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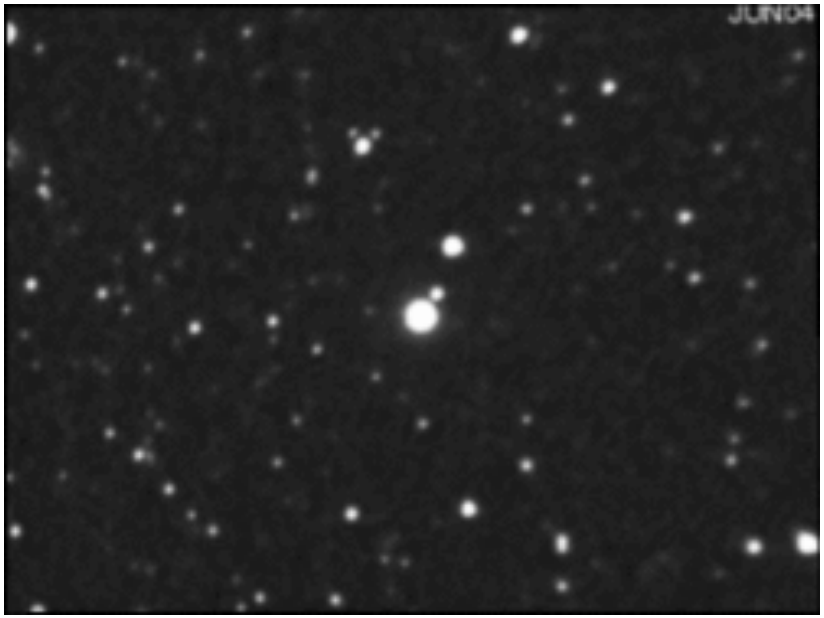
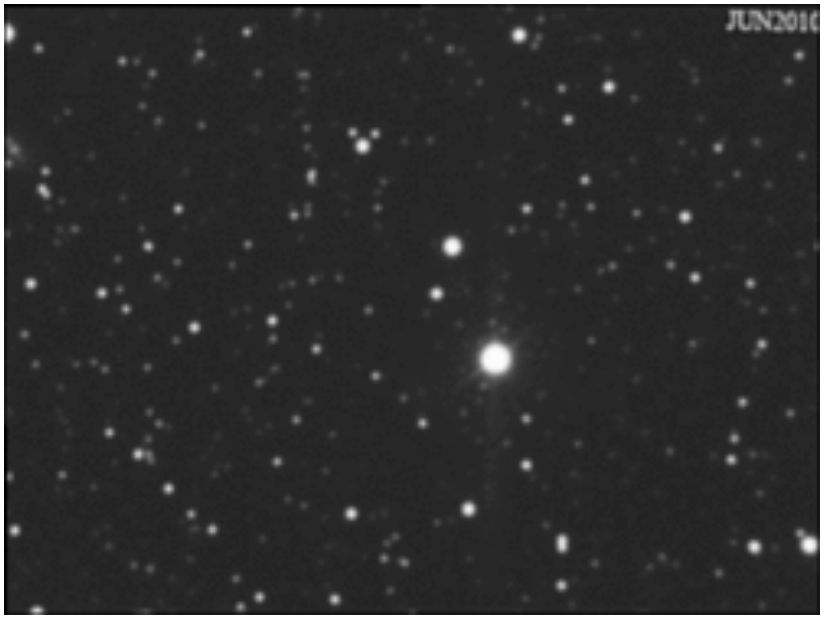
Proper motions and brown dwarfs in the VVV survey

Juan Carlos Beamín

Collaborators:
Dante Minniti, Valentin Ivanov, Radostin Kurtev,
Rene Mendez, Mariusz Gromadzki, Karla Peña,
Roberto Saito, Philip Lucas, Jura Borissova...

Spot the difference.





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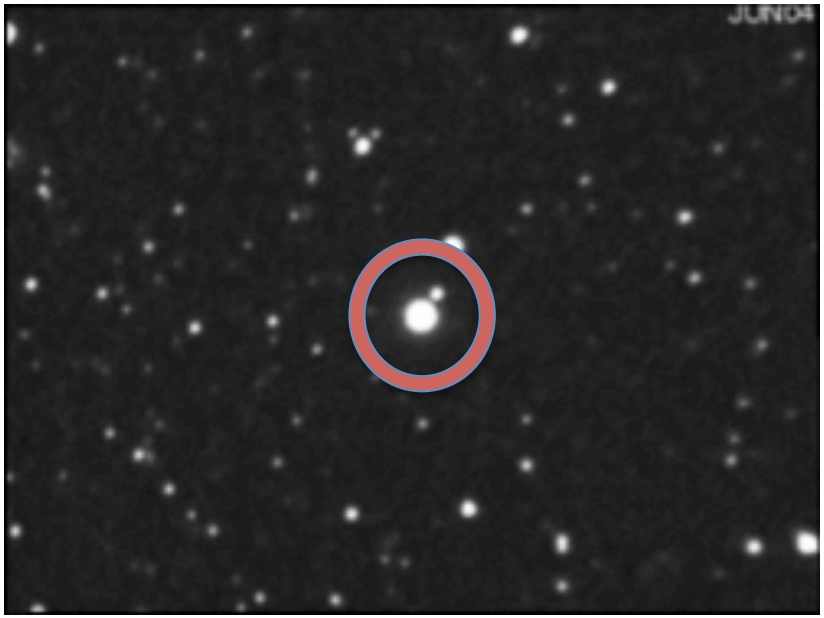

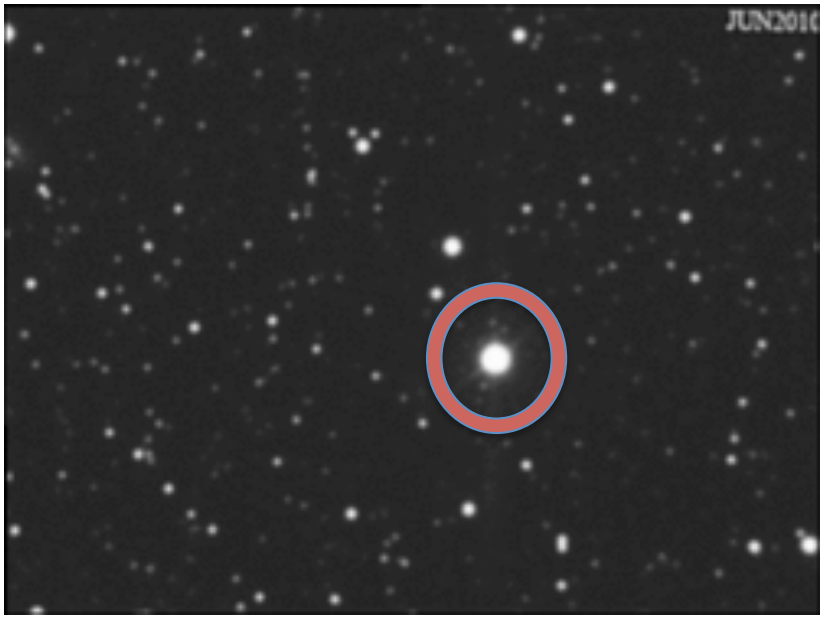

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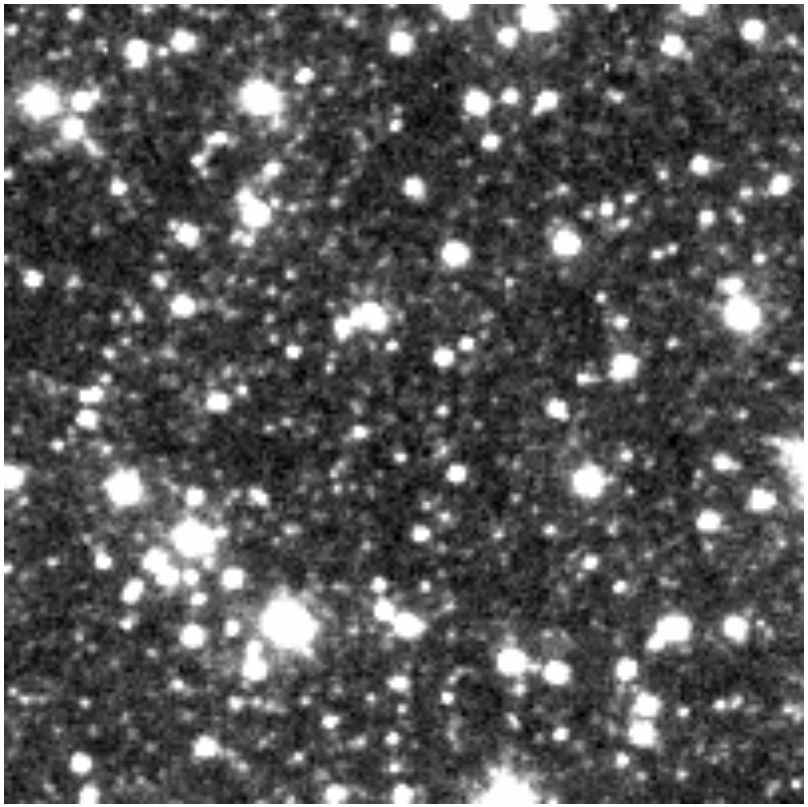

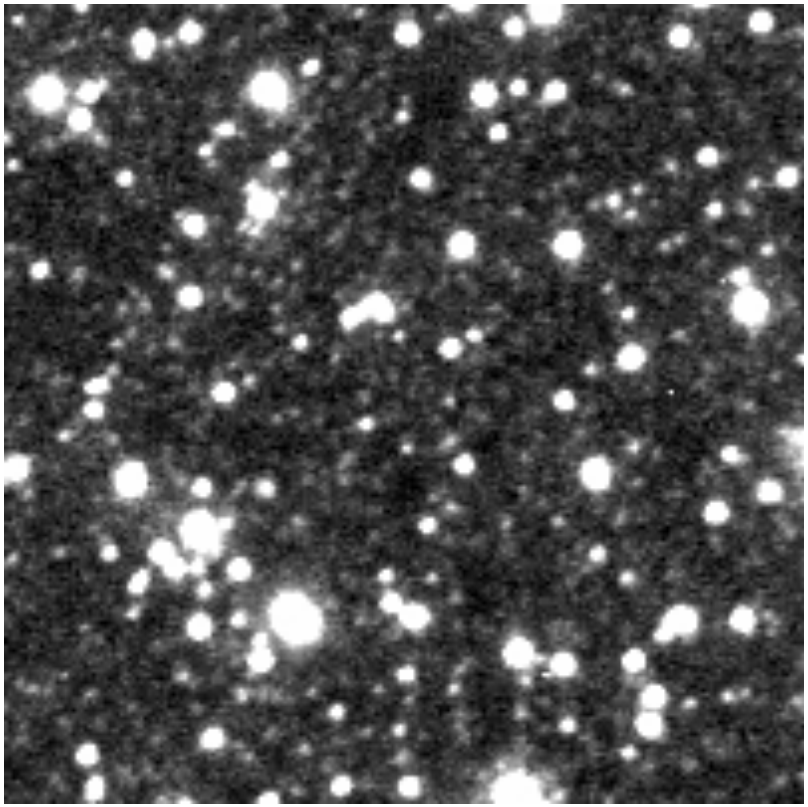

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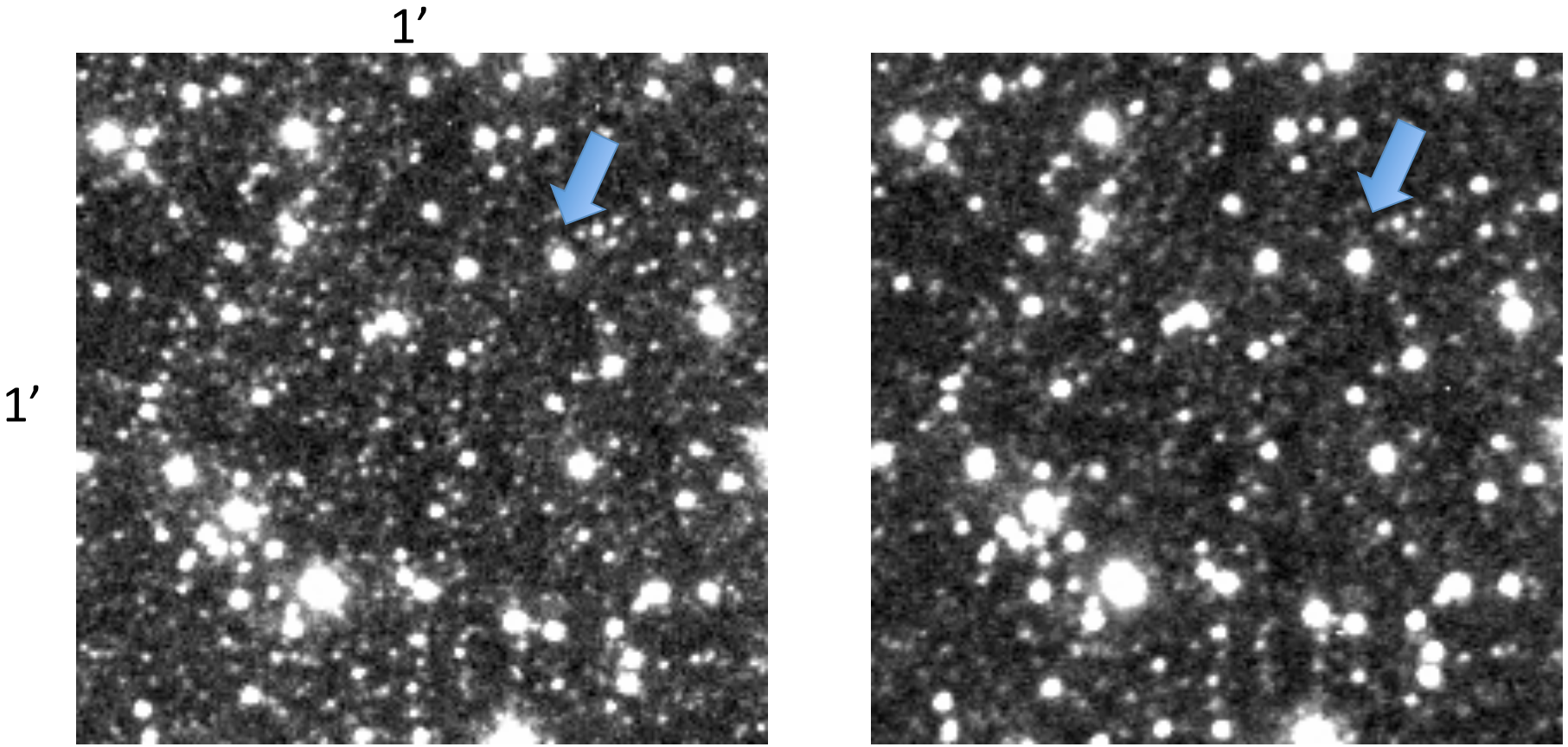

2 VVV images separated by 2 years

Spot all the differences

Knowledge about nearby stars is key in astronomy

Give us hints about:

How much mass is in stars

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Types of stars, multiplicity & IMF

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Brown dwarfs and planet conection

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How much mass is in stars

Types of stars, multiplicity & IMF

Brown dwarfs and planet conection

Astrometric characterization,
age, atmospheres, etc…

Gaia is AWESOME… but…

… Still need help? Where?

Crowded fields (only V~18 ?)

Interesting for microlensing!

Also in extincted regions

Gaia is AWESOME… but…

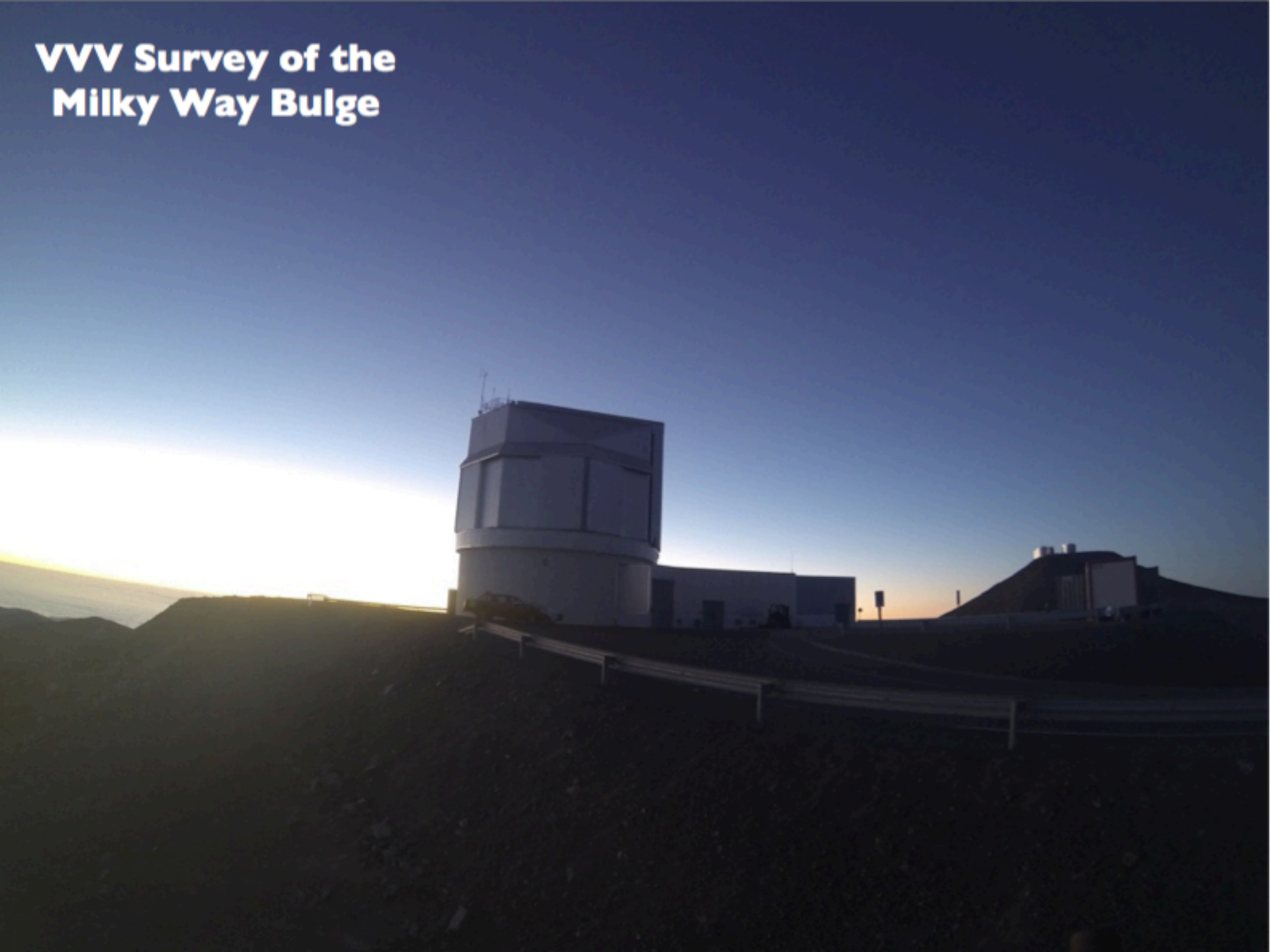
… Still need help? Where?

Crowded fields (only V~18 ?)

Interesting for microlensing!

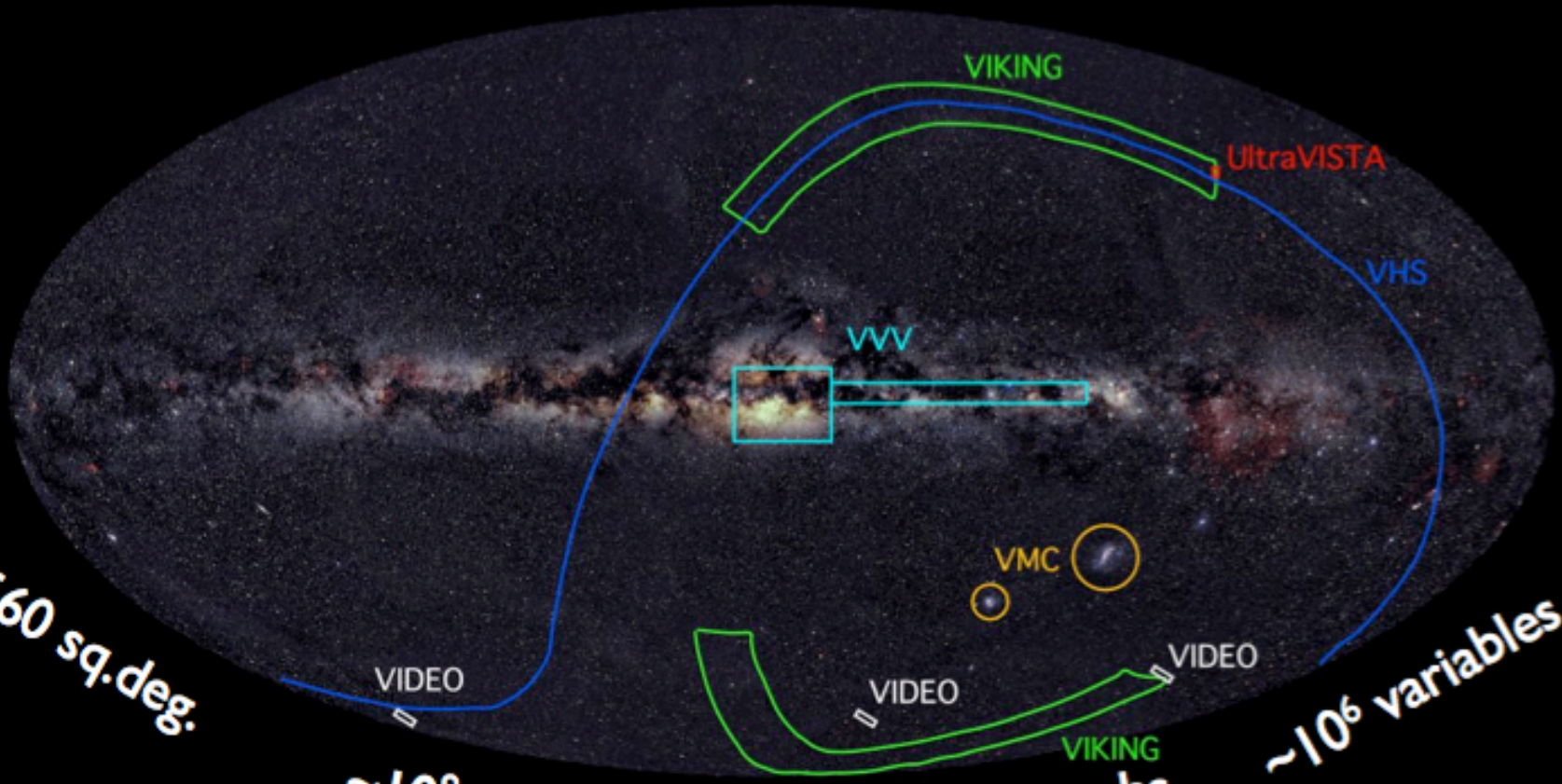
How can we help??

Extincted regions


VVV Survey of the
Milky Way Bulge

VISTA PUBLIC SURVEYS
VISTA VARIABLES IN THE VIA LACTEA

VVV



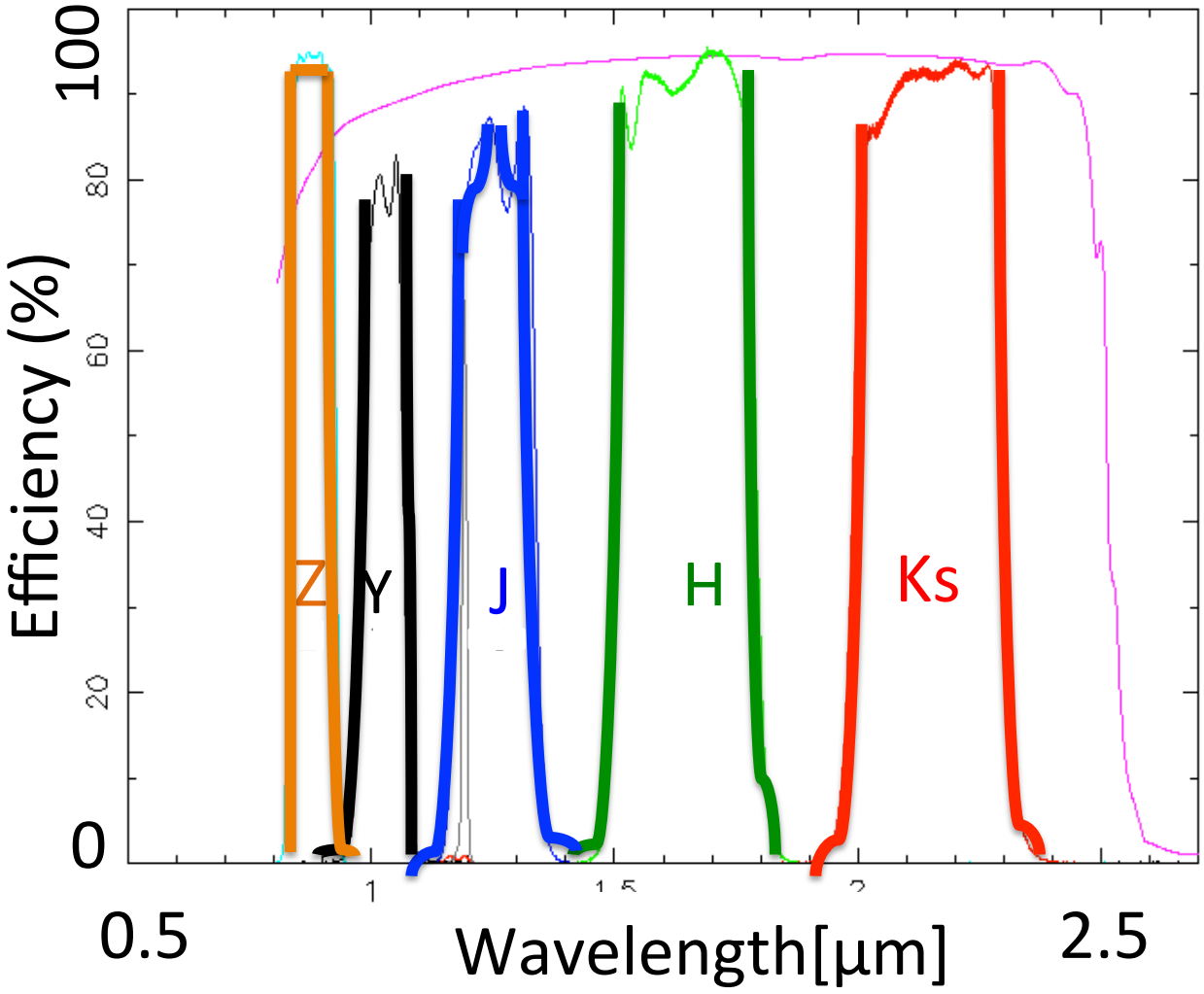
560 sq.deg.

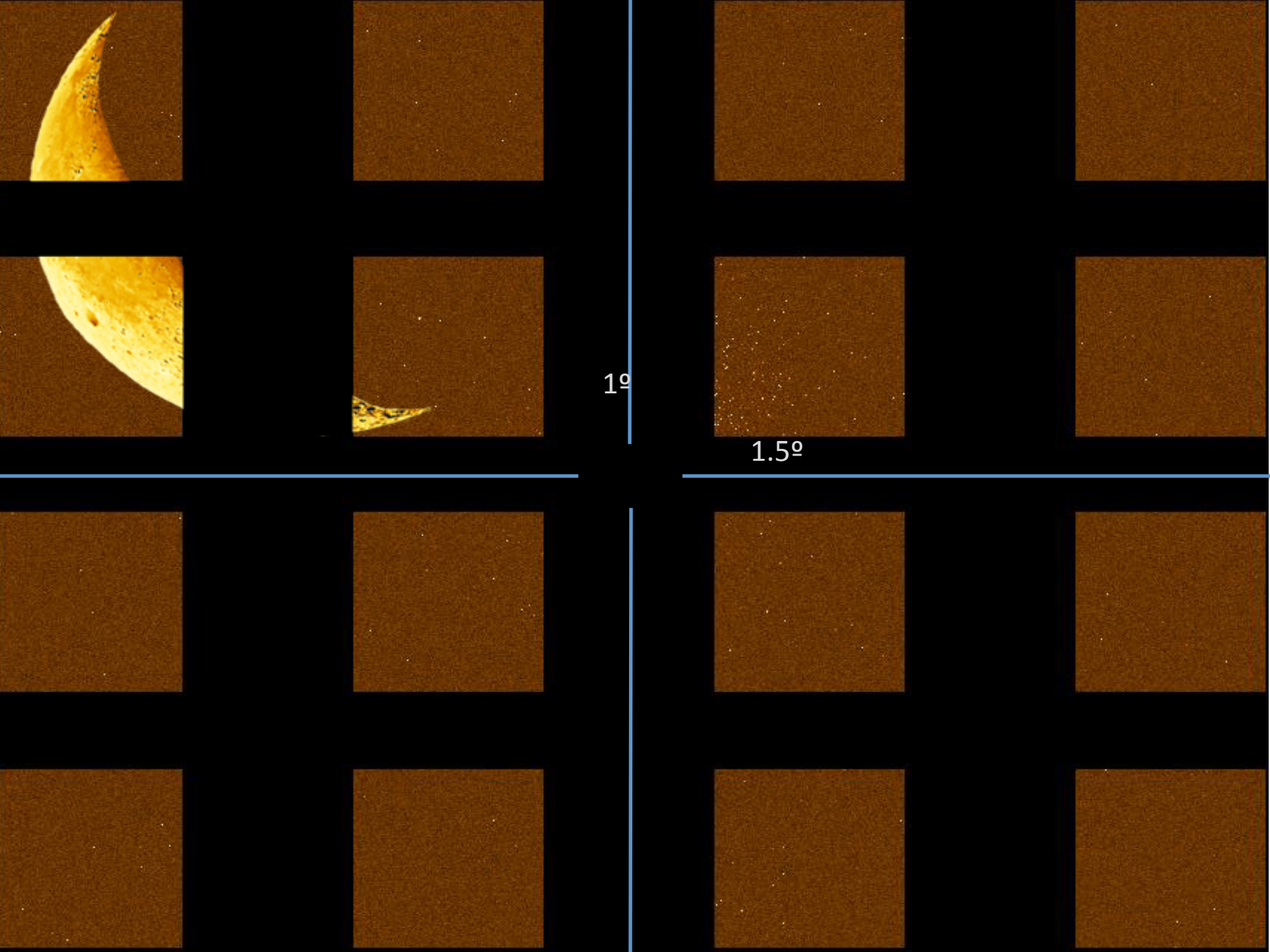
~10^9 stars

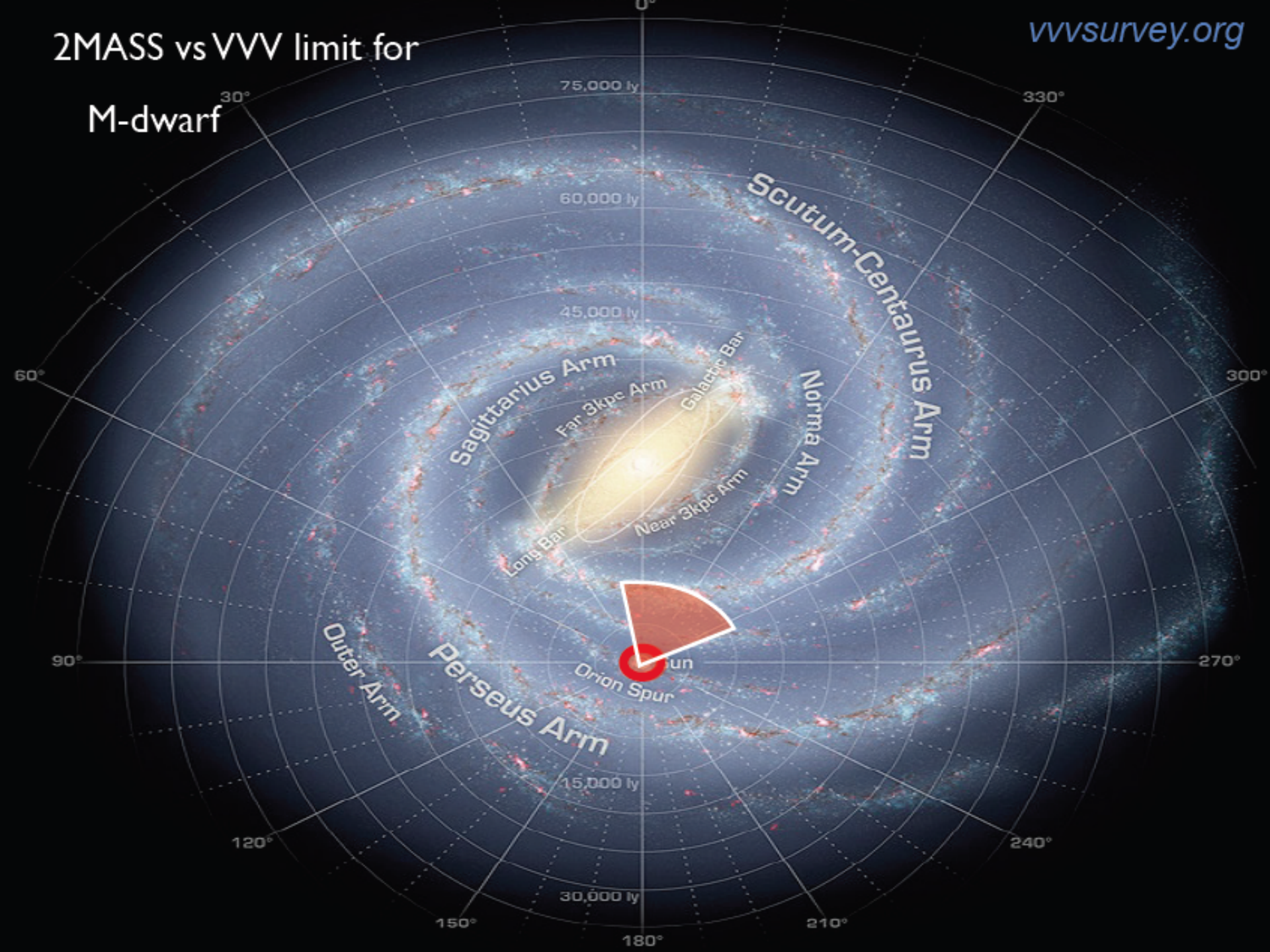
~100 epochs

~10^6 variables

VISTA Filter system




1º
1.5º


2MASS vs VVV limit for
M-dwarf
vvvsurvey.org
0°
30°
330°
60°
300°
90°
270°
120°
240°
150°
210°
180°
75,000 ly
60,000 ly
45,000 ly
30,000 ly
15,000 ly
Scutum-Centaurus Arm
Sagittarius Arm
Far 3kpc Arm
Galactic Bar
Norma Arm
Near 3kpc Arm
Long Bar
Outer Arm
Perseus Arm
Orion Spur
Sun

The VVV survey

A seven year Project

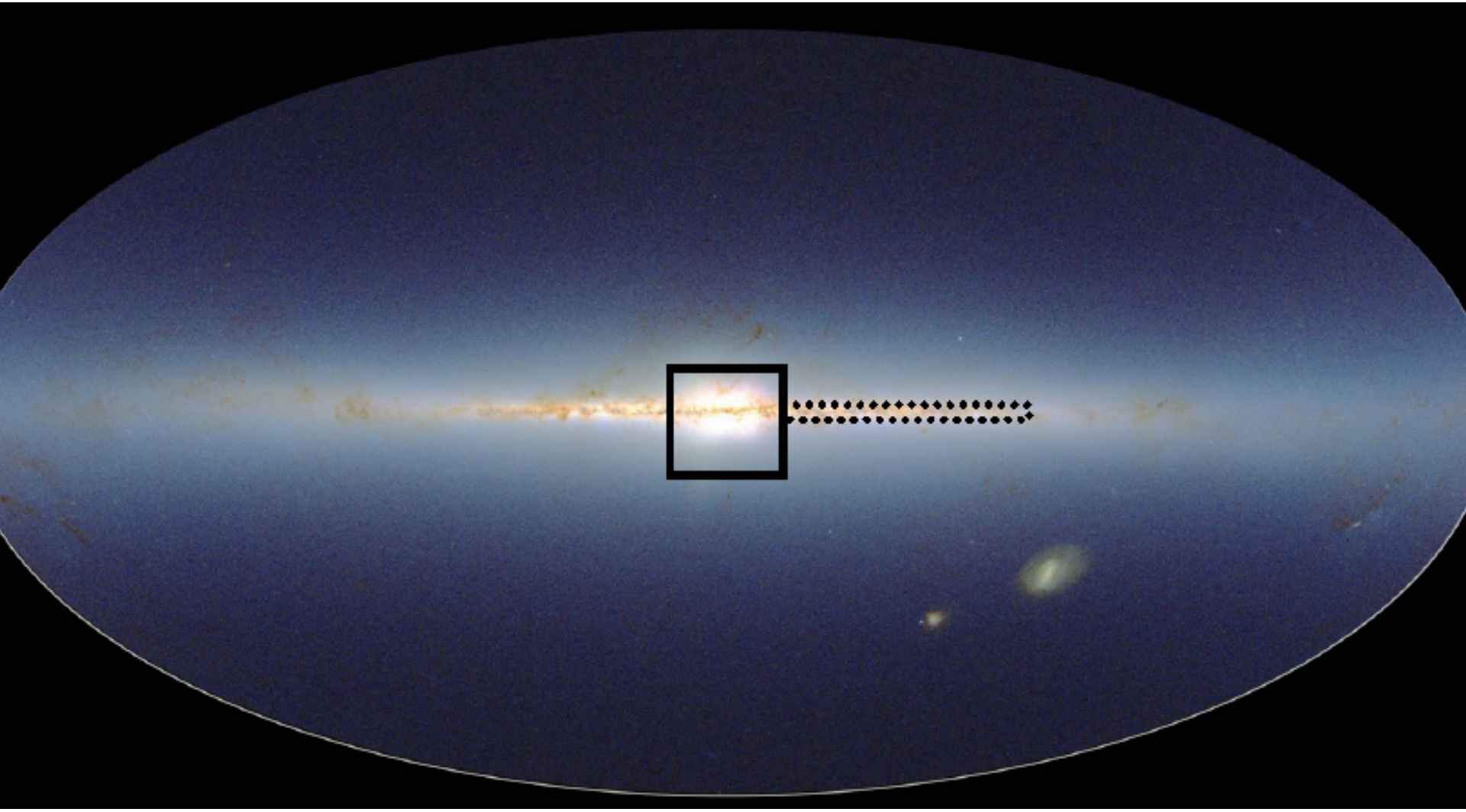
4m NIR VISTA telescope

Coverage ~560 sq. Degrees

High spatial resolution

~ 100 epochs in Ks band

Region where we are looking for proper motions



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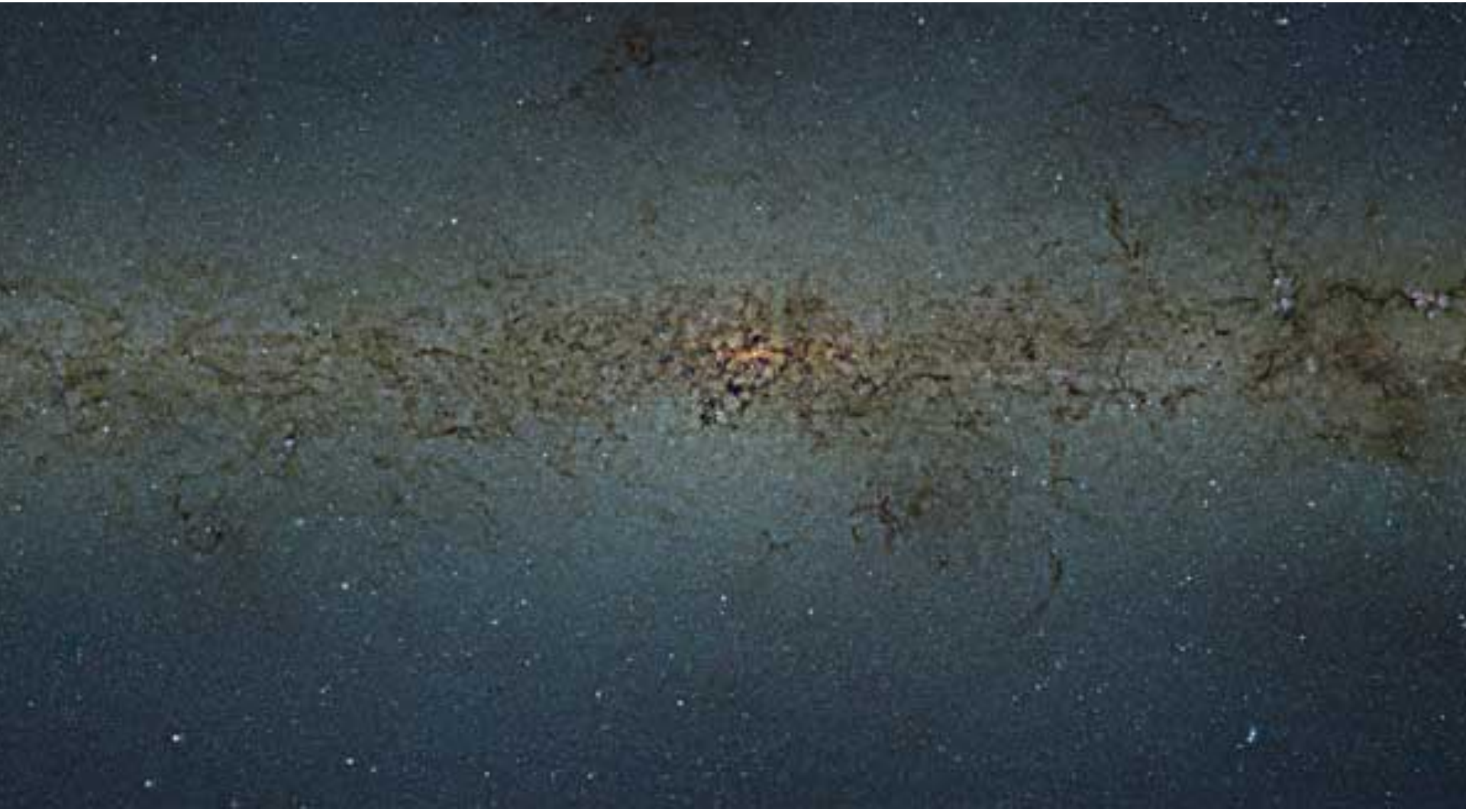
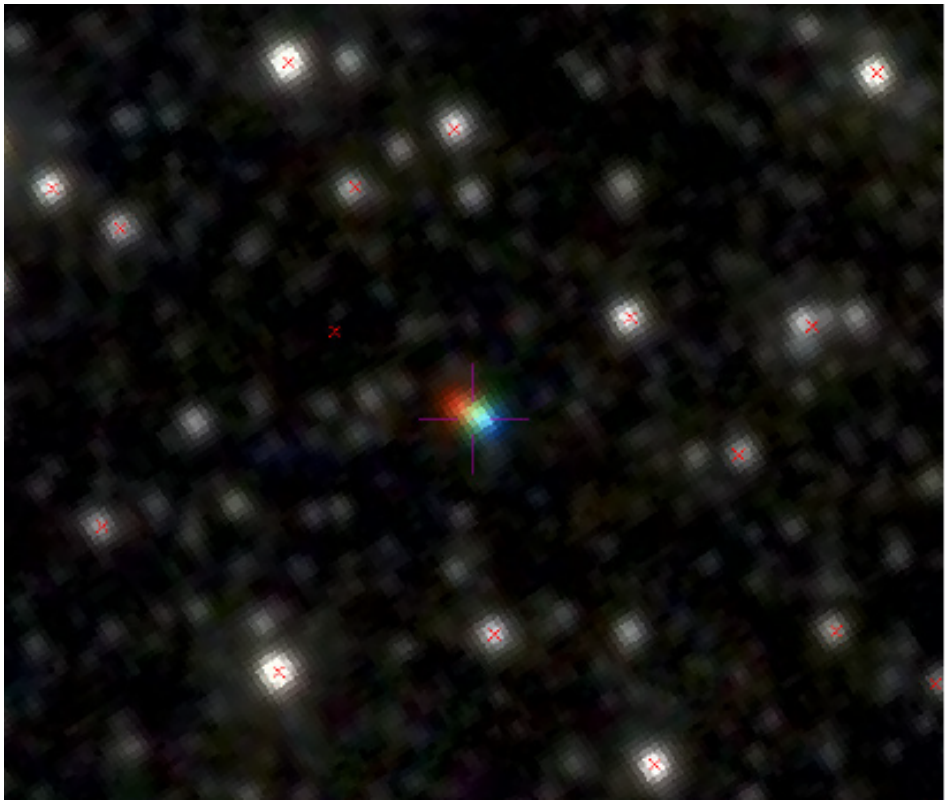


Searching for those nearby stars

Manually



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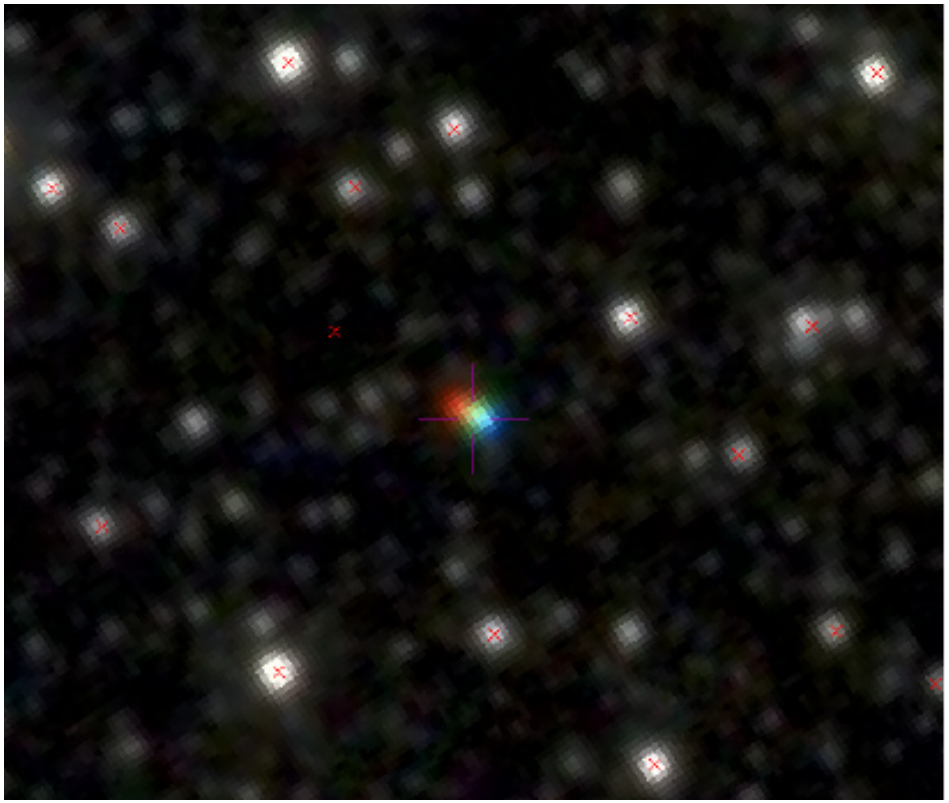
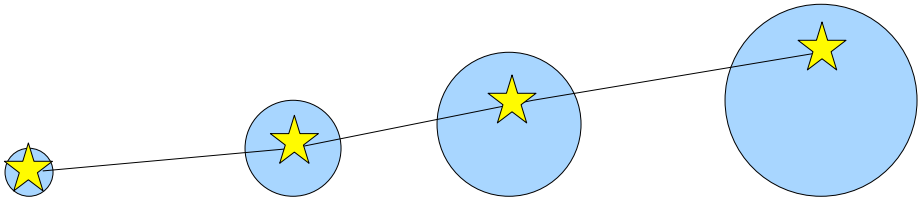


Automatically

Comparing several catalogs of stars



Searching for those nearby stars

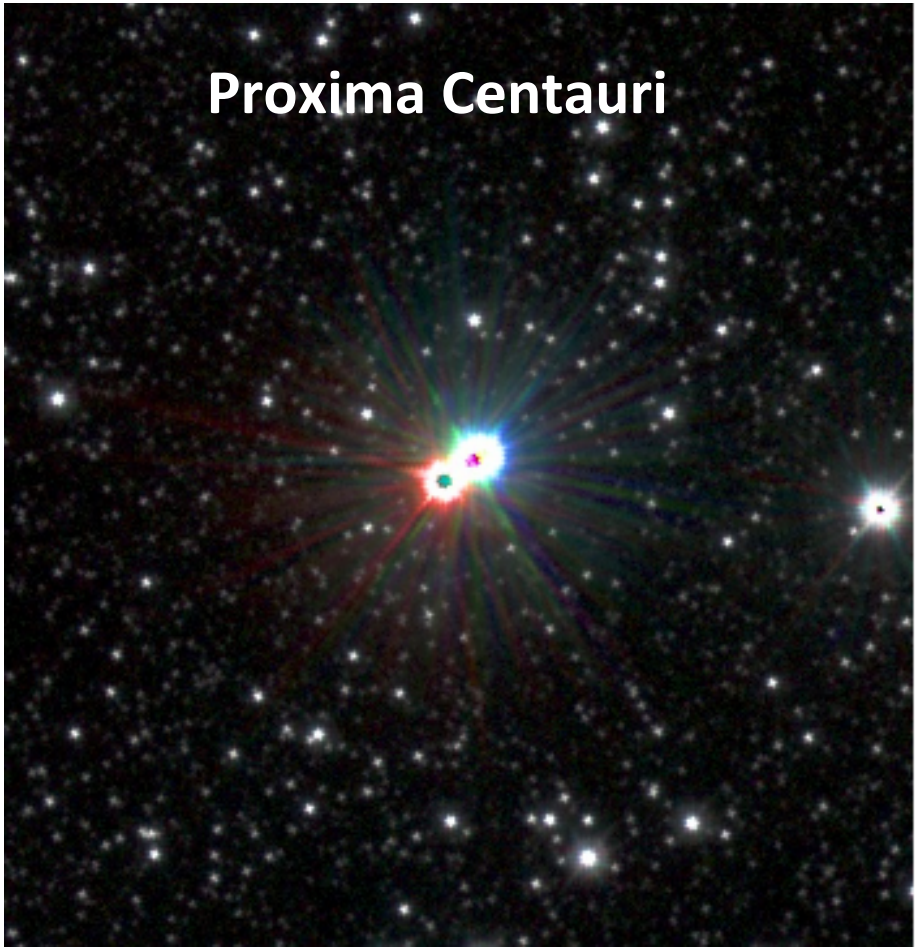
Manually

Pros:

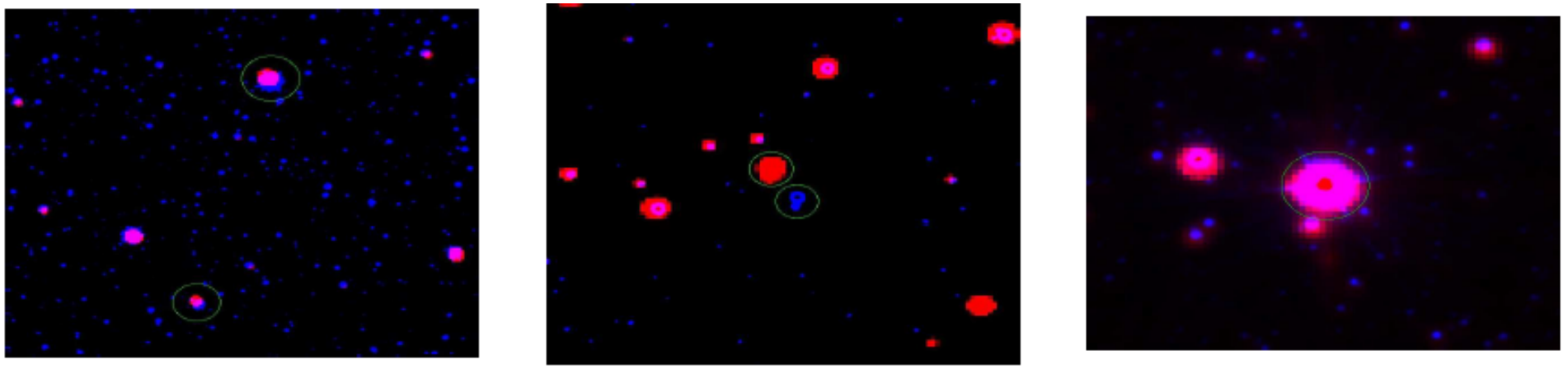
- Certainty

- Brighter objects

- Hard to miss
  the fastest objects.



New companions to nearby HPM stars



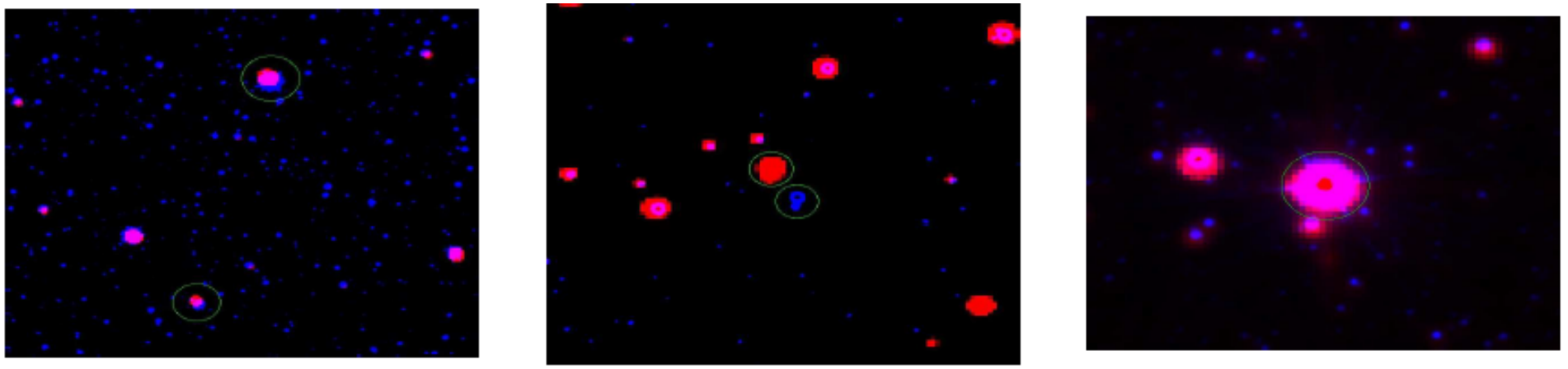
Red 2MASS, Blue VVV (10 years baseline)

7 new companions to stars with PM>200mas/yr

(total sample in VVV area 167)

Ivanov et al 2013 A&A

New companions to nearby HPM stars



Red 2MASS, Blue VVV (10 years baseline)

7 new companions to stars with PM>200mas/yr

(total sample in VVV area 167)

4% incompleteness of an incomplete list!

Ivanov et al 2013 A&A

Searching for those nearby stars

Manually

Pros:

- Certainty
- Brighter objects
- Hard to miss the fastest objects.

Automatically

Pros:

- Same process for all images
- Detect fainter objects
- Wide range of velocities
- Faster (once software is "up and running")

Pursuing the “best” method to detect proper motions

Semi-automatic procedure:

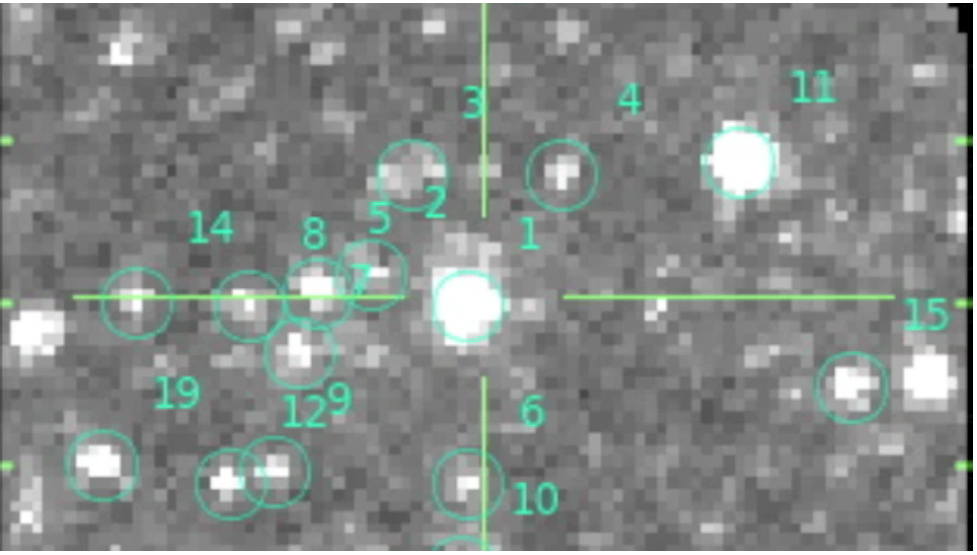
Choose 4 epochs “evenly” separated.

X-match and select high PM candidates

Constrain and clean some false positives.

Visual inspection of remaining candidates

More cool neighbors.

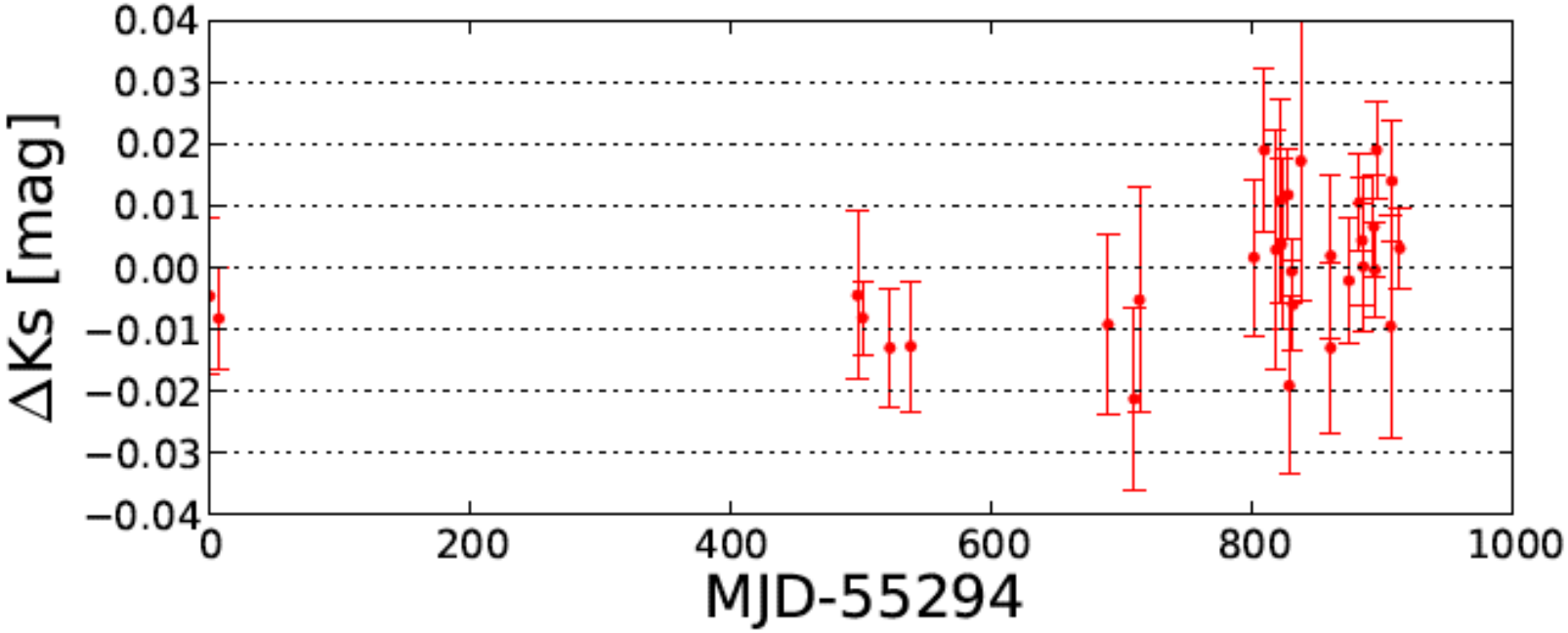


A nearby unusually blue brown dwarf (BD) towards the galactic center region

Beamin et al 2013 A&A letter

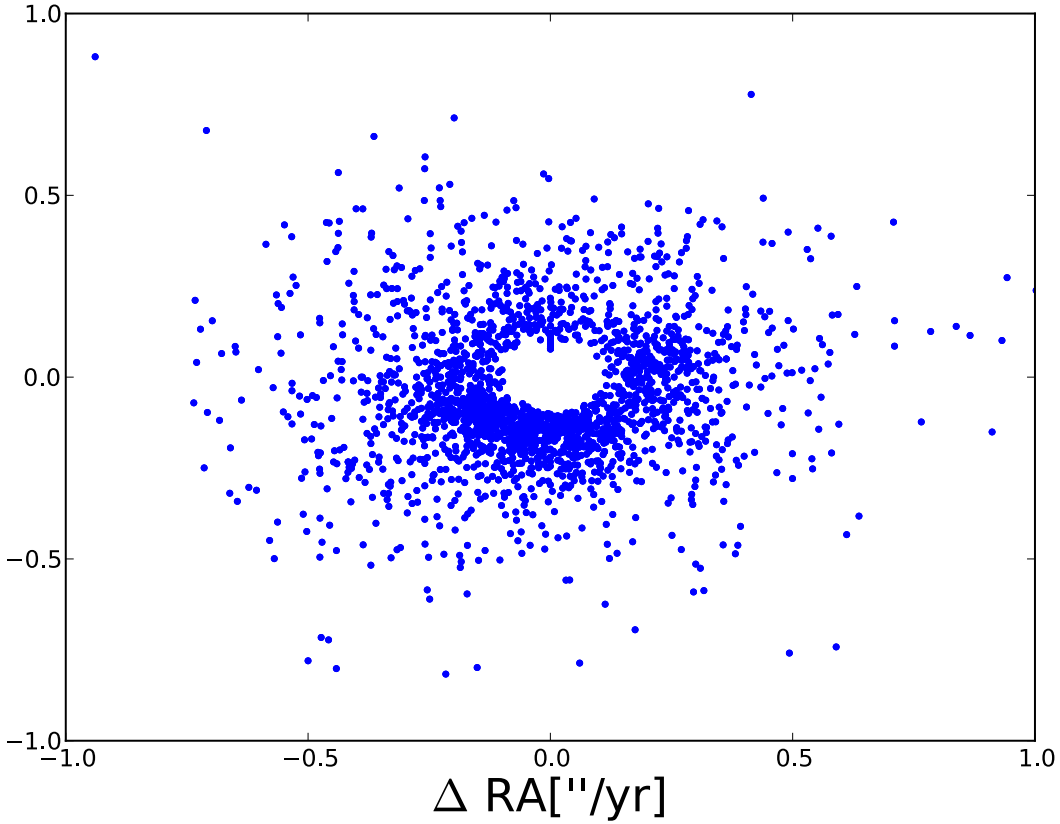
Some “free” extra science with VVV

Signs of variability
on this brown dwarf?



More exciting discoveries coming

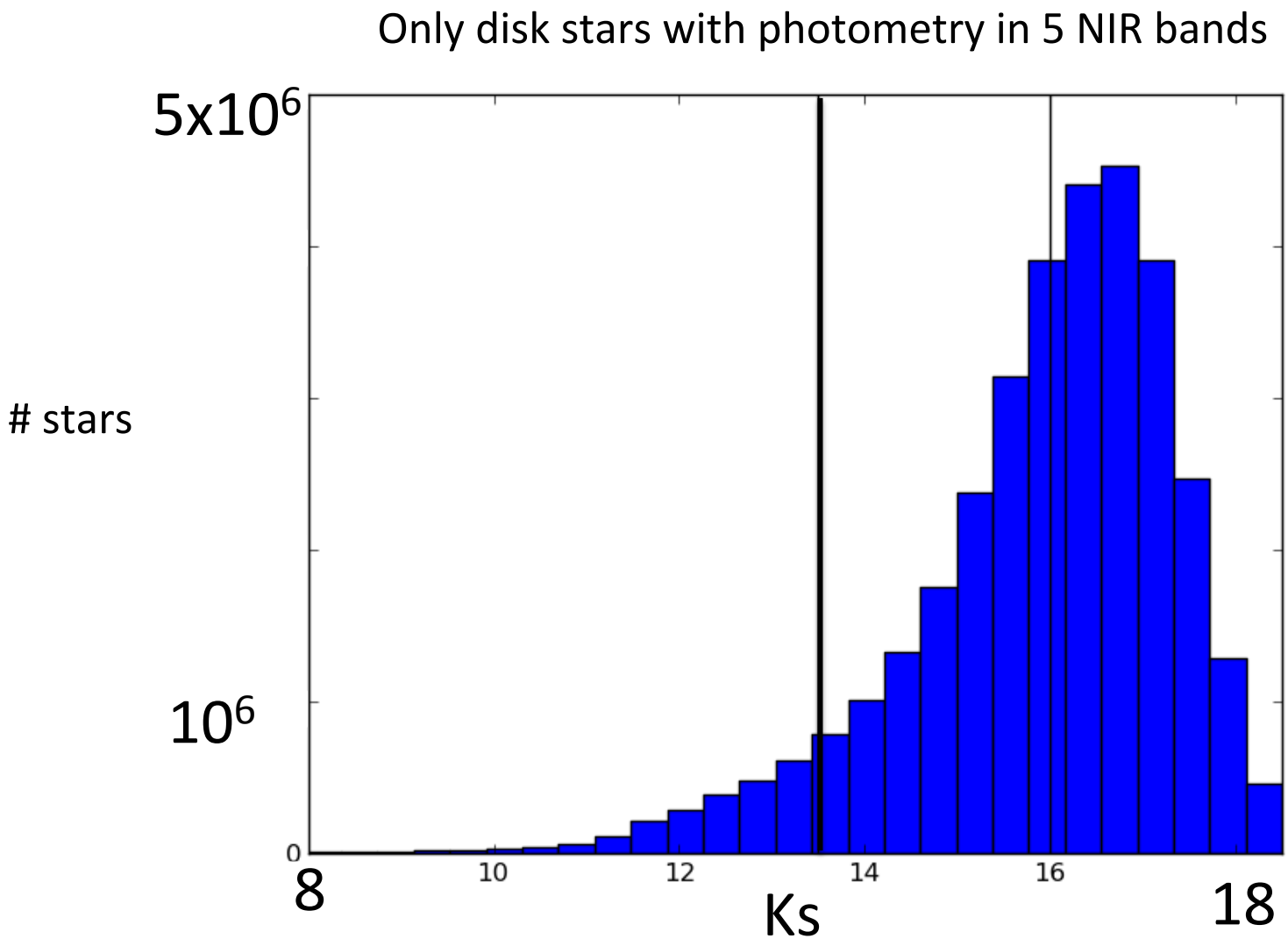
A new catalog with ~3000 high proper motion objects



Studying only a tiny fraction of the stars in VVV

Kurtev et al in preparation

Lots of new discoveries to come



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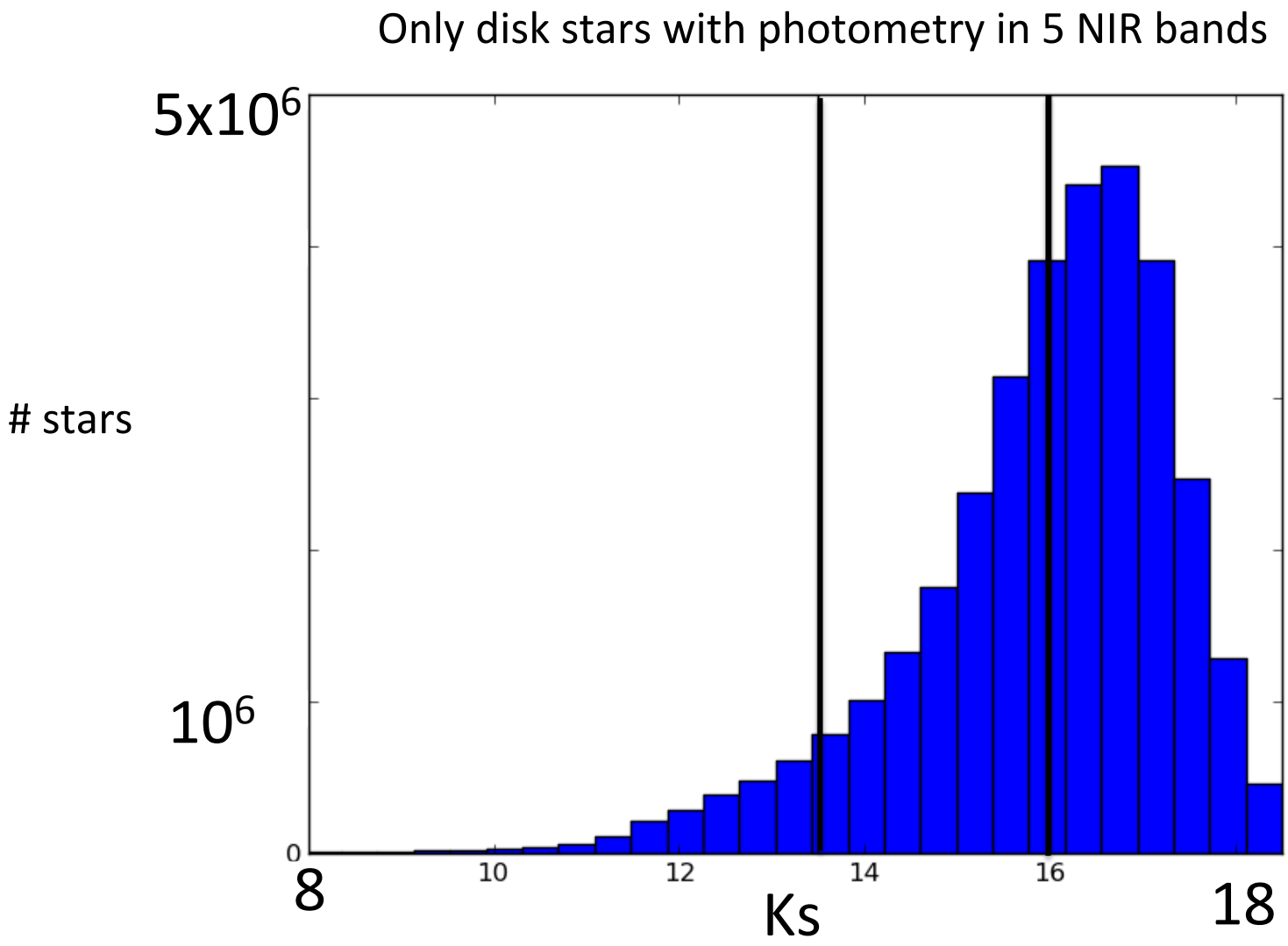
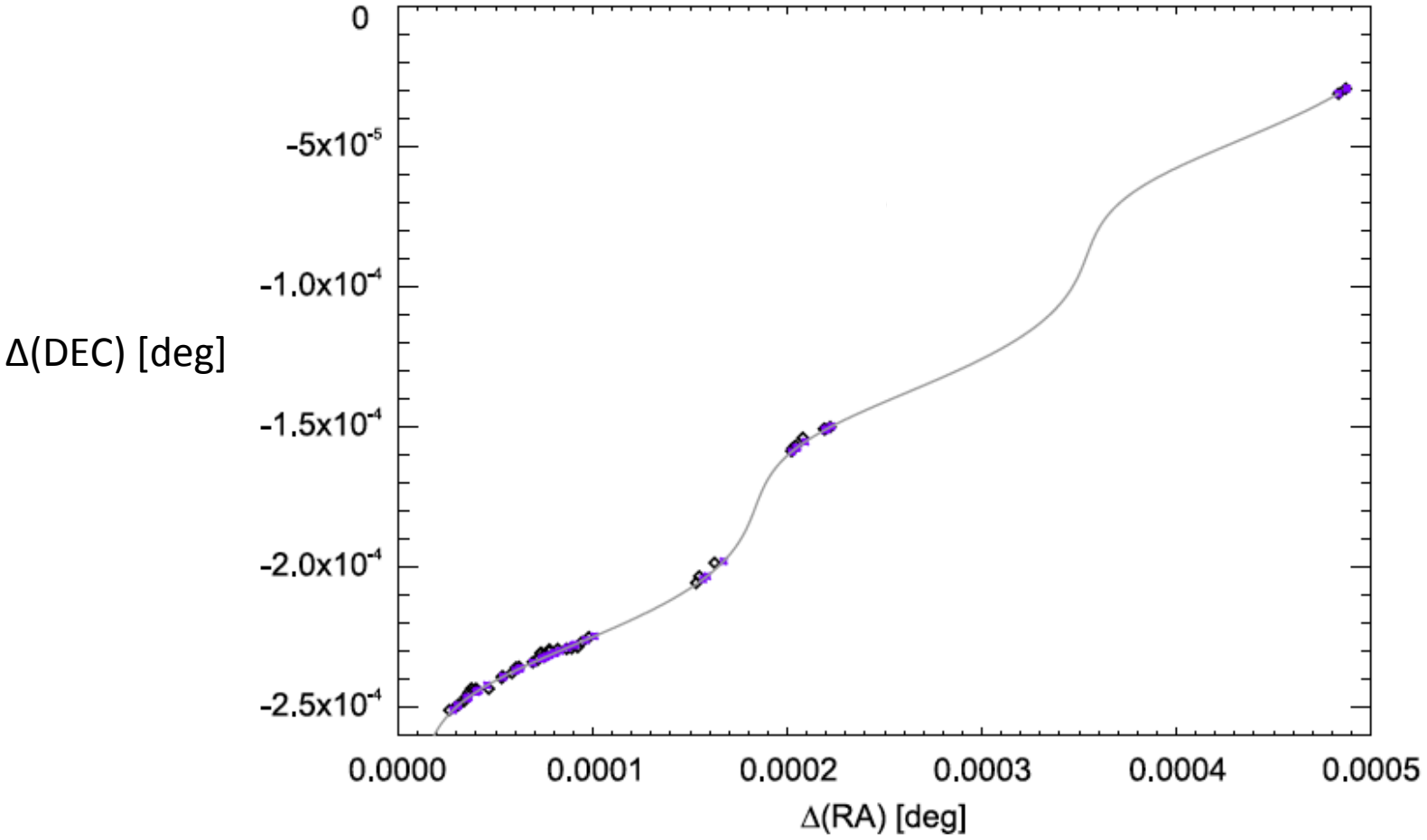


Parallax measurements

Parallax and proper motion of the new Brown dwarf at 17.5 pc



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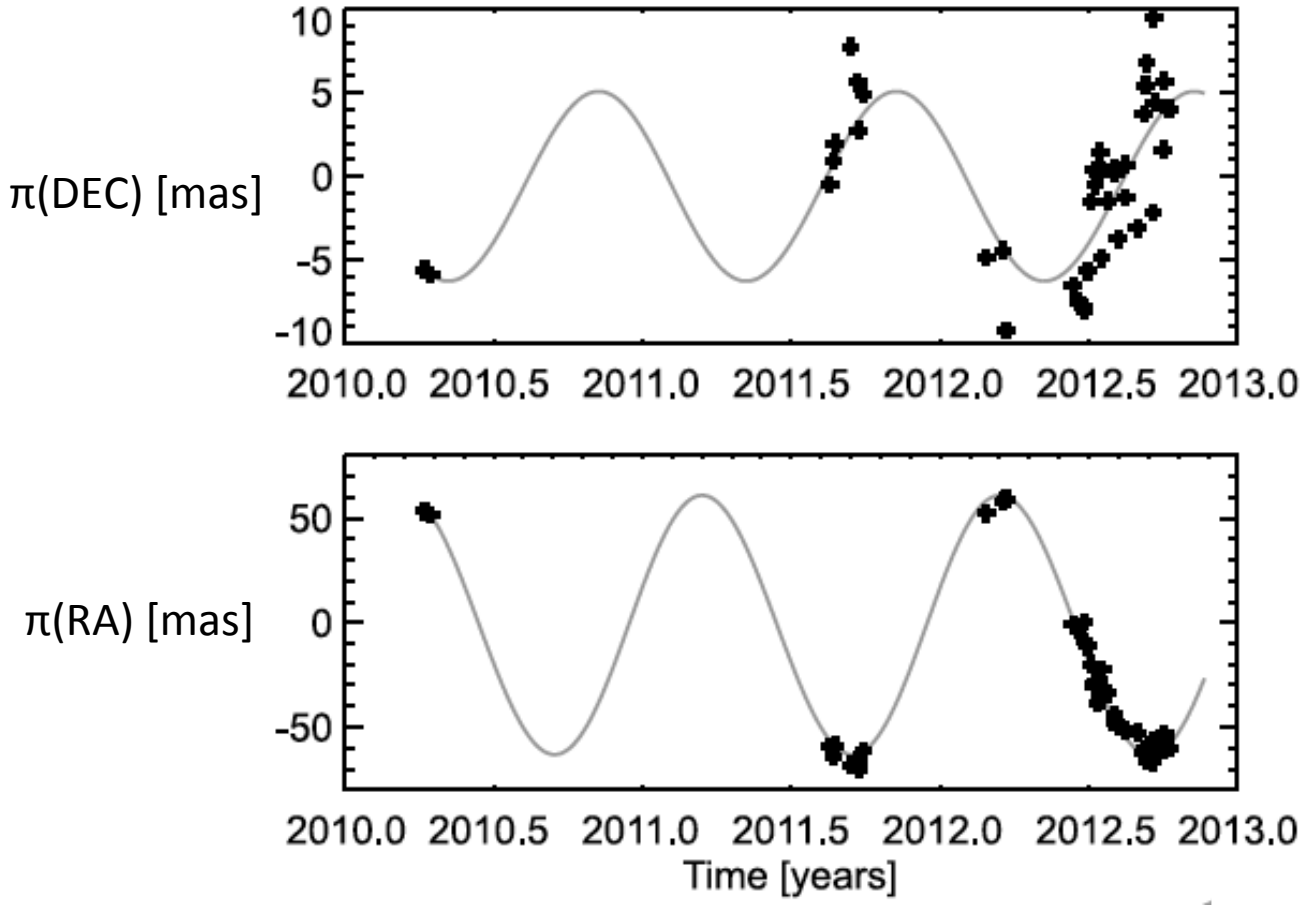

Next Goals: Going Fainter

Do PSF photometry on each VVV field

(16 x 6 x 350 x 50-100) = 1.6 - 3.5 Million images

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(~10^9 objects, ~100 epochs)

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(16 x 6 x 350 x 50-100) = 1.6 - 3.5 Million images

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Clean the final PM-Parallax catalog, and look for the UCD

Characterization of "red" high proper motion objects

VVV ✓

VVV + GLIMPSE ✓✓✓

Characterization of "red" high proper motion objects

Analyzing HPM objects with red colors and GLIMPSE "clean" detections

Characterization of "red" high proper motion objects

Analyzing HPM objects with red colors and GLIMPSE "clean" detections

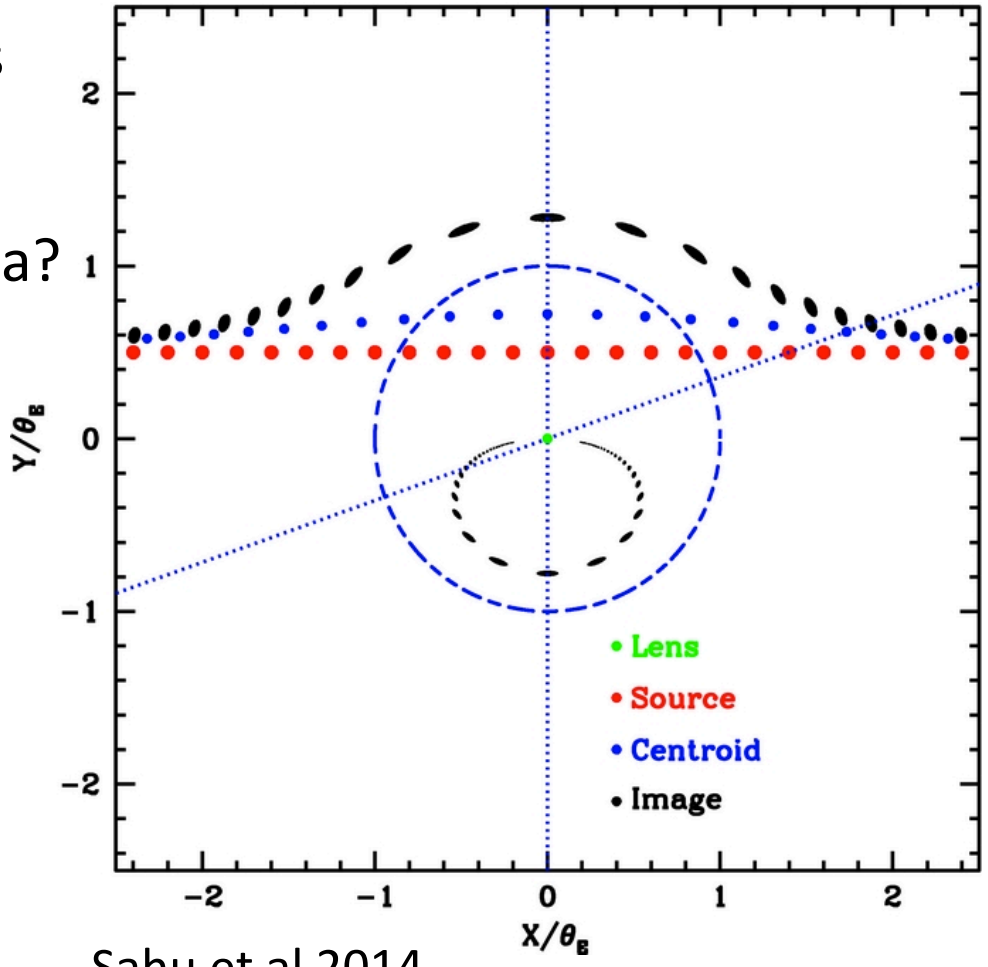
15+ intersting red objects (mid M dwarfs)

with companions? Disks? Young? …

+ few more L type brown dwarf candidates

Future follow up with Gaia

New discoveries in crowded areas are very interesting targets for astrometric microlensing with Gaia?



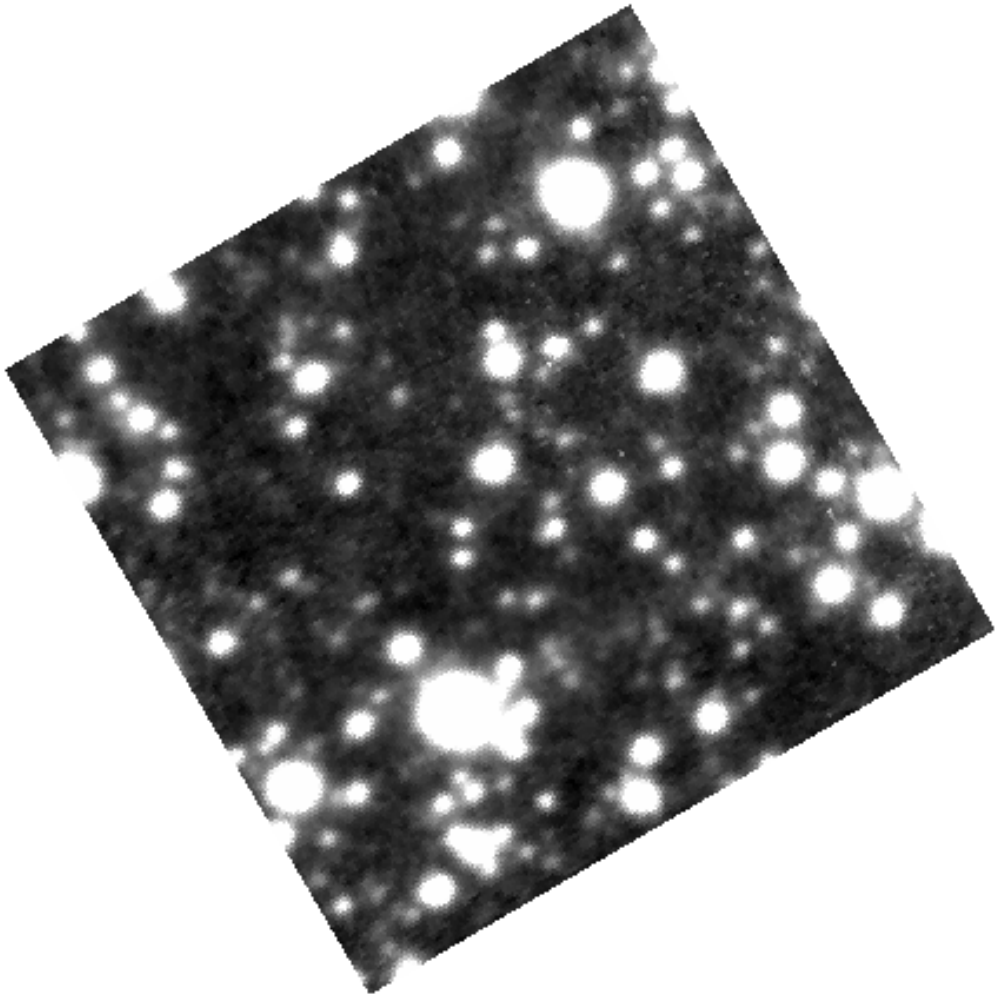
Sahu et al 2014

Towards a kinematic understanding of our Galaxy

We plan to build a proper motion catalog based in NIR data alone.

…because the bulge is… complicated

z



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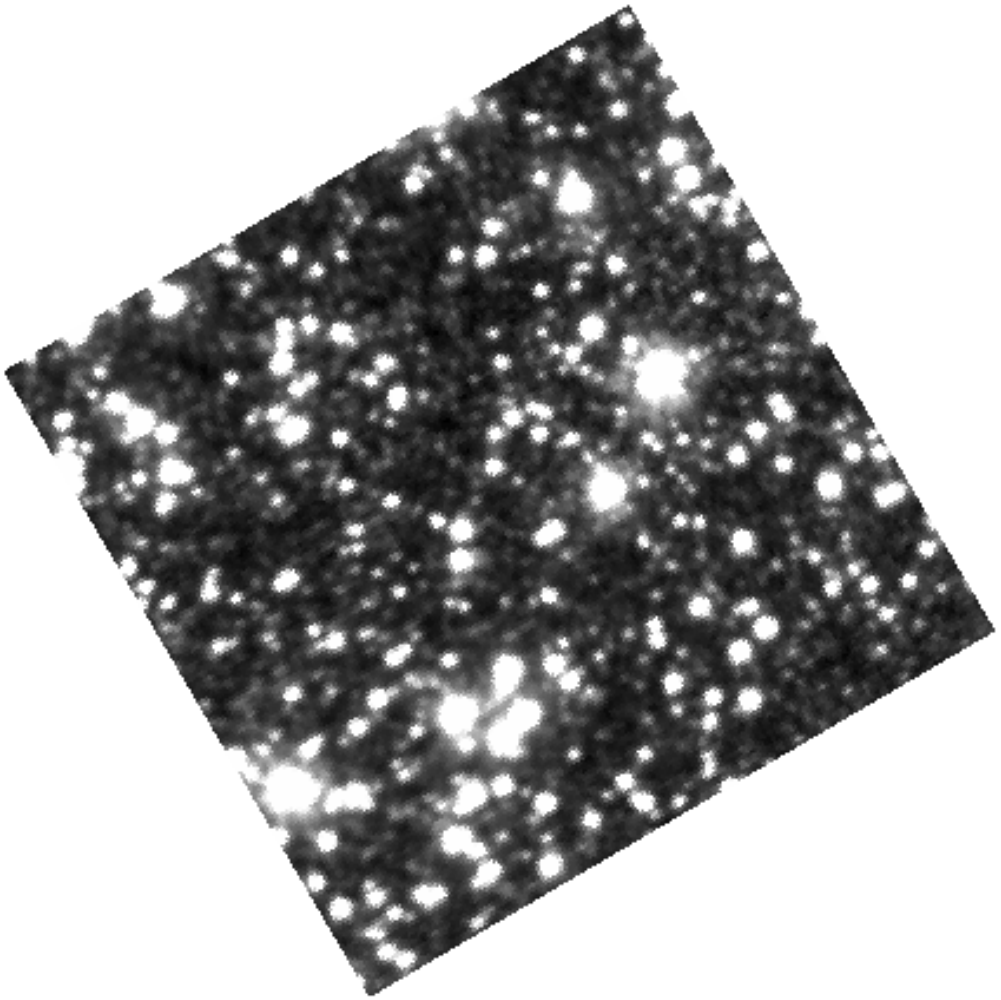
Ks



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Determine the shape and kinematics of the Galactic bulge

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Distinguish different stellar populations, and clusters of stars, across the bulge and disk

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WE NEED GAIA FOR AN ABSOLUTE REFERENCE FRAME

www.eso.org

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Juan Carlos Beamín
jcbeamin@astro.puc.cl
And
Dante Minniti, Valentin Ivanov, Radostin Kurtev,
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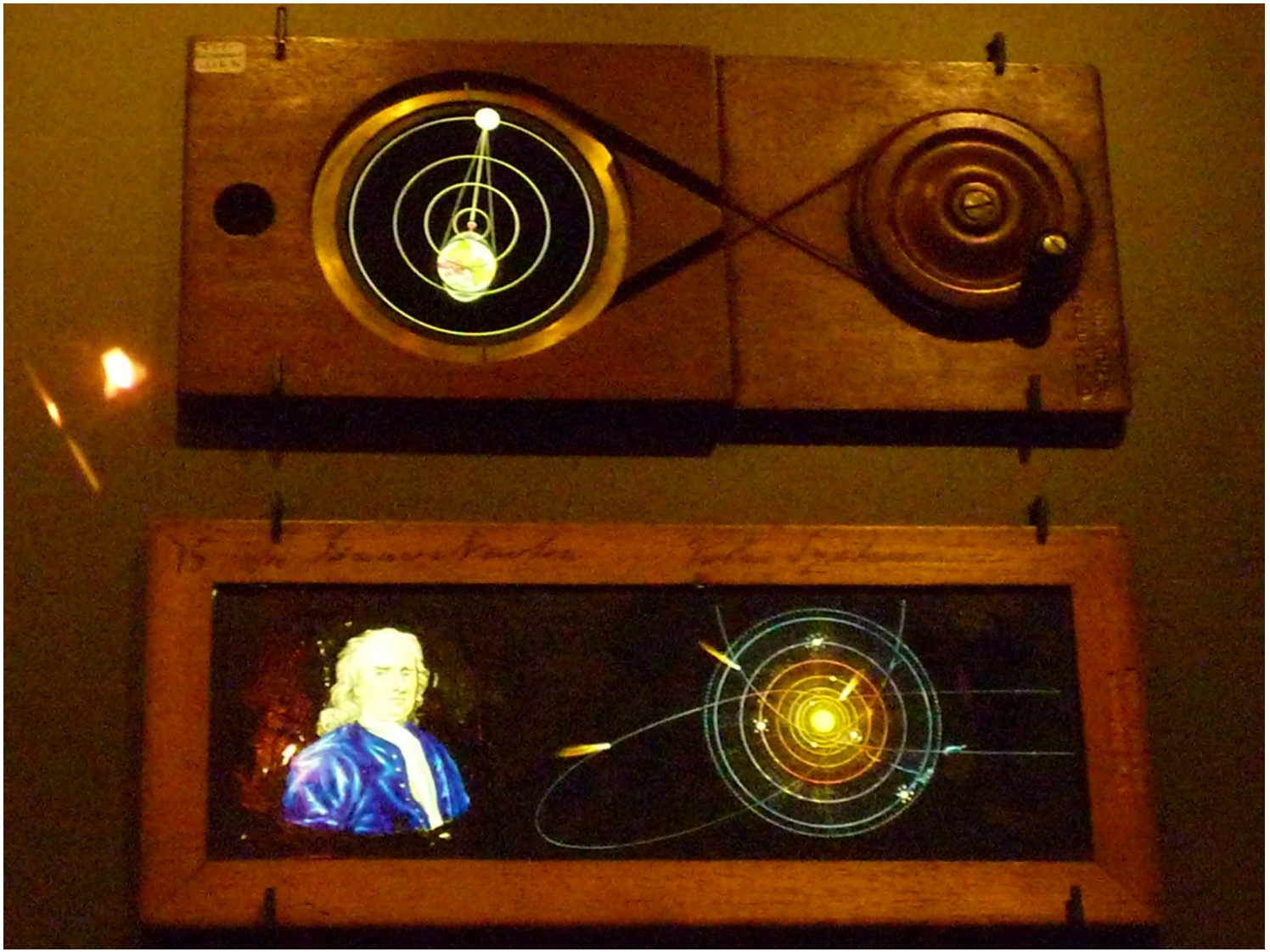
Roberto Saito, Philip Lucas, Jura Borissova.
and VVV Science Team

A WORD ABOUT PUBLIC OUTREACH



@CINEMA MUSEUM, TORINO

Diagram for explaining the Earth-Moon system centre of gravity and tides

Hand-painted, animated pulley slide
William & Samuel Jones, London, ca. 1830

Don’t Forget people and
new technologies to teach them
“old” and cool new science

and maybe stop hearing
if 2036 is the end of the world…