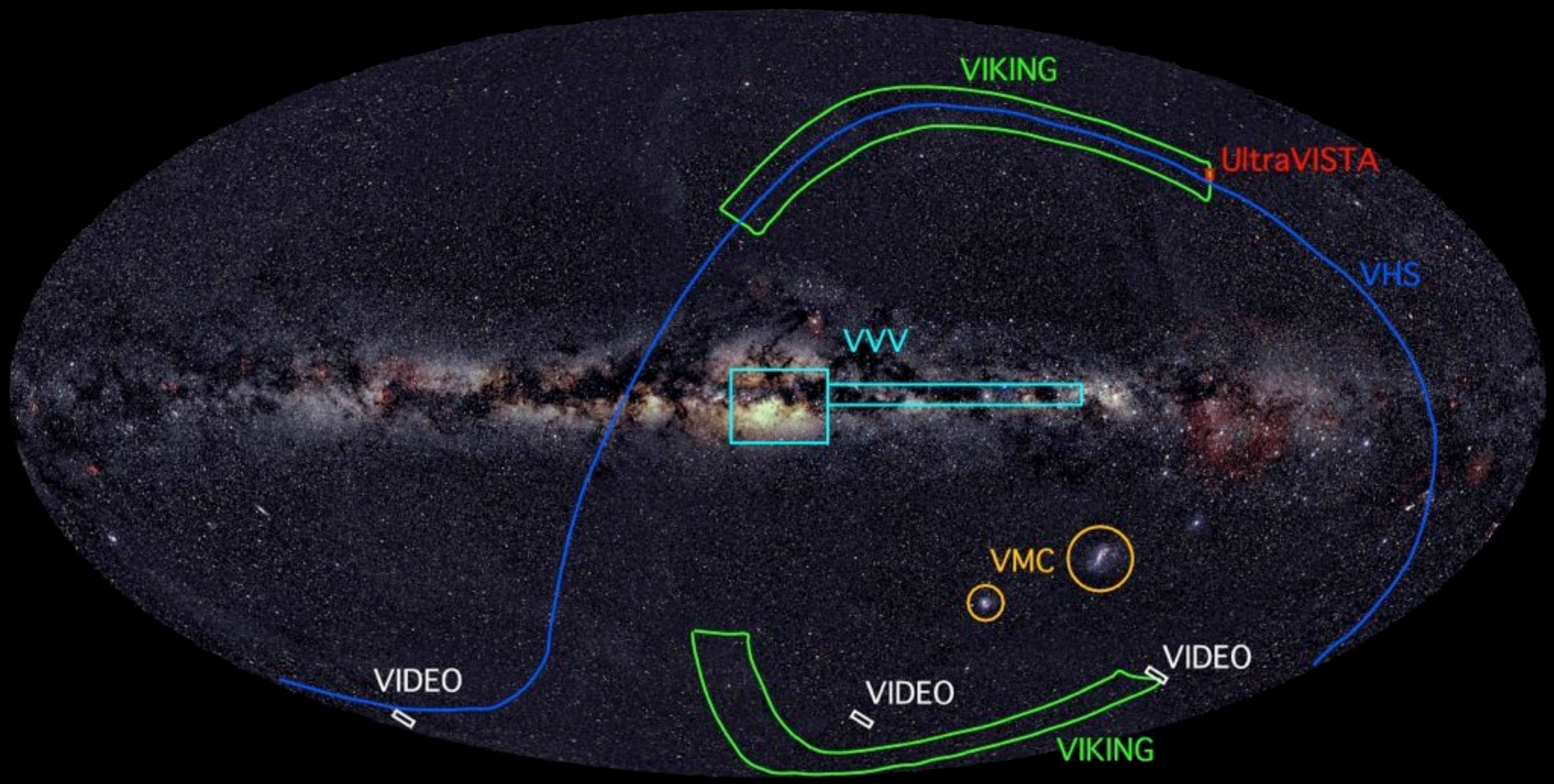
THE VVV SURVEY

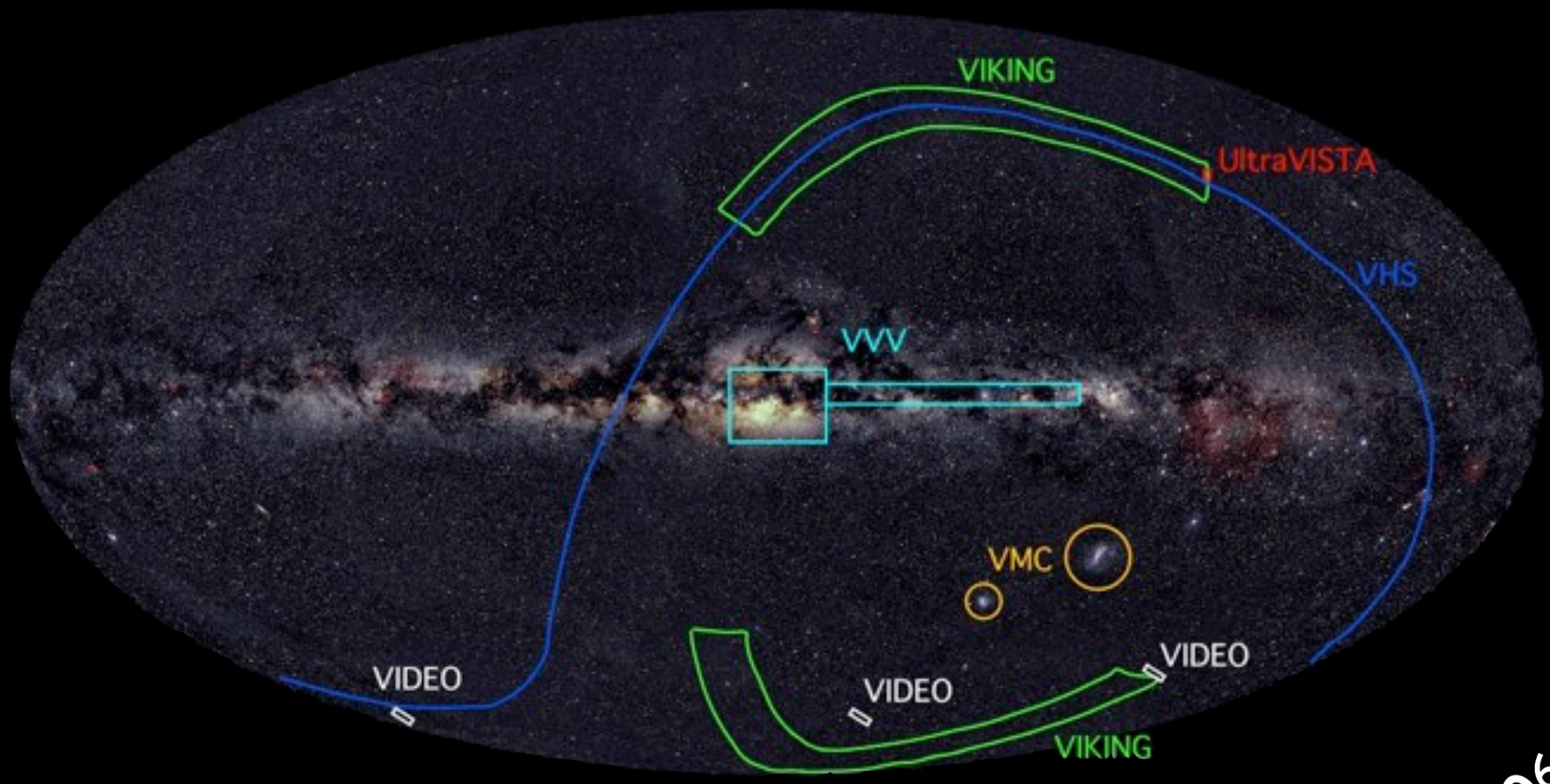
SOL

VISTA PUBLIC SURVEYS



VISTA PUBLIC SURVEYS

VVV



520 sq.deg.

~10^9 stars

~100 epochs

~10^6 variables

VVV Goal

How did the
Milky Way form

Stairway to heaven (Led Zeppelin)
“Ooh, it makes me wonder
Ooh, it really makes me wonder”

VVV Survey Scientific Goals

What is the 3-D structure of our Galaxy?

- To find bulge RR Lyrae
- To search for new star clusters
- To map star forming regions along the plane
- To measure proper motions
- To find eclipsing binaries and planetary transits
- To search for microlensing events

(Also high energy sources, TNOs, SN light echoes, background QSOs...)

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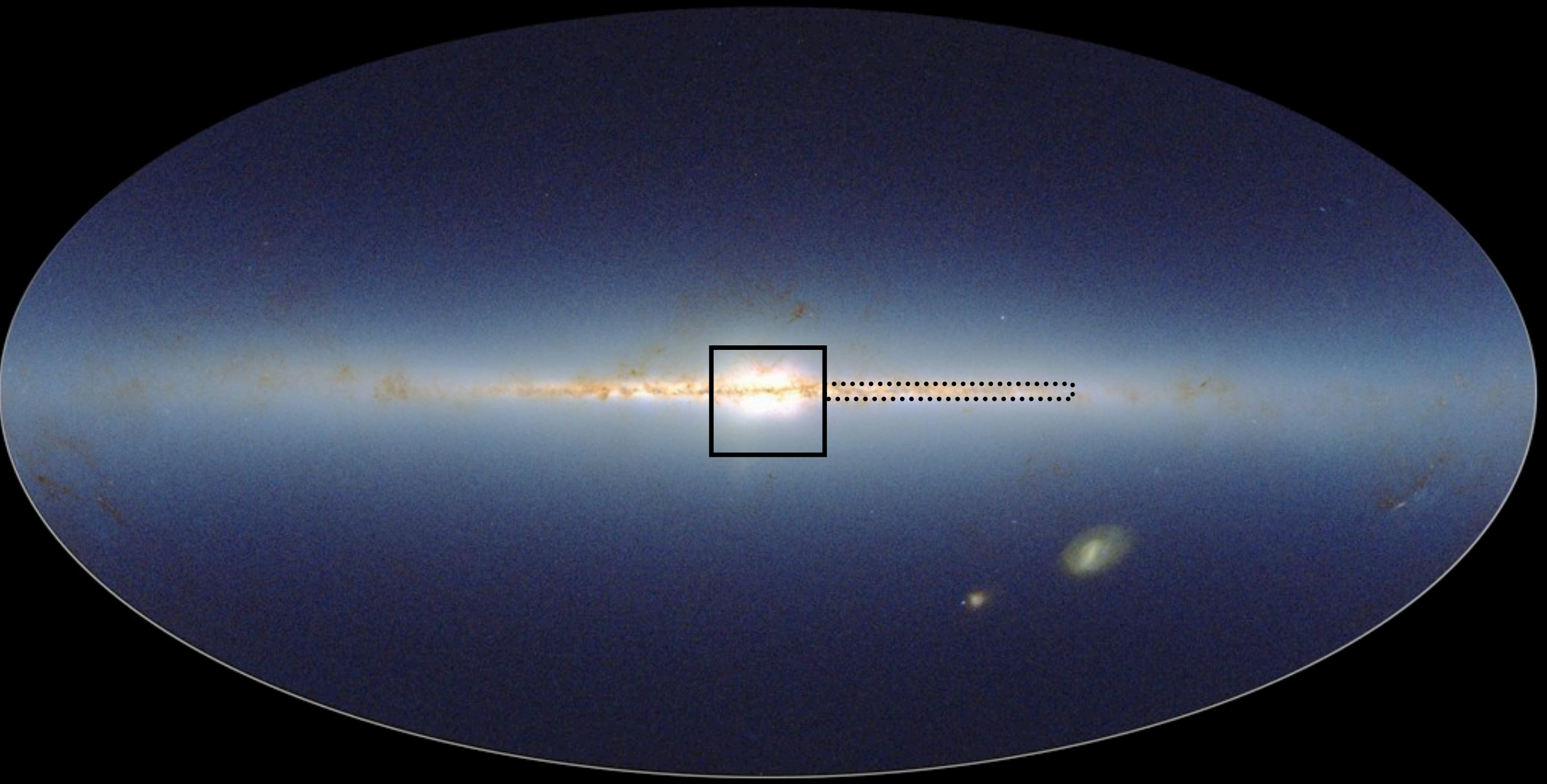
- **2-D MW maps are not sufficient, need 3-D**
- **a single snapshot is not sufficient, need time coverage**



2MASS JHK

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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

vvvsurvey.org

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

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

~30% of the MW

2MASS JHK

VISTA TELESCOPE AT ESO PARANAL

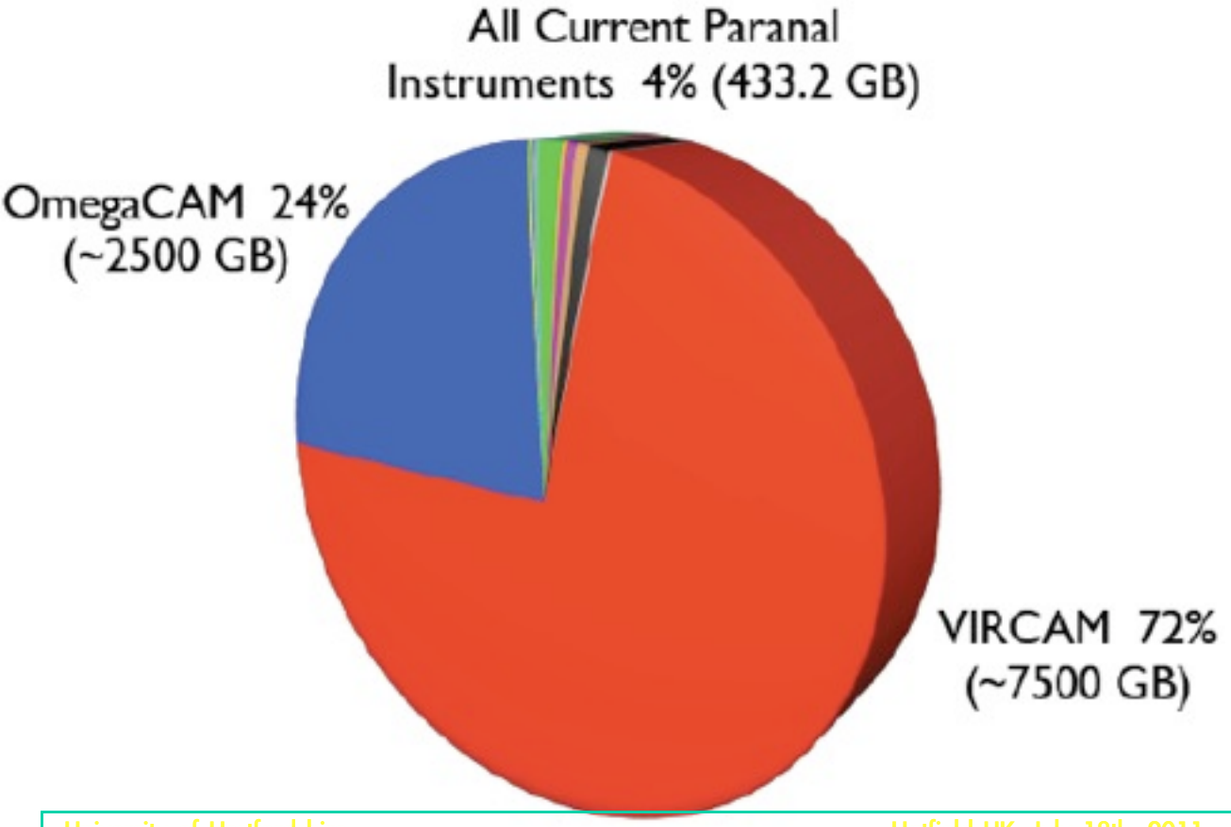
4.1 m telescope
f3.25 focus
1.5 sqdeg fov

La cúpula
(Soda Stereo)
“Yo conozco ese lugar donde revientan las estrellas.
Yo conozco la escalera en espiral hacia la cúpula.”

Expected monthly dataflow: raw calibrations and science frames

from Magda Arnaboldi (EDT)

FORS1 FORS2 GIRAFFE ISAAC
MIDI NACO SINFONI UVES
VIMOS VISIR VIRCAM OmegaCAM



Jim Emerson

VISTA Near-IR Wide Field Camera

vvvsurvey.org

Brain damage (Pink Floyd)
“And if your head explodes with dark forebodings too
I'll see you on the dark side of the moon”

VISTA Near-IR Wide Field Camera

vvvsurvey.org

16x 2048x 2048 VIRGO IR detectors

large numbers of hot pixels, dead zones in detector 1

sensitivity: 0.84 to 2.5 microns

filters: Z, Y, J, H, Ks

pixel scale: 0.34¨

active optics

“tile” field of view: 1.636 sqdeg (6 pointings)

best image quality: 0.6¨ (incl. seeing, optics, sampling)

image distortion: <15% of PSF at field corners

Brain damage (Pink Floyd)
“And if your head explodes with dark forebodings too
I'll see you on the dark side of the moon”

VVV Color Tiles

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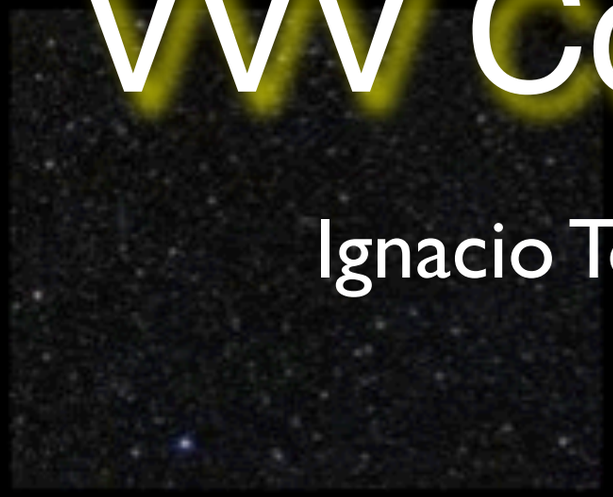
Ignacio Toledo

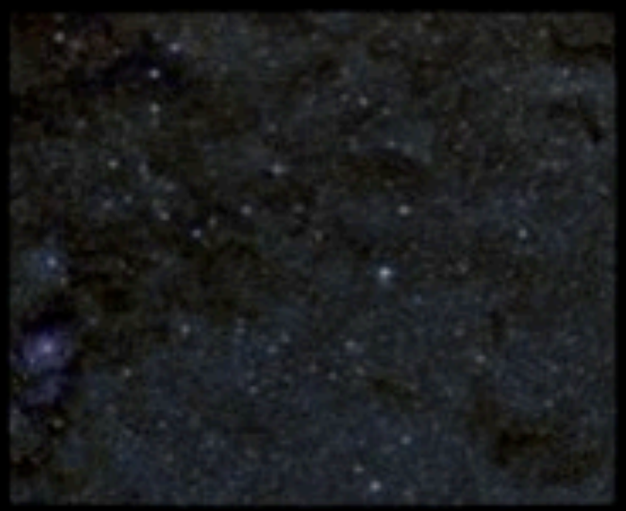


b271

b372

b322

b274

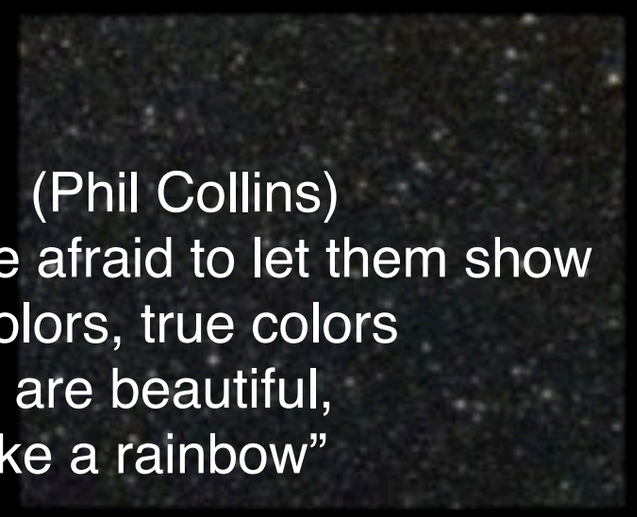


b323

SV

b349

d003



d014

True colors (Phil Collins)
“So don't be afraid to let them show
Your true colors, true colors
True colors are beautiful,
Beautiful, like a rainbow”

DEEPER AND HIGHER RESOLUTION

Main differences with 2MASS

2MASS covers the whole sky, VVV only 1.3% of it

VVV has higher resolution (0.34”/pix)

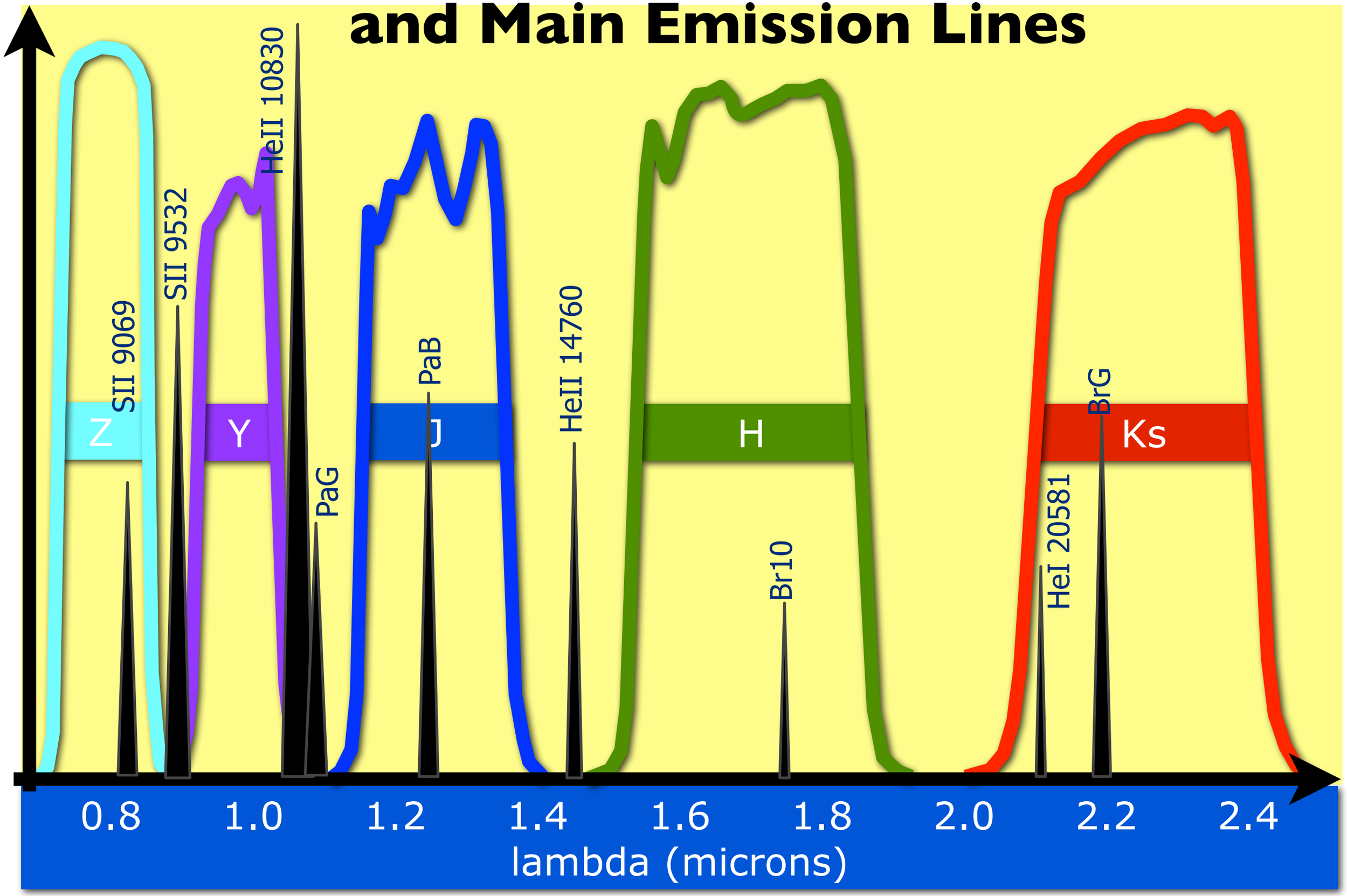
VVV is deeper (Ks<18)

VVV has 5 filters (ZYJHKs)

VVV is a multiepoch survey (~100 epochs)

All in all the VVV survey is 2x bigger than 2MASS

VISTA filter transmissions and Main Emission Lines



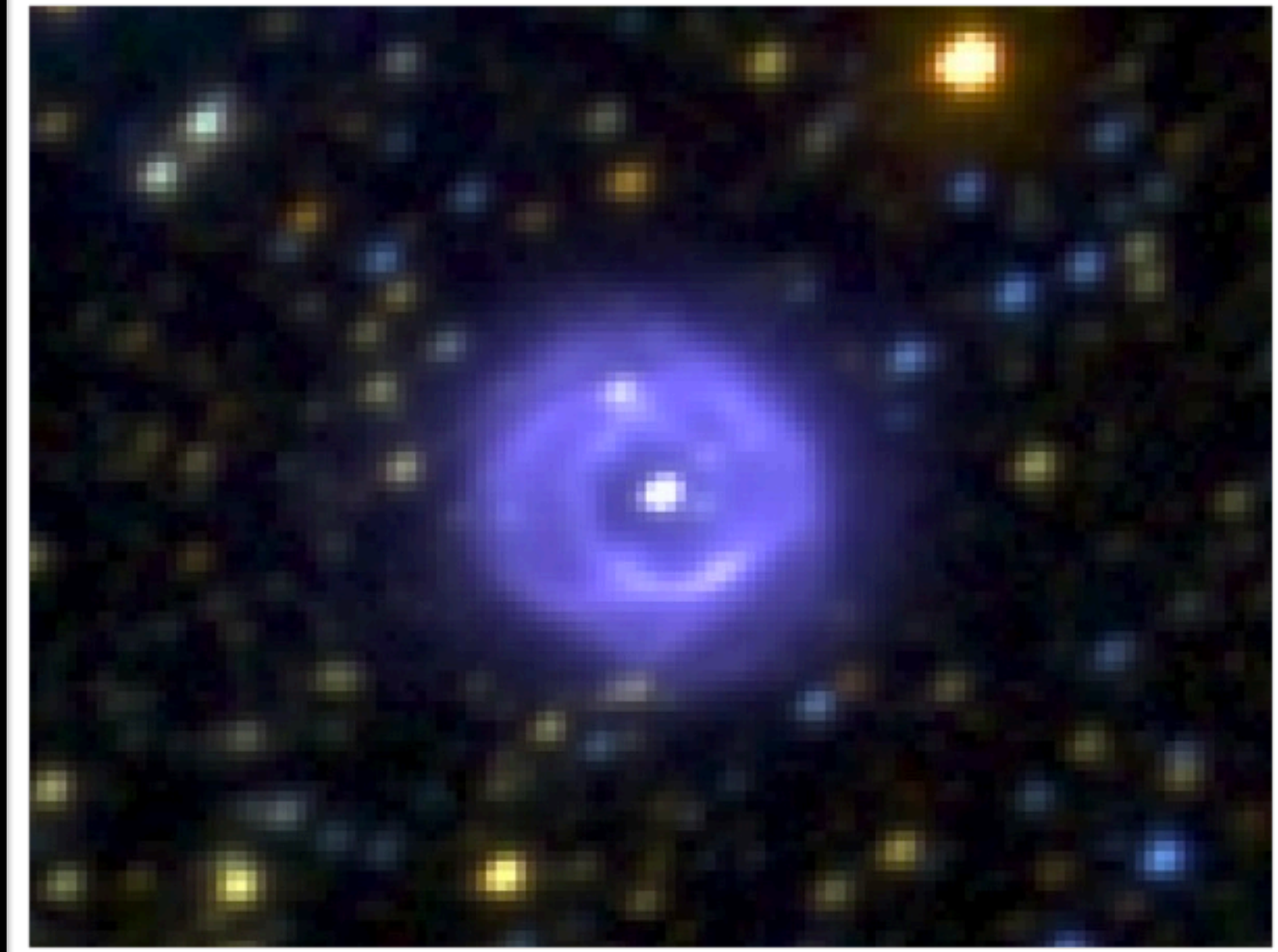
LAGOON NEBULA (CENTRAL REGION)

vs

When the Stars go blue (Bono/U2)
“Where do you go when you´re lonely?
I’ll follow you... When the stars go blue”

vvvsurvey.org

Planetary Nebulae



VVV field b328

VVV Phase 2

vvvsurvey.org

YR1: ~2500 OBs

- all 348 disk and disk tiles observed in 2010A:
  - multicolor ZYJHKs
  - Ks 5 epochs

YR2 ~ 5400 OBs

- multiepoch Ks band of bulge+disk ongoing 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. Credits: Maren Hempel, Roberto Saito et al.

VVV Phase 3

vvvsurvey.org

Phase 3 basically consists on handing the processed data (images and catalogues) to the ESO Archive.

Dear Dante,

this is to inform you that the data products from the ESO public surveys VVV with VISTA have now passed scientific validation and have been ingested into the ESO Scientific Archive Facility. Having now prepared the VVV release pages, ESO is getting ready to release the data to the community via dedicated Archive query interfaces.

The Phase 3 for this data release can be considered complete: ESO would like to thank you for your collaboration in carrying out this important part of the process which facilitates access to public survey data by the community at large.

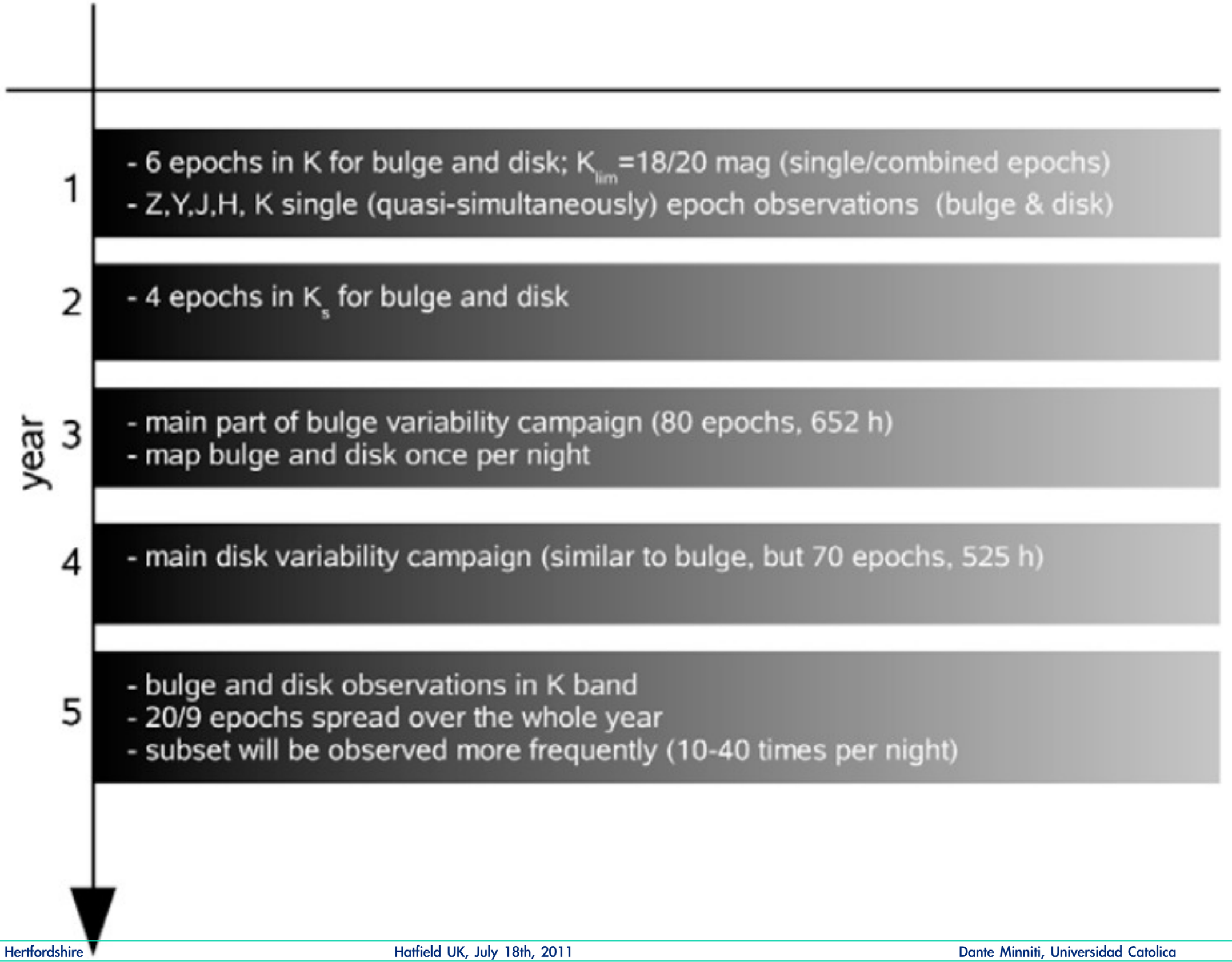
With best regards,

Fernando Comerón

YR1: completed

This is the first time that we do the phase 3, which is also a complex activity. Many details and problems needed to be solved. Credits: P. Lucas, E. Gonzalez, M. Irwin, CASU et al.

The VVV Survey: Timeline



Year 1 Completeness

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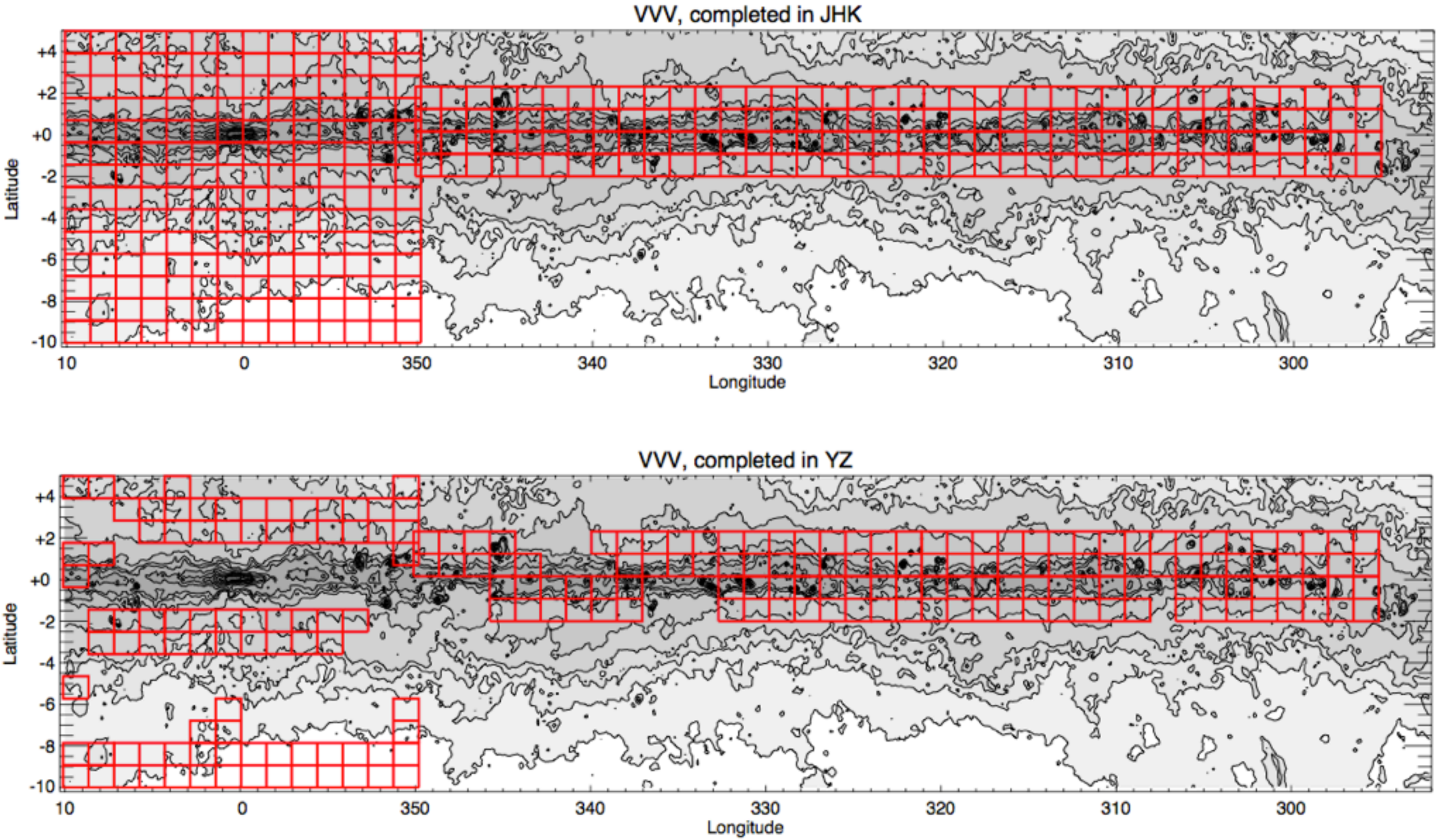

Maren Hempel

University of Hertfordshire Hatfield UK, July 18th, 2011 Dante Minniti, Universidad Catolica

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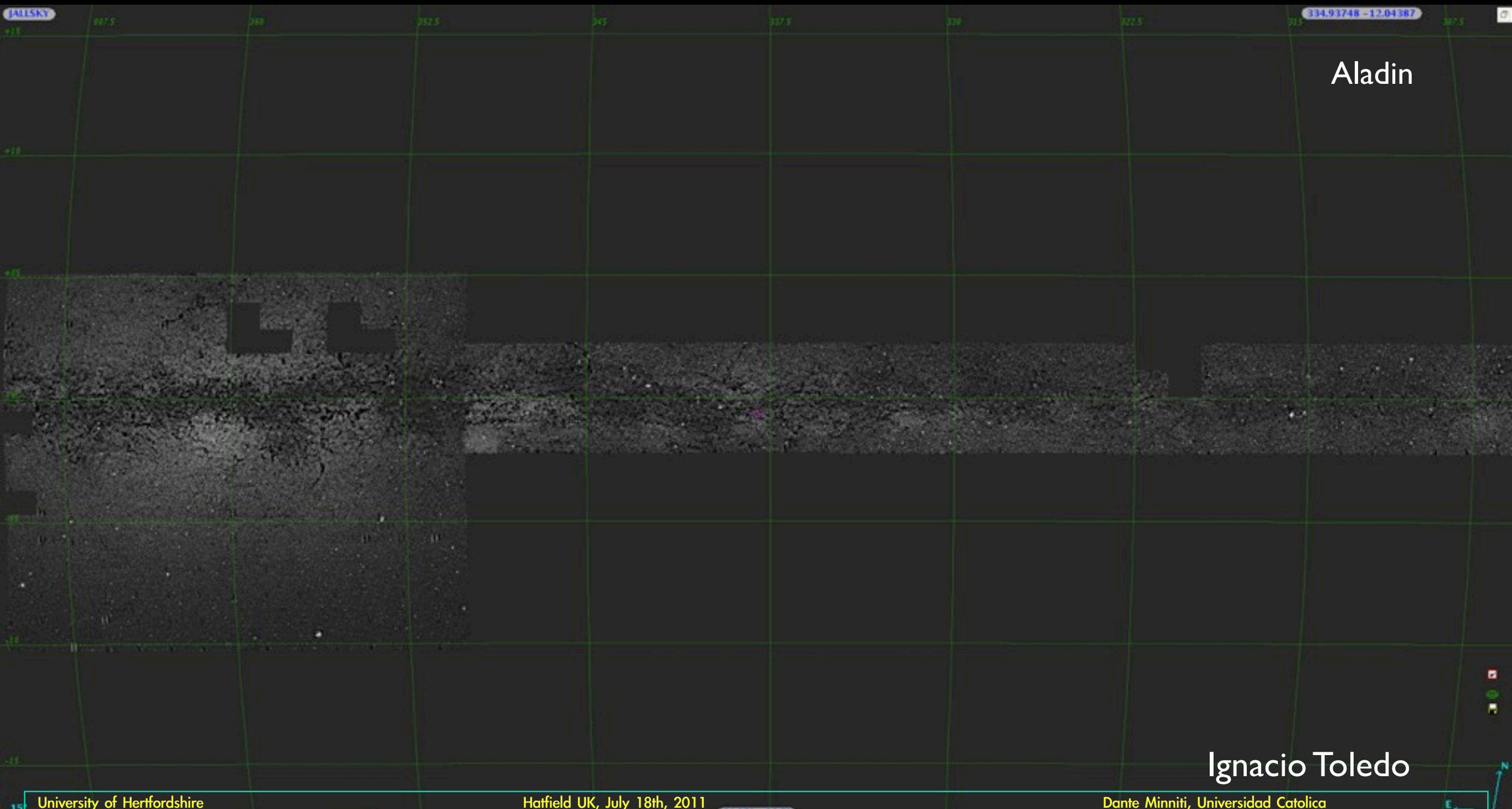
VVV Allsky Map

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



Ignacio Toledo

Variability

Year 1 Observations Completeness

Maren Hempel

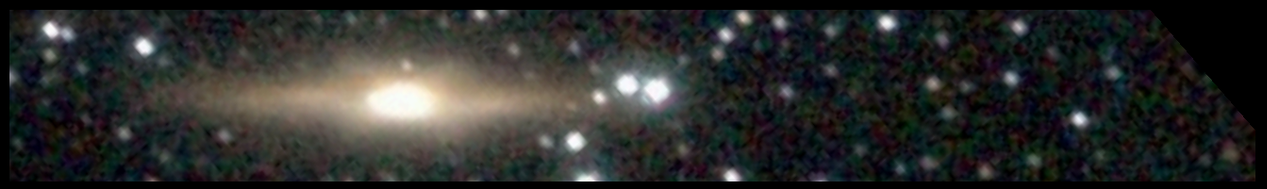
Maren Hempel

The most important thing...

for variability
for microlensing
for SNe
for extrasolar planetary transits

is the baseline

Time (Alan Parsons)
Good bye my friend,
the stars wait for me,
who knows when we shall meet again…



Some problems / difficulties

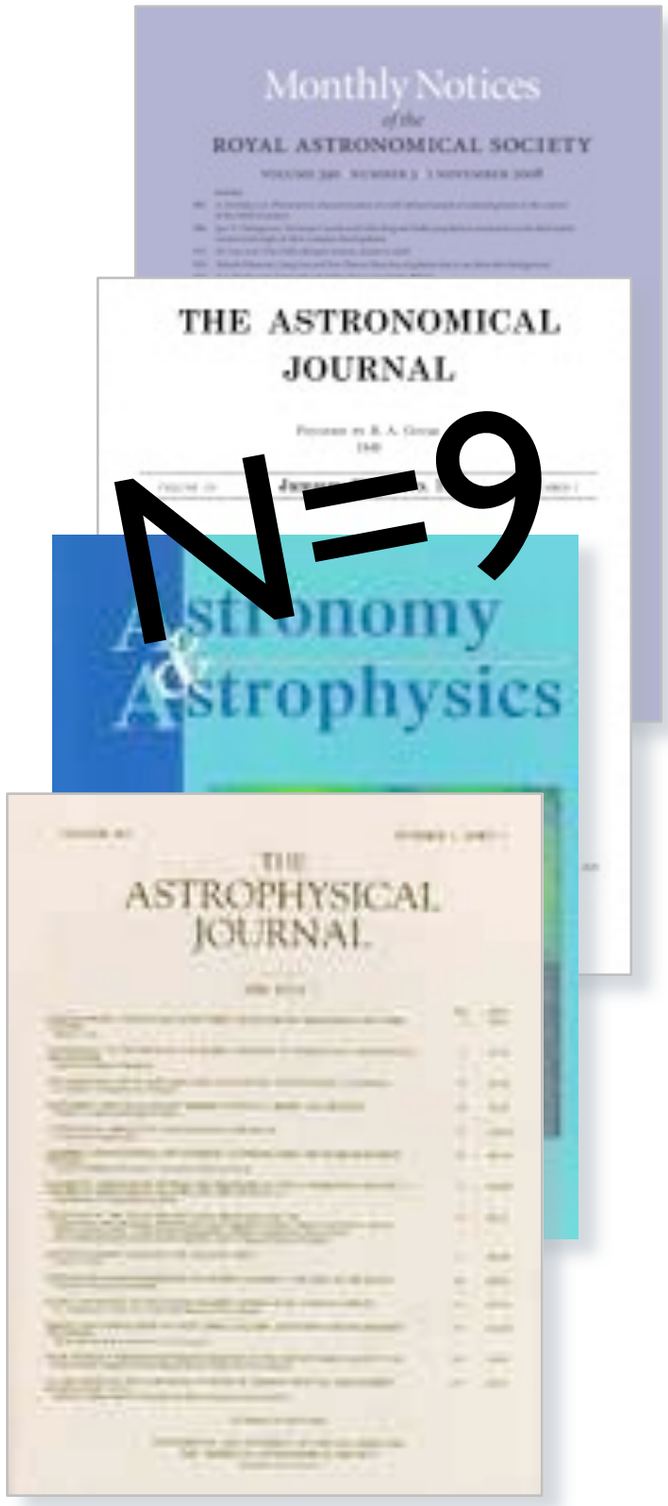
- large number of OBs
- huge dataset: handling and transmission
- delays
- completeness/homogeneity/book-keeping
- large team

The scientist (Coldplay)
“Nobody said it was easy,
no one ever said it would be so hard,
I’m going back to the start”

vvvsurvey.org

- CATALOGS
  - ASTROMETRY
    - Asteroids ~10^3
    - TNOs ~10^1
    - high-PM ~10^4
    - BDs ~10^3
  - VARIABLES ~10^6
    - Transients ~10^4
      - AGNs, QSOs ~10^3
      - SN ~10^2
      - 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, F ~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

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VVV Year 1:
Multiple epoch explorations

Multiple epoch explorations

Purpose of this part of the talk: to show that we can already start doing some neat variability studies.

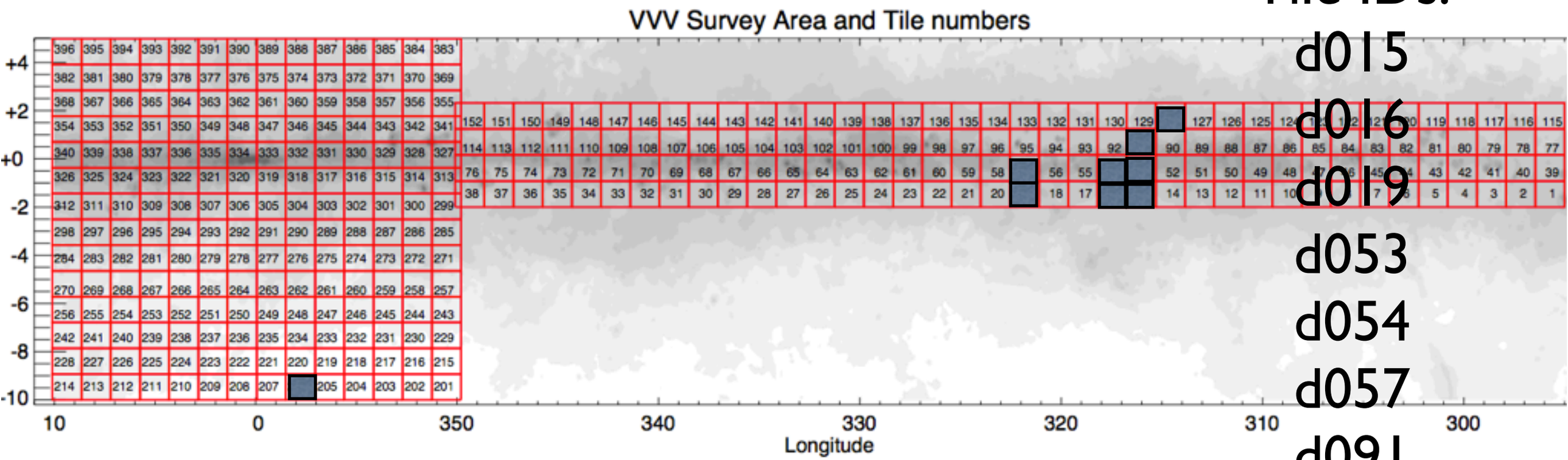
Some examples of image variations and defects that become evident when comparing three different epochs.

Color images made by ***Ignacio Toledo***.
All three epoch images are acquired with the same filter (Ks).
The individual epochs were observed in 2010, and are separated by 3-4 months each.
The sequence of observations is first epoch blue, second epoch green, third epoch red.

Multiple epochs

vvvsurvey.org

Inspected 14 sqdeg so far



Tile IDs:

d015
d016
d019
d053
d054
d057
d091
d128
b206

Search for:

- High proper motion objects
- Variable stars
- Light echoes from ancient Galactic SN
- SN in distant galaxies
- Unknown bursts

Multiple epochs

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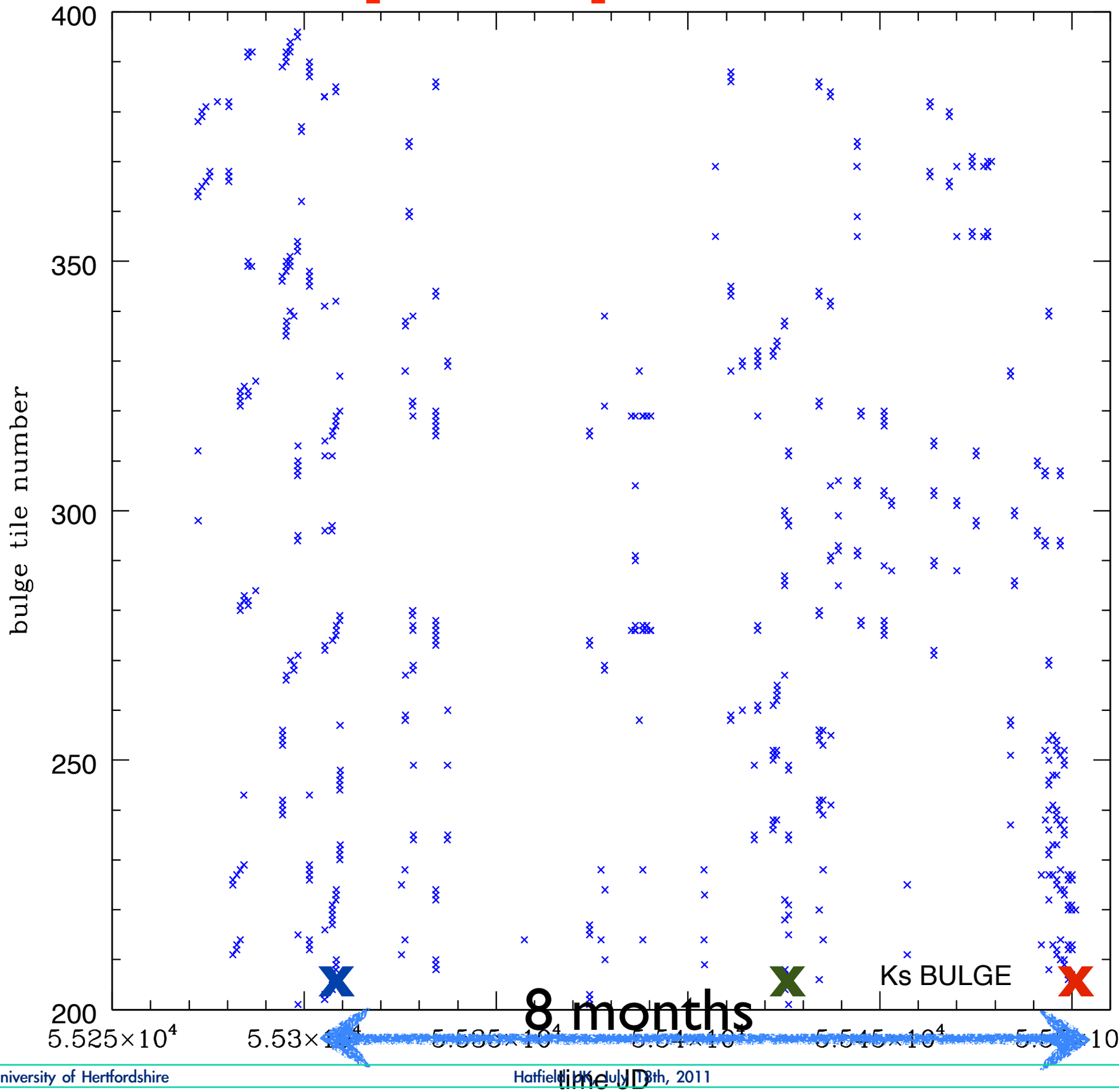


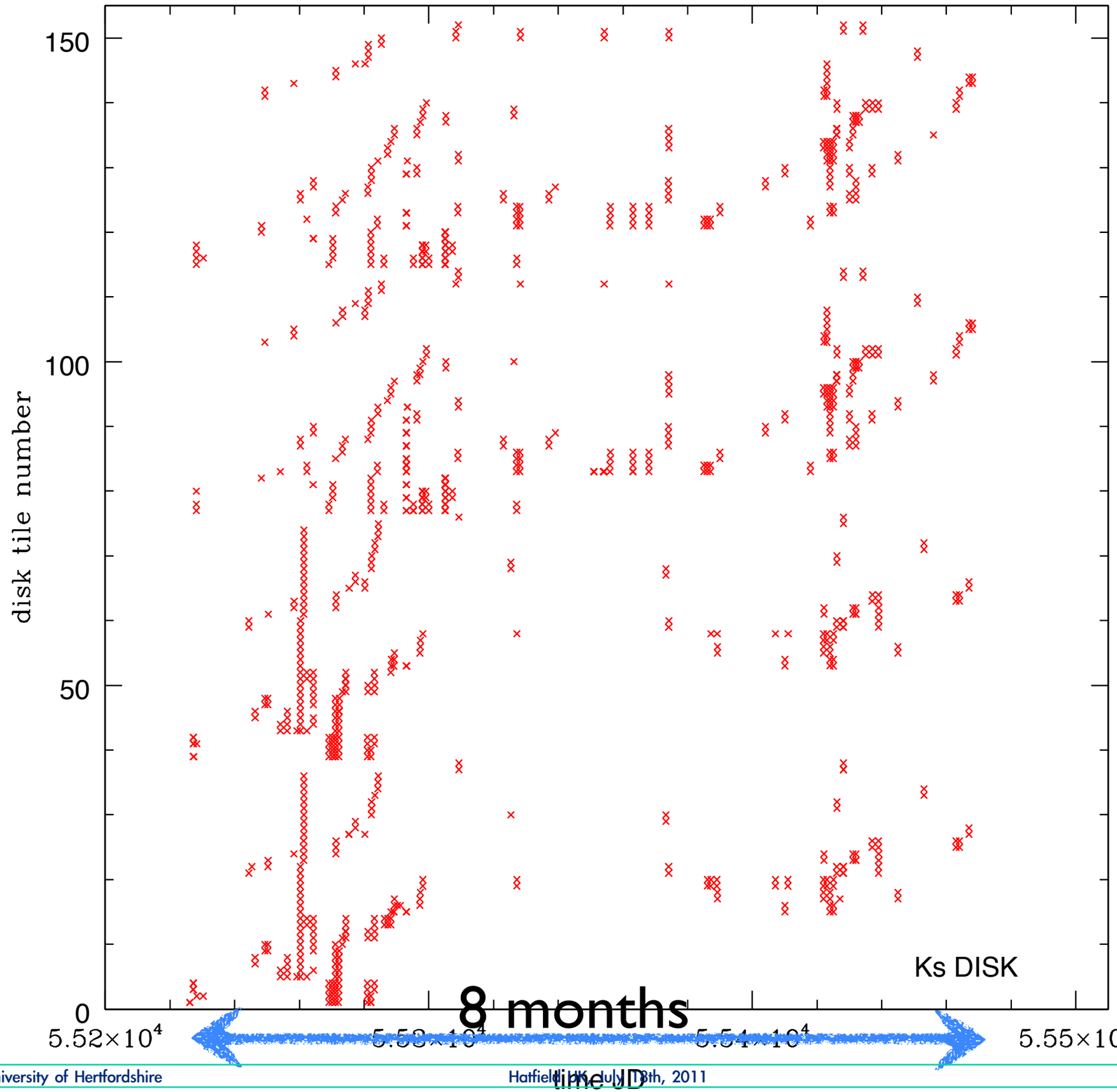
Bulge tiles

Some other time
(The Alan Parsons Project)
“Now the starlight which has found me
Lost for a million years
Tries to linger as it fills my eyes
Till it disappears”

b206

Multiple epochs

vvvsurvey.org



Disk tiles

Some other time
(The Alan Parsons Project)
“Now the starlight which has found me
Lost for a million years
Tries to linger as it fills my eyes
Till it disappears”

Detector 1 defects

vvvsurvey.org

Tile d091

Color differences due to centering errors or different sensitivity of bad pixels at different epochs.
Important because it shows the expected range of colors.

Edge defects

okmarks Window Help

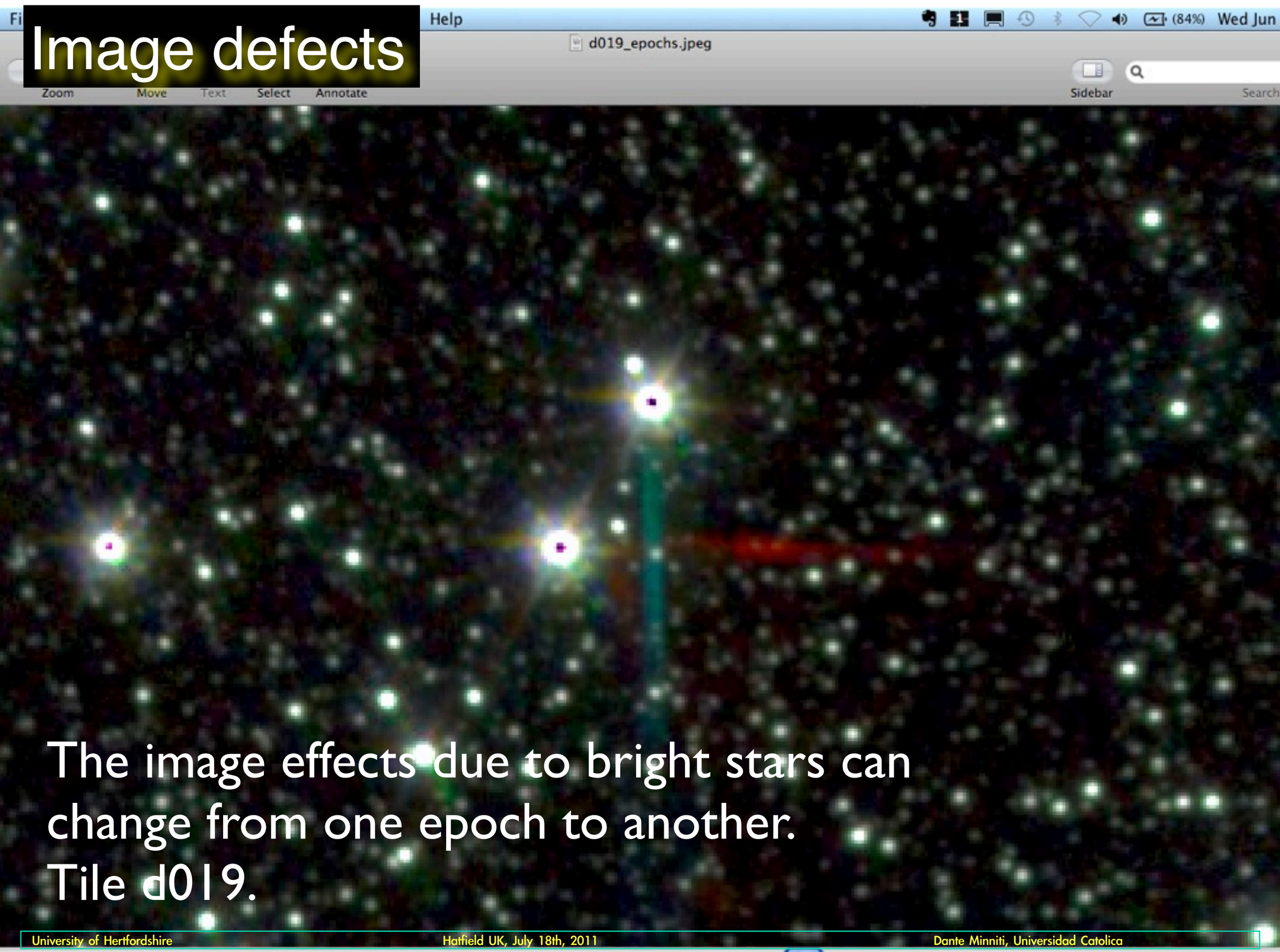
d054_epoch.jpeg

Previous Next Zoom Move Text Select Annotate Sidebar

Tile d054

University of Hertfordshire Hatfield UK, July 18th, 2011 Dante Minniti, Universidad Catolica

Image defects



The image effects due to bright stars can change from one epoch to another.
Tile d019.

Motion of Alpha Cen AB

vvvsurvey.org

Tile d054

Motion of Alpha Cen AB

vvvsurvey.org

Tile d054

Motion of Alpha Cen AB

vvvsurvey.org

We can see the proper motion even in this very saturated star...

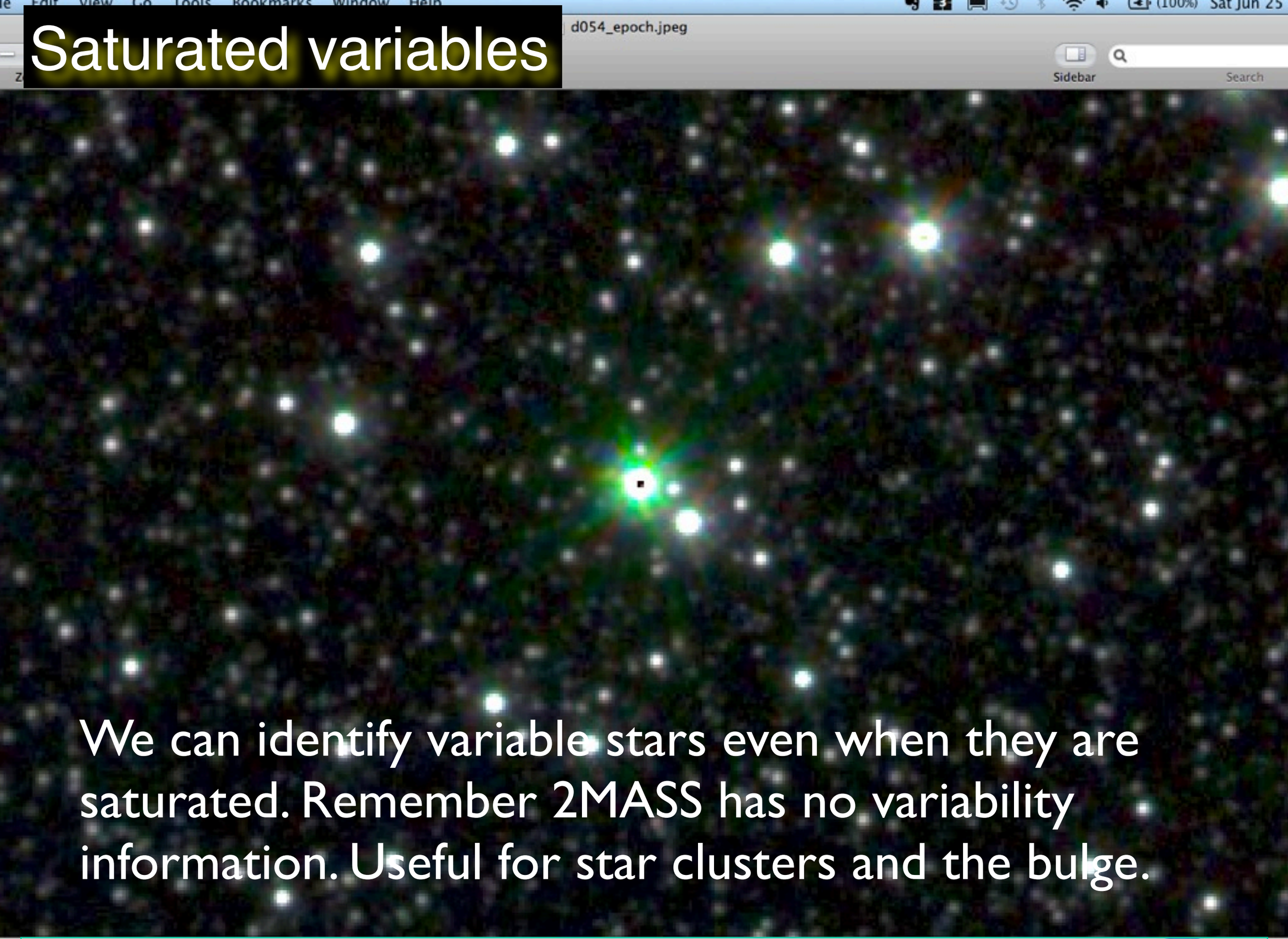
Nebular regions

The coadded images show better the nebular regions, but some bright stars can cause the background to change.

Nebular regions

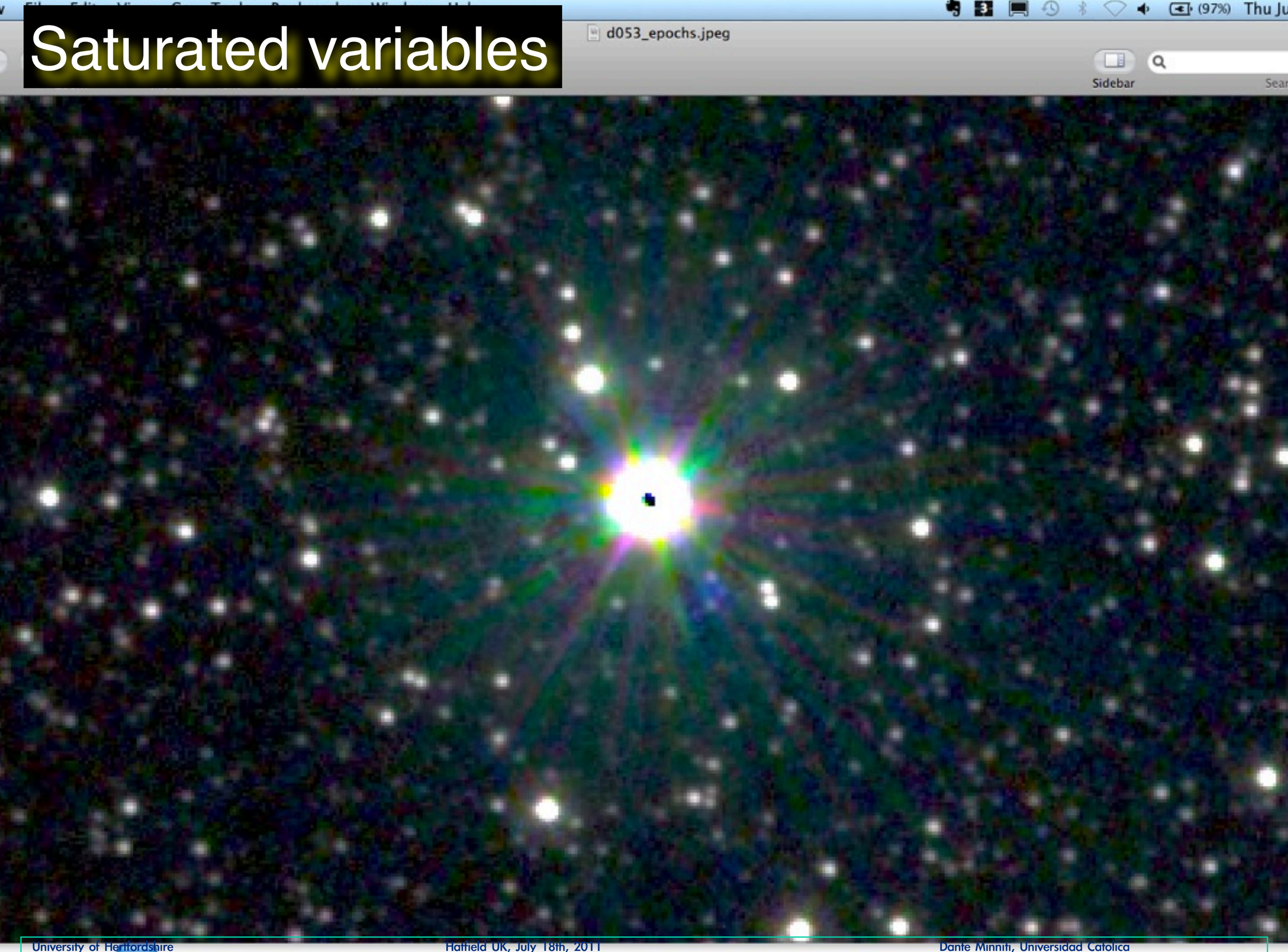
The coadded images show better the nebular regions, but some bright stars can cause the background to change.

Saturated variables

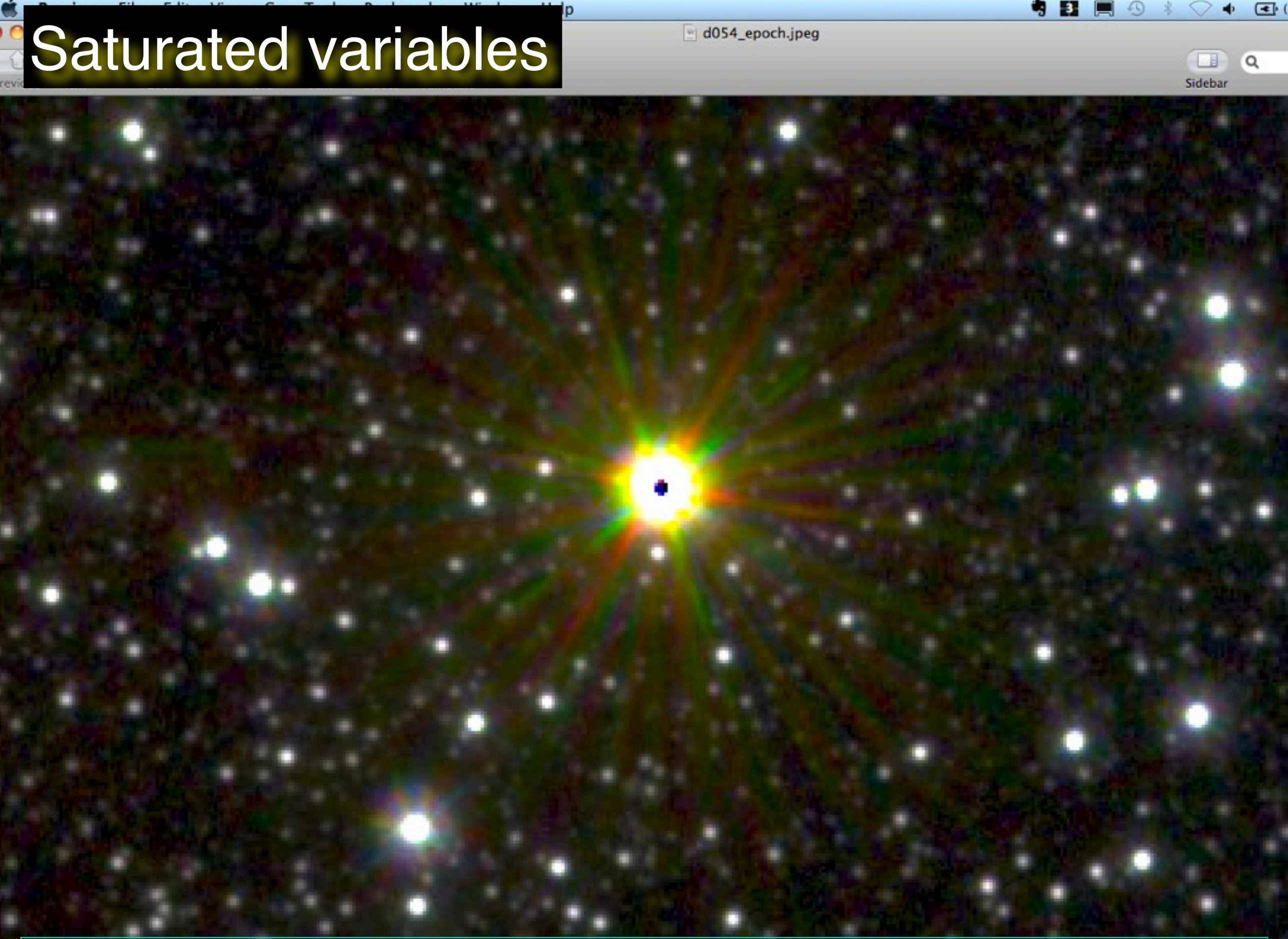


We can identify variable stars even when they are saturated. Remember 2MASS has no variability information. Useful for star clusters and the bulge.

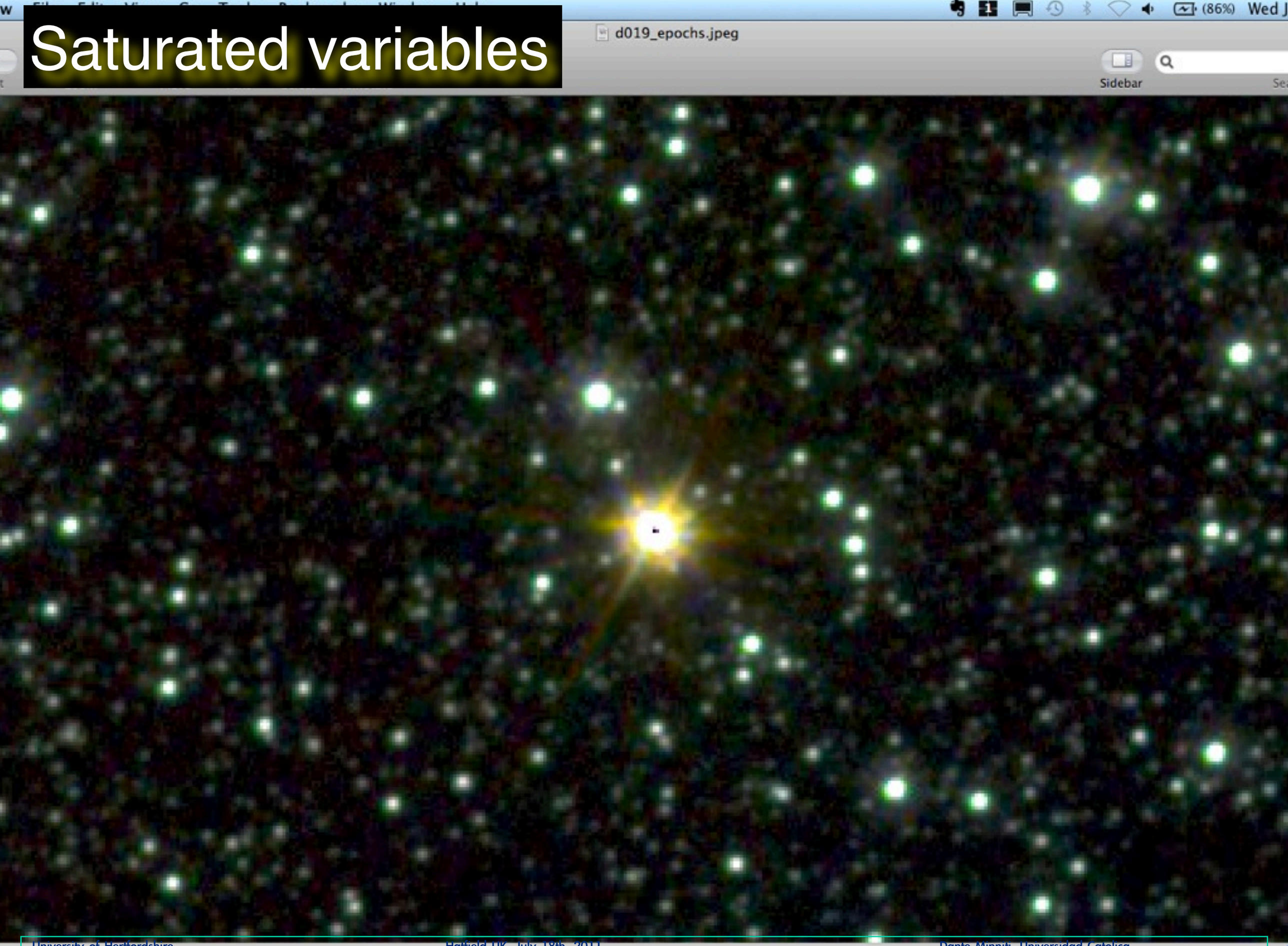
Saturated variables



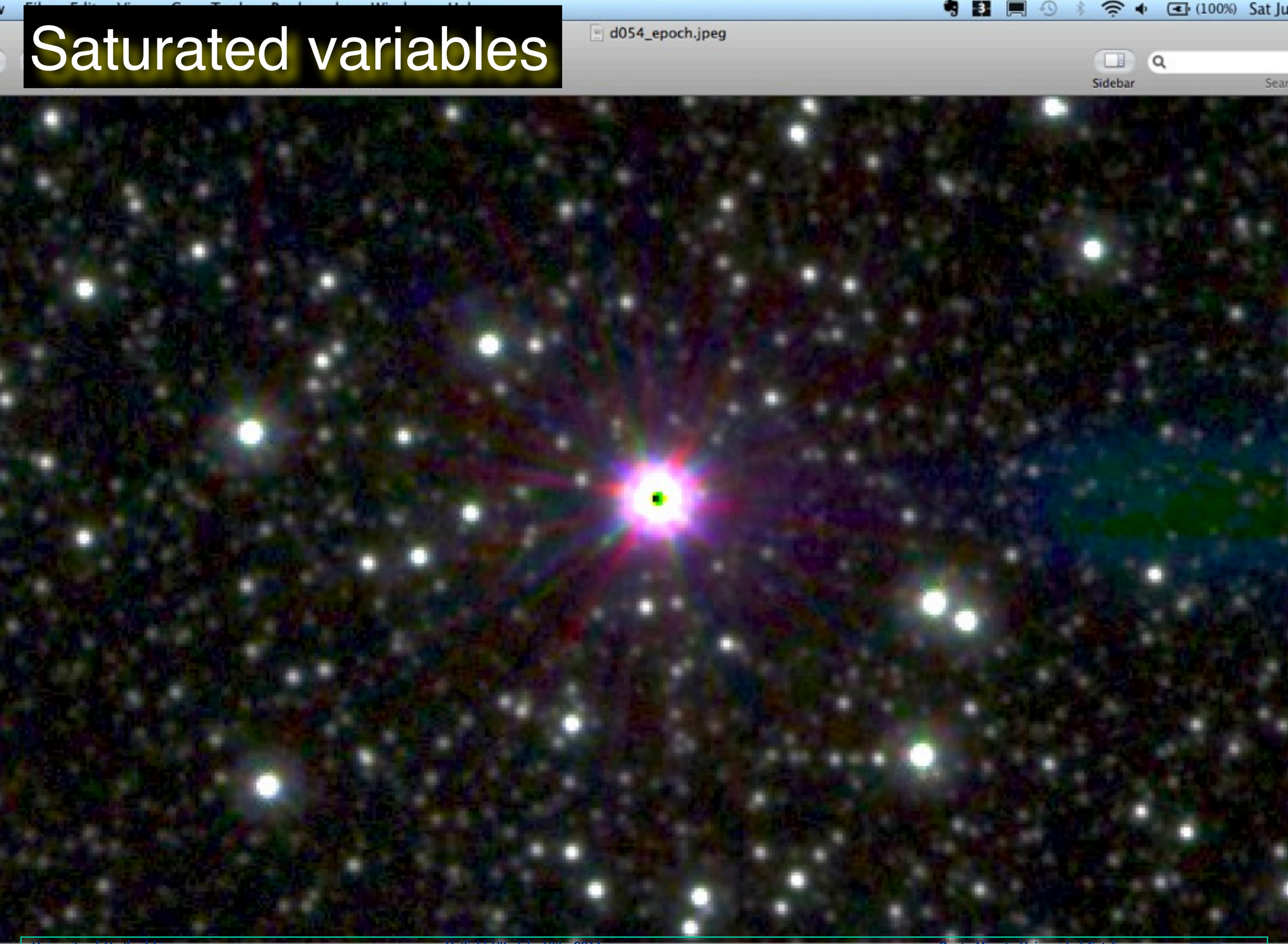
Saturated variables



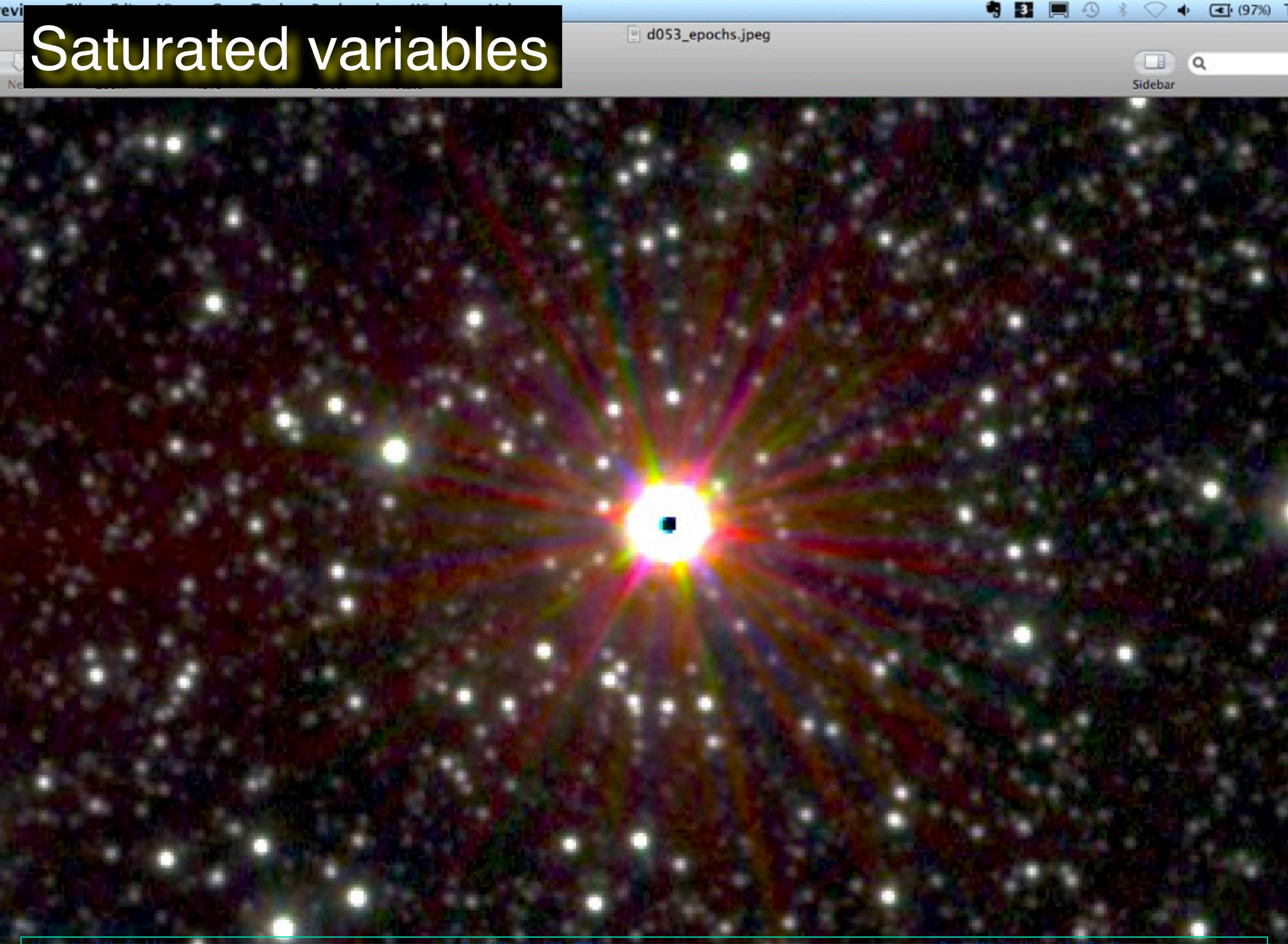
Saturated variables



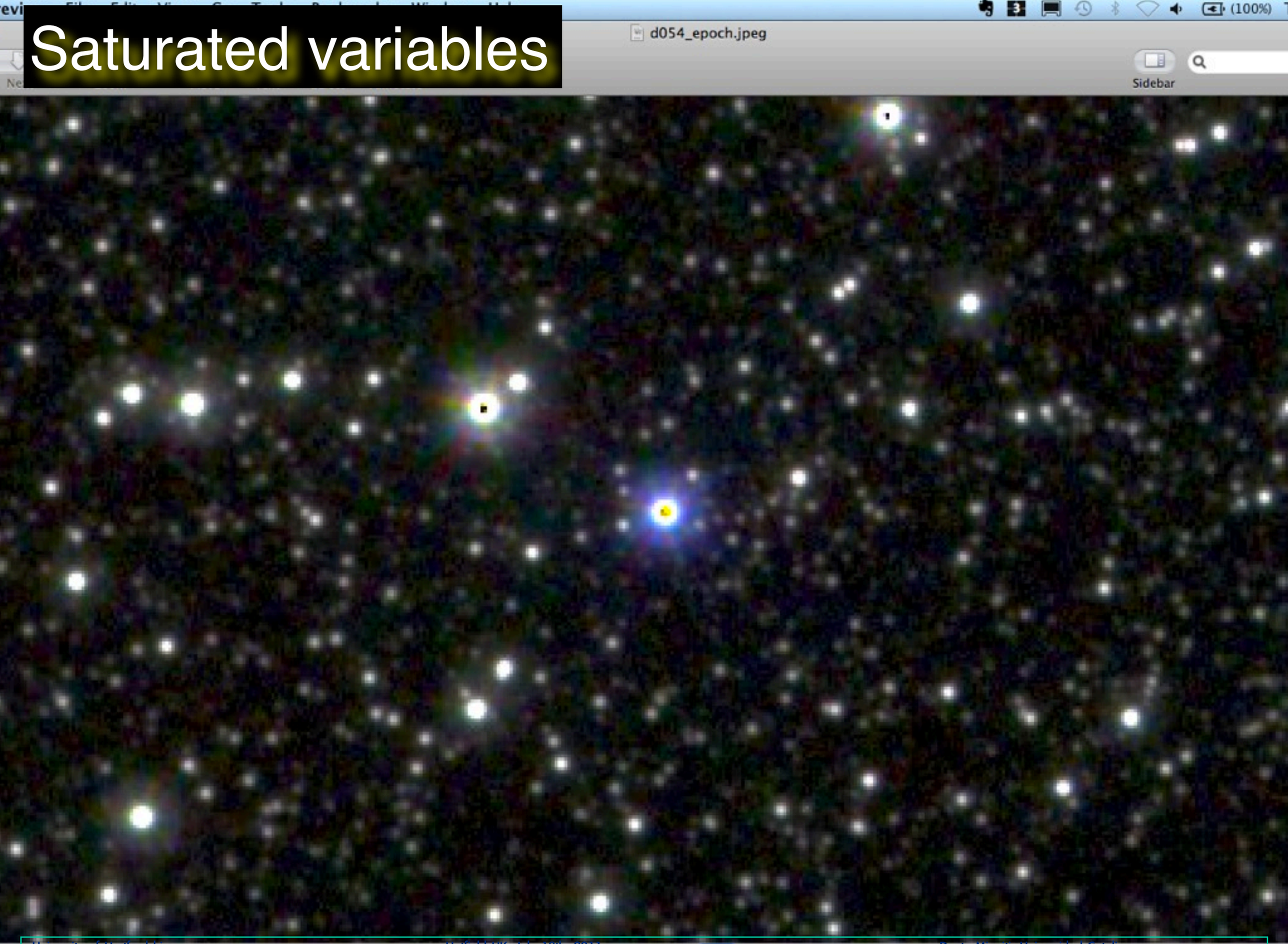
Saturated variables



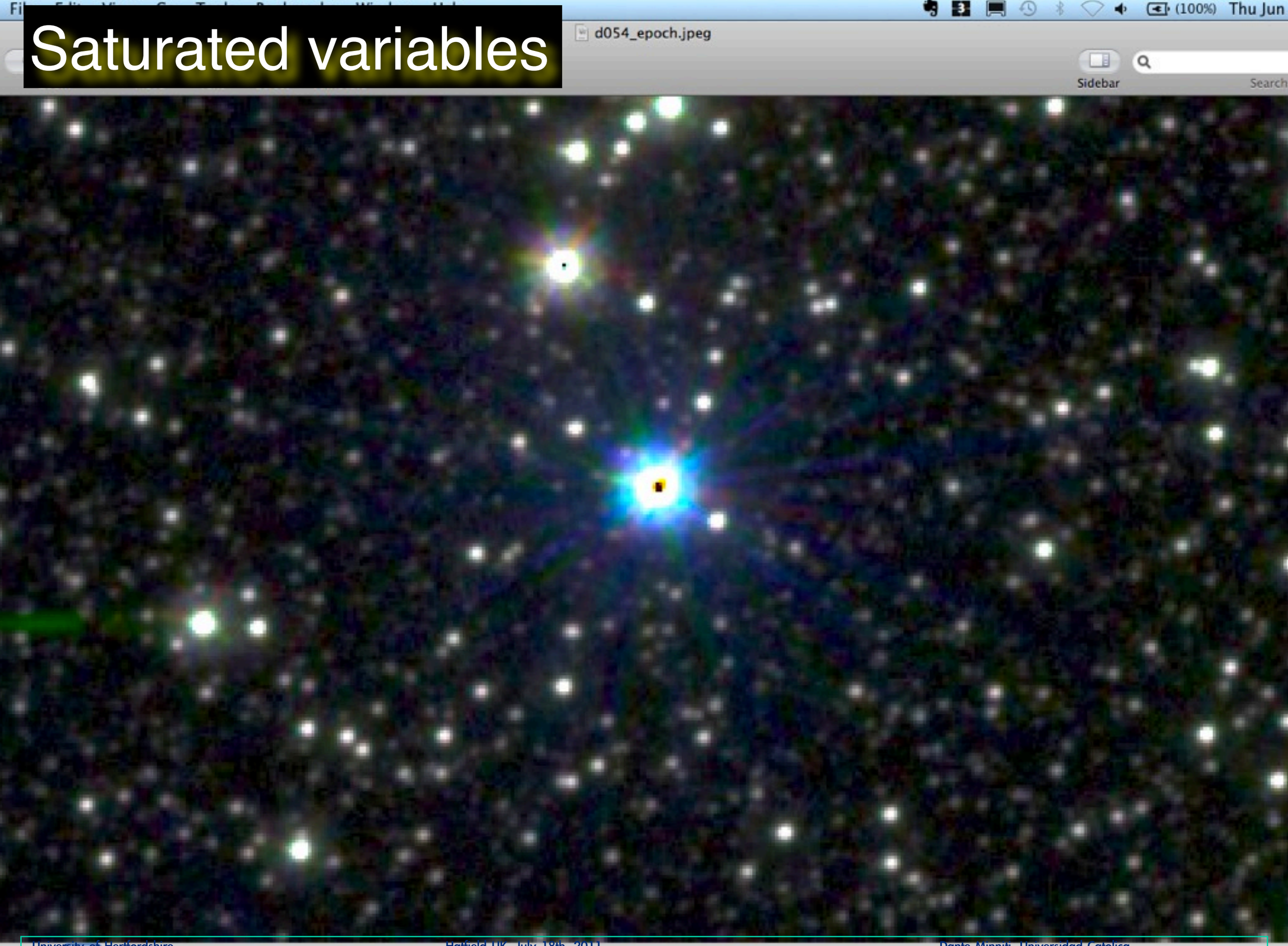
Saturated variables



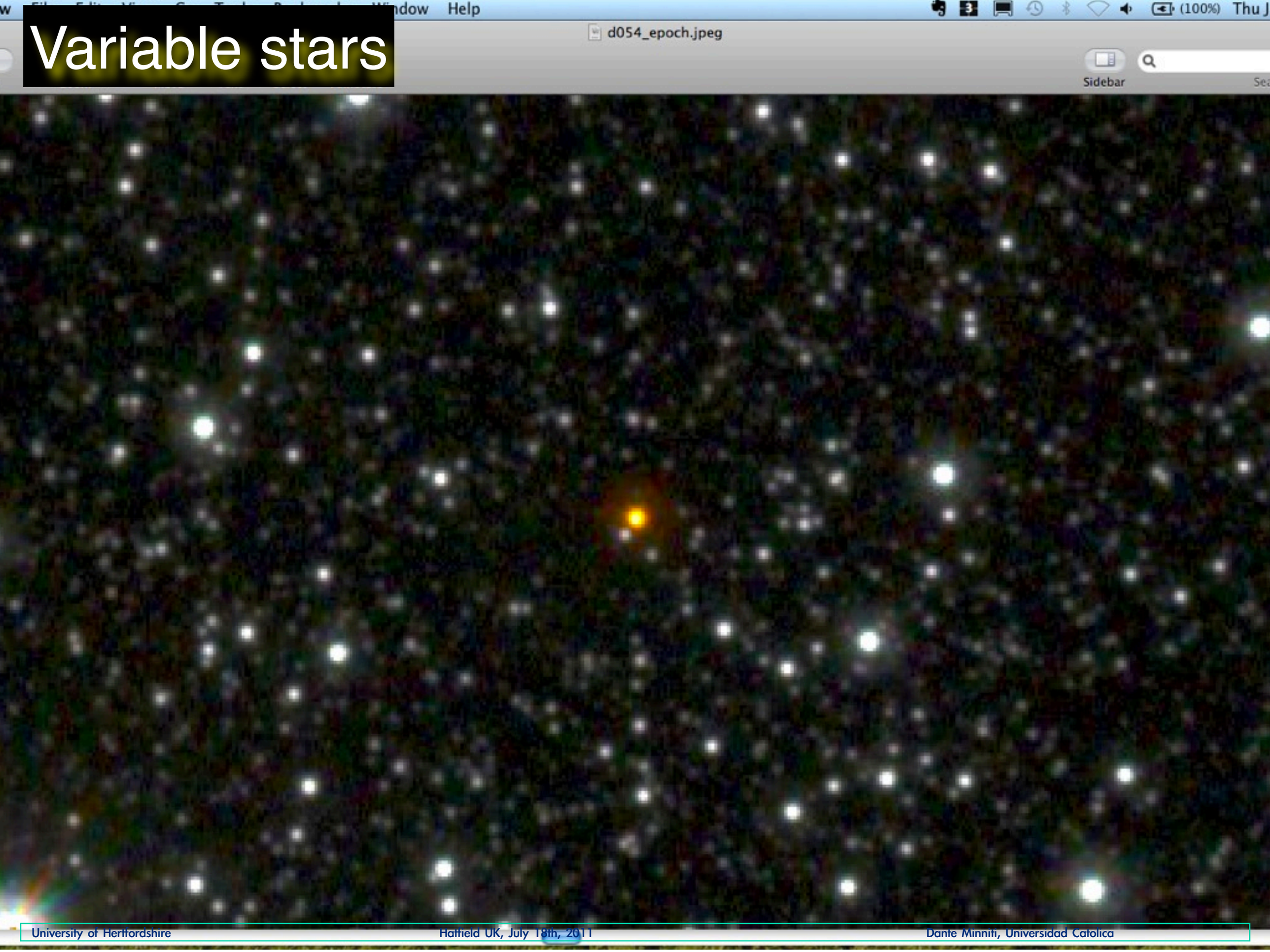
Saturated variables



Saturated variables



Variable stars



Variable stars

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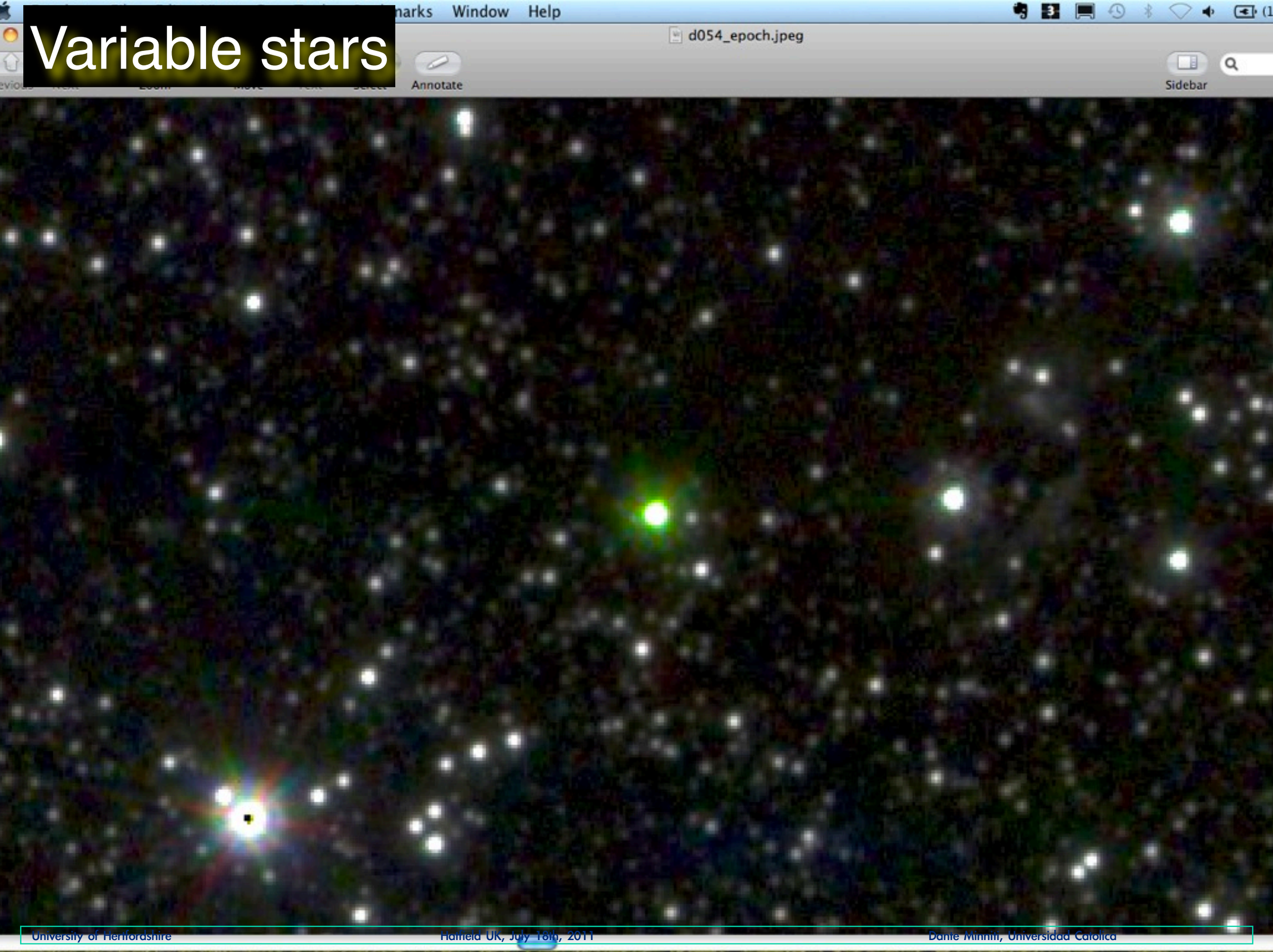
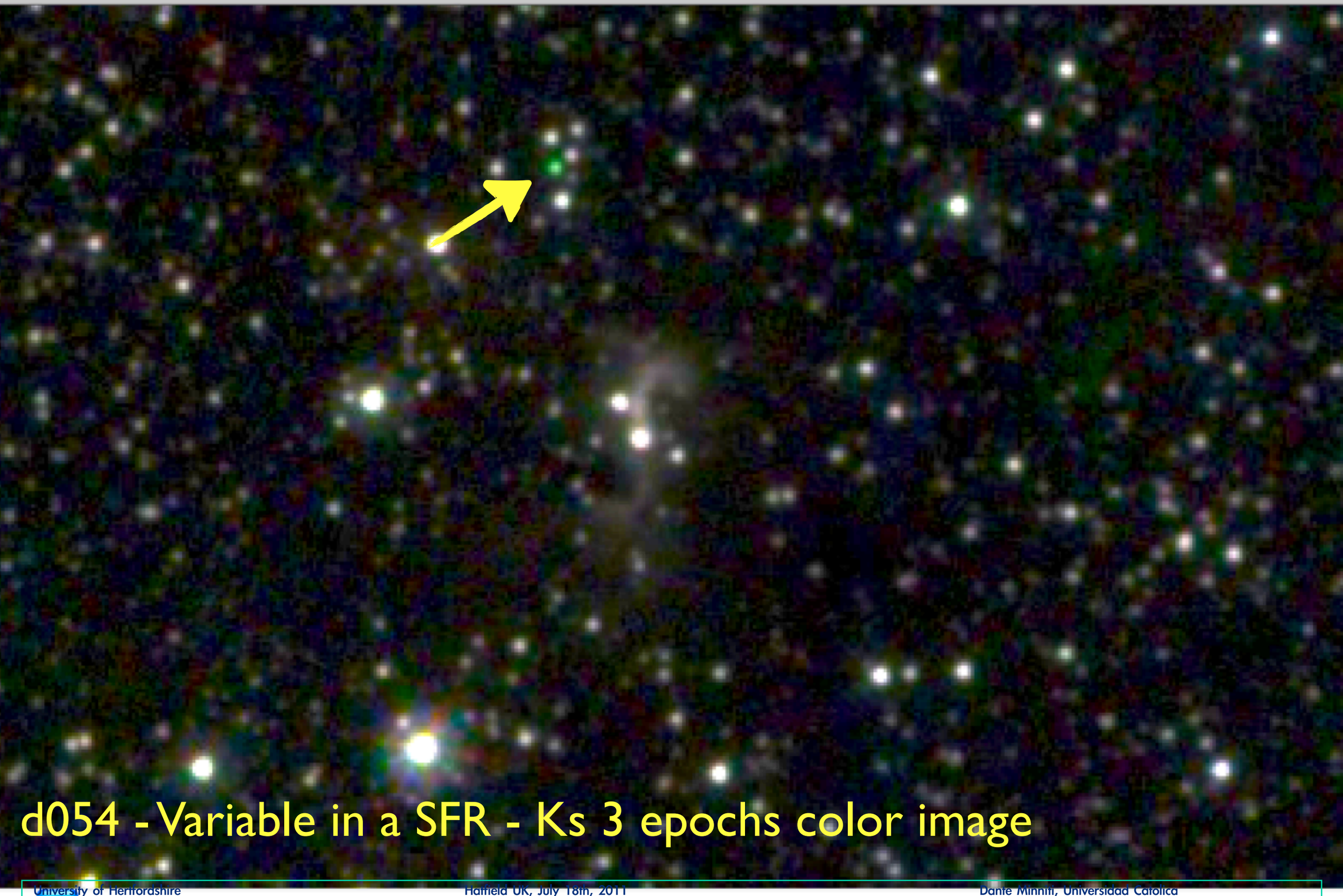
Variable stars

Variable stars





d054 - Variable in a SFR - Ks 3 epochs color image

d054 - Variable in a SFR - JHKs color image

d054 - Variable in a SFR - Ks 3 epochs color image

d054 - Variable in a SFR - JHKs 3 color image

d054 - Variable in a SFR - Ks 3 epochs color image

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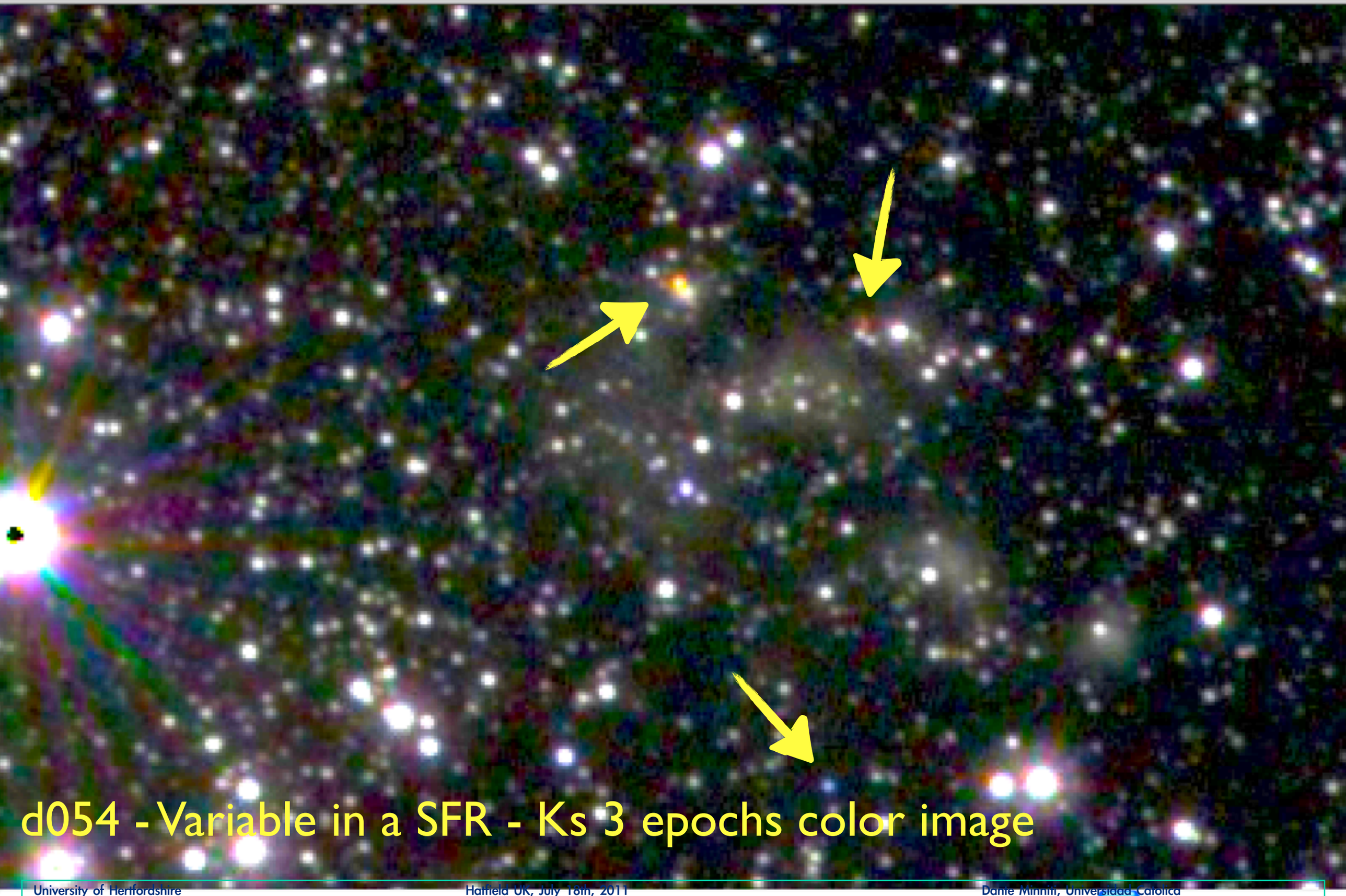
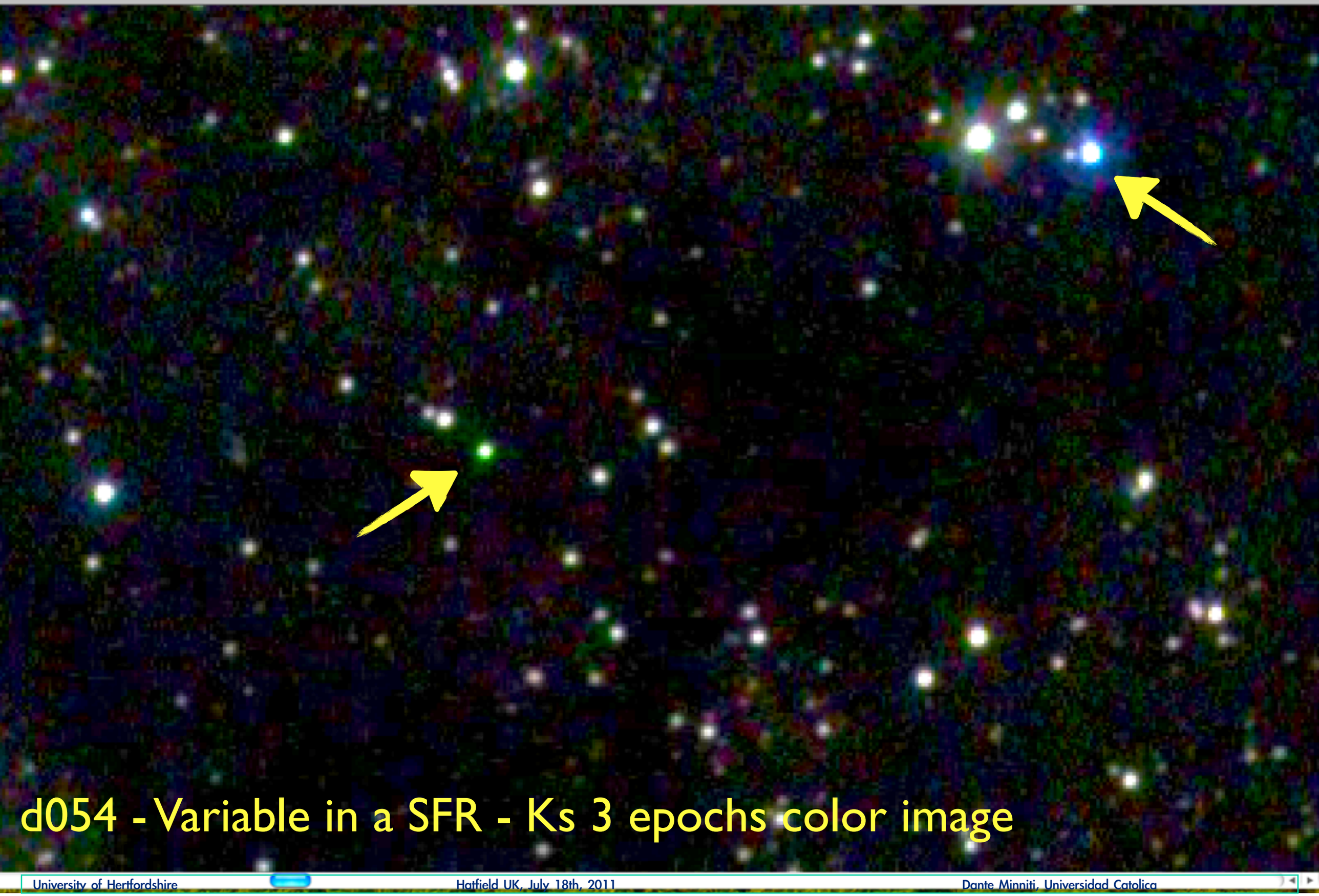


d054 - Variable in a SFR - Ks 3 epochs color image



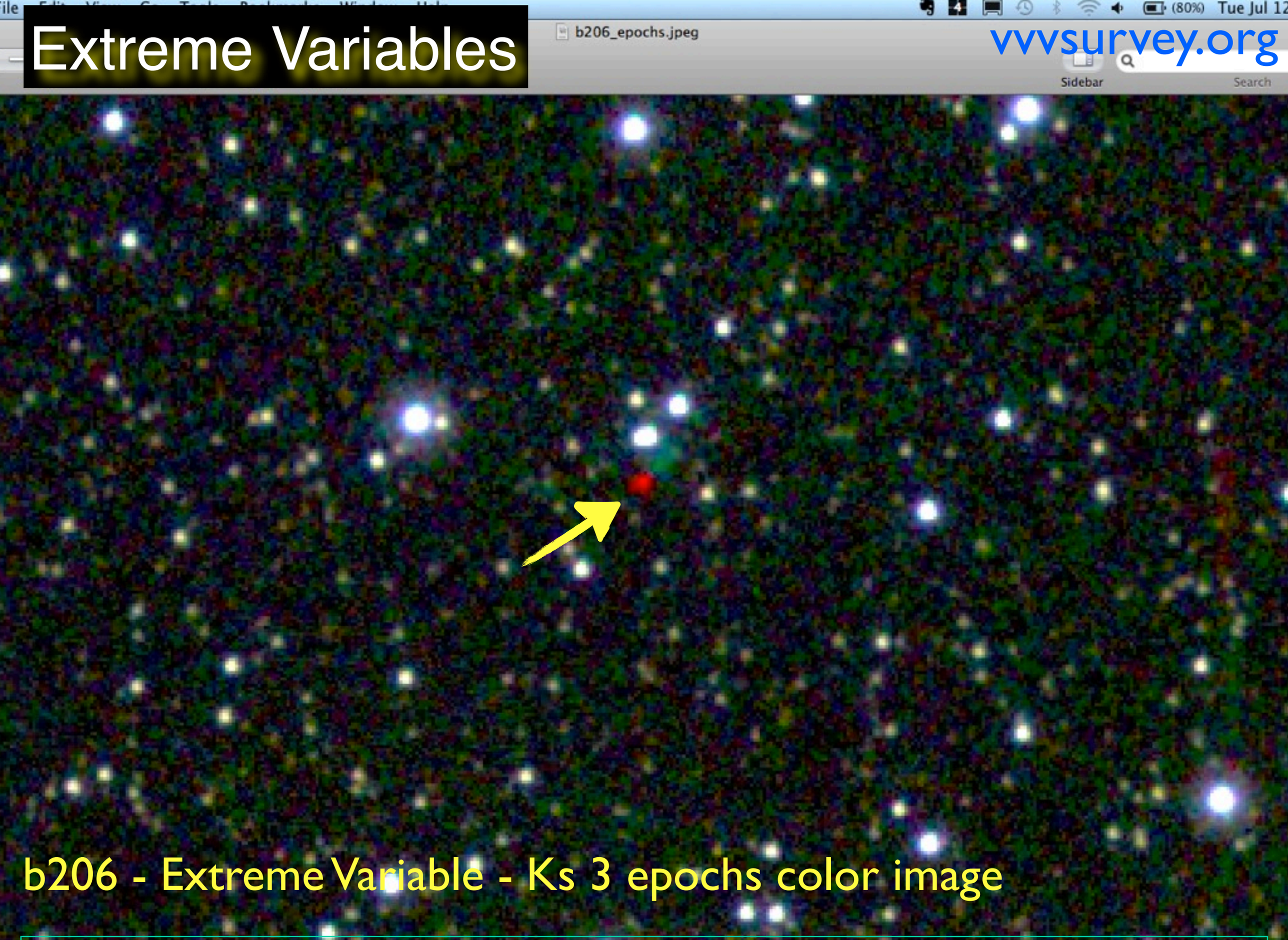
d054 - Variable in a SFR - Ks 3 epochs color image

Extreme variables

Objects that are only present (i.e. several magnitudes brighter) in one of the Ks band epochs.
Possible explanations:
- Known variables (CVs, FUOris, etc)
- SN in faint galaxies
- Moving objects
- Unknown bursts
- Image defects

Extreme Variables

vvvsurvey.org



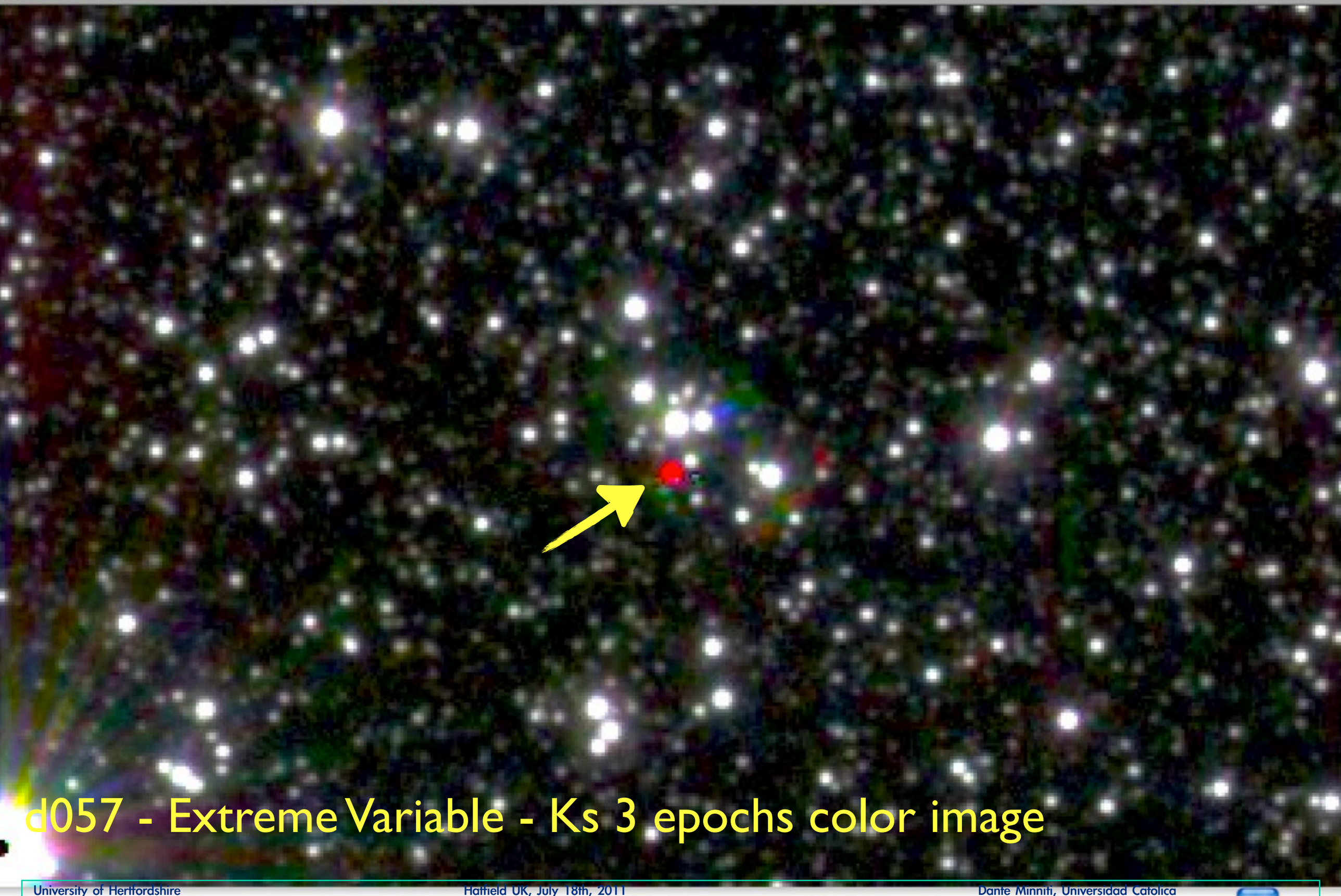
b206 - Extreme Variable - Ks 3 epochs color image

Extreme Variables

d057_epochs.jpeg

vvvsurvey.org

Sidebar



d057 - Extreme Variable - Ks 3 epochs color image

Extreme Variables

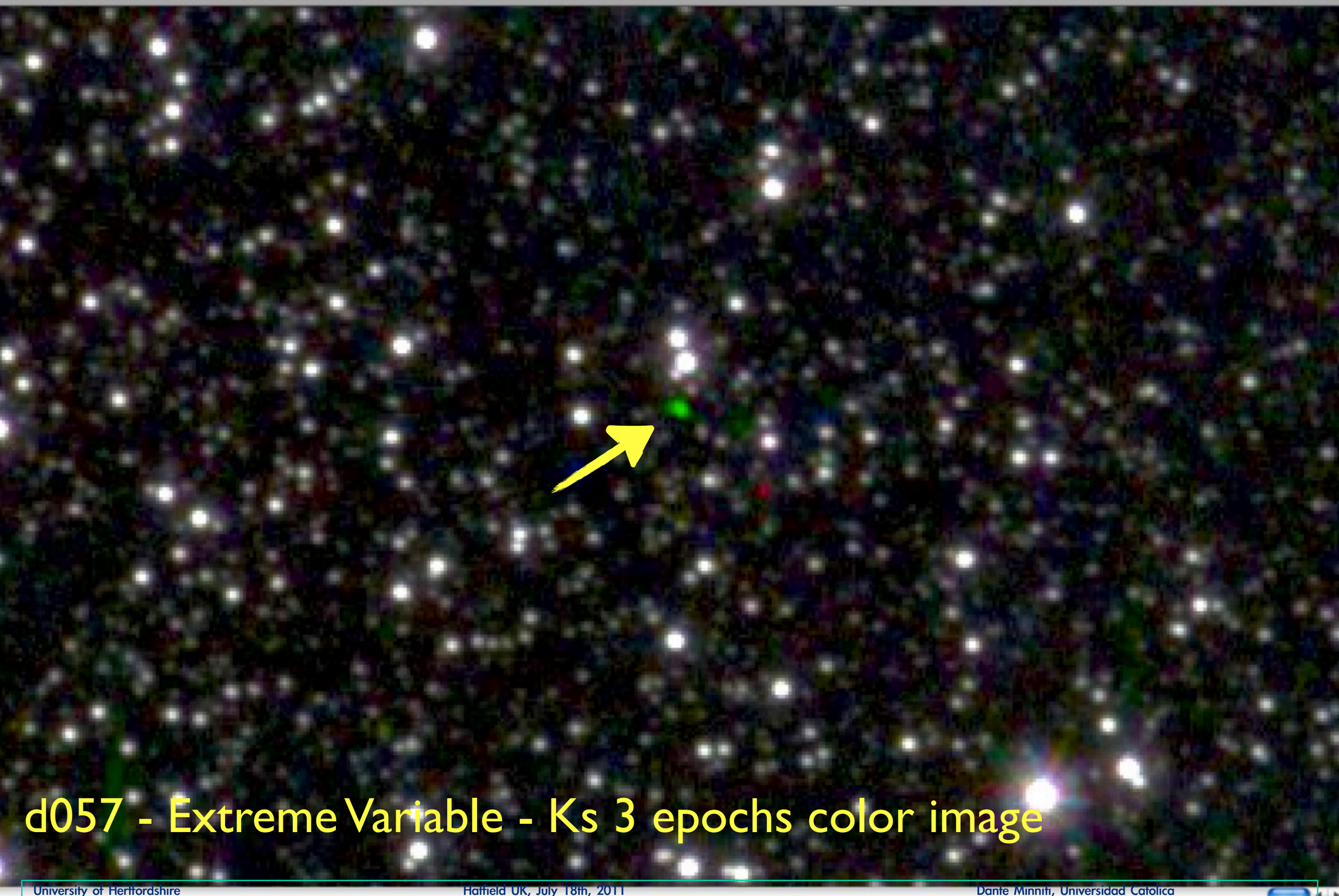
epochs.jpeg

vvvsurvey.org

Sidebar

Search

(95%) Thu Jul 14 02:04



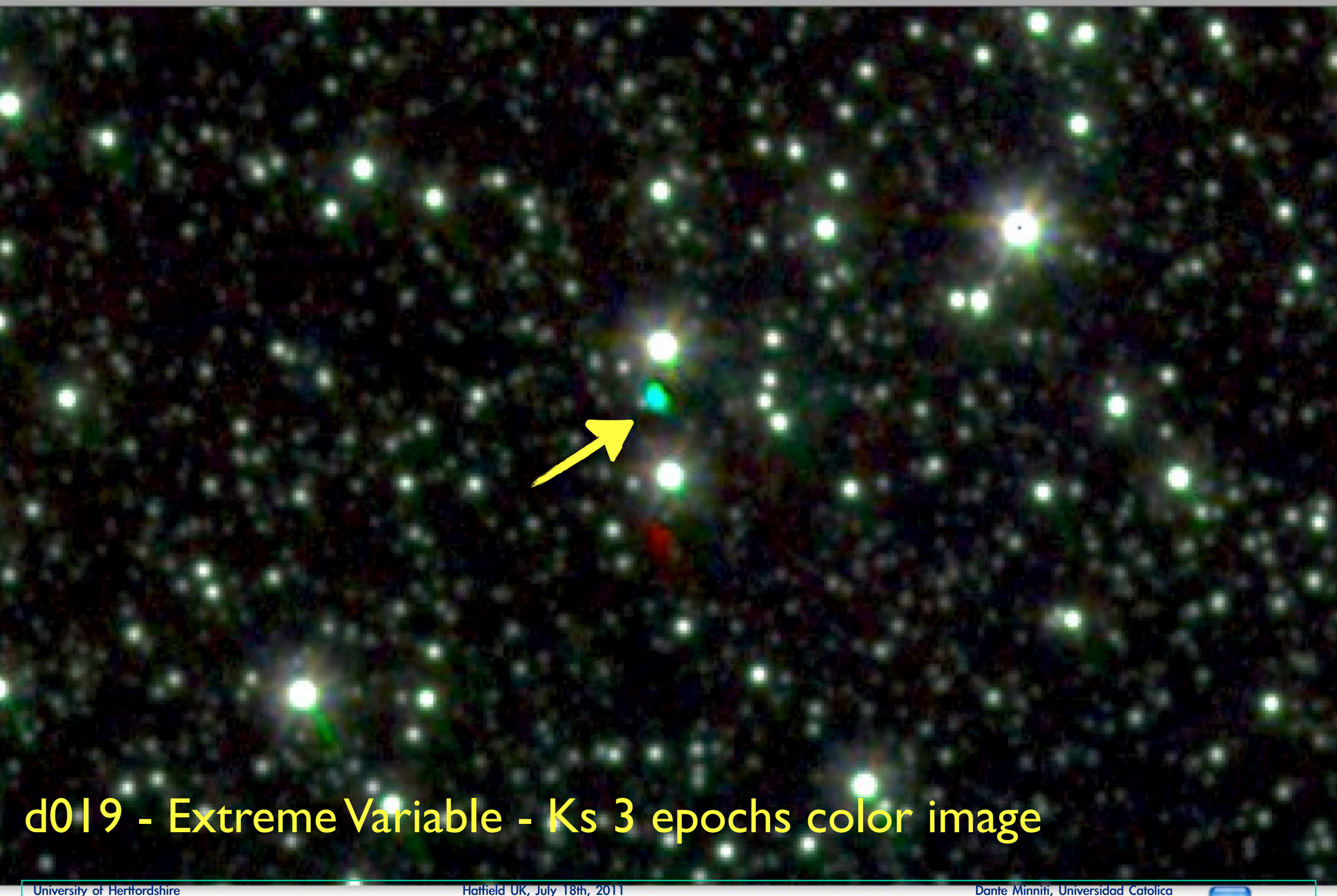
d057 - Extreme Variable - Ks 3 epochs color image

Extreme Variables

d019_epochs.jpeg

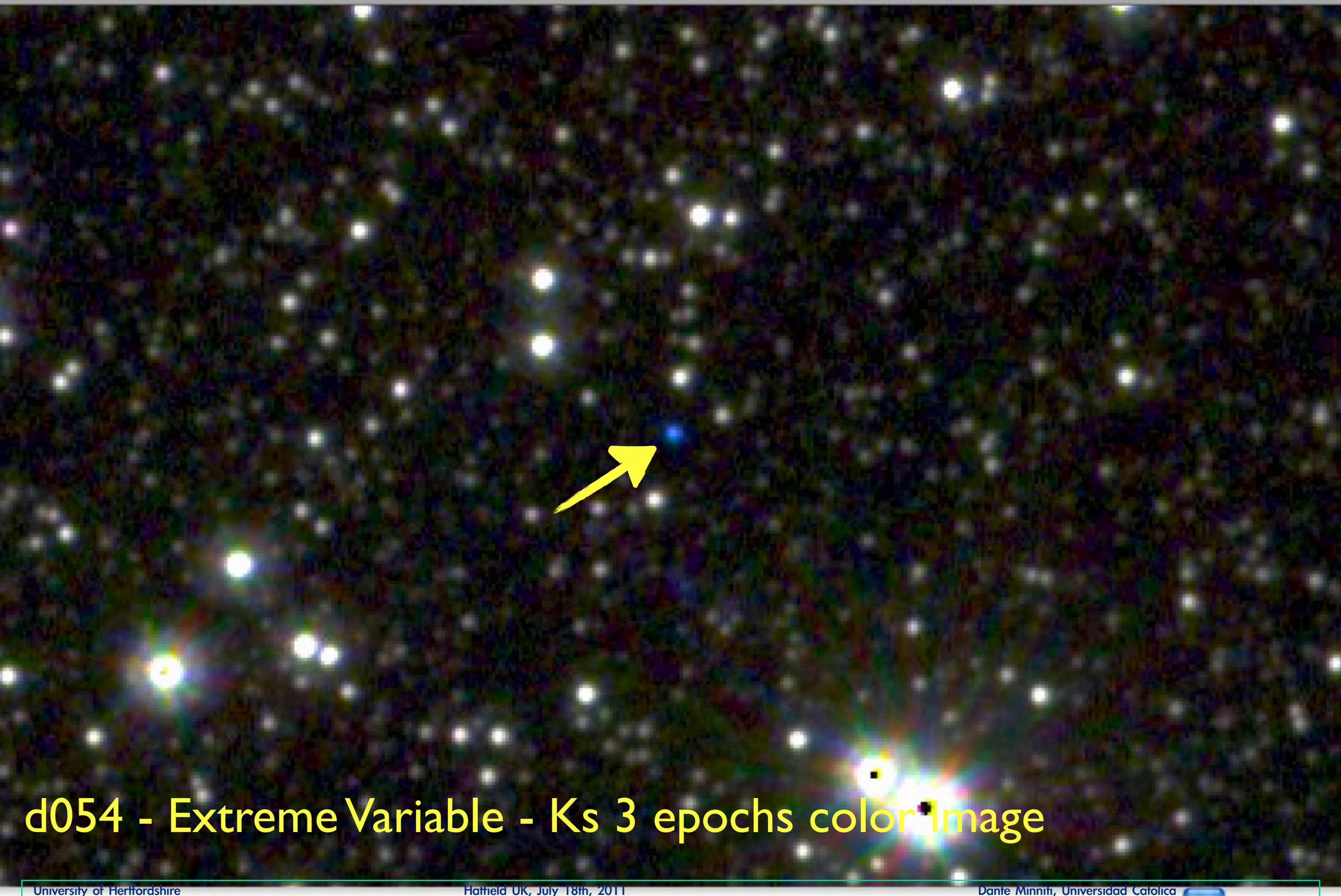
vvvsurvey.org

Sidebar



d019 - Extreme Variable - Ks 3 epochs color image

Extreme Variables



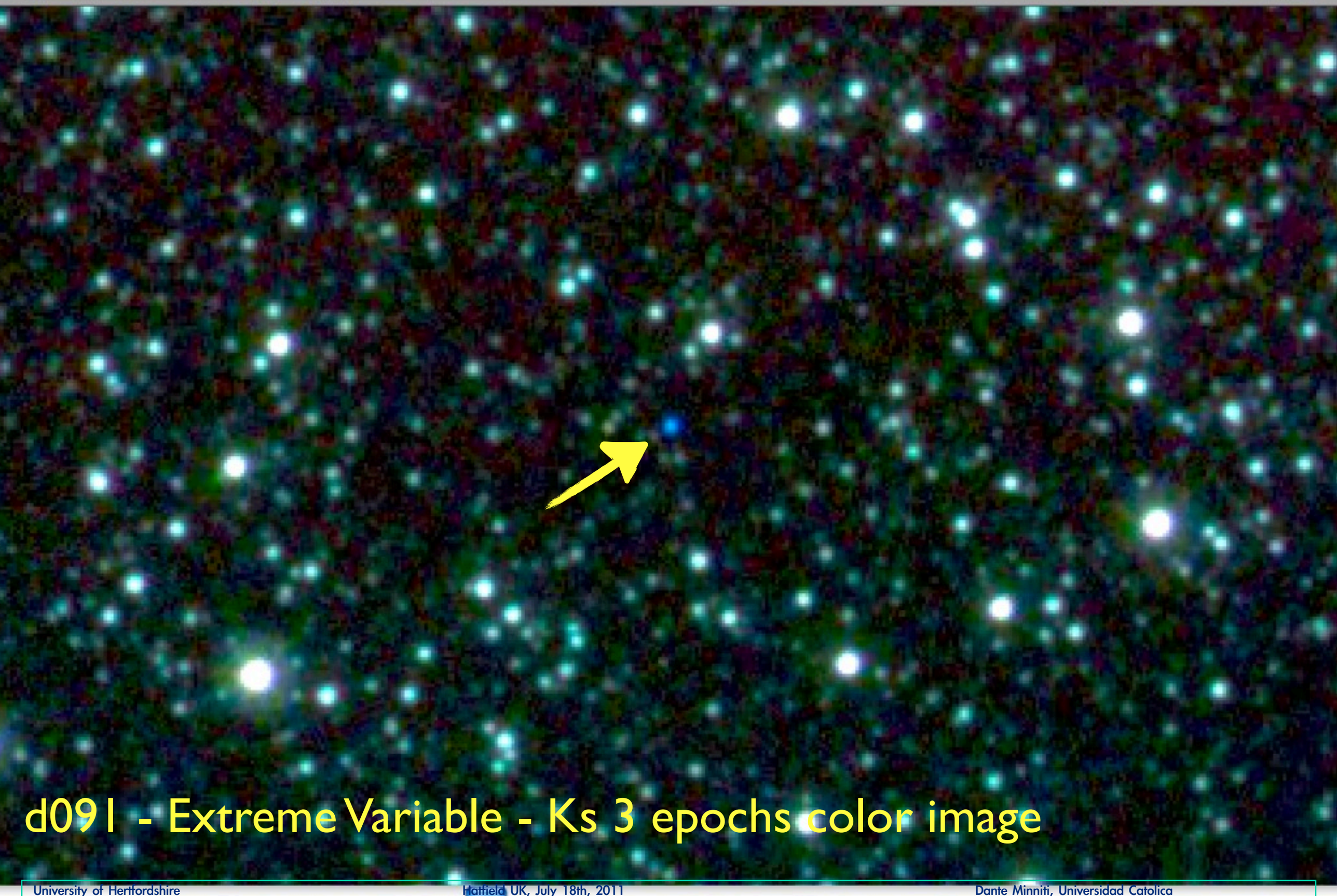
d054 - Extreme Variable - Ks 3 epochs color image

Extreme Variables

d091_epochs.jpeg

vvvsurvey.org

Sidebar Search



d091 - Extreme Variable - Ks 3 epochs color image

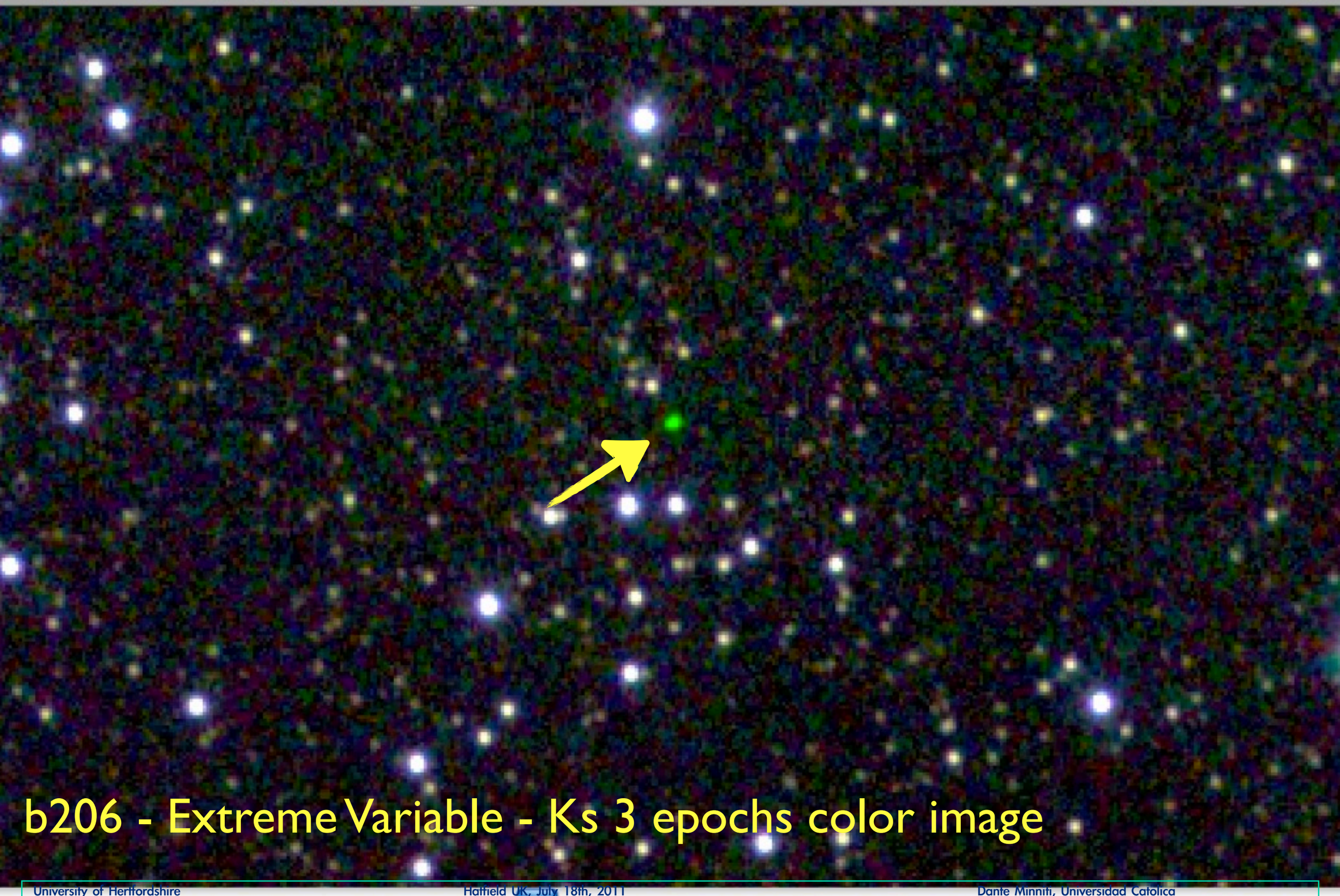
Extreme Variables

b206_epochs.jpeg

vvvsurvey.org

Sidebar

Search



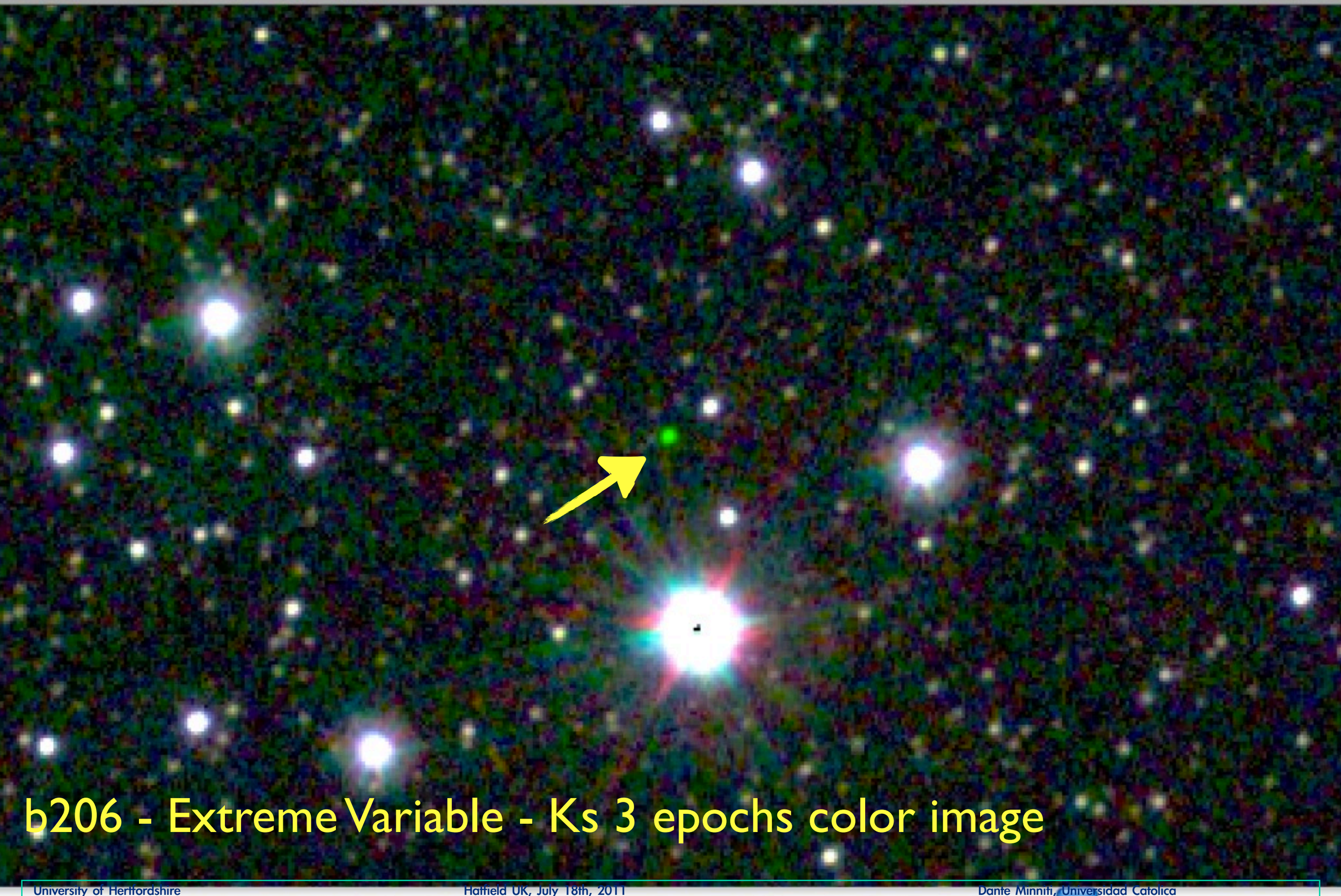
b206 - Extreme Variable - Ks 3 epochs color image

Extreme Variables

b206_epochs.jpeg

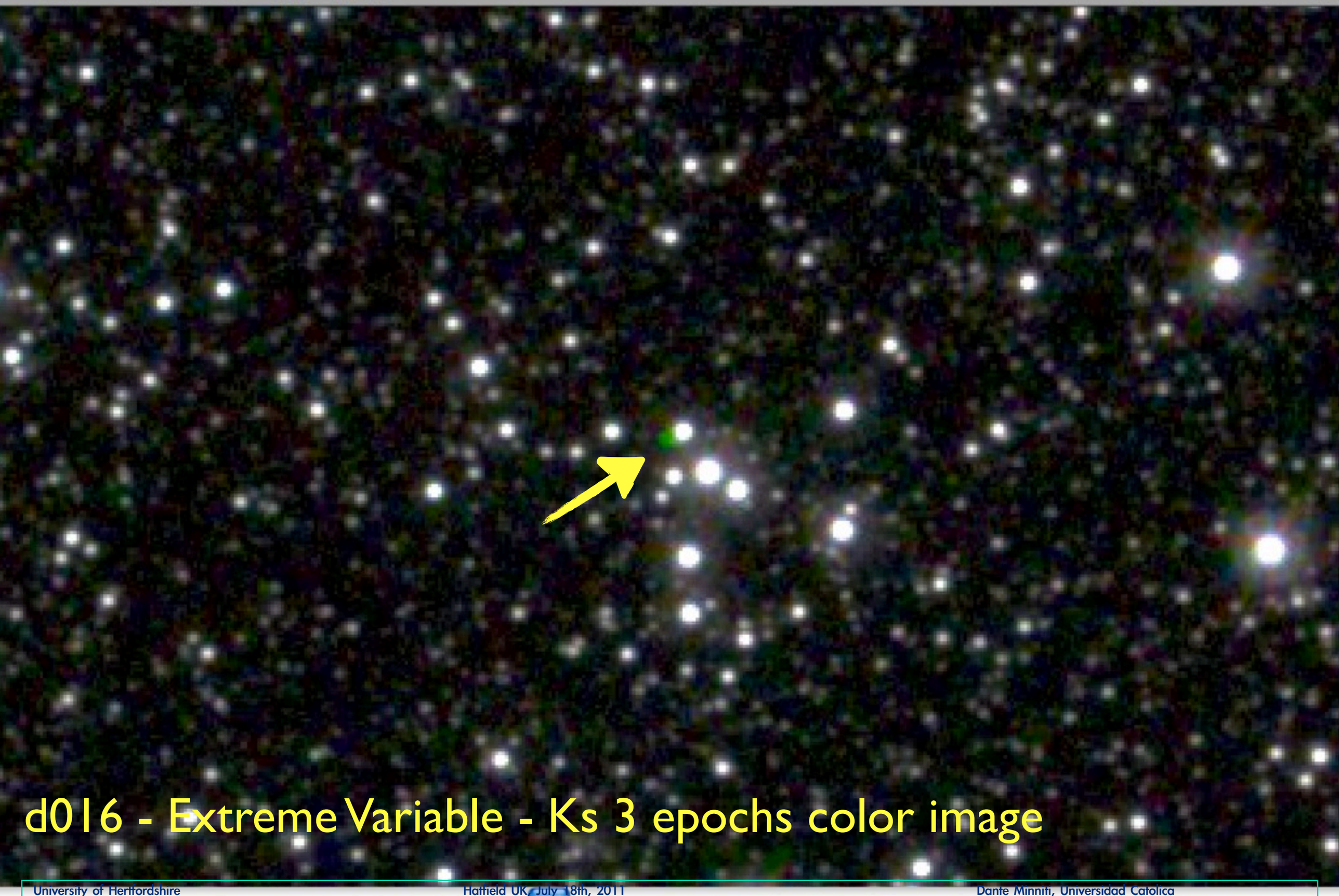
vvvsurvey.org

Sidebar



b206 - Extreme Variable - Ks 3 epochs color image

Extreme Variables



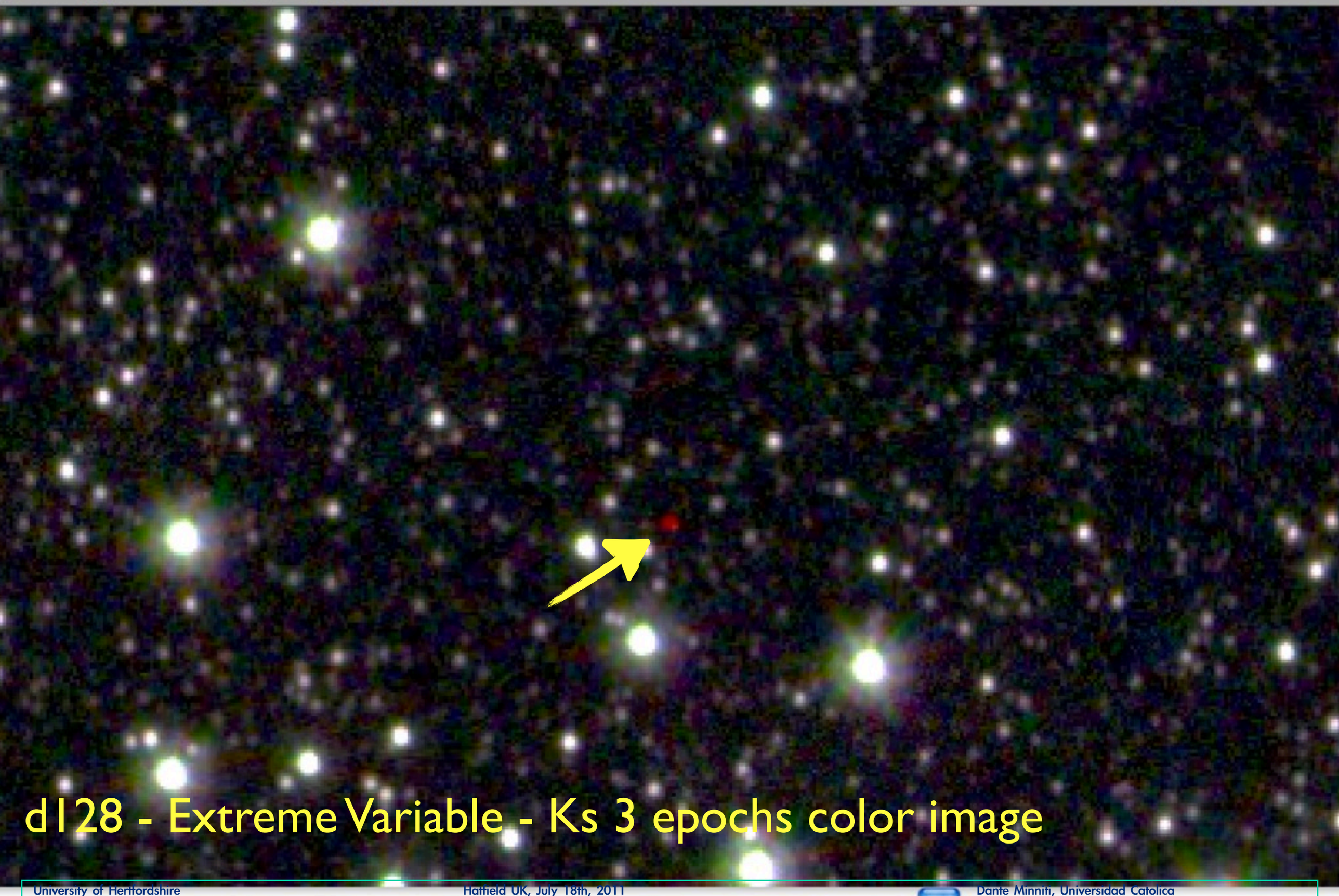
d016 - Extreme Variable - Ks 3 epochs color image

Extreme Variables

d128_epochs.jpeg

vvvsurvey.org

Sidebar



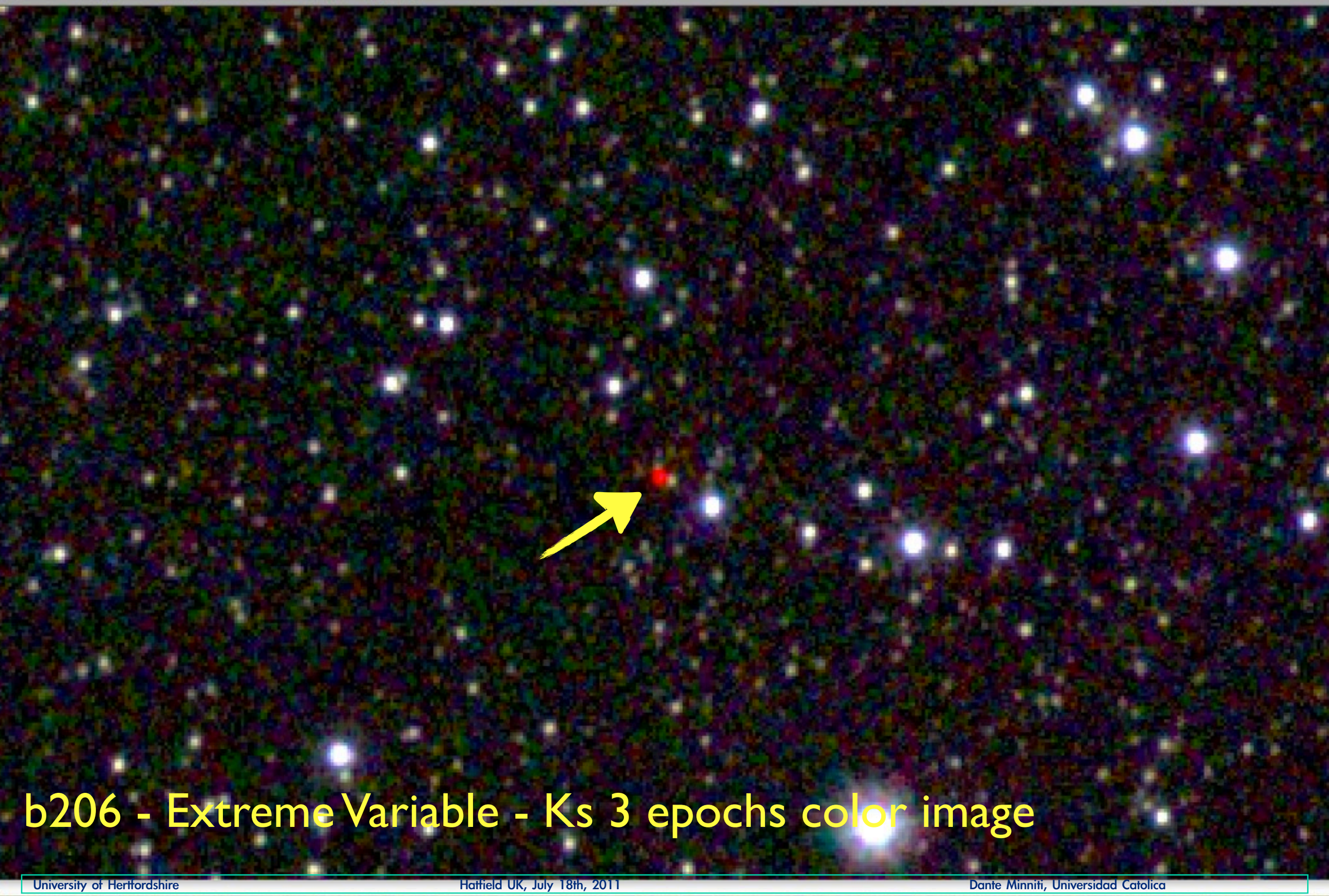
d128 - Extreme Variable - Ks 3 epochs color image

Extreme Variables

b206_epochs.jpeg

vvvsurvey.org

Sidebar



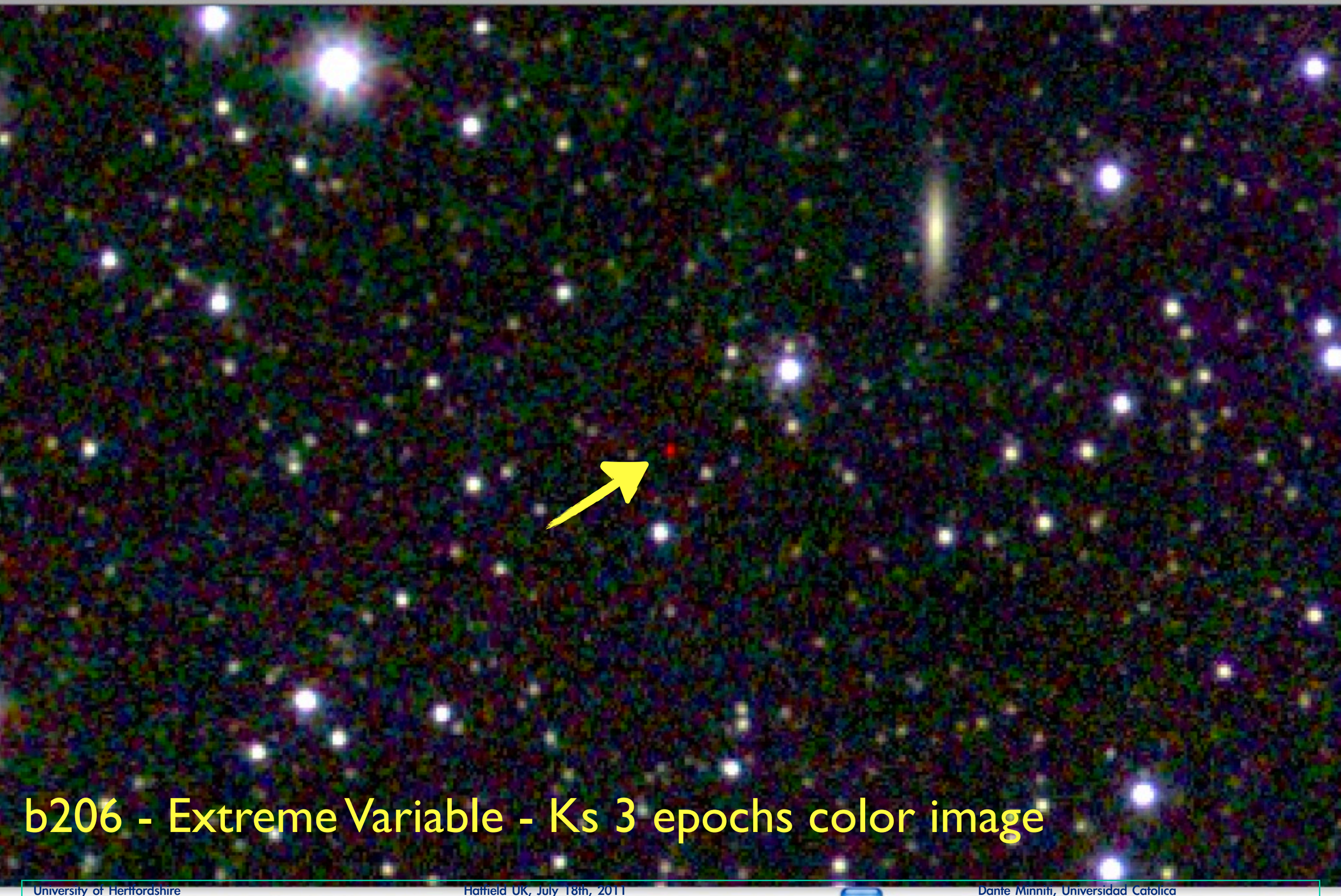
b206 - Extreme Variable - Ks 3 epochs color image

Extreme Variables

b206_epochs.jpeg

vvvsurvey.org

Sidebar



b206 - Extreme Variable - Ks 3 epochs color image

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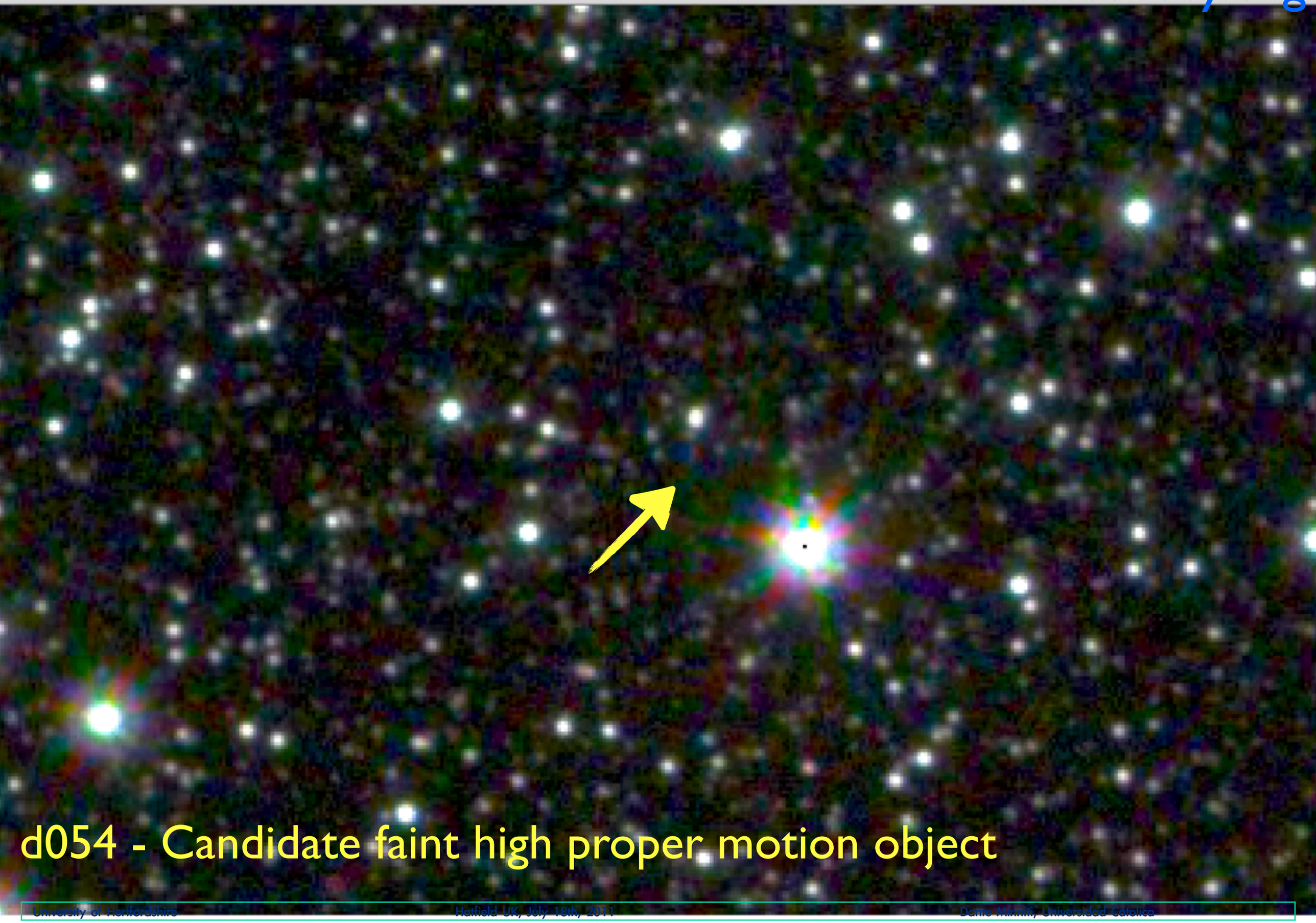
b206 - Large spiral galaxy - Ks 3 epochs color image.
There are thousands of galaxies in the VVV images.

d019 - Candidate SN in a distant galaxy

d054 - Candidate SN in a distant galaxy



d054 - Candidate faint high proper motion object

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d054 - Candidate faint high proper motion object

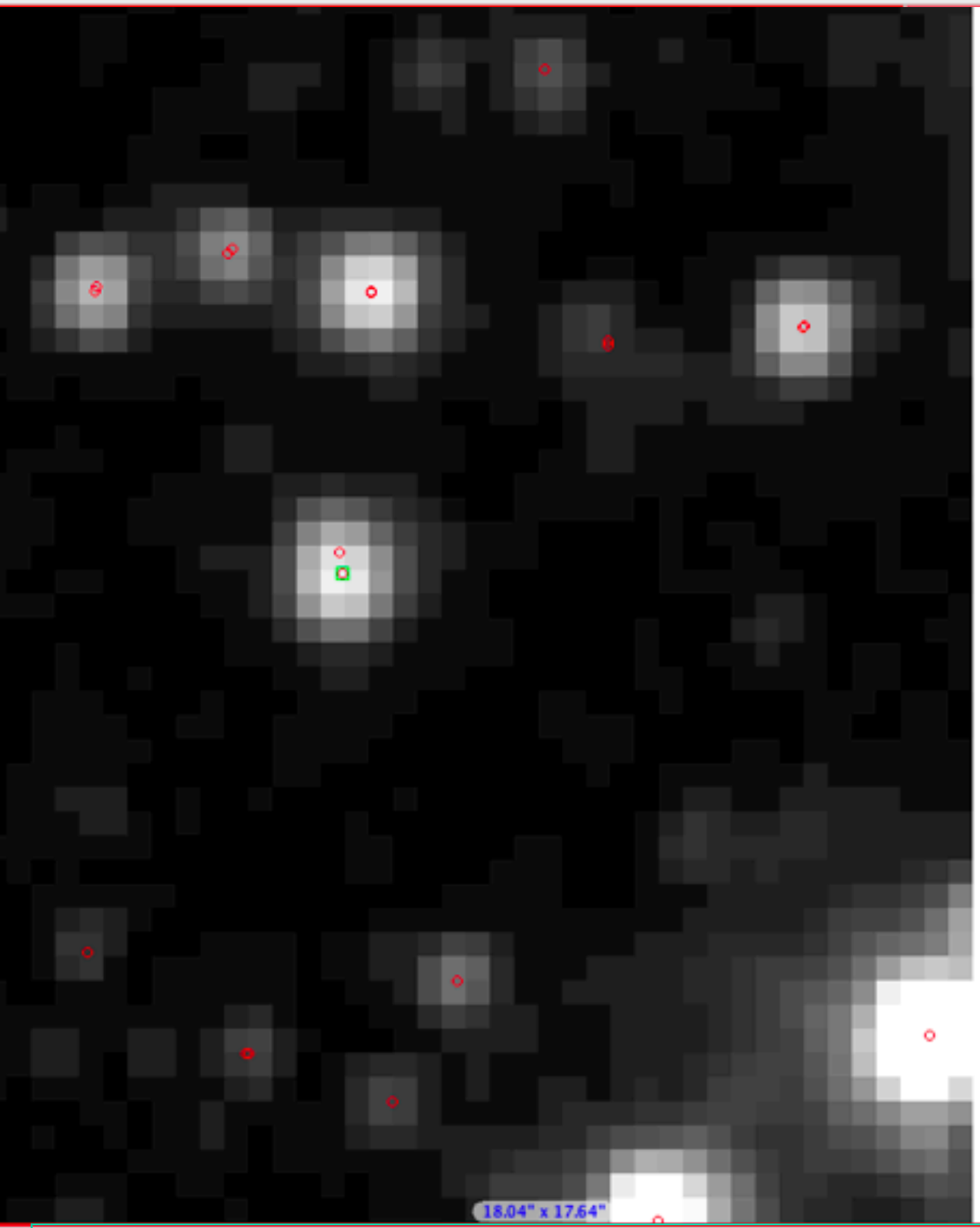
d054 - Candidate faint high proper motion object

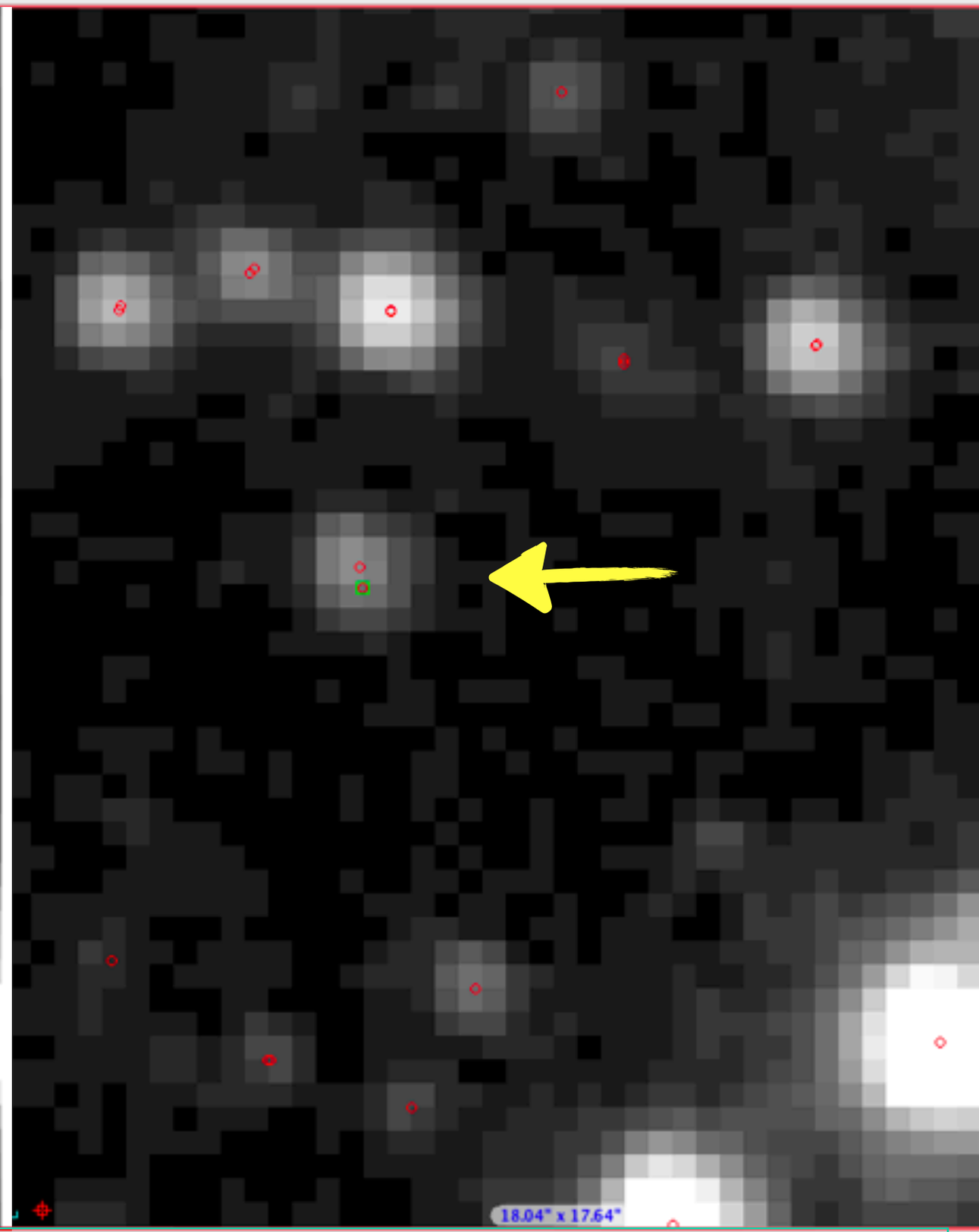
d054 - Candidate faint high proper motion object

Aladin v7.0 *** BETA VERSION (based on v7.046) ***

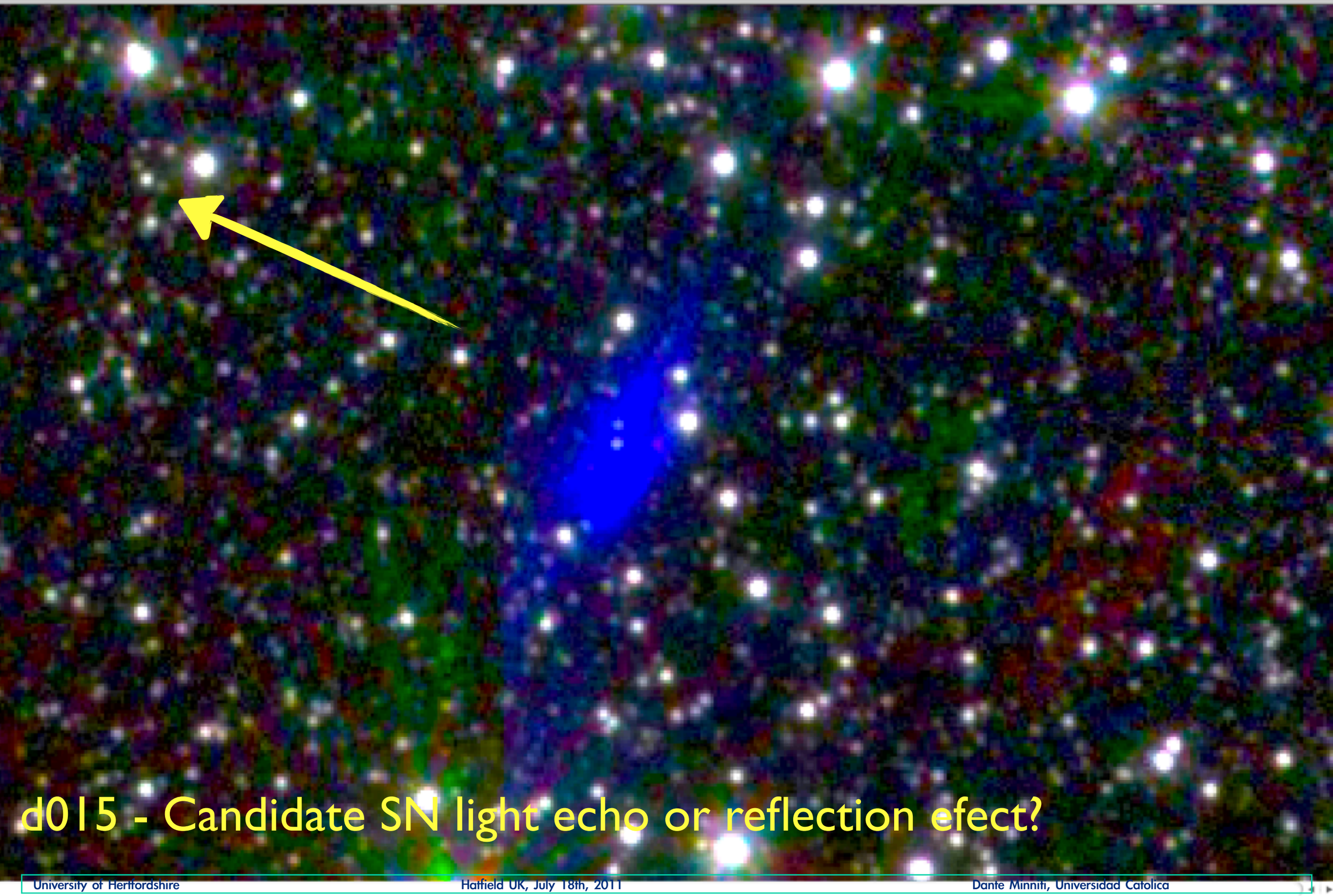
-00.95926

oad NED PPMX 2MASS





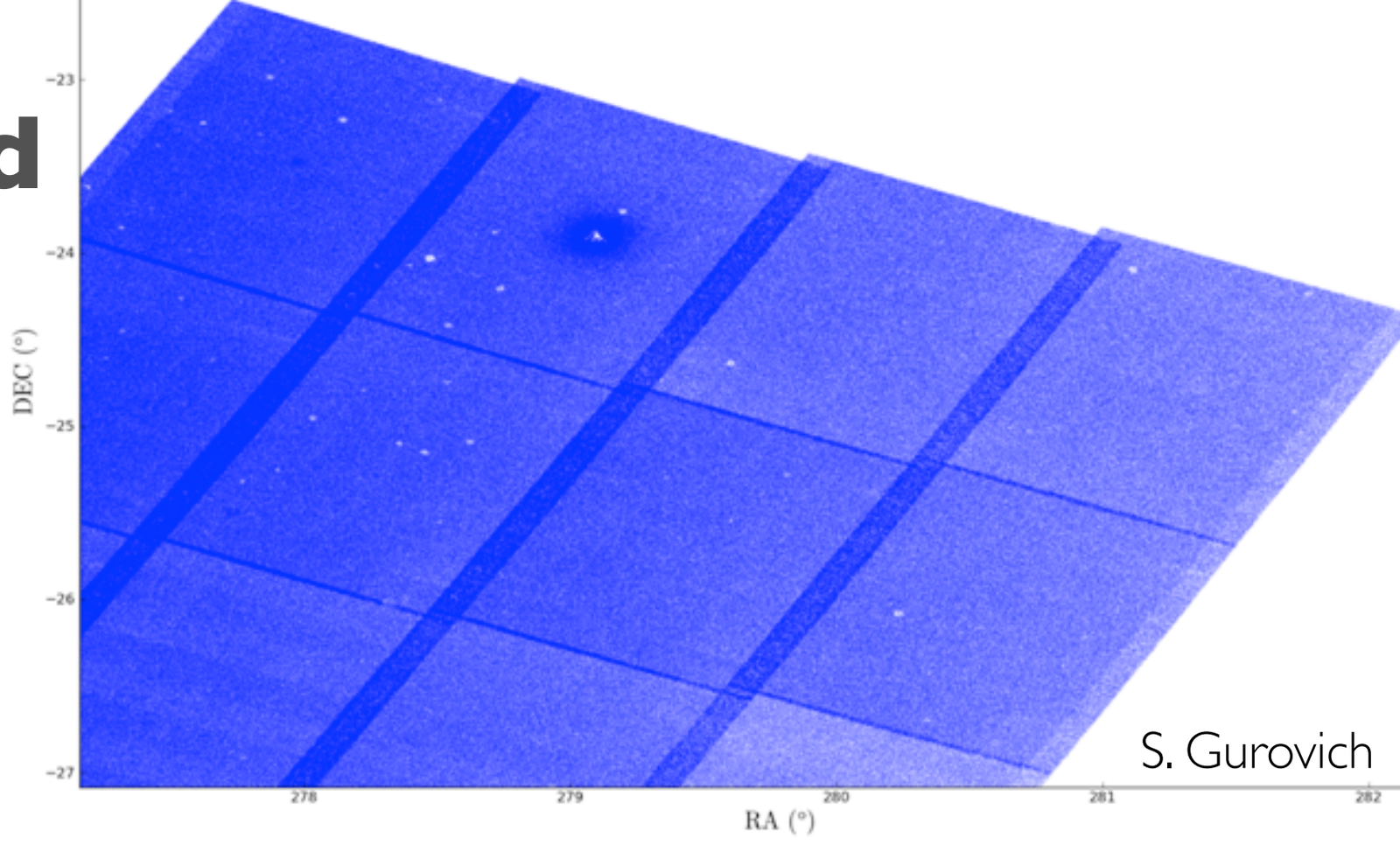
d015 - Candidate bright high proper motion object



d015 - Candidate SN light echo or reflection efect?

Astrometry and photometry in overlap areas

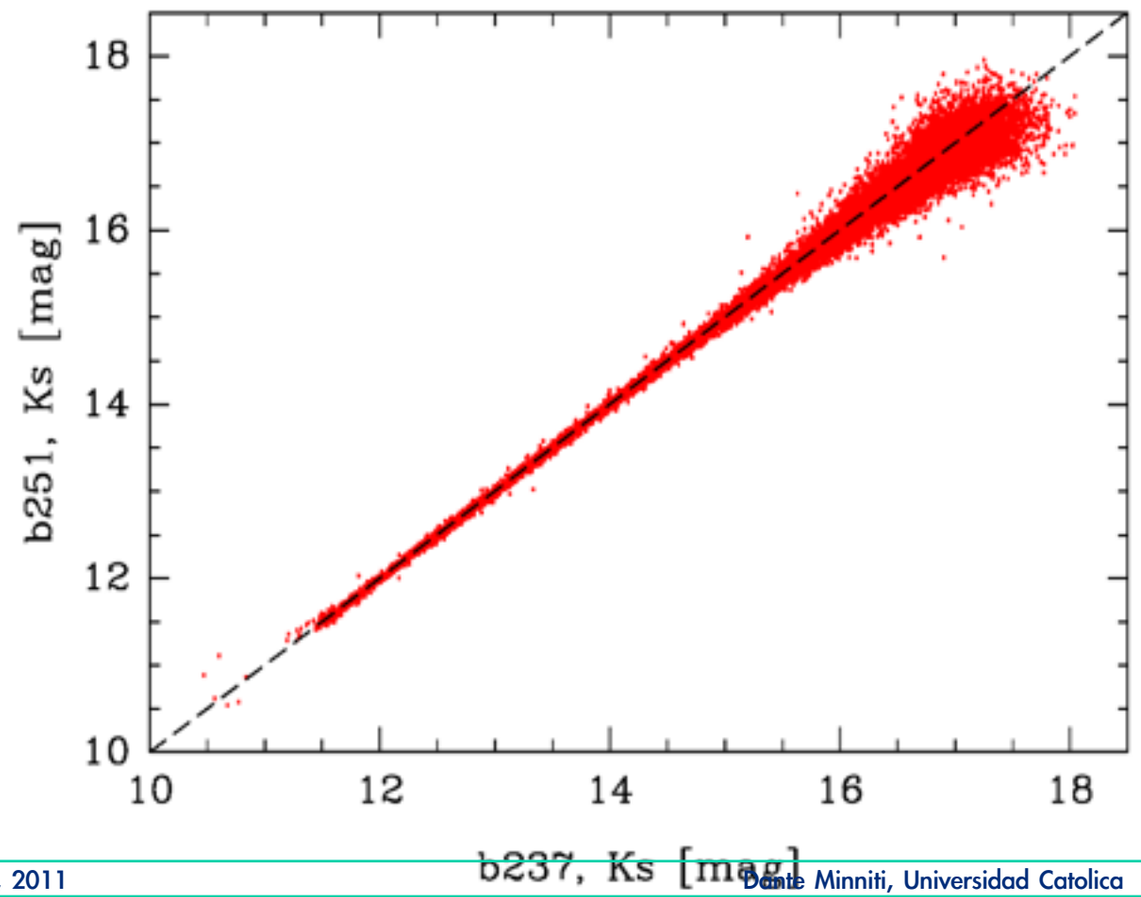
Total overlapping areas ~42 sqdeg !!!



S. Gurovich

Useful for QC and overall calibration.

This doubles the number of points for millions of light curves.



R. Saito

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.

I Think It's Going To Be A Long Long Time
(Elton John)
“And all this science I don't understand
it's just my job five days a week”