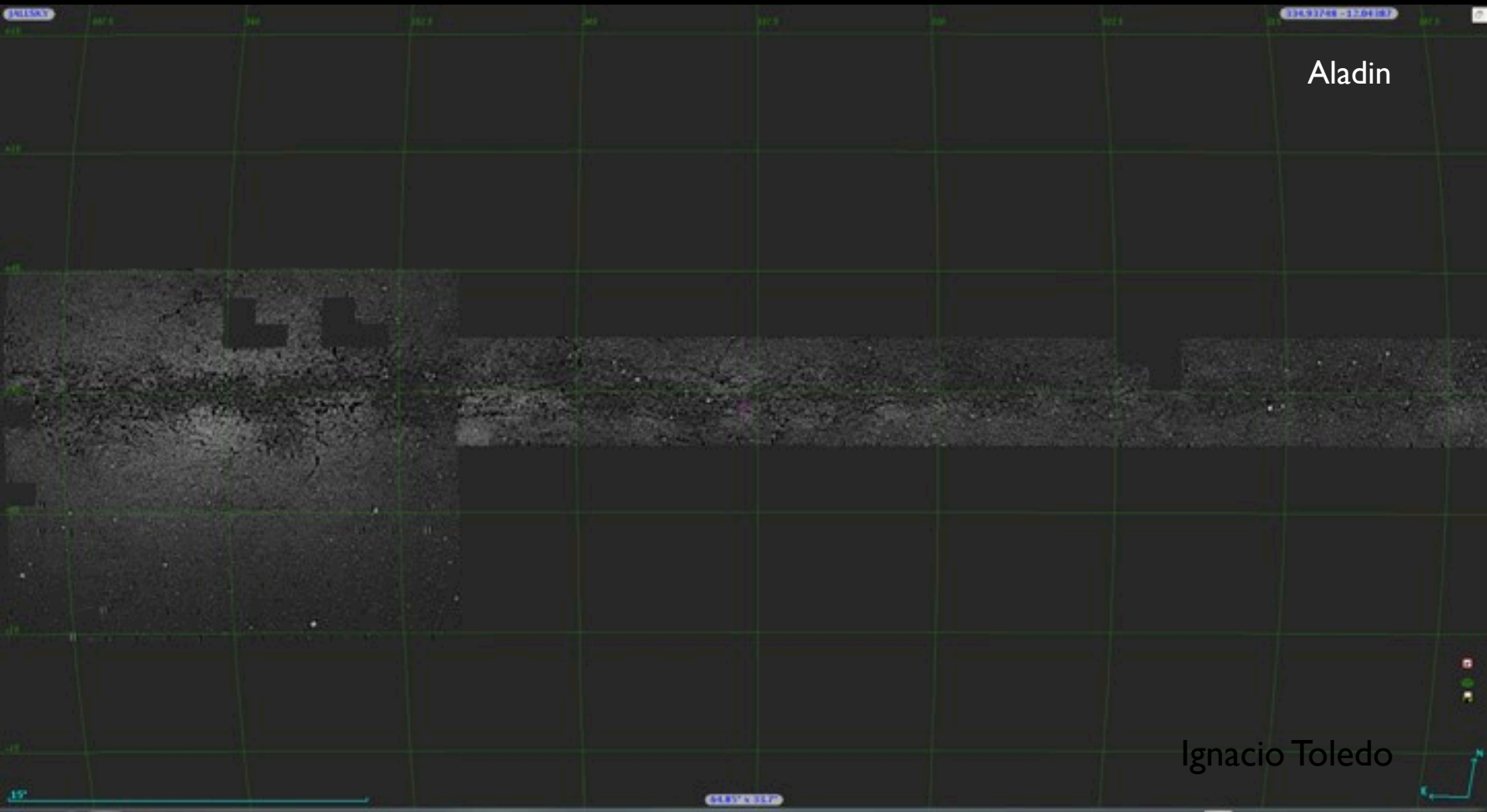
vvvsurvey.org



vvvsurvey.org

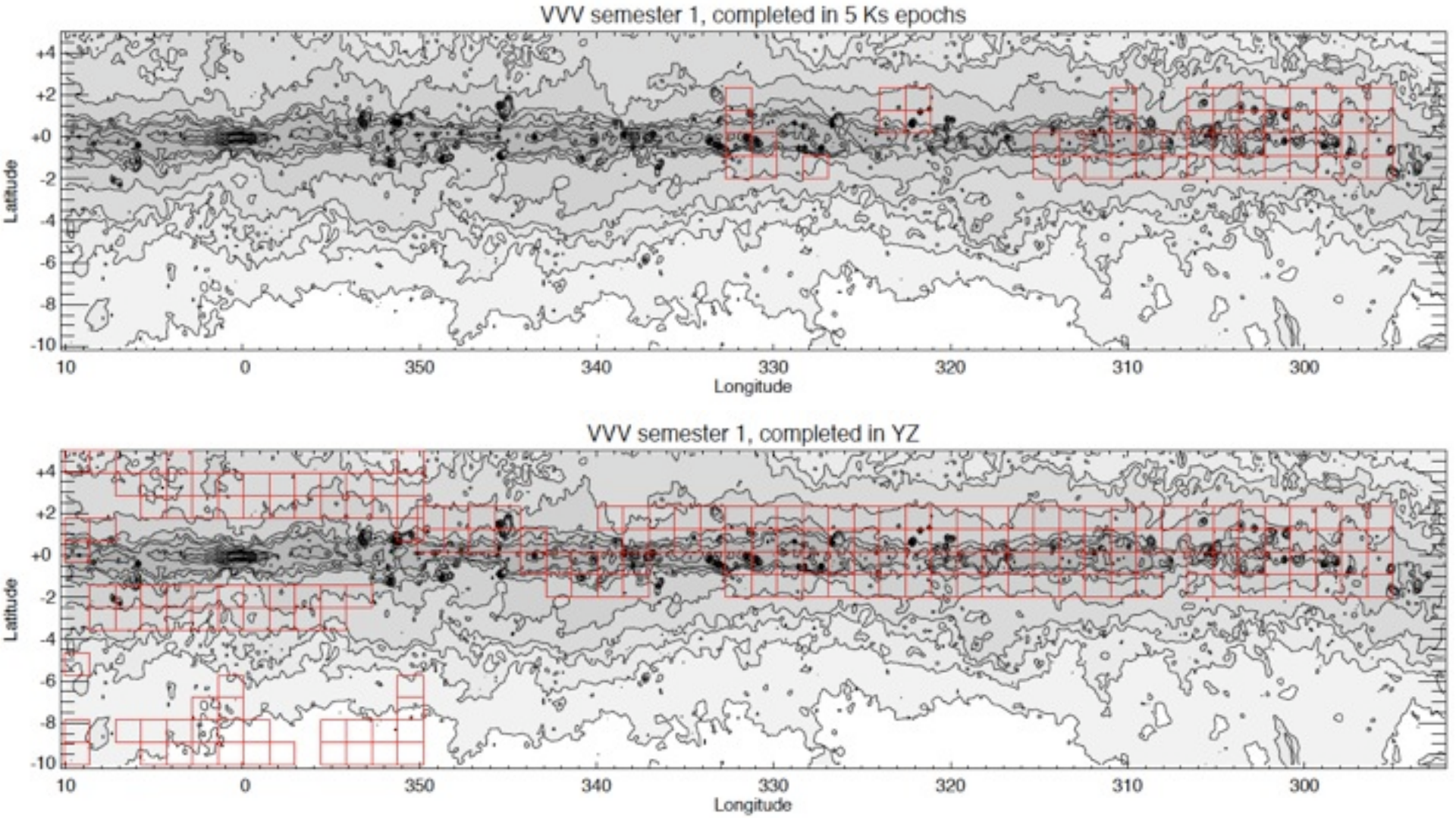
VVV Allsky Map

230 Gb image in the J-band
~500 sqdeg (11 tiles missing)
1pix = 0.4", total 4x10^10 pix
~223000 images of 512x512



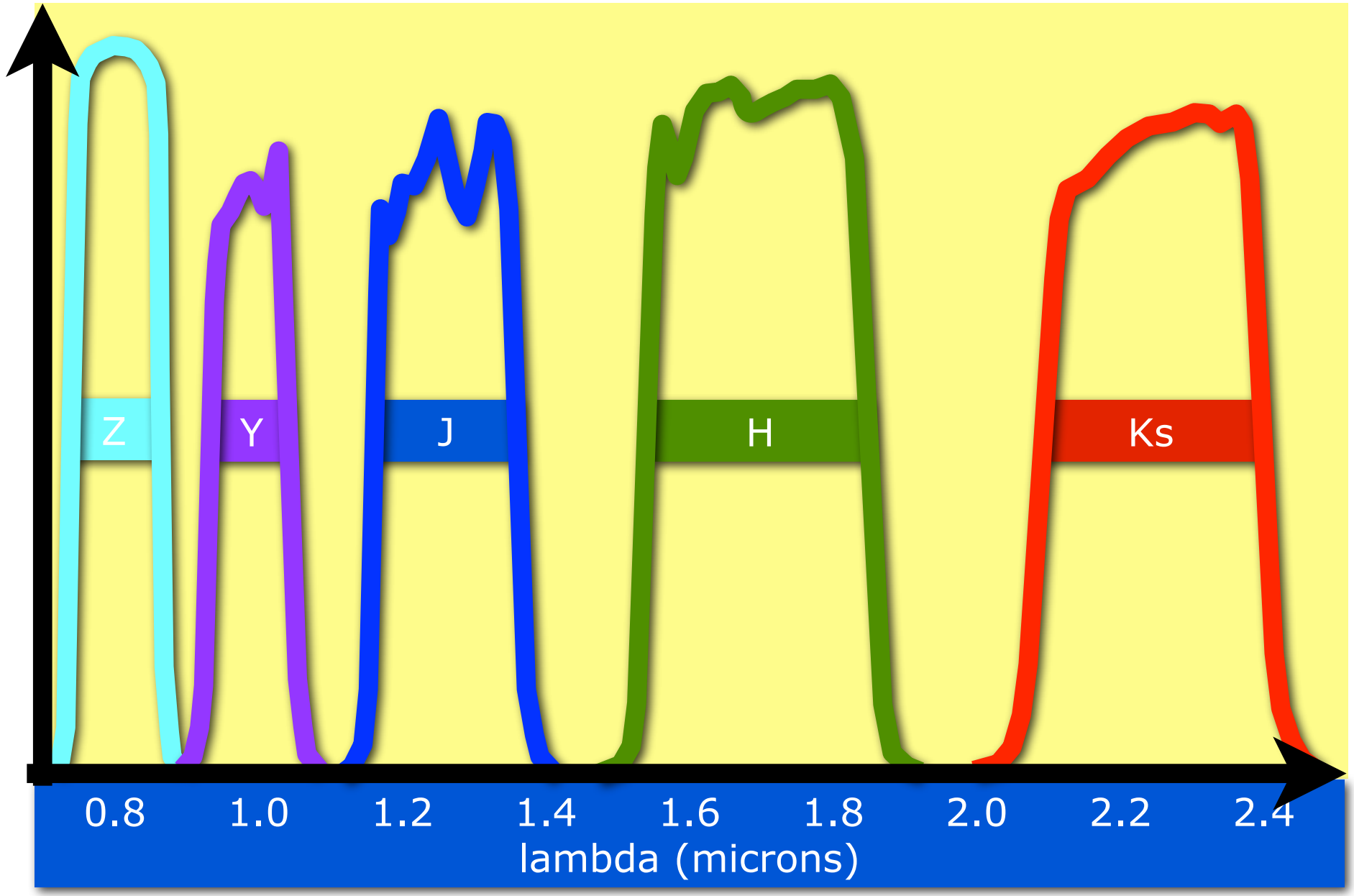
Year 1 Completeness

vvvsurvey.org



Maren Hempel

VISTA filter transmissions



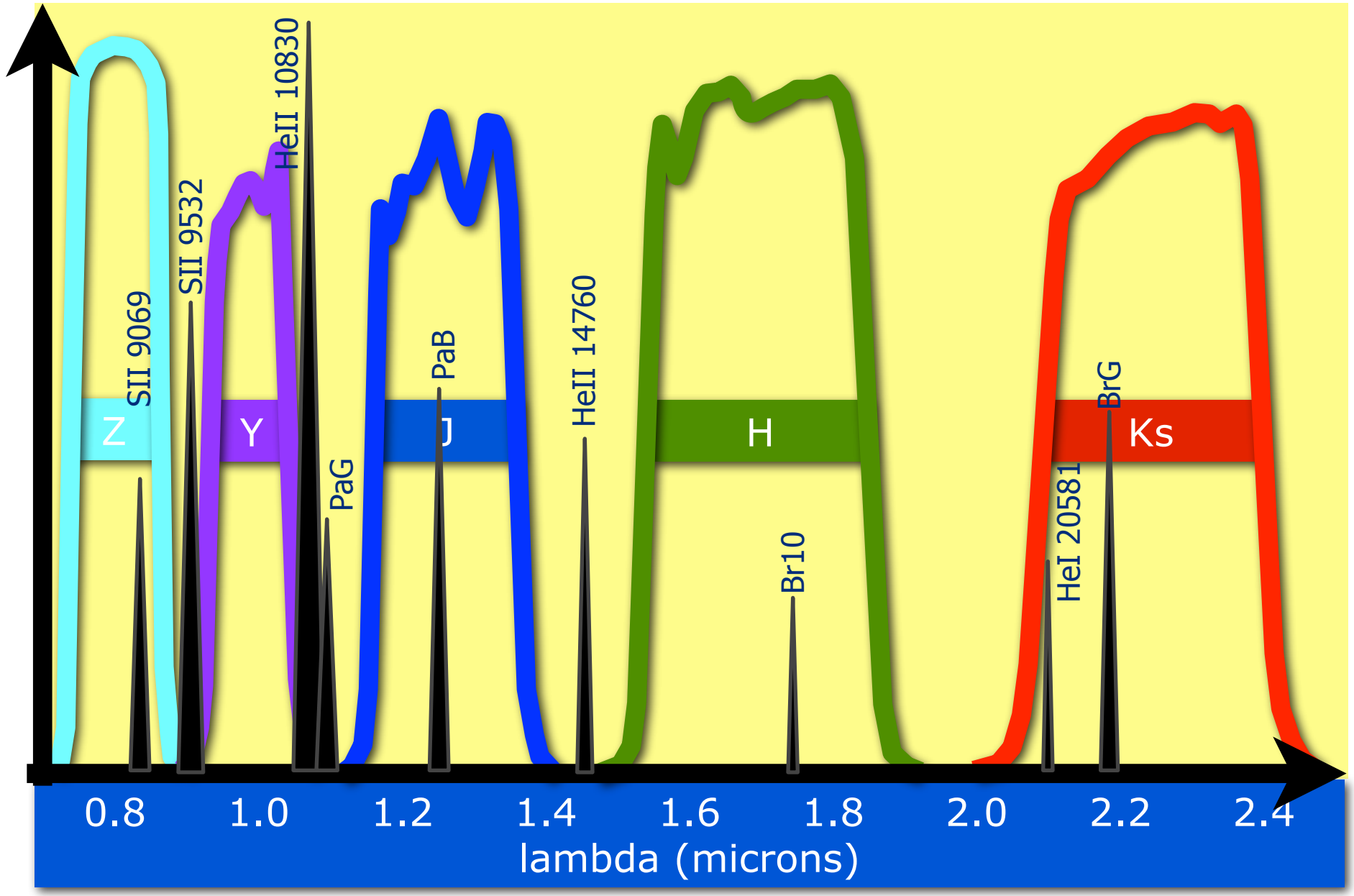
DEEPER AND HIGHER RESOLUTION

ZYJHKs Ks<18

vs

JHK Ks<14

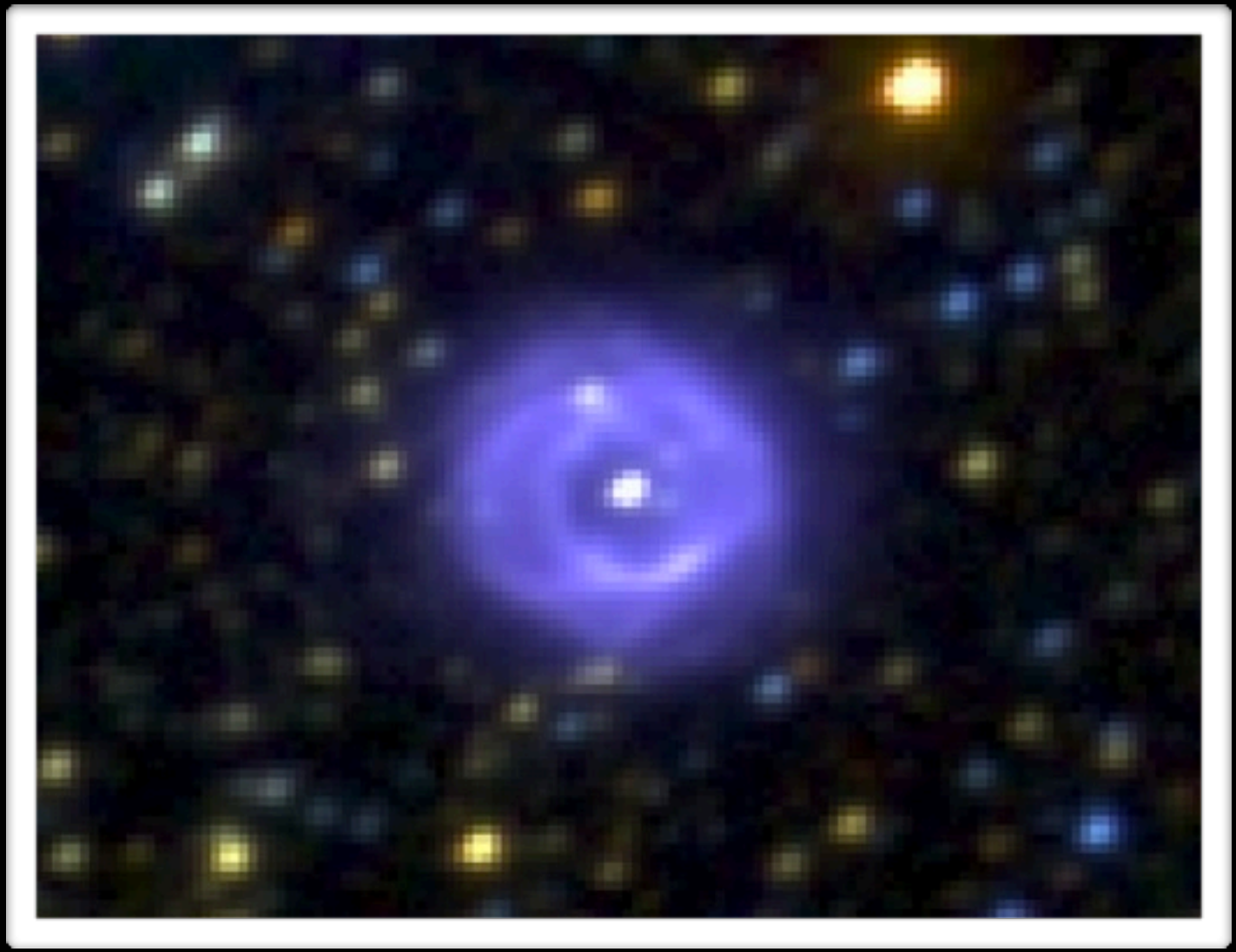
Line emission w/in filters




DEEPER AND HIGHER RESOLUTION
VVV
vs
2MASS
Lagoon Nebula (central region)

vvvsurvey.org

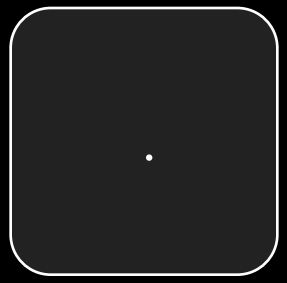
Planetary Nebula

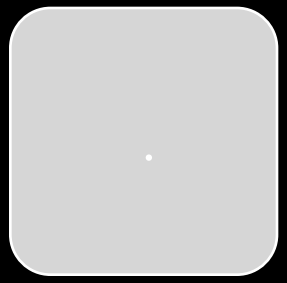


VVV field b328

A WORD ABOUT IR PHOTOMETRY

Tricky...

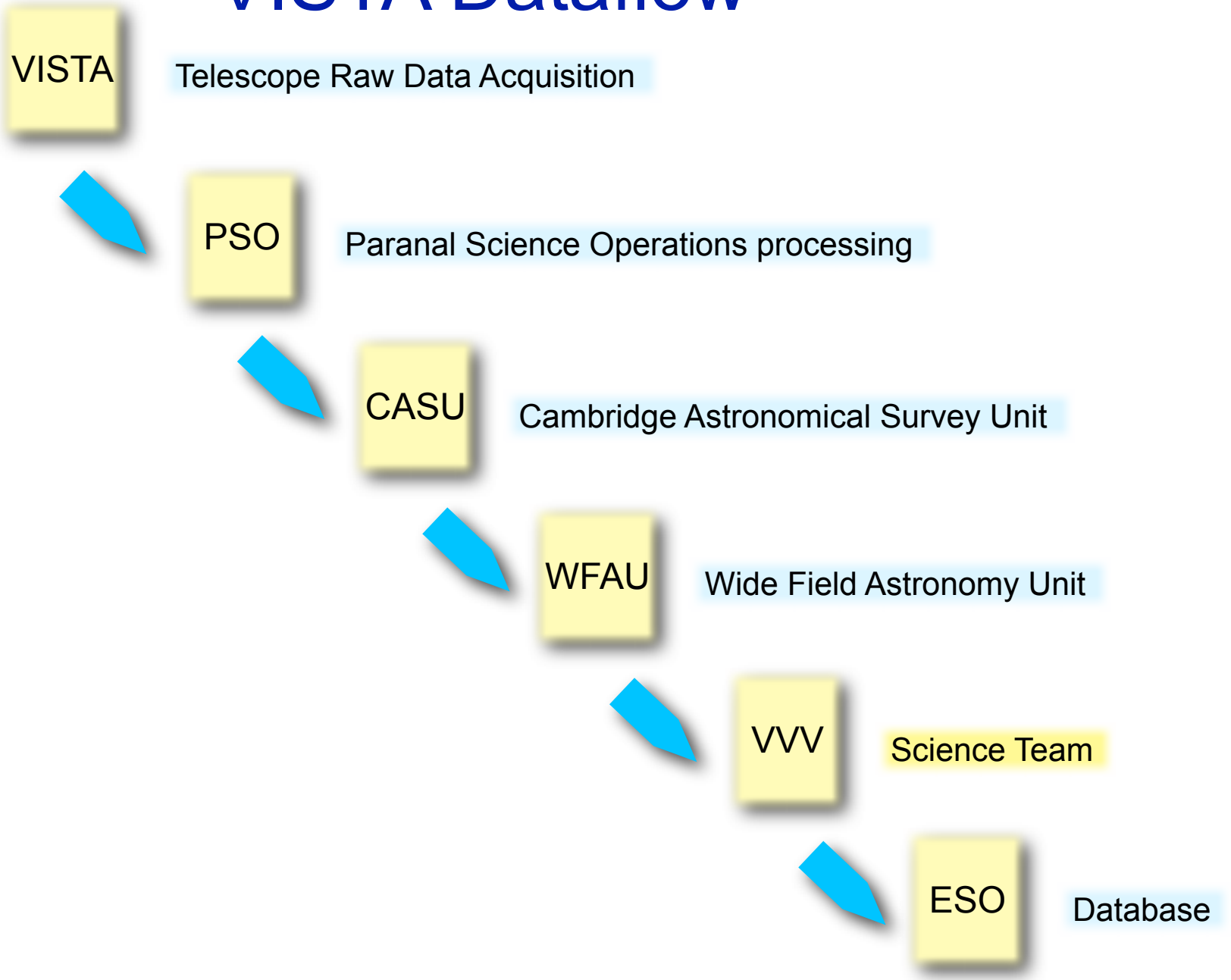


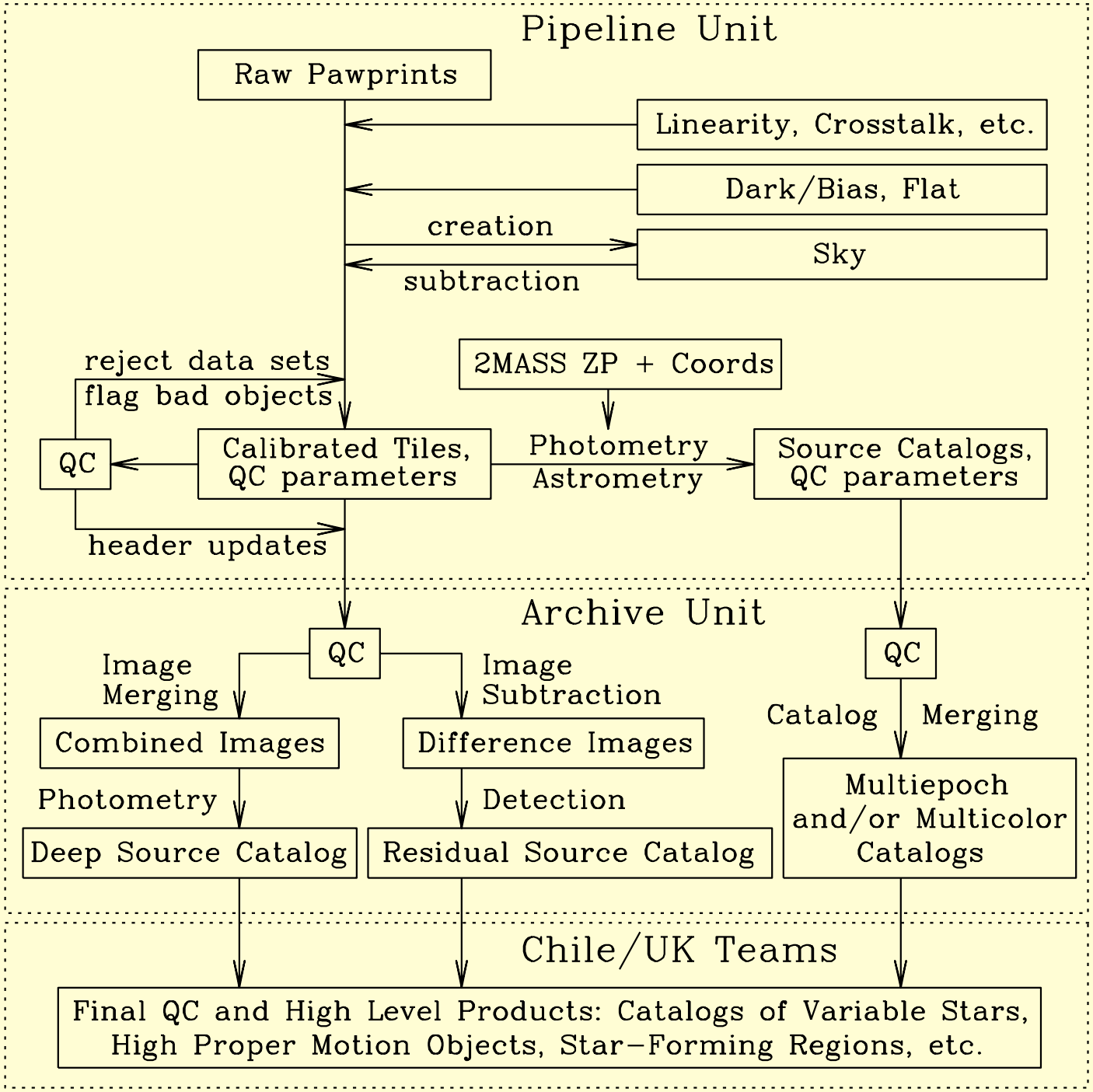


because the sky is very bright in the IR.

VISTA Dataflow

vvvsurvey.org




Pipeline Unit
Raw Pawprints
Linearity, Crosstalk, etc.
Dark/Bias, Flat
creation
Sky
subtraction
reject data sets
flag bad objects
2MASS ZP + Coords
QC
Calibrated Tiles,
QC parameters
Photometry
Astrometry
Source Catalogs,
QC parameters
header updates
Archive Unit
QC
QC
Image
Merging
Image
Subtraction
Catalog
Merging
Combined Images
Difference Images
Photometry
Detection
Multiepoch
and/or Multicolor
Catalogs
Deep Source Catalog
Residual Source Catalog
Chile/UK Teams
Final QC and High Level Products: Catalogs of Variable Stars,
High Proper Motion Objects, Star−Forming Regions, etc.

VVV OBs

vvvsurvey.org

YR1: ~2500 OBs

- all 152 disk fields observed in 2010A:
    - multicolor ZYJHKs
    - Ks 5 epochs
- all 196 bulge fields observed in 2010A:
    - multicolos ZYJHKs
    - Ks 5 epochs

YR2 ~ 5400 OBs

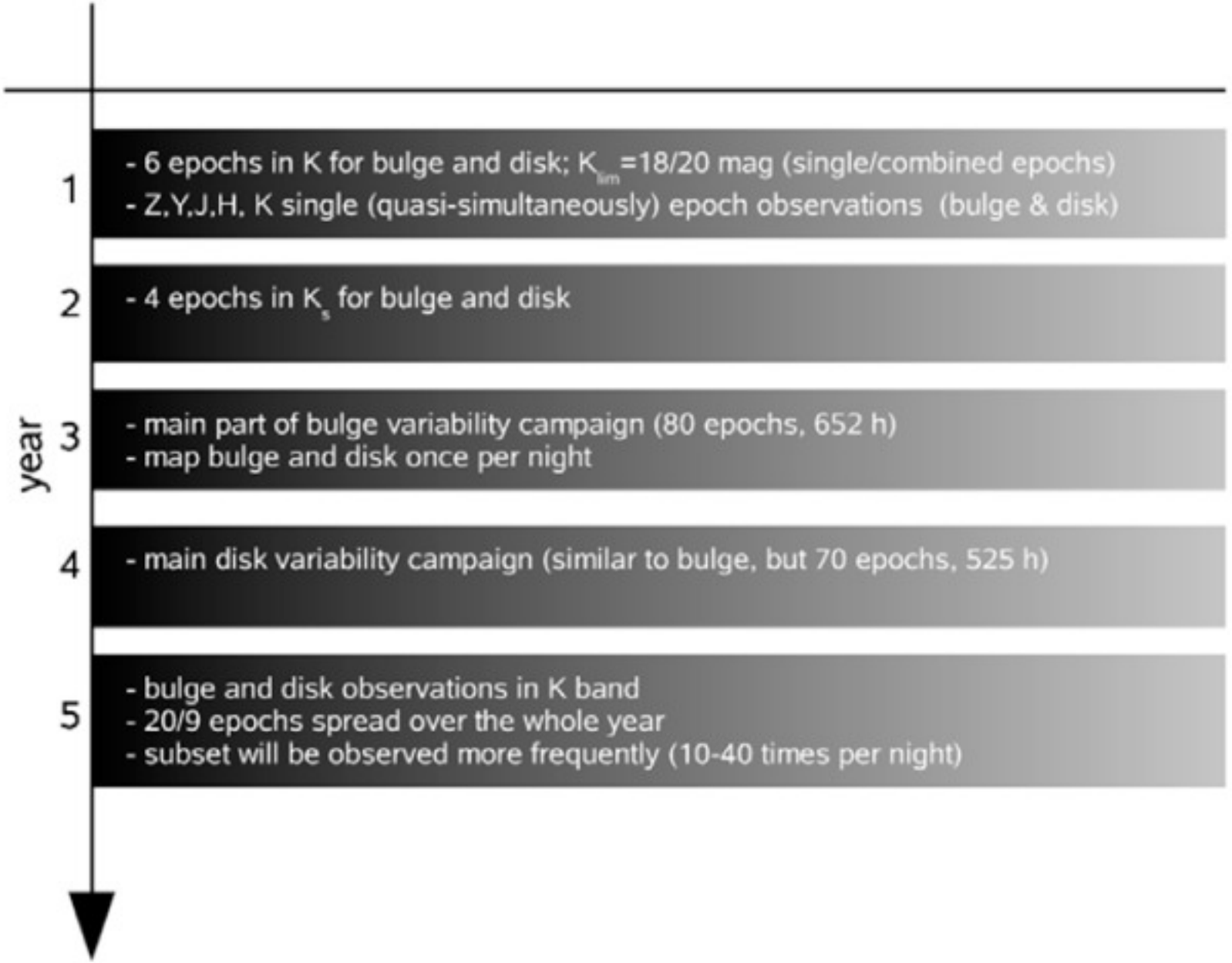
- multiepoch Ks band of bulge+disk in 2011A

YR3 ~ 15500 OBs

- multiepoch Ks band of bulge in 2012A

This major activity is carried out periodically. Many details needed to be solved, many problems encountered (skies, concatenations, labeling, etc), this was indeed a huge work.

The VVV Survey: Timeline



Sky conditions and estimated observing time for the full VVV Survey.

Year	Time	RA range	Moon	Seeing	Transp.	Nr of Ks epochs
2010	292h	12:00–19:00	any*	0.8	clear	6 bulge + 6 disk + ZYJH
2011	292h	12:00–19:00	any*	0.8	clear	20 bulge + disk
2012	652h	17:00–19:00	any*	any	thin	80 bulge
2013	525h	12:00–17:00	any*	any	thin	70 disk
2014	168h	12:00–19:00	any*	0.8	clear	20 bulge + 9 disk

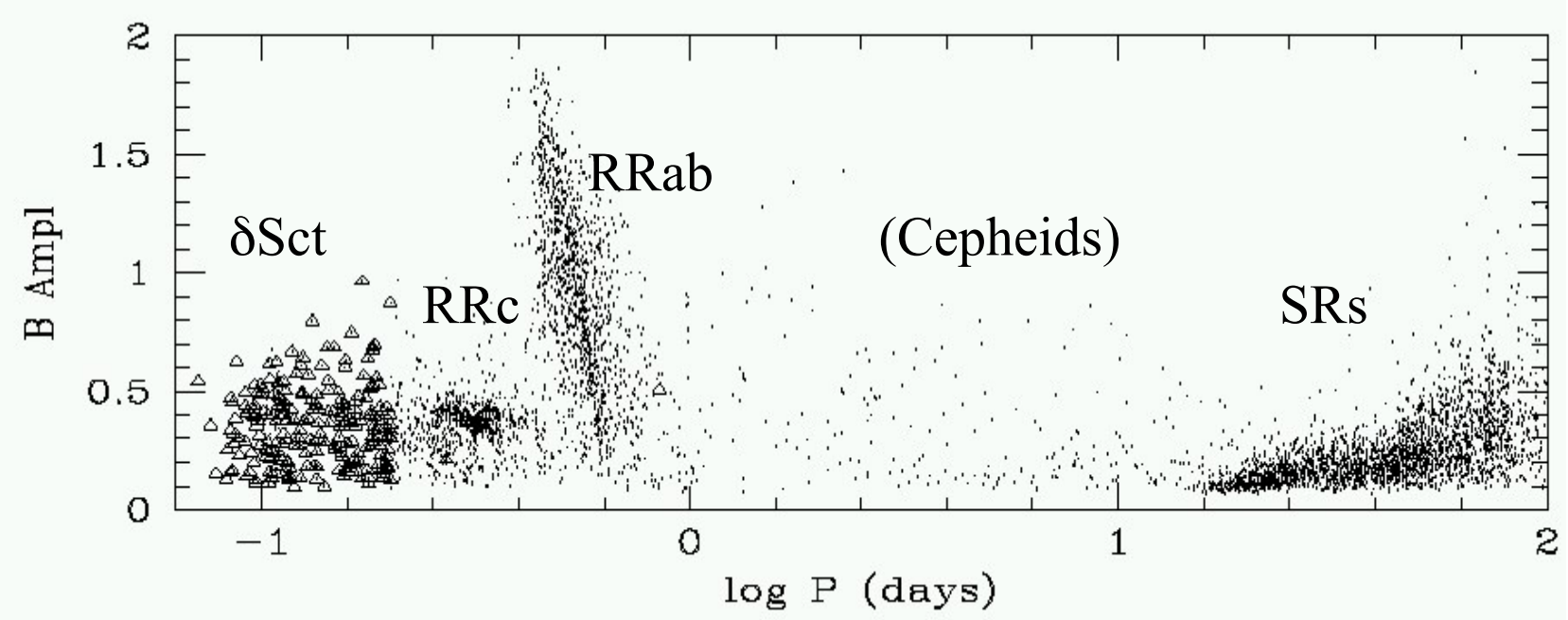
Total 193 nights

* The Moon has to be away from the bulge
Also constraining airmass to < 2.0 and ellipticity to <0.2

Variable stars

- **~10^9 stars**
- **~10^6 variables**

MACHO variables (Alcock et al. 1998)

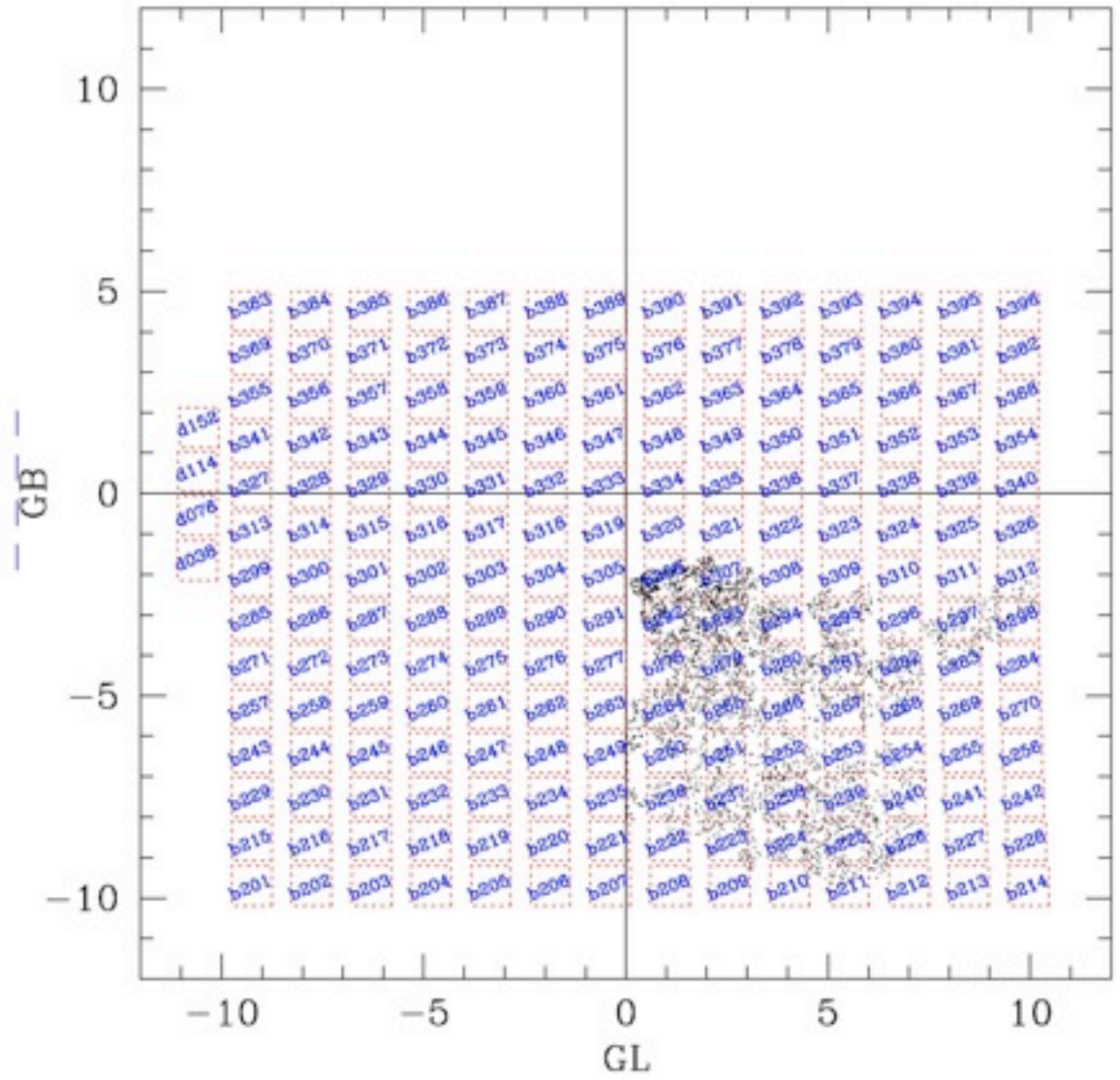


To find RR Lyrae in the bulge

To find eclipsing binaries and planetary transits

To study rare variable sources

VVV vs. MACHO



10x sqdeg

100x stars

vvvsurvey.org

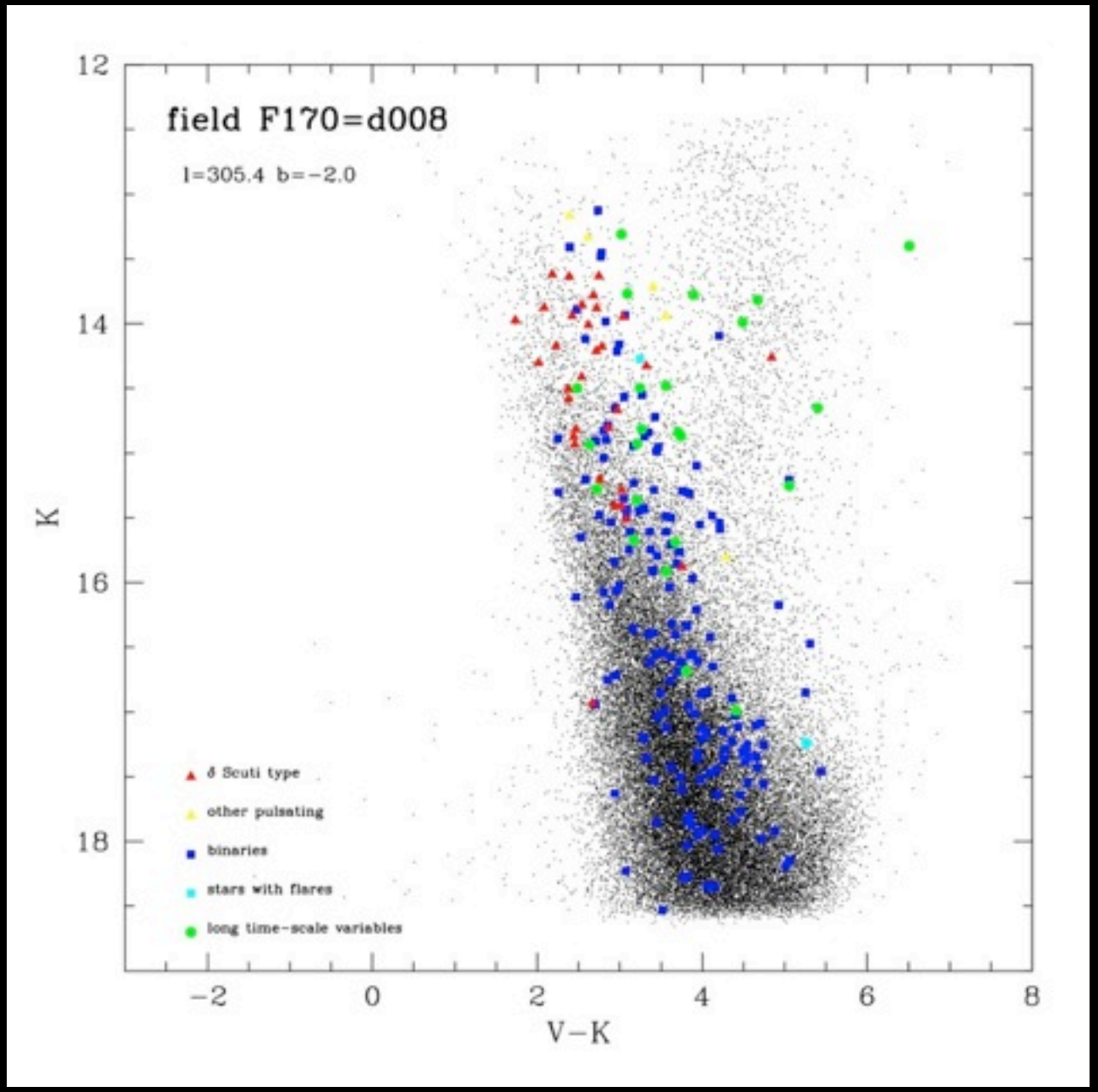
Disk Field

Combined VLT-optical and VISTA-IR photometry

230 new variables

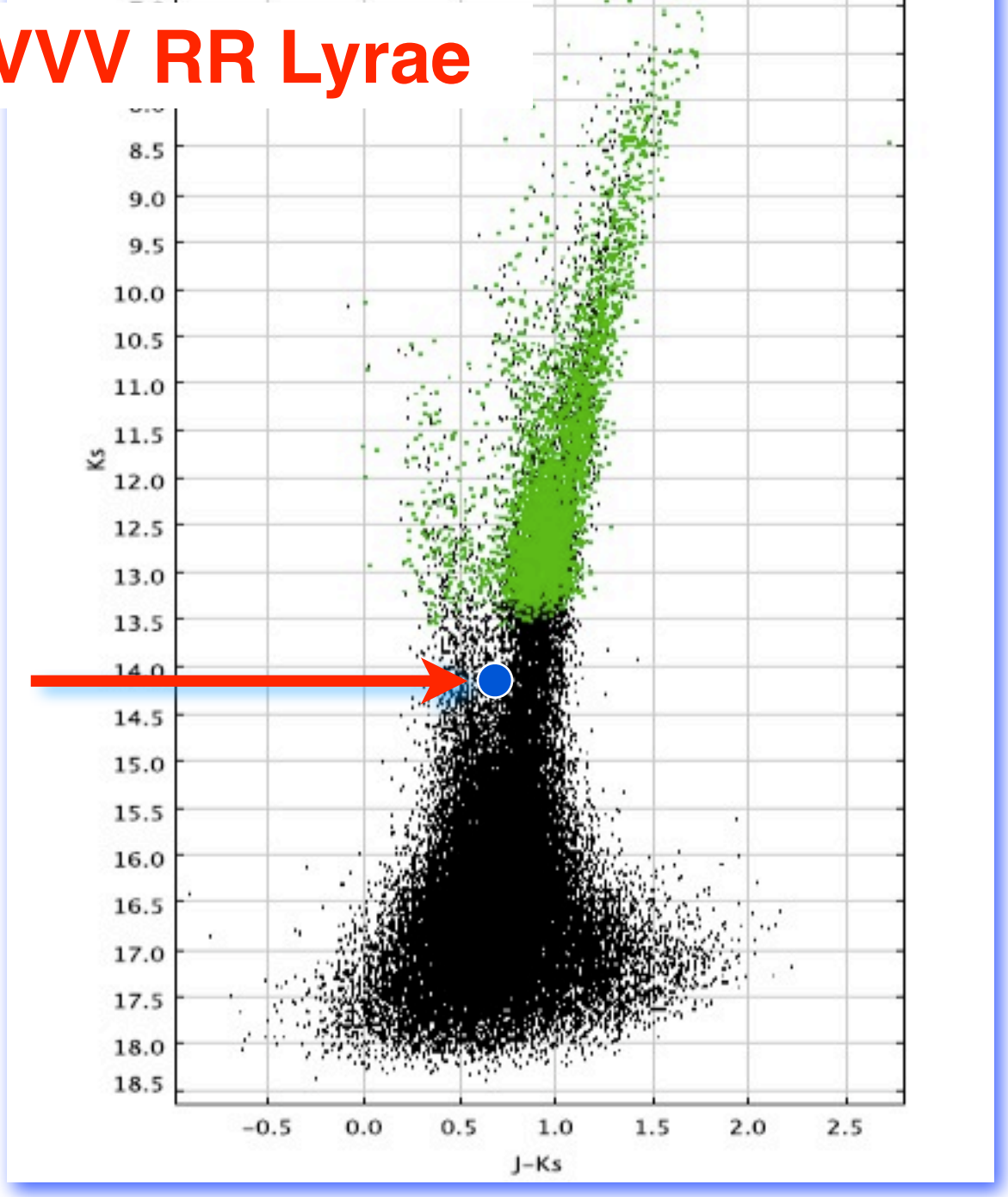
more than expected!

Pawel Pietrukowicz



1st VVV RR Lyrae

vvvsurvey.org



green = 2MASS

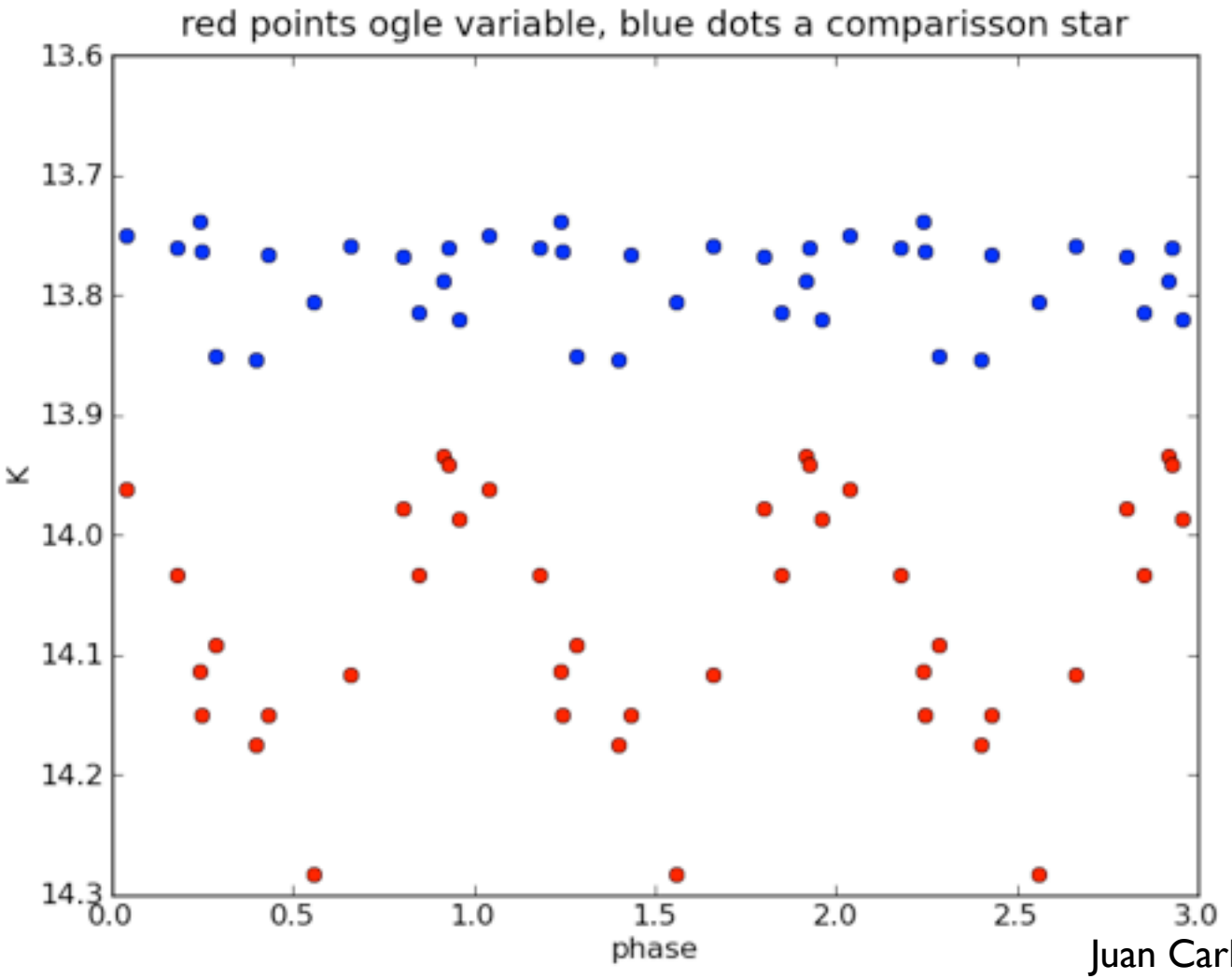
black = VISTA

Oscar Gonzalez

1st VVV RR Lyrae

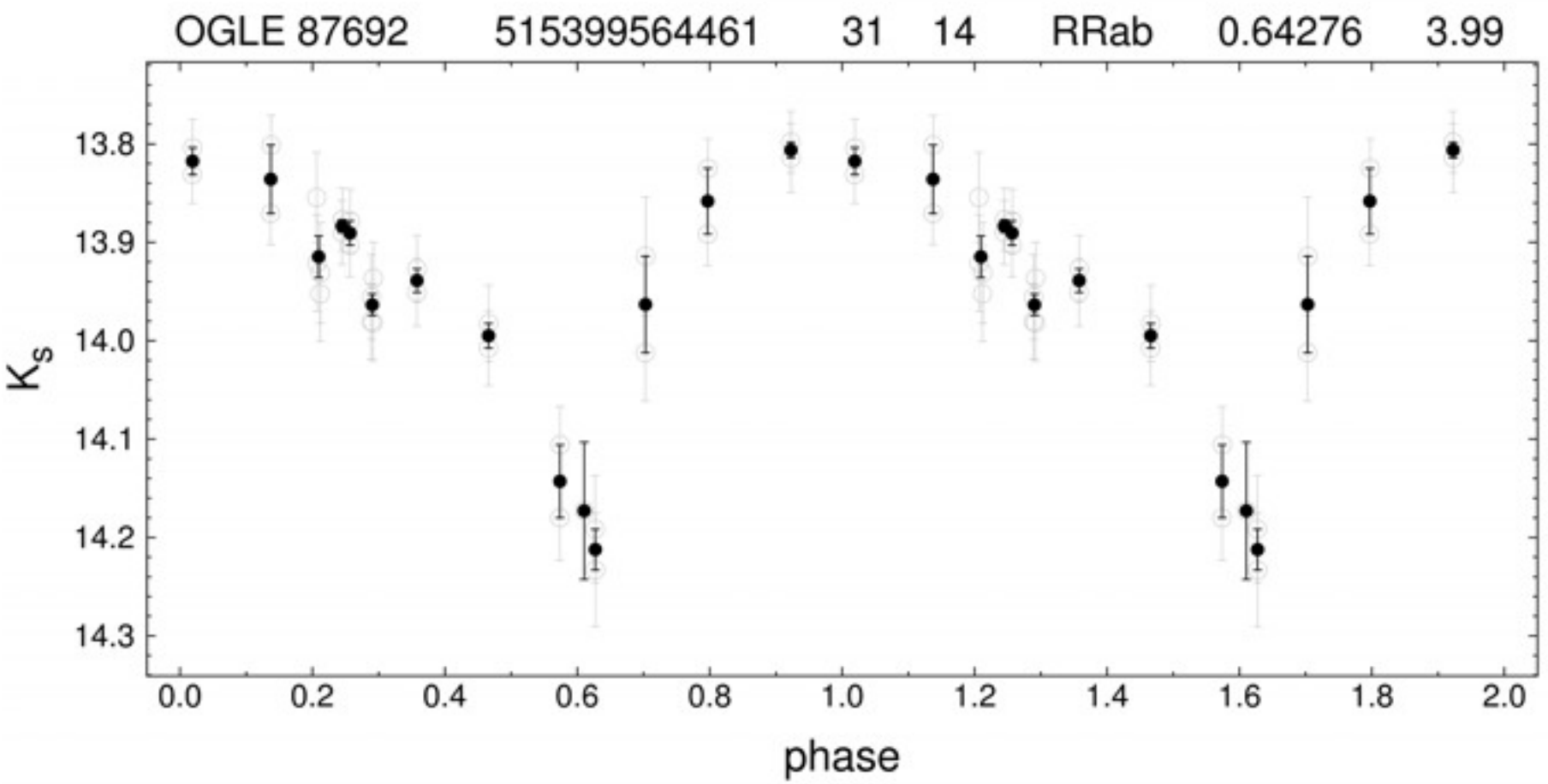
vvvsurvey.org

OGLE field 30 star 189770
RRab Period = 0.72946 day Amplitude_I = 0.33 mag
I = 15.60 V=17.08 V-Imin=1.54



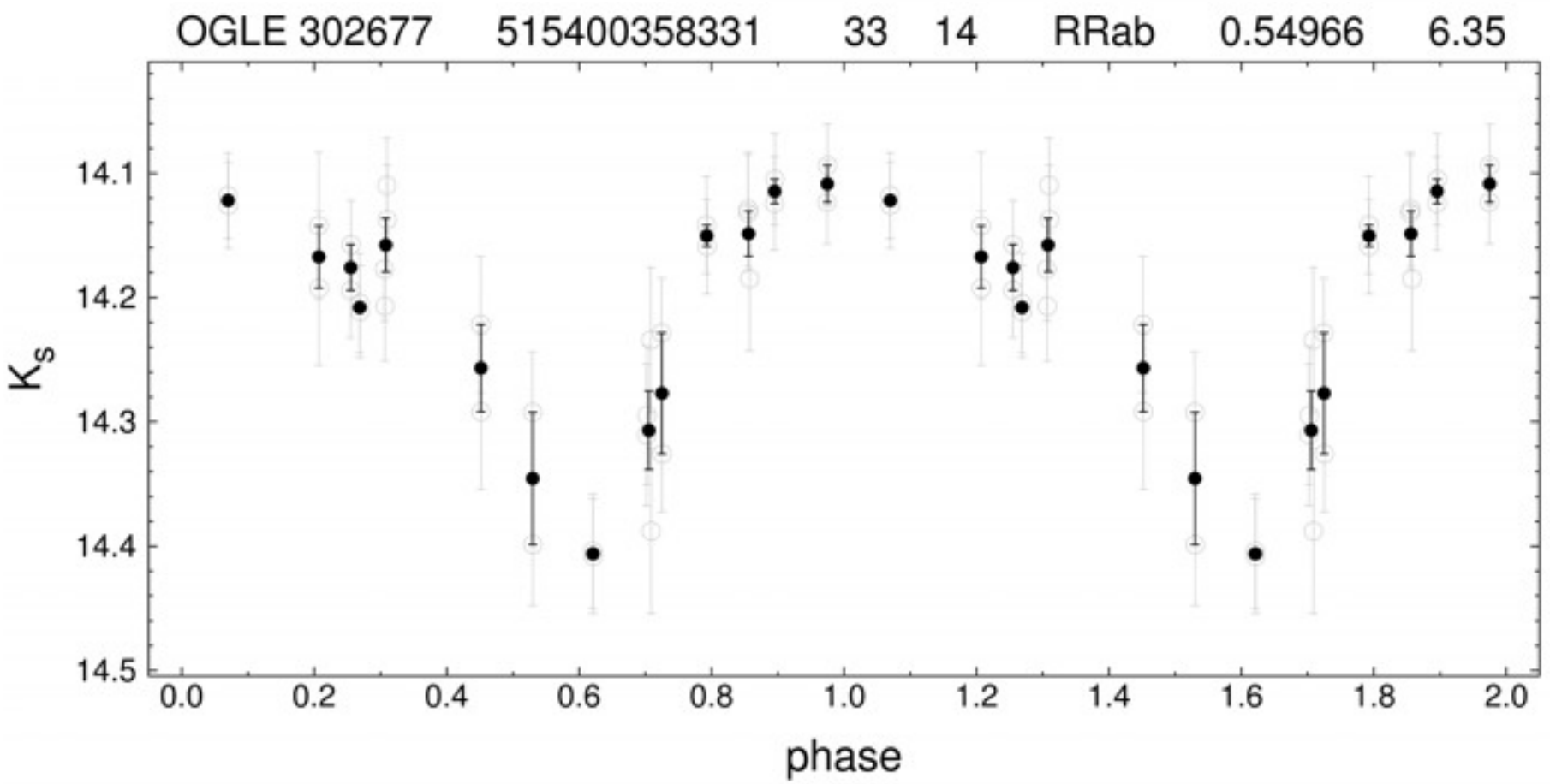
Juan Carlos Beamin

A few more RR Lyrae light curves



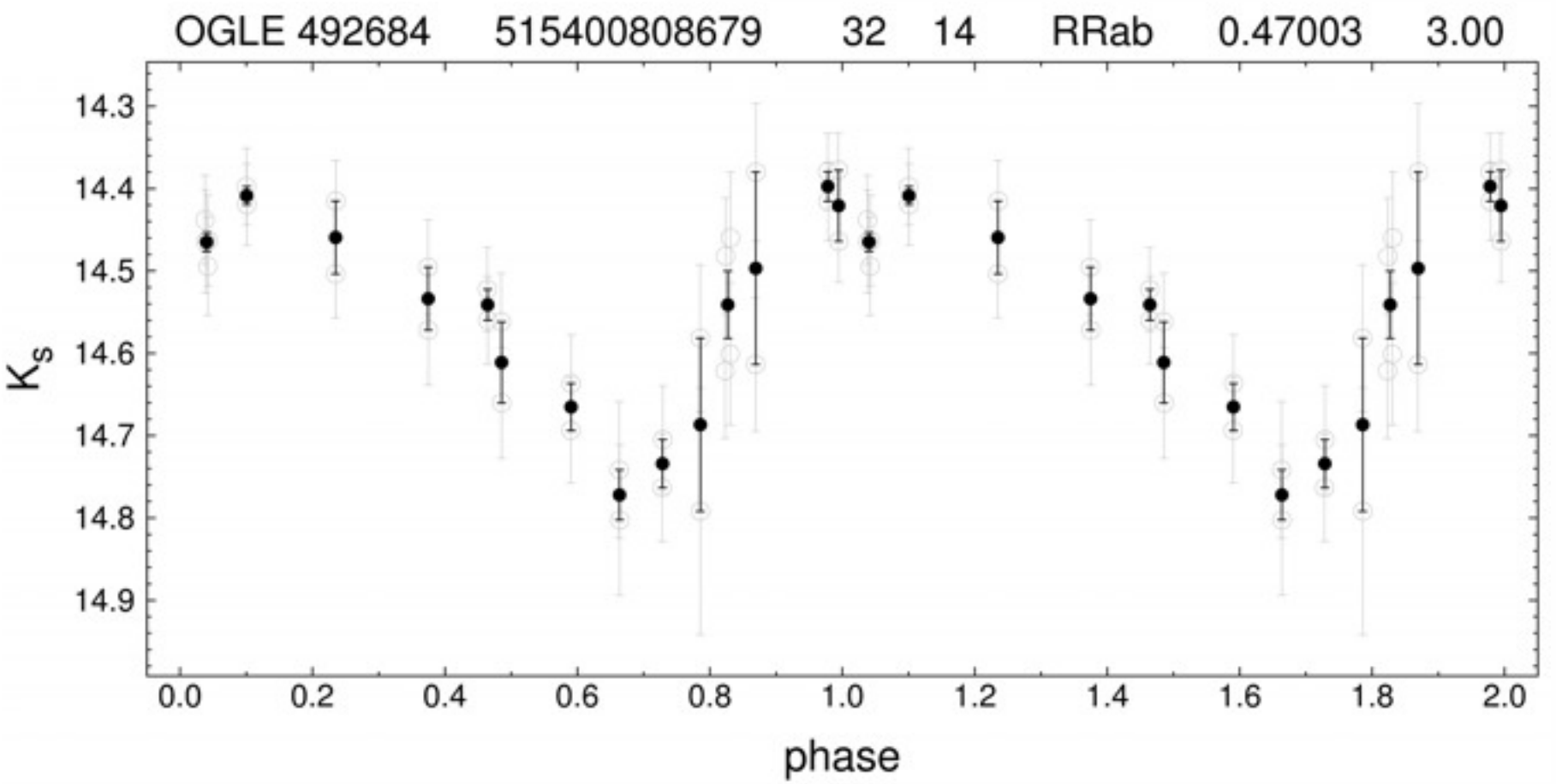
Istvan Dekany

A few more RR Lyrae light curves



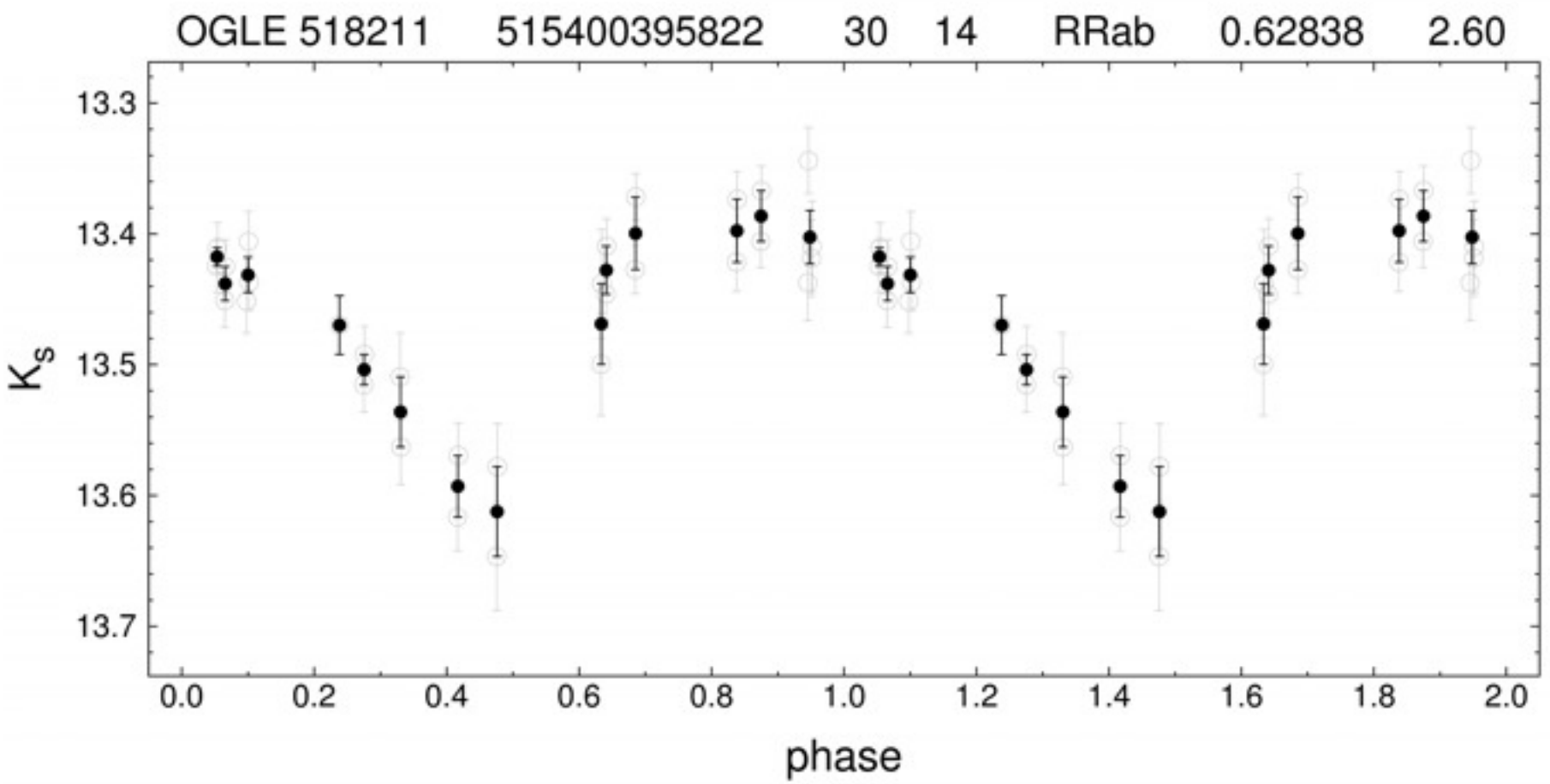
Istvan Dekany

A few more RR Lyrae light curves



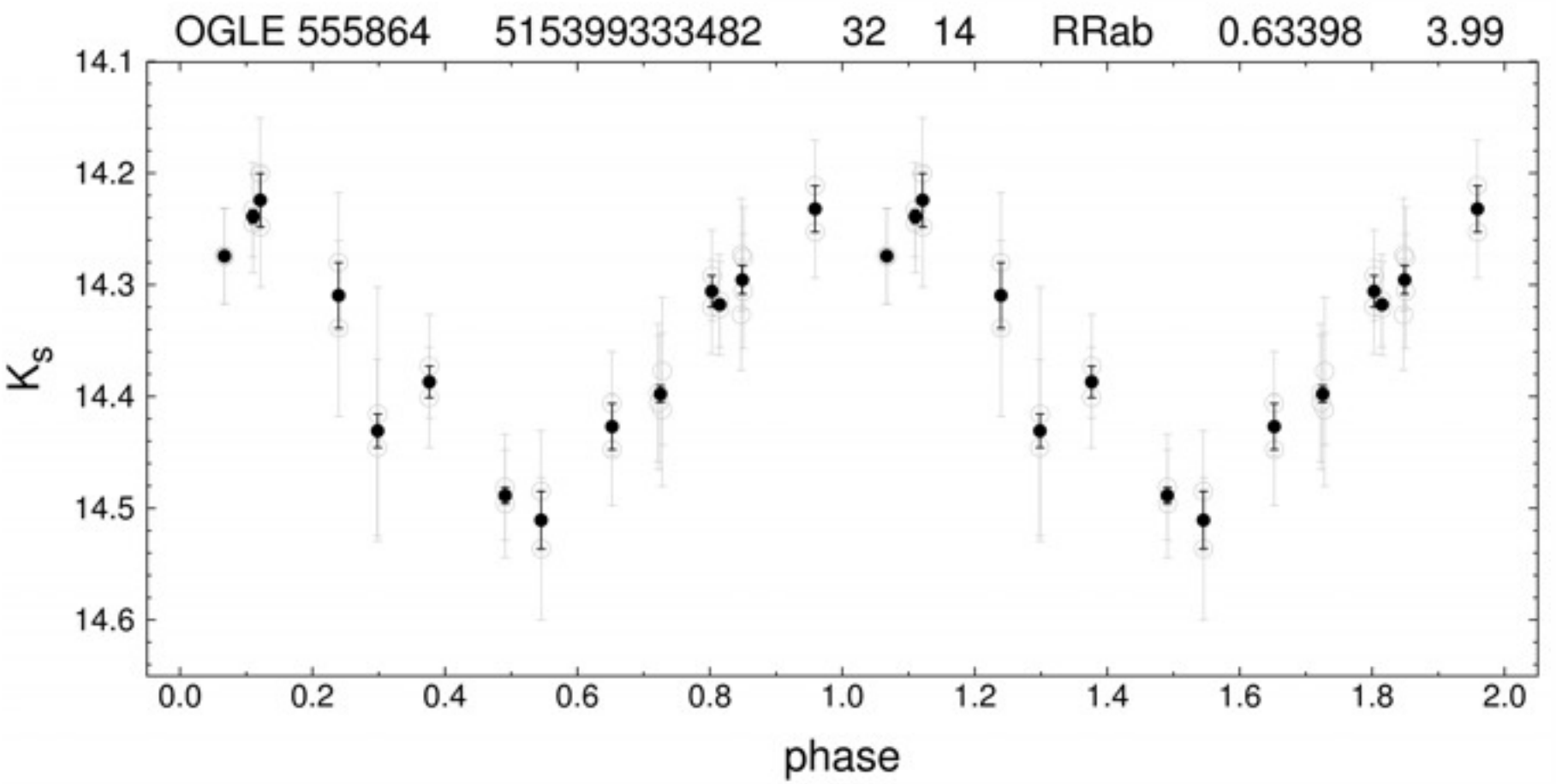
Istvan Dekany

A few more RR Lyrae light curves



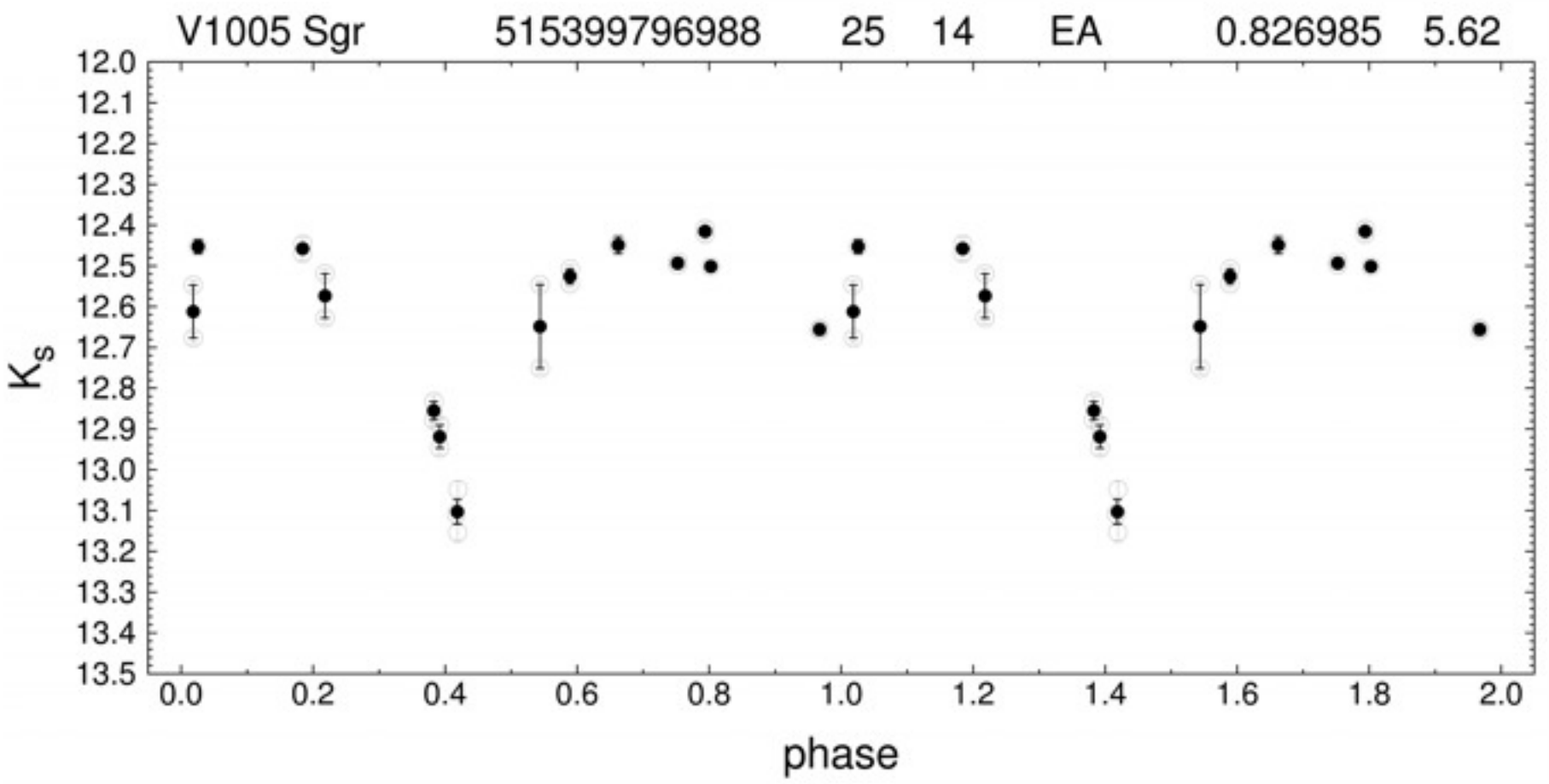
Istvan Dekany

A few more RR Lyrae light curves



Istvan Dekany

A few more EB light curves



Istvan Dekany

High Energy Sources

vvvsurvey.org

Follow-up of sources from CHANDRA, INTEGRAL, FERMI, SPITZER, ALMA,...

CSO

Credit: NASA/UMass/D.Wang et al.

VVV will monitor the variability around the Galactic Center.

Progress report

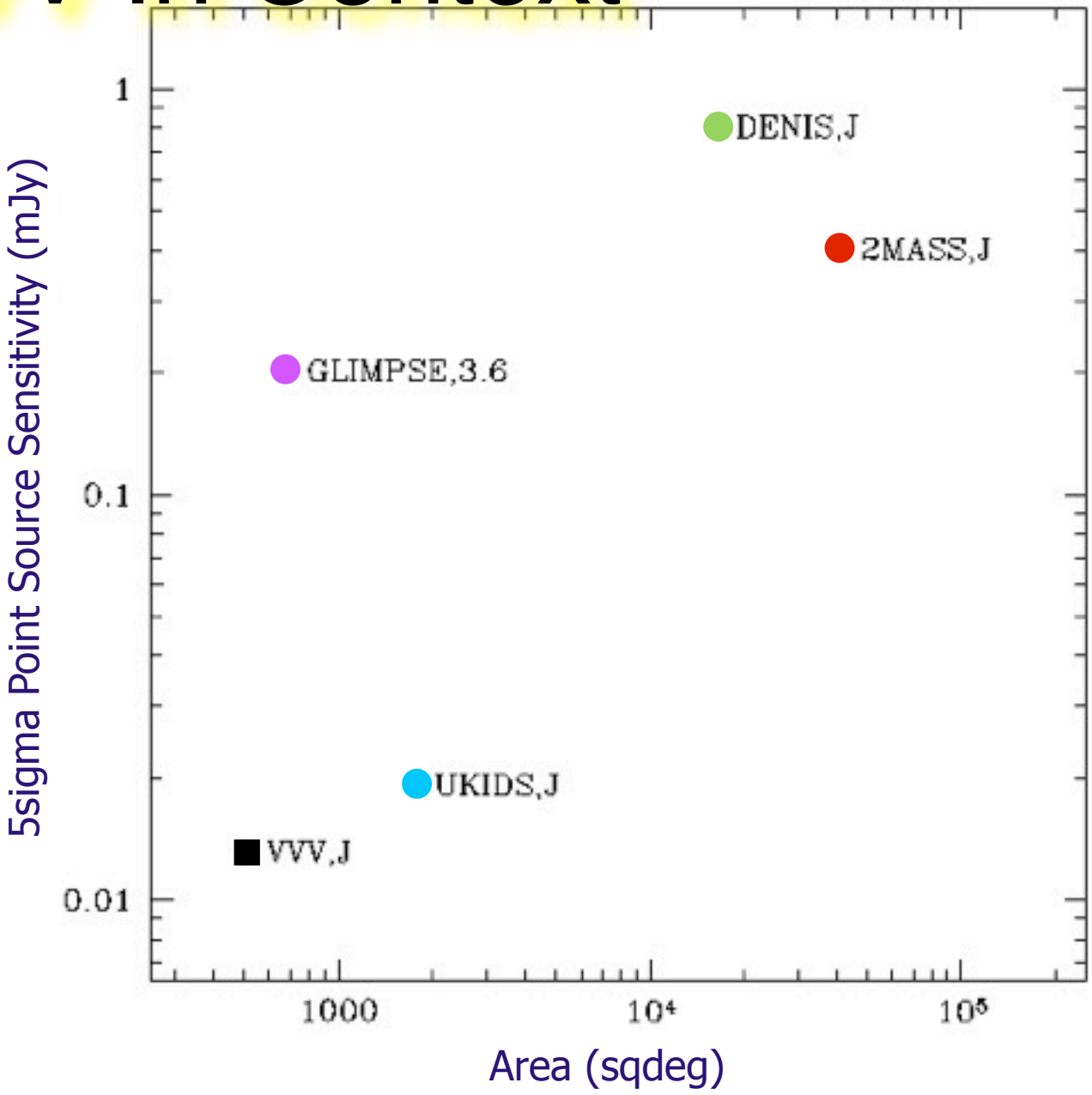
- observations OK
- photometry OK
- astrometry OK

Some problems / difficulties

- low efficiency (shutter open time/total time)
- large number of OBs
- huge dataset
- completeness/homogeneity
- large team
- delays, delays and more delays

VVV In Context

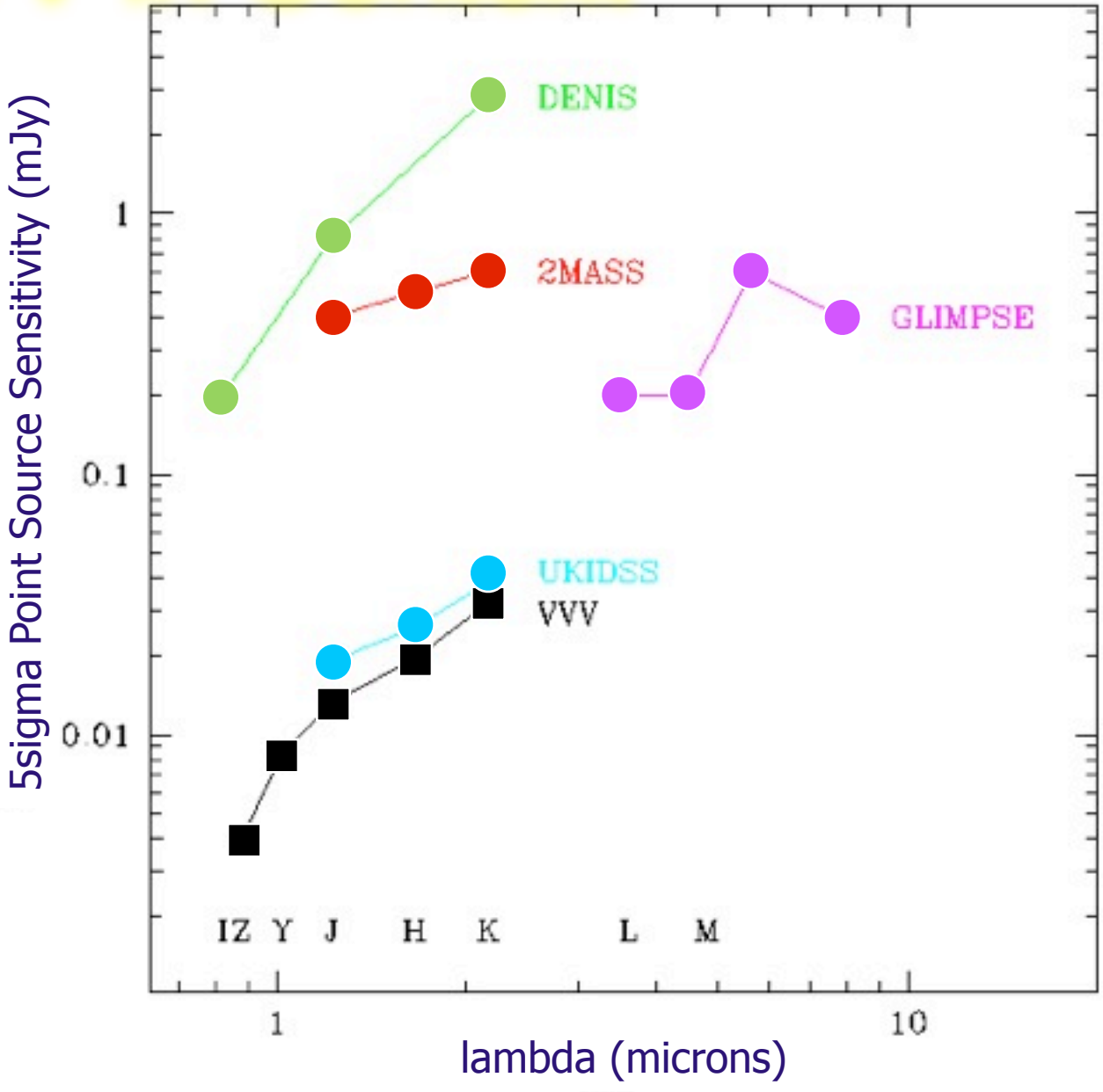
vvvsurvey.org



Valentin Ivanov

VVV In Context

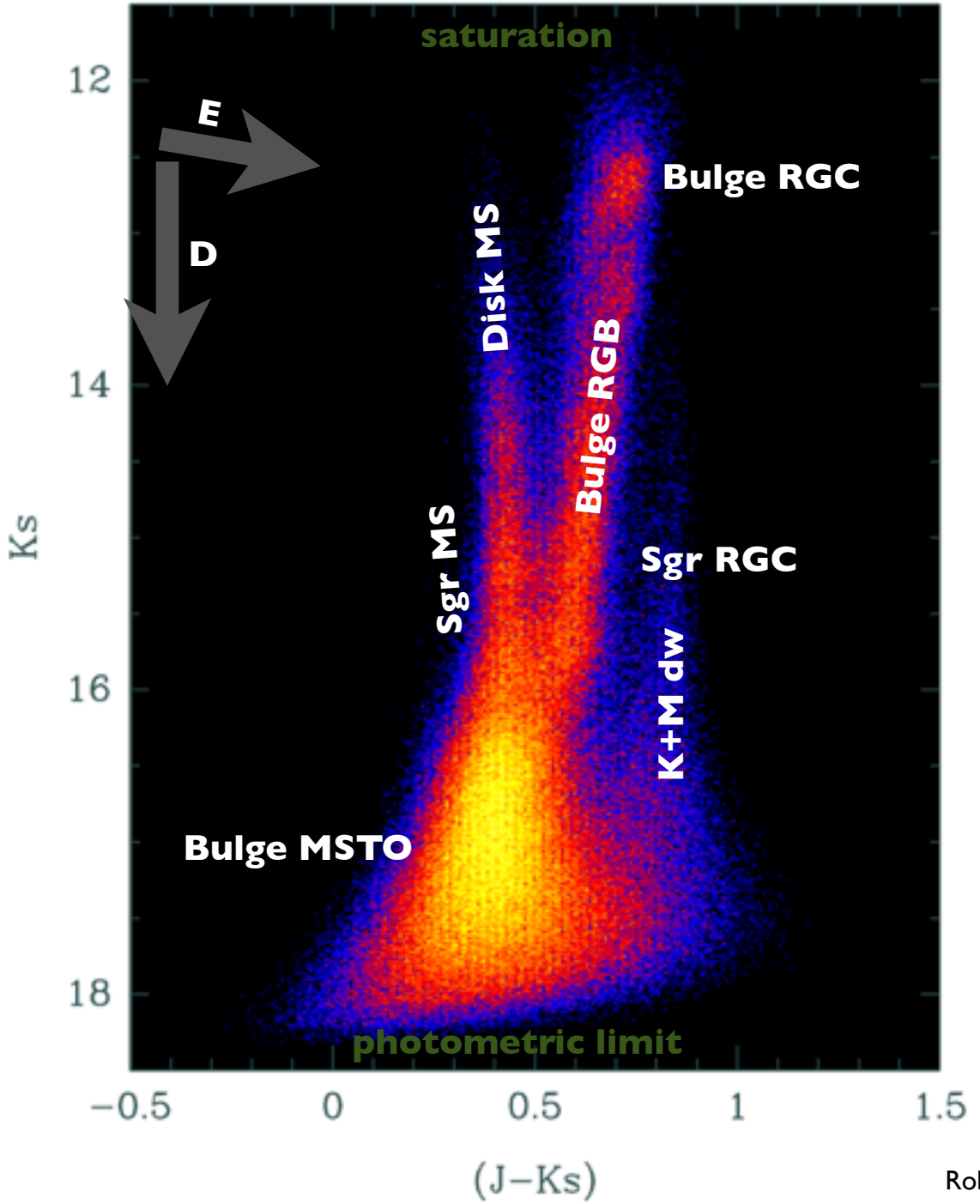
vvvsurvey.org



Valentin Ivanov

VVV 0.6M+ STARS CMD

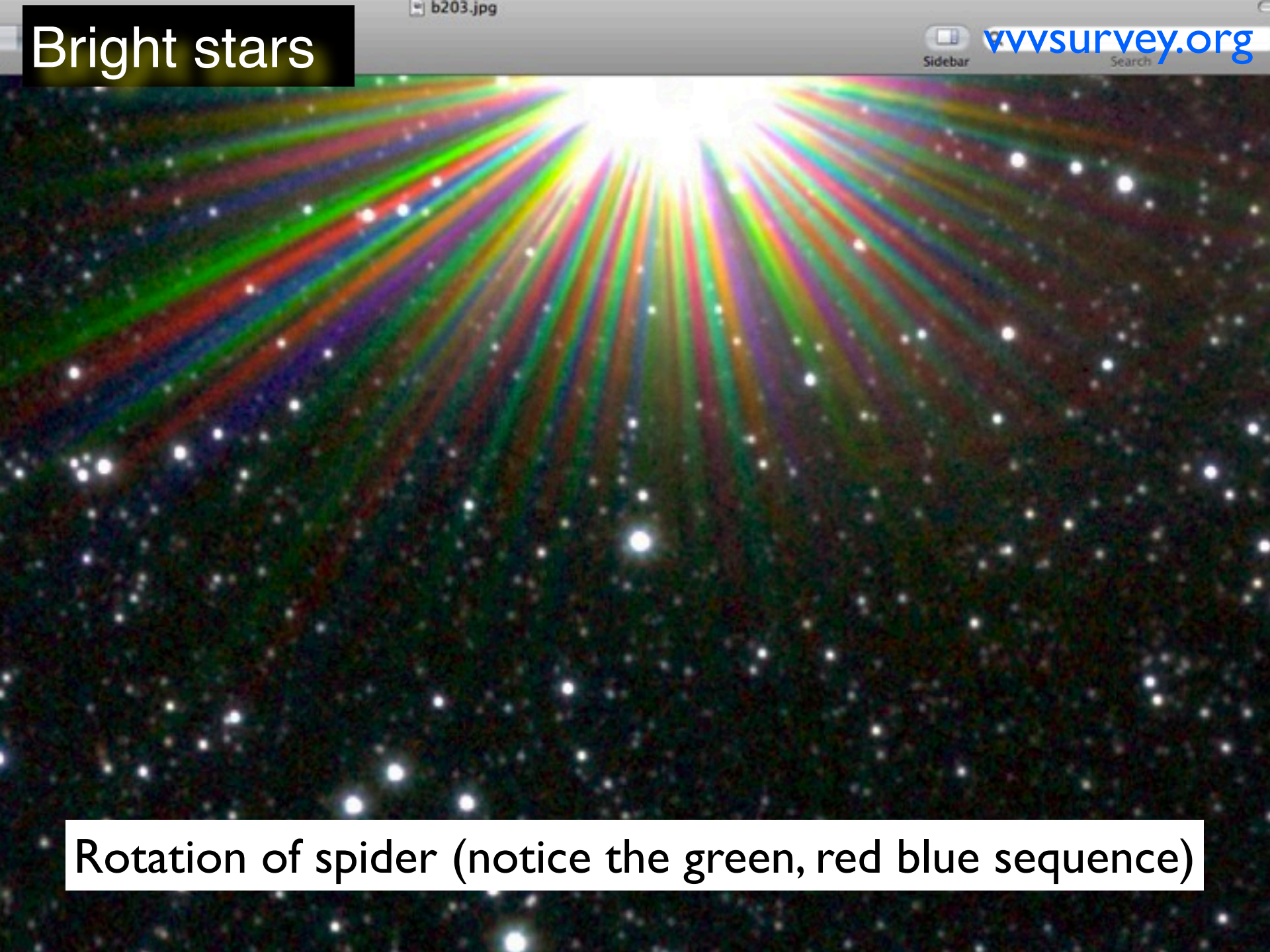
4.5 sqdeg
b209+b210+b211



Roberto Saito

QUALITY CONTROL

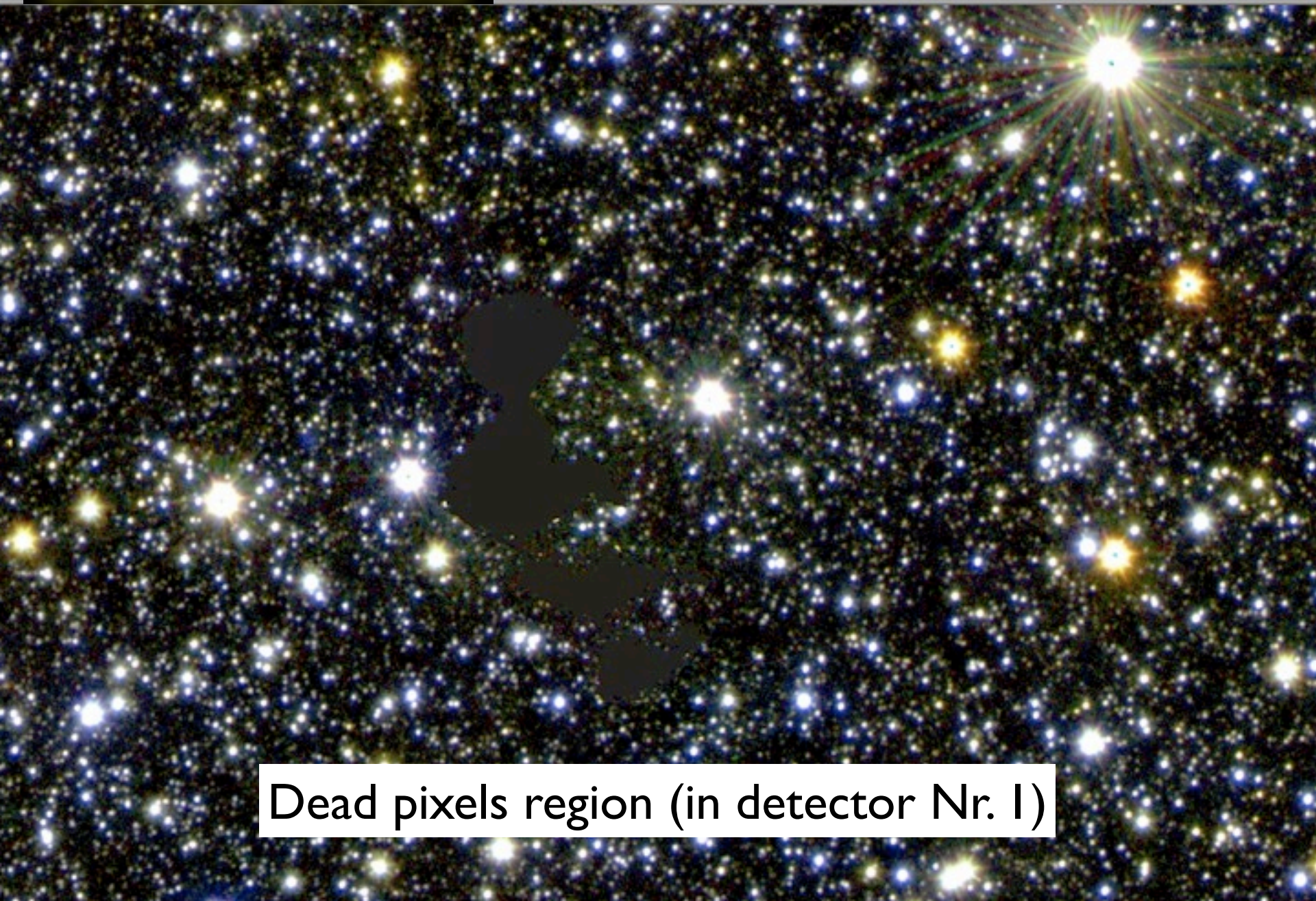
qualitative → quantitative


b203.jpg
Sidebar
vvvsurvey.org
Search
Bright stars
Rotation of spider (notice the green, red blue sequence)

Detector defects

d003_col.jpg

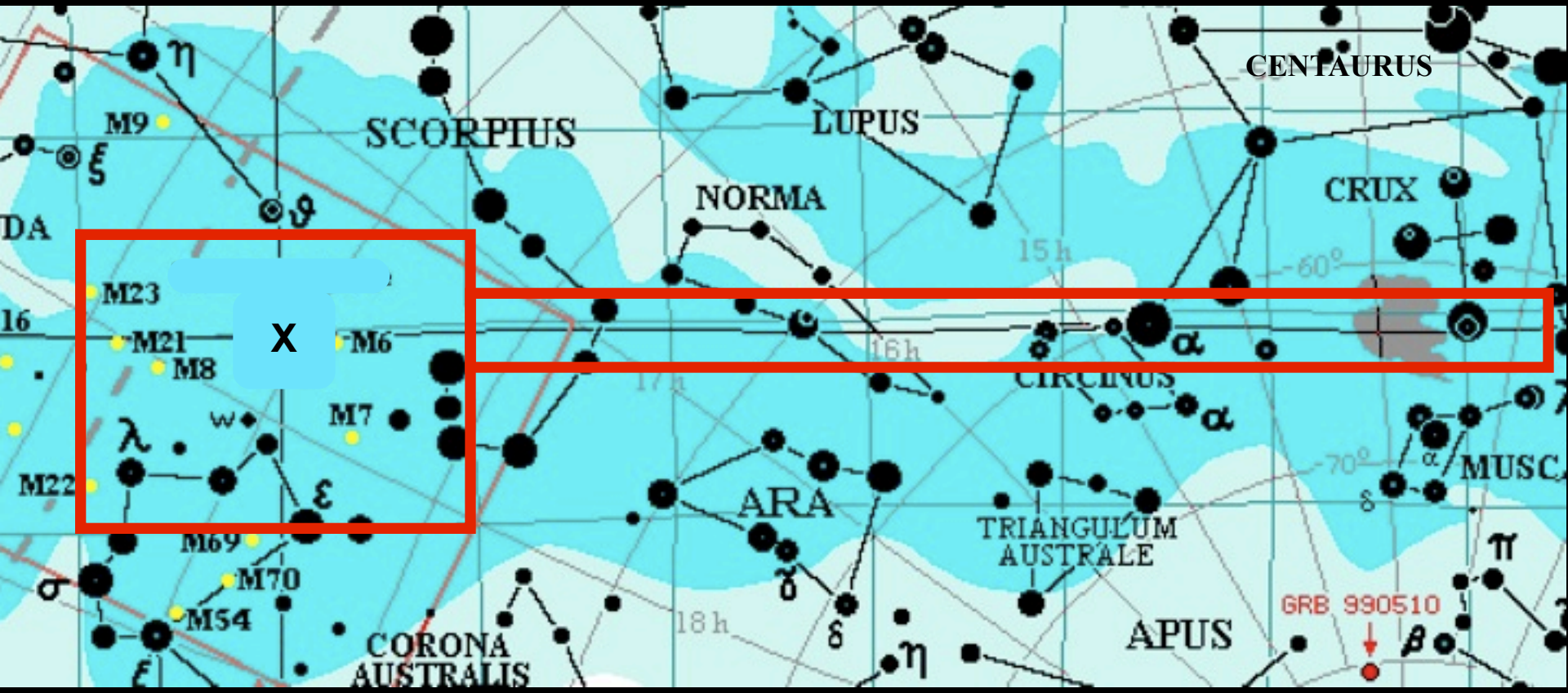
vvvsurvey.org



Dead pixels region (in detector Nr. 1)

Bright stars

vvvsurvey.org



Very bright stars present in the VVV fields can cause problems...

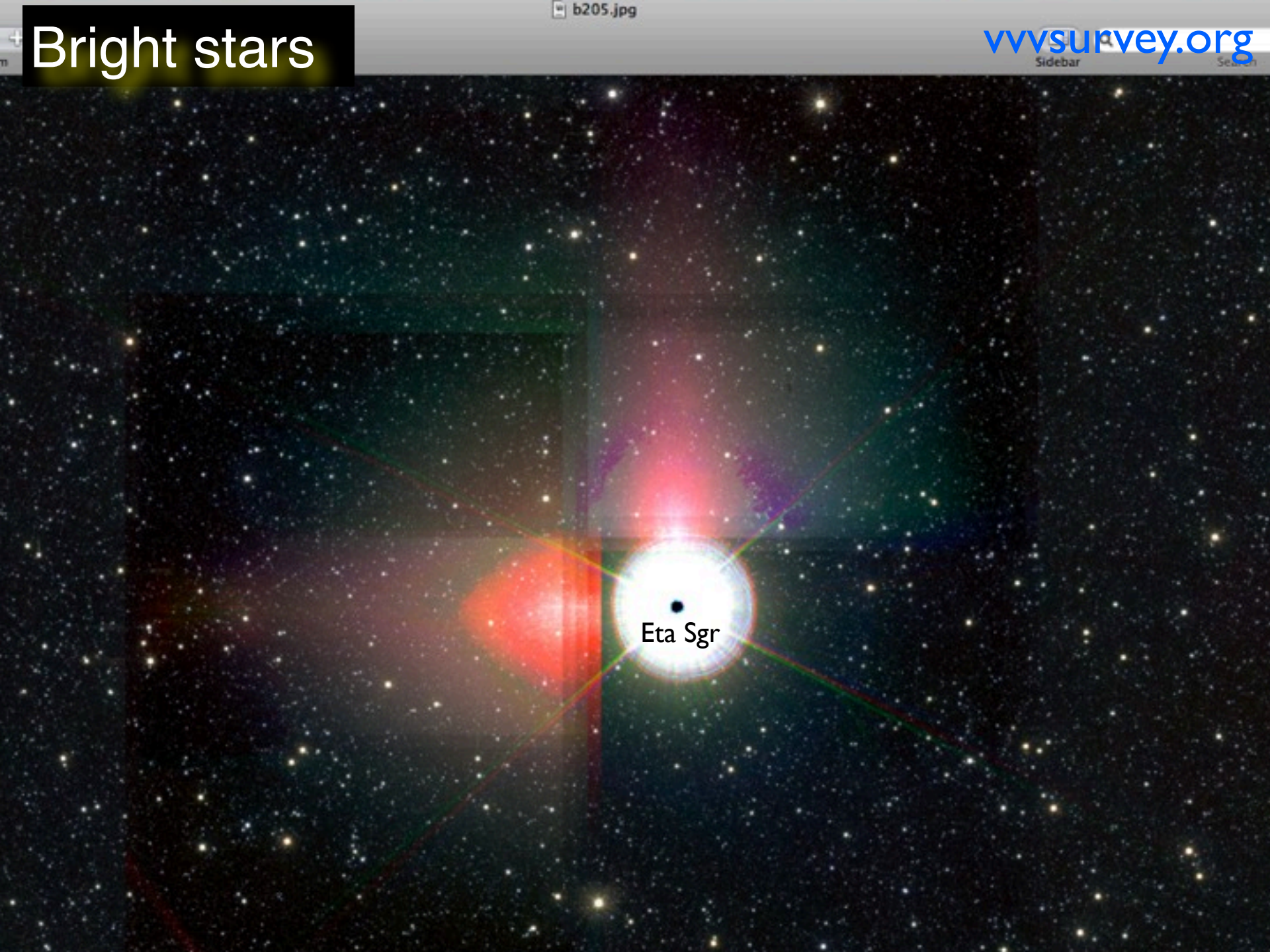
Bright stars

vvvsurvey.org

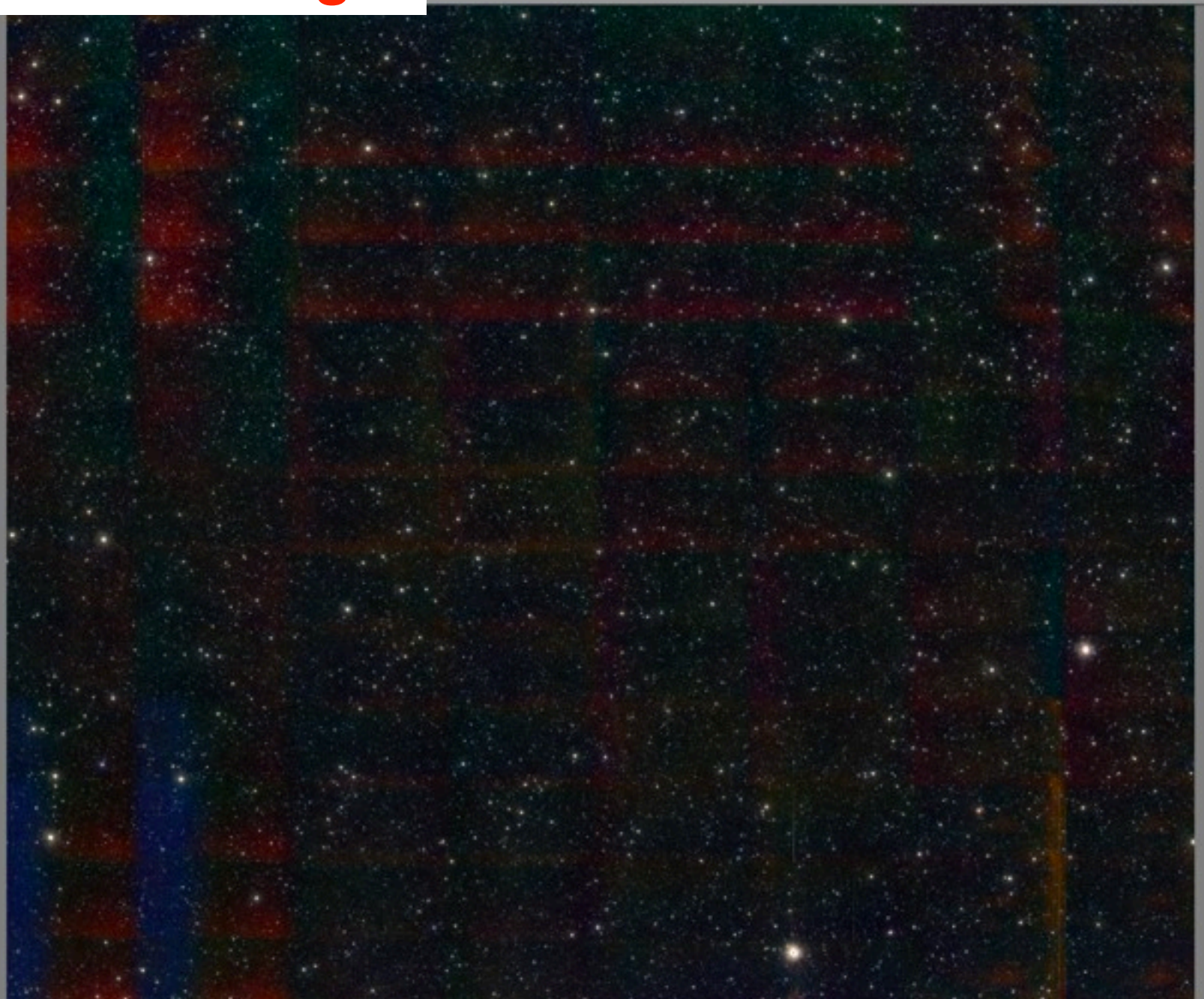
Bright stars not only saturate but also damage the neighboring regions, preventing the recovery of faint stars nearby, and affecting the photometry of neighboring stars.
In addition, **very bright** stars produce bad flat fielding, affecting the whole tile.
This is a list of the brightest stars located in the VVV fields.

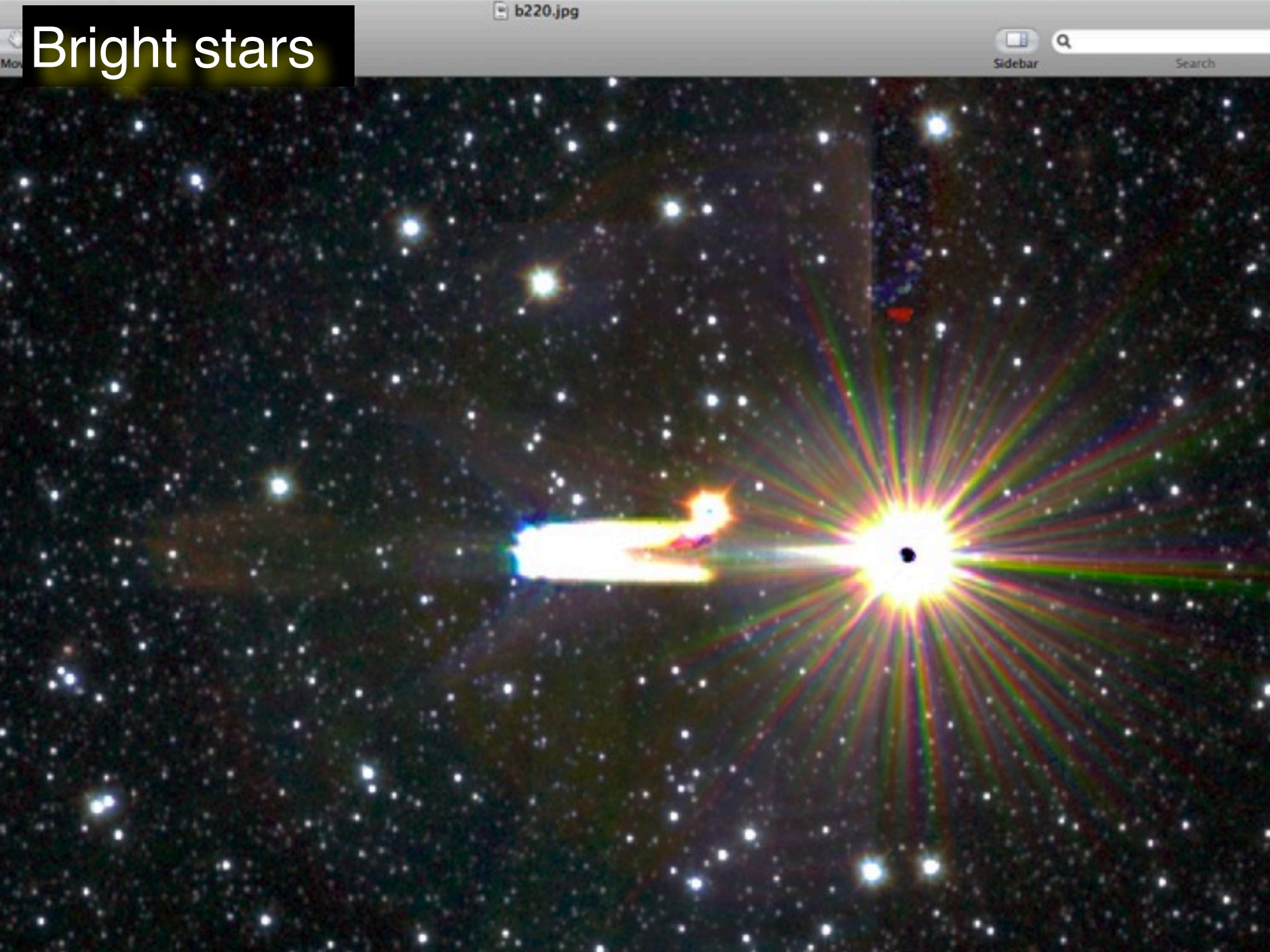
Star Name	Equatorial	Galactic	SpType	VisualMag	VVVField
Alpha Centauri	14 40 -60.8	315.8 -0.7	G2V+K1V	-0.29	d052-brightest Ks
Beta Centauri	14 04 -60.4	311.8 +1.2	B1III	0.61	d126
Alpha Crucis	12 27 -63.1	300.2 -0.4	B0.5IV+B1V	0.79	d042
Lambda Scorpii	17 34 -37.1	351.8 -2.3	B2IV	1.62	b300
Epsilon Sagittarii	18 24 -34.4	359.2 -9.8	B9.5III	1.84	b207
Kappa Scorpii	17 42 -39.0	351.0 -4.6	B1.5III	2.39	b257-just off edge
Upsilon Scorpii	17 31 -37.3	351.3 -1.9	B2IV	2.70	b300??
Delta Sagittarii	18 21 -29.8	3.0 -7.2	K2II	2.72	b238
Lambda Sagittarii	18 28 -25.4	7.7 -6.5	K1III	2.82	b255
Gamma^2 Sagittarii	18 06 -30.4	0.9 -4.5	K0III	2.98	b278
Iota^1 Scorpii	17 48 -40.1	350.6 -6.1	F2Ia	2.99	b243
Eta Sagittarii	18 18 -36.8	356.4 -9.7	M3.5III	3.10	b205-2nd brightest
Lambda Centauri	11 36 -63.0	294.5 -1.4	B9III	3.11	d039??
Eta Scorpii	17 12 -43.2	344.4 -2.3	F3III-IV	3.32	d036-just off edge

Bright stars



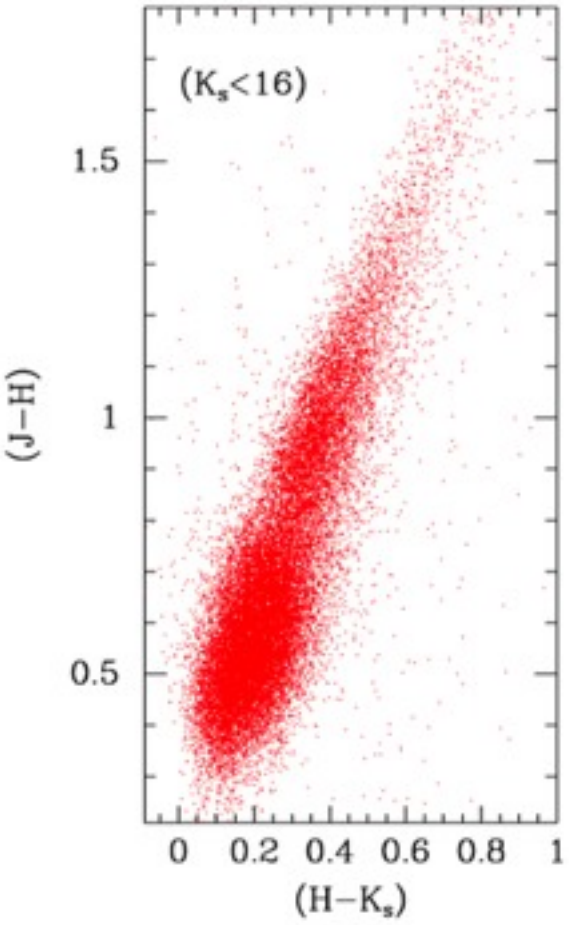
Flat Fielding

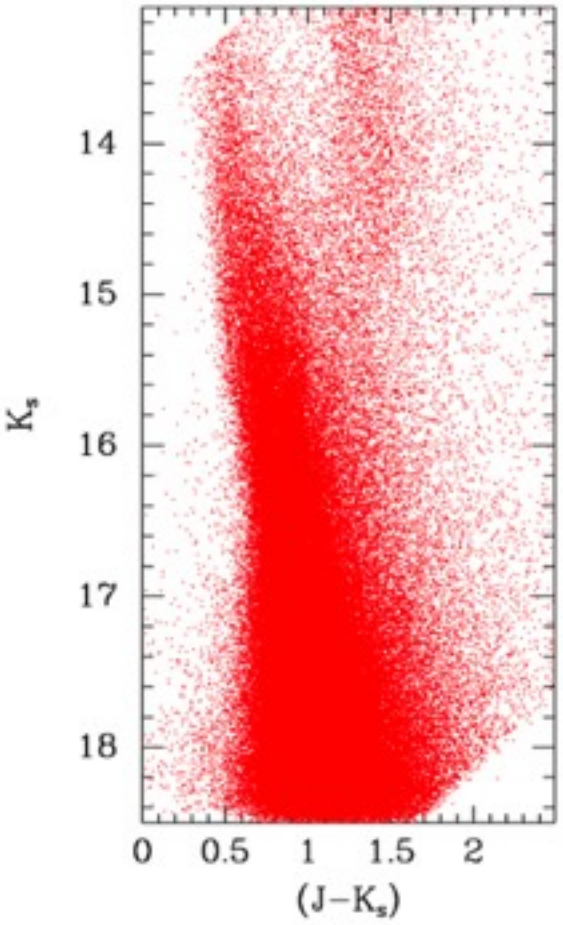


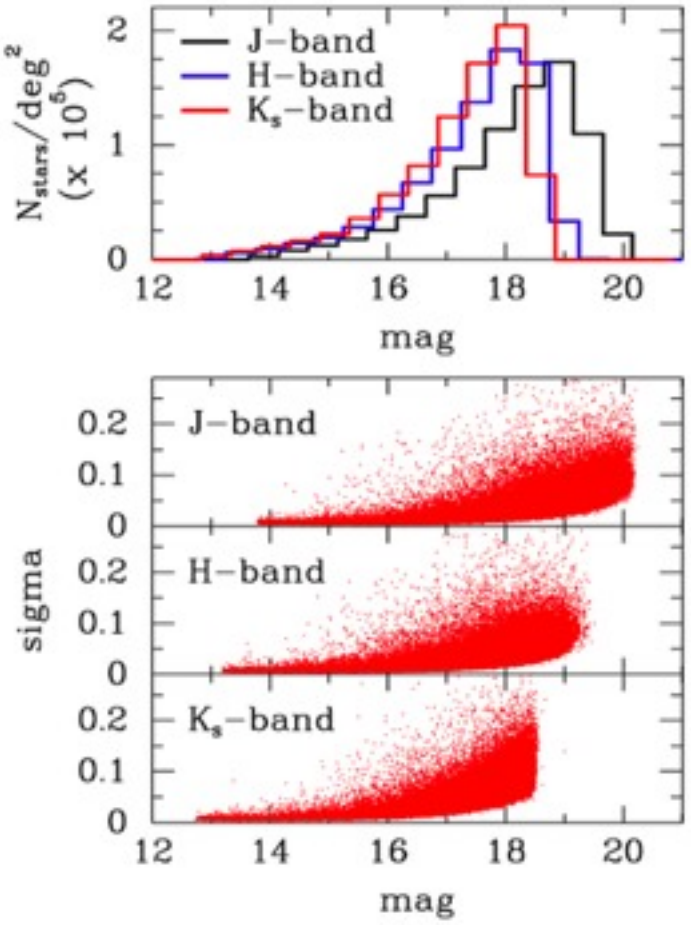

b220.jpg
Sidebar
Search
Bright stars

Year 1 Disk Photometry

vvvsurvey.org







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Year 1 Bulge Photometry

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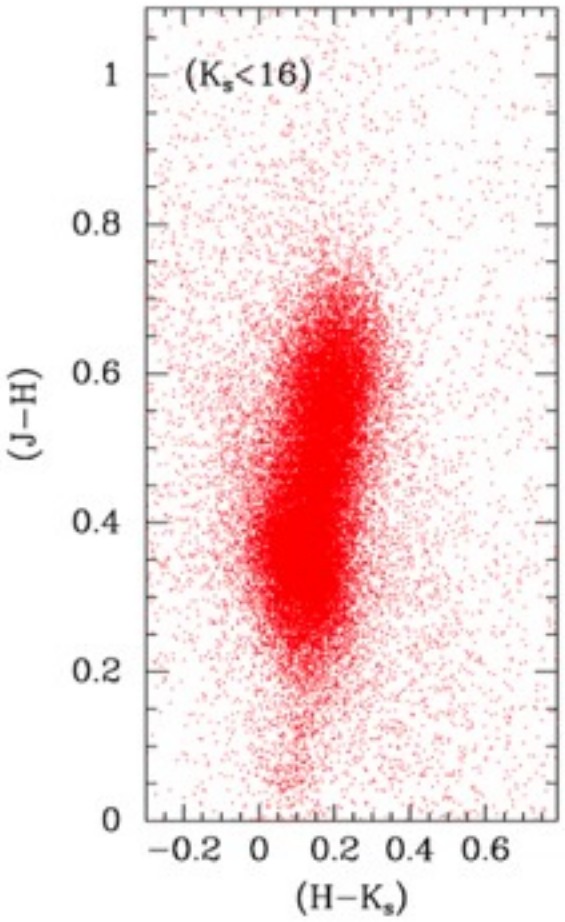

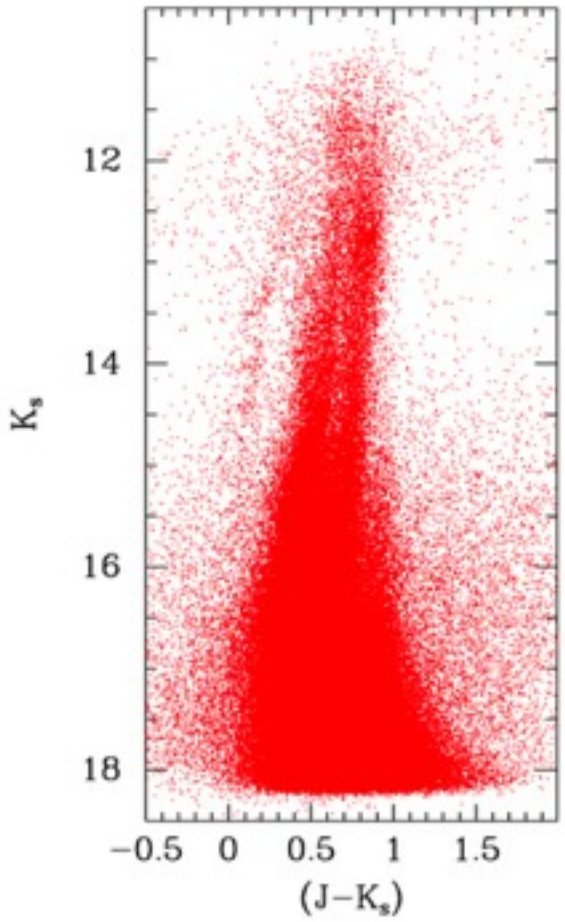

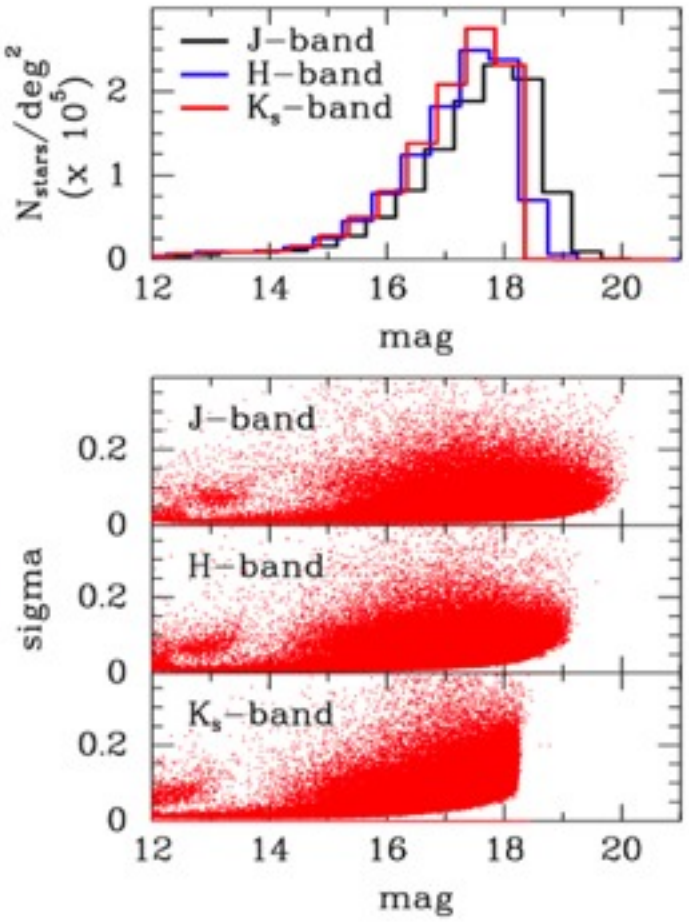

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Year 1 Astrometry

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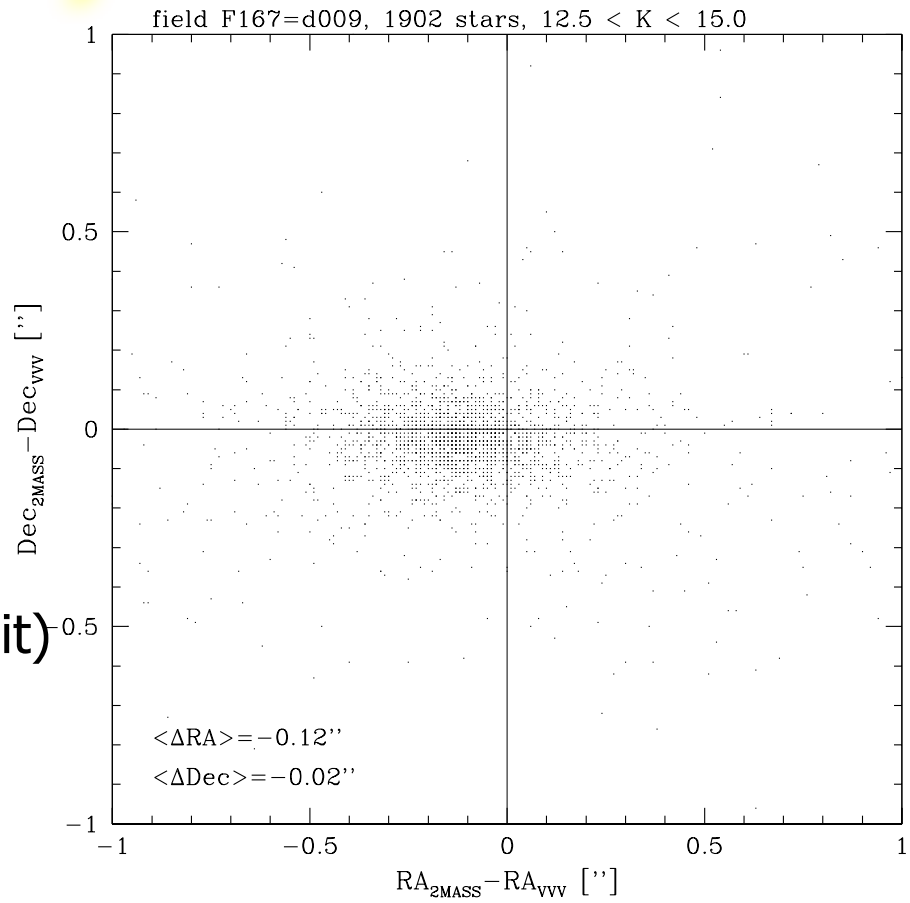
Pixel scale: 0.34”

Typical image seeing: 1”

Best image: 0.6” (including telescope, instrument, seeing)



Typical astrometric accuracy (rms per visit)

→~35 mas for Ks=15

→~175 mas for Ks=18

Typical proper motion accuracy (after 5yr long survey)

→~7 mas/yr for Ks=15

→~15 mas/yr for Ks=18

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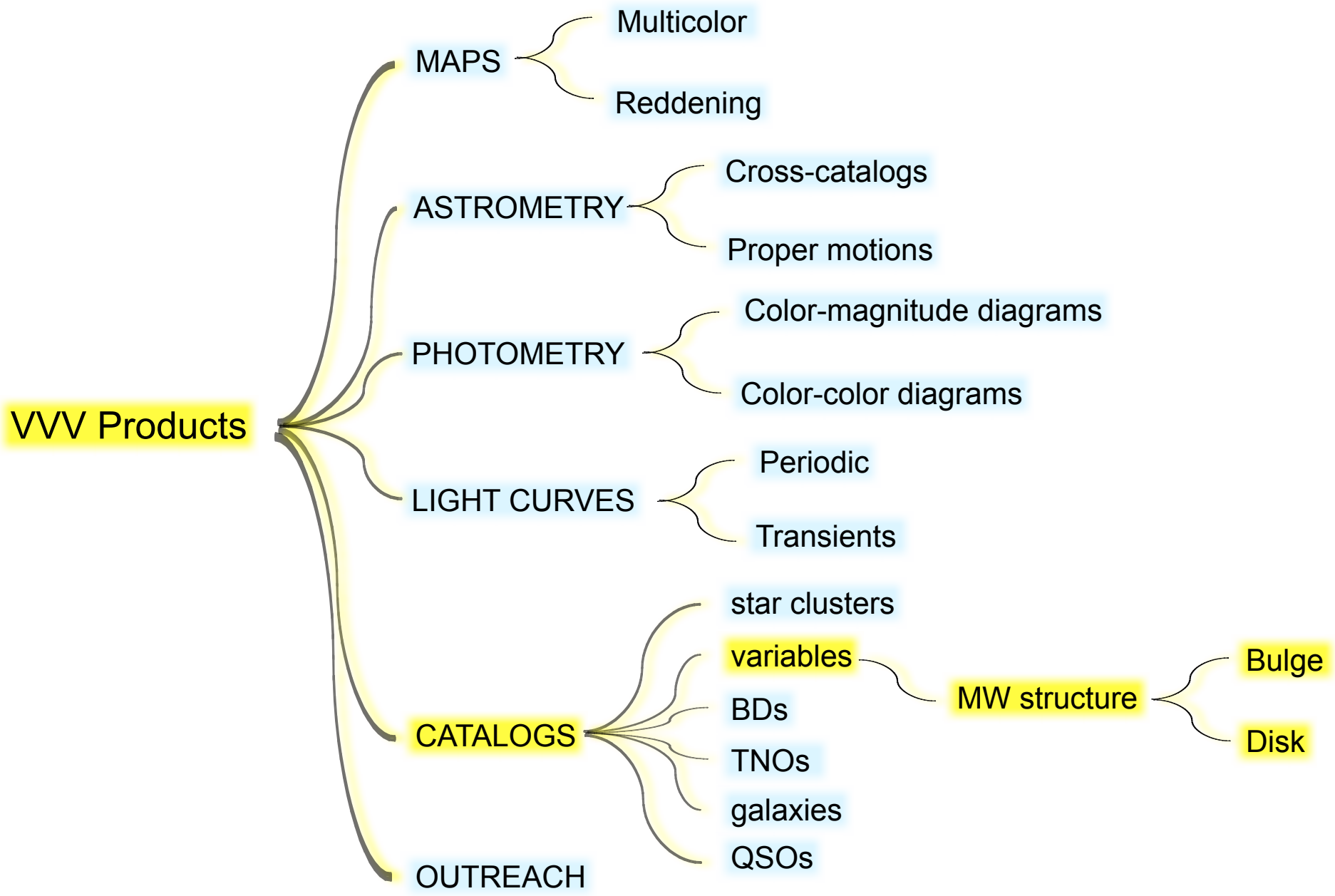

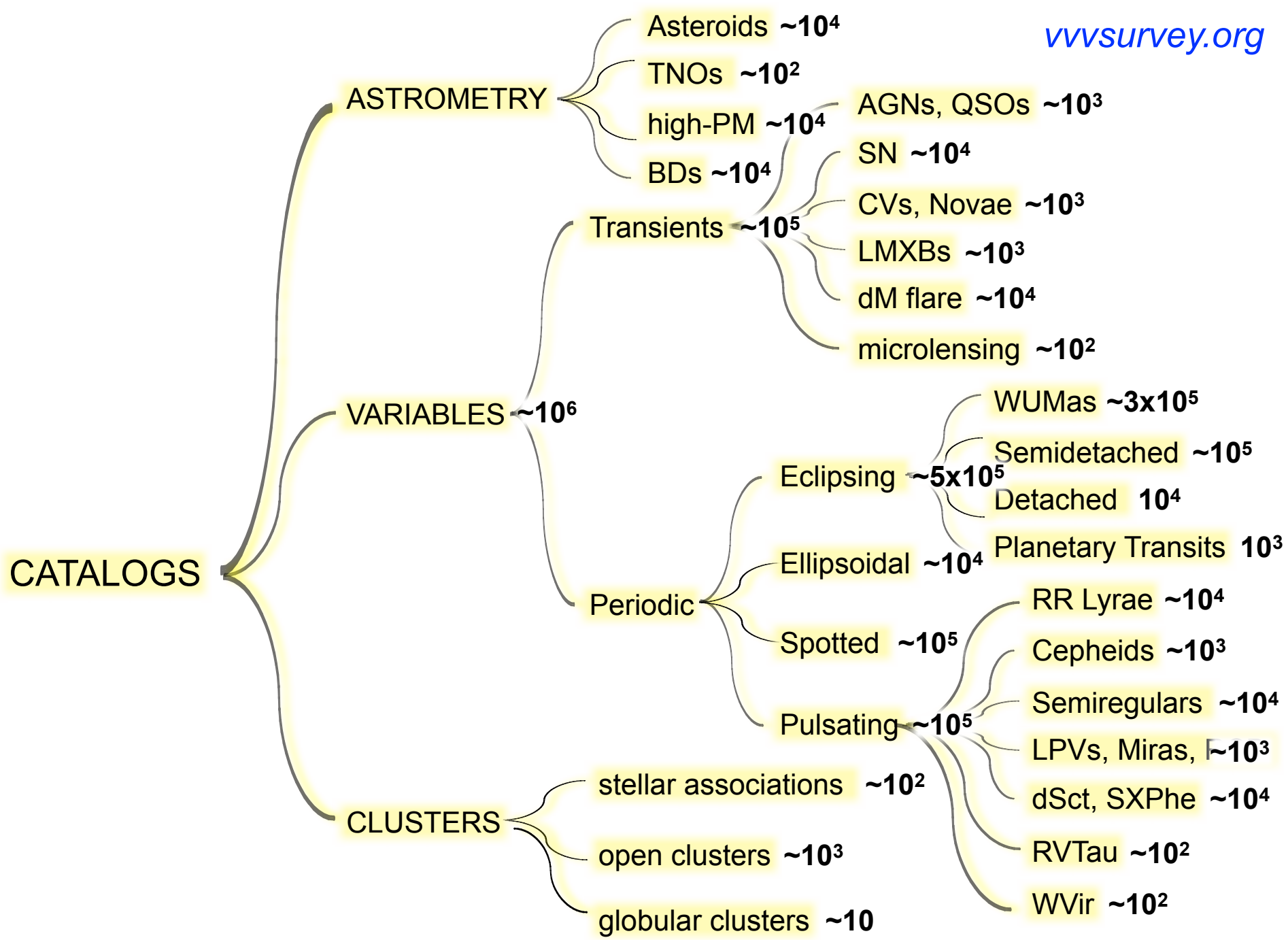
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CATALOGS
ASTROMETRY
Asteroids ~10^4
TNOs ~10^2
high-PM ~10^4
BDs ~10^4
VARIABLES
~10^6
Transients
~10^5
AGNs, QSOs ~10^3
SN ~10^4
CVs, Novae ~10^3
LMXBs ~10^3
dM flare ~10^4
microlensing ~10^2
Periodic
Eclipsing
~5x10^5
WUMas ~3x10^5
Semidetached ~10^5
Detached 10^4
Planetary Transits 10^3
Ellipsoidal ~10^4
Spotted ~10^5
Pulsating
~10^5
RR Lyrae ~10^4
Cepheids ~10^3
Semiregulars ~10^4
LPVs, Miras, ~10^3
dSct, SXPhe ~10^4
RVTau ~10^2
WVir ~10^2
CLUSTERS
stellar associations ~10^2
open clusters ~10^3
globular clusters ~10

Not only...

but also:

OUTREACH

- products for planetaria
- PRs with science discoveries
- large multicolor posters, maps and prints
- web based pictures and data access
- projects for high school students
- involvement of amateur astronomers
- Google sky or somesuch
- variable stars Zoo, VVV@home

VVV Nomeclature

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New Clusters:

VVV-CL001

New PN:

VVV-PN001

New Stars:

VVV-J123456.78-456789.1

New Variables

VVV-J123456.78-456789.1 v

New Galaxies:

VVV-X123456.78-456789.1

VVV Survey Workshop

Next Workshop:

Univ. Hertfordshire,
July 18-21, 2011

Conclusions (Year 1)

- observations: OK, but many delays
- photometry: OK, but technique depends on need
- astrometry: OK so far, but longer baseline needed
- variability detection: OK so far, but more epochs needed

The high quality of the data suggests that the VVV Survey should be able to accomplish its goals.


vvvsurvey.org
The VVV Science Team: working
to obtain a 3-D view of our Galaxy.