UNC | BOARD OF TRUSTEES

STRATEGIC FRAMEWORK COMMITTEE

March 28, 2018, 4:30PM
Chancellor's Ballroom East, Carolina Inn

OPEN SESSION

FOR INFORMATION ONLY
(No formal action is requested at this time)

1. Chair's Remarks
   Julia Grumbles, UNC-CH Board of Trustees

2. Creativity Hubs
   Terry Magnuson, Vice Chancellor for Research
   - UNC's Evryscope: A Watchful Eye on the Entire Sky
     Nick Law, Assistant Professor, Physics & Astronomy
   - From Molecules to Organisms: Pushing the limits of Fluorescence Microscopy
     Wesley Legant, Assistant Professor, Pharmacology and Biomedical Engineering

COMMITTEE MEMBERS
Julia Sprunt Grumbles, Chair
Kelly Matthews Hopkins, Vice Chair
Jefferson W. Brown
W. Lowry Caudill
Allie Ray McCullen
Hari H. Nath

Administrative Liaison:
Bob Blouin, Executive Vice Chancellor and Provost
Judith Cone, Vice Chancellor for Innovation, Entrepreneurship, & Economic Development

UNC's Evryscopes: Watchful Eyes on the Entire Sky

Nicholas Law

Assistant Professor

Dept. of Physics and Astronomy

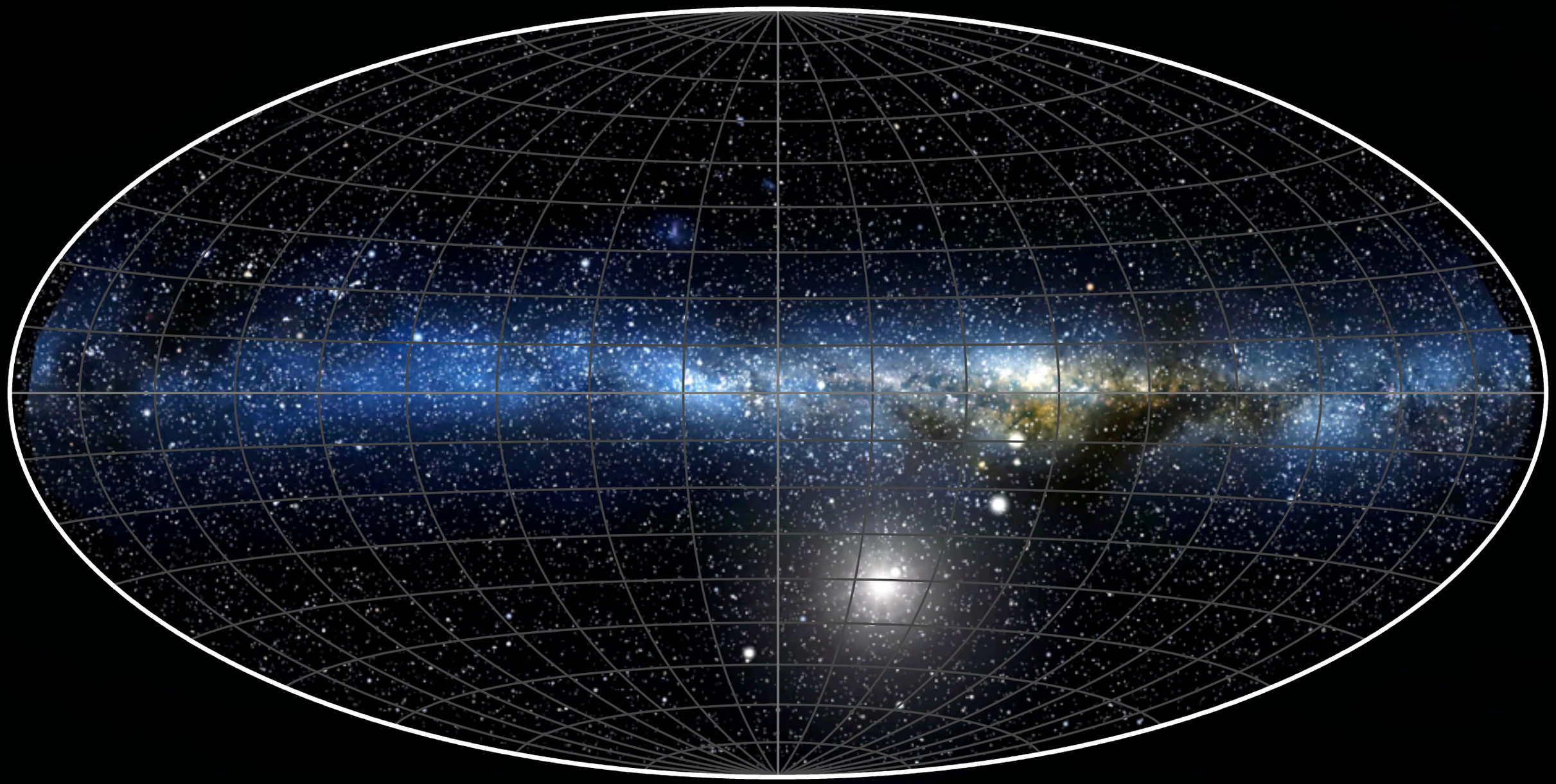
University of North Carolina, Chapel Hill

XRP/NNX15AC91G

ATI: 1407589

CAREER: 1555175

The dynamic sky

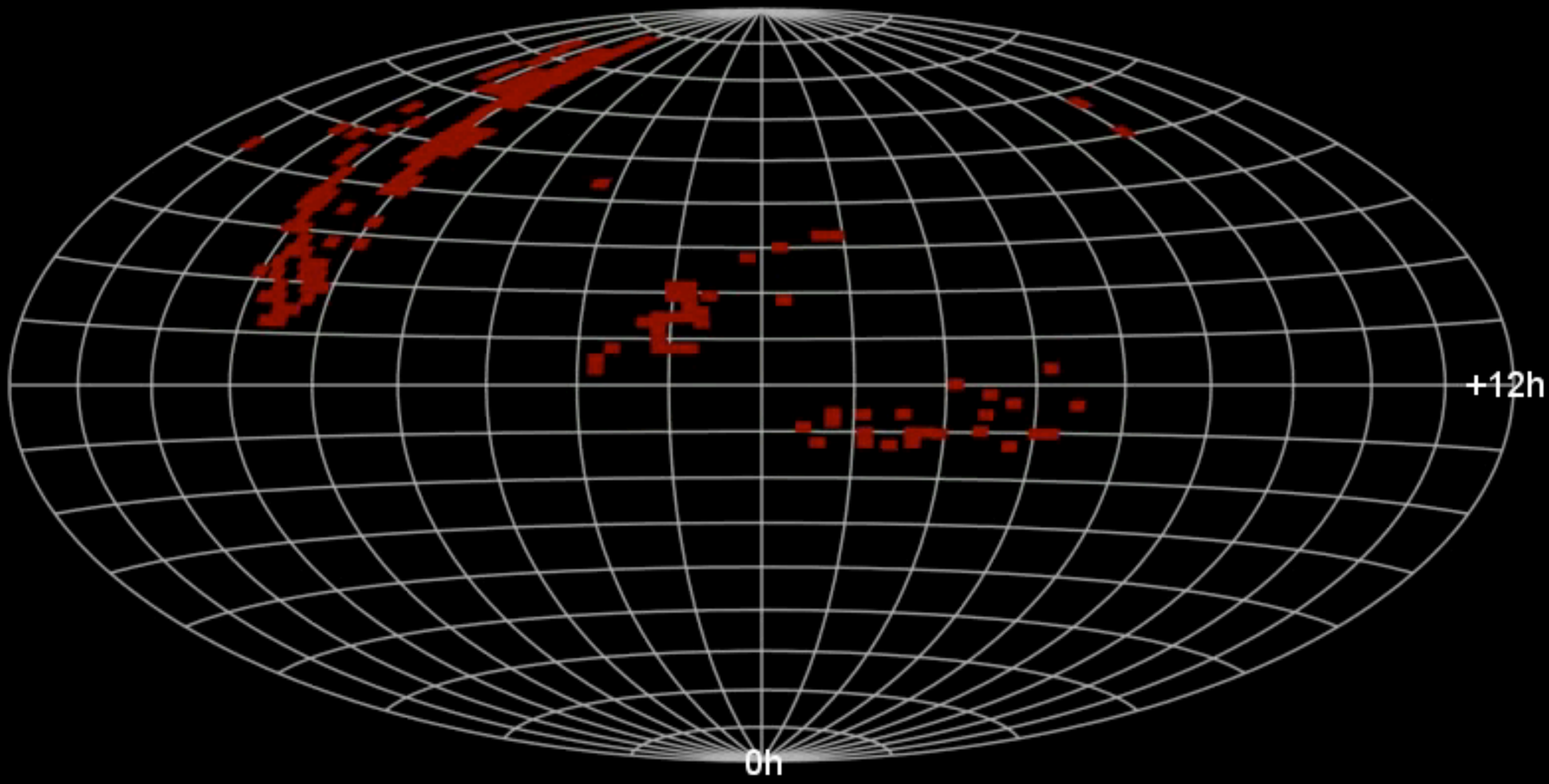


Standard sky surveys: tiling across the sky

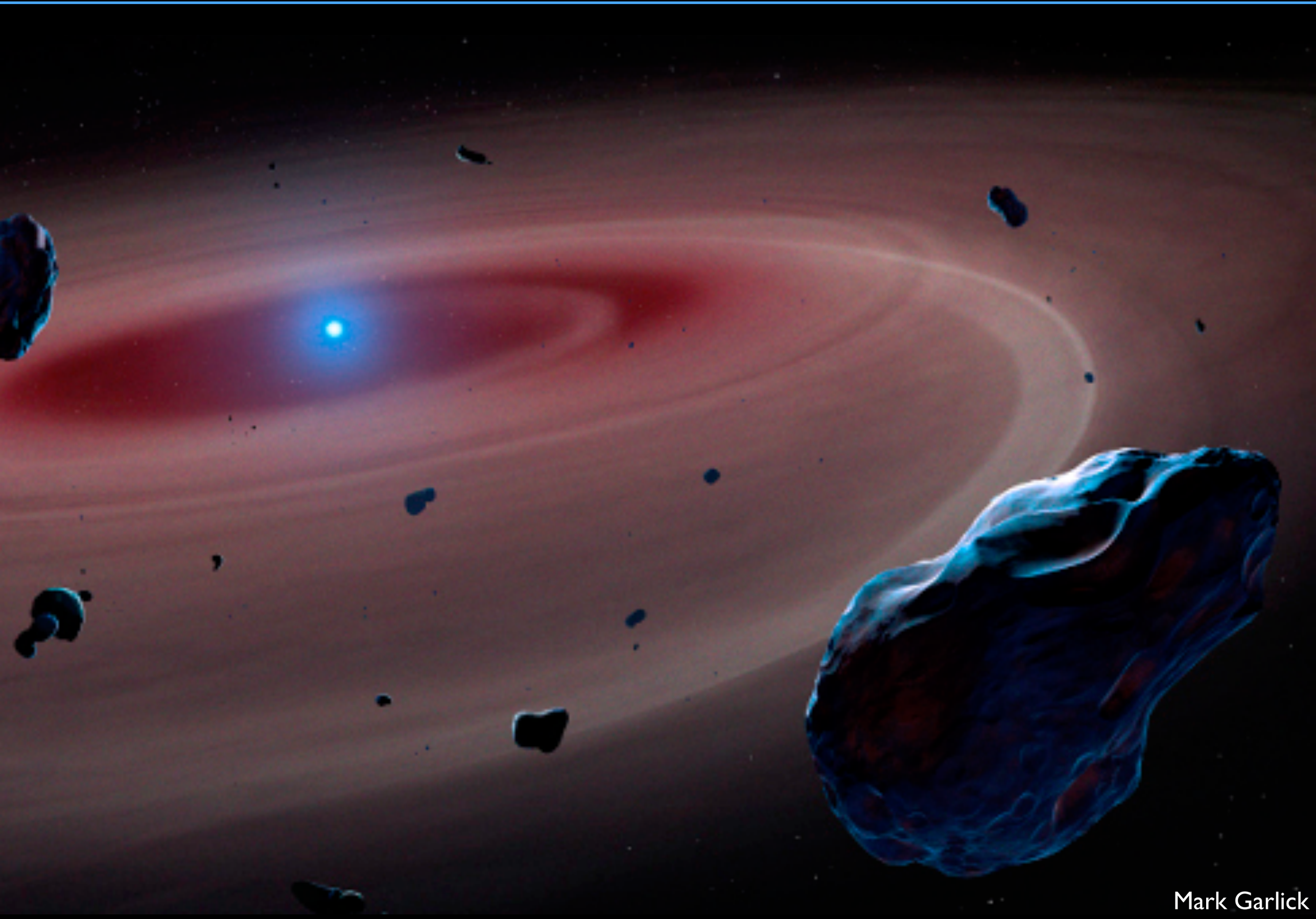
PTF supernova survey: Law et al. 2009

Standard sky surveys: tiling across the sky

PTF supernova survey: Law et al. 2009

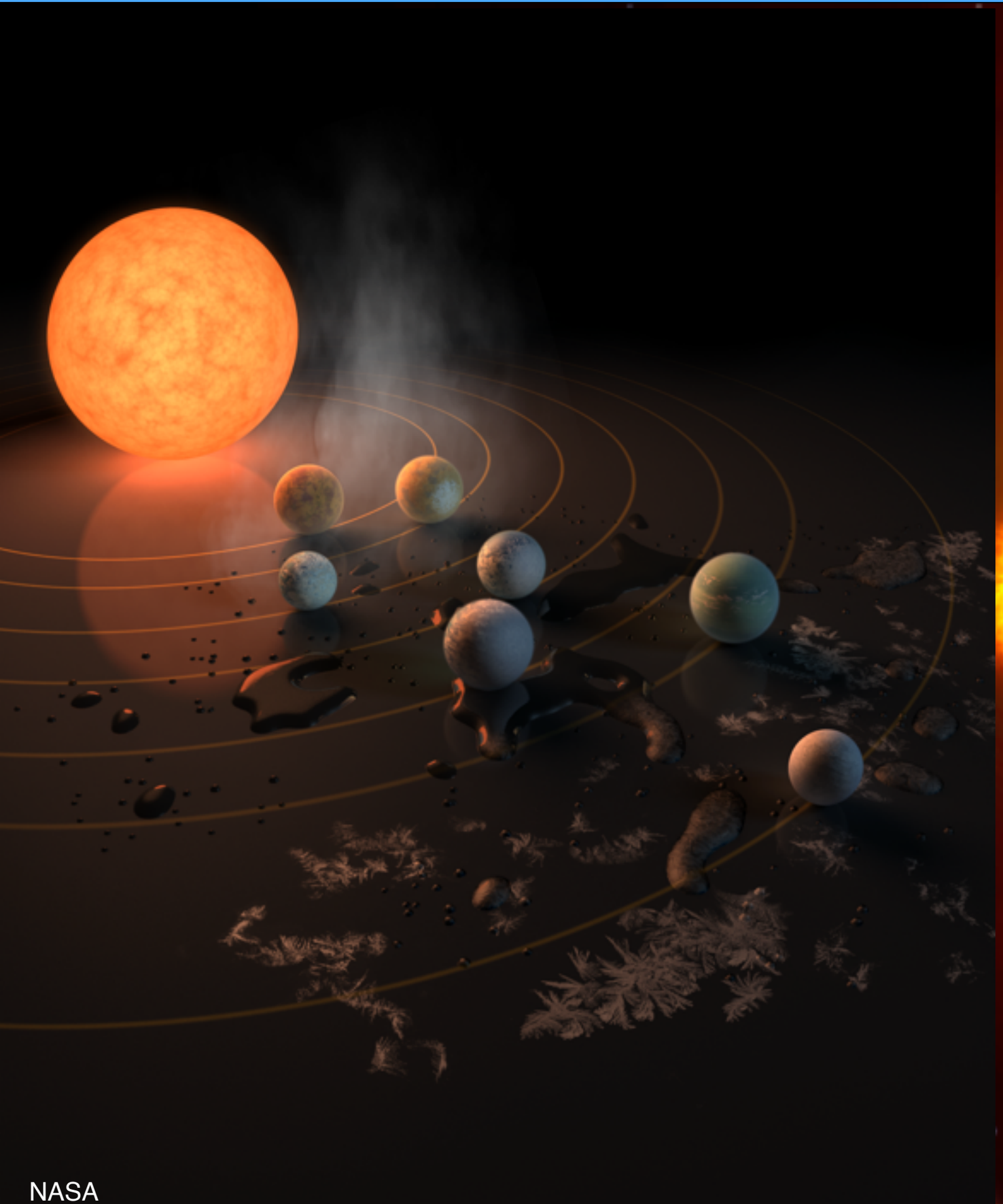


White dwarf transits



Mark Garlick

Exoplanet habitability & flares



NASA

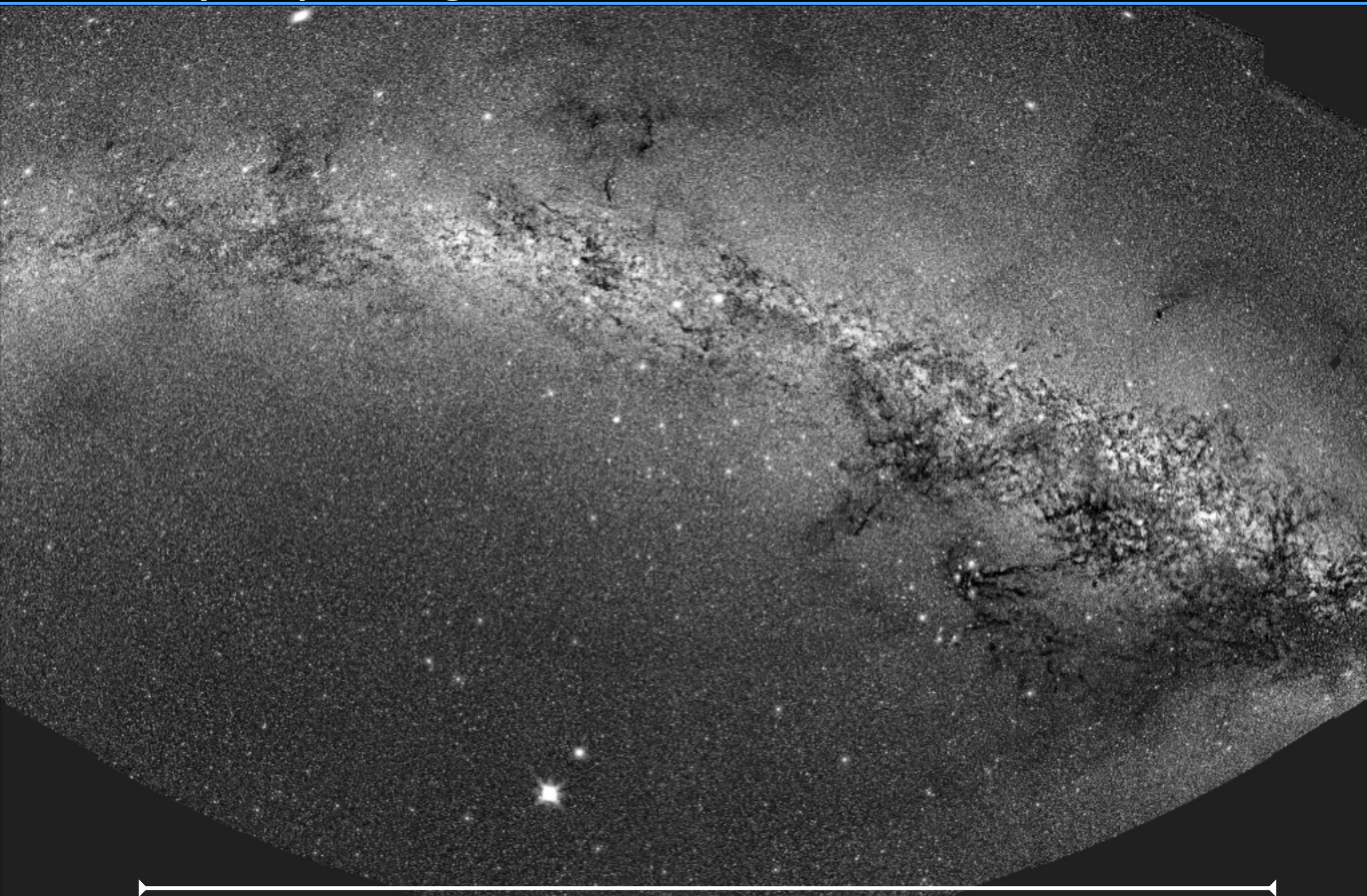
The Evryscope ("wide-seer")

"Bug-eyed" - Popular Mechanics

"Looks more like an architectural folly than a telescope" - Science

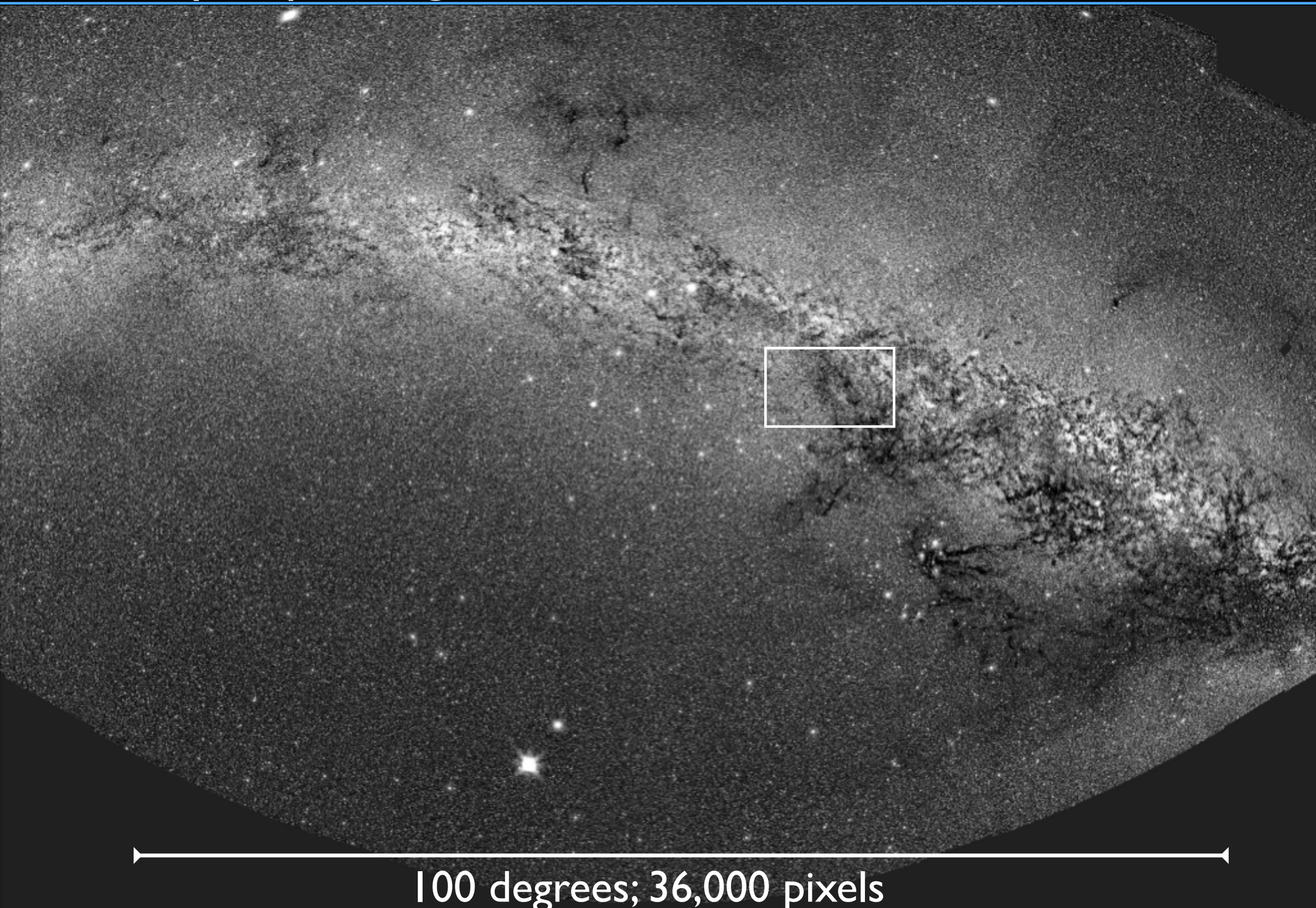
"Like an upside-down colander repurposed into a Star Trek prop" - Science News

One Evryscope Image

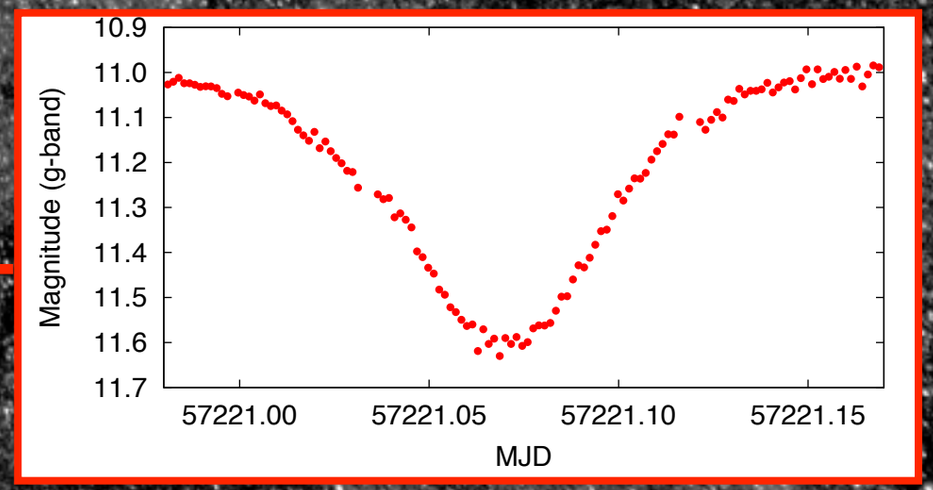


100 degrees; 36,000 pixels

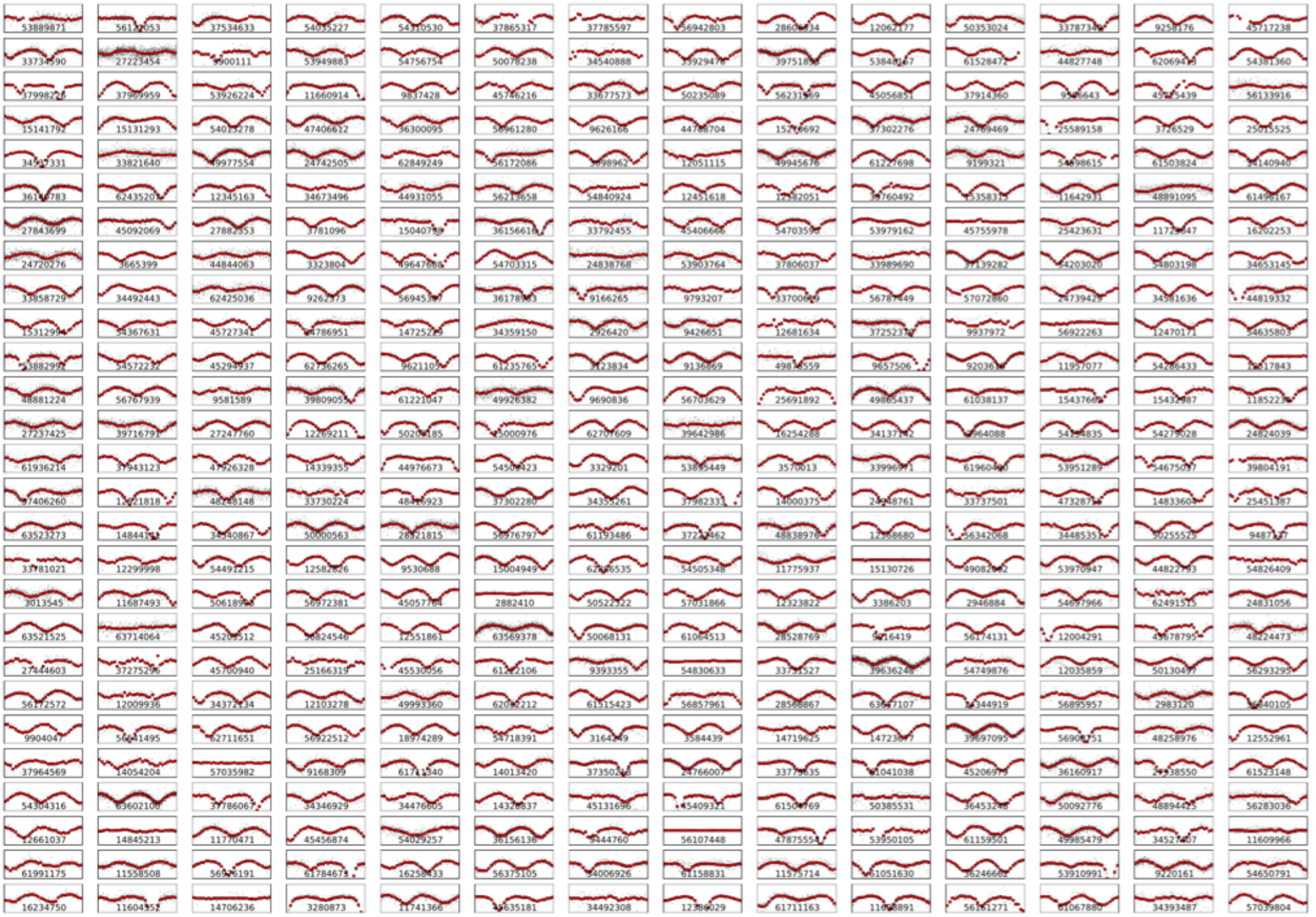
One Evryscope Image



1% of Evryscope field of view



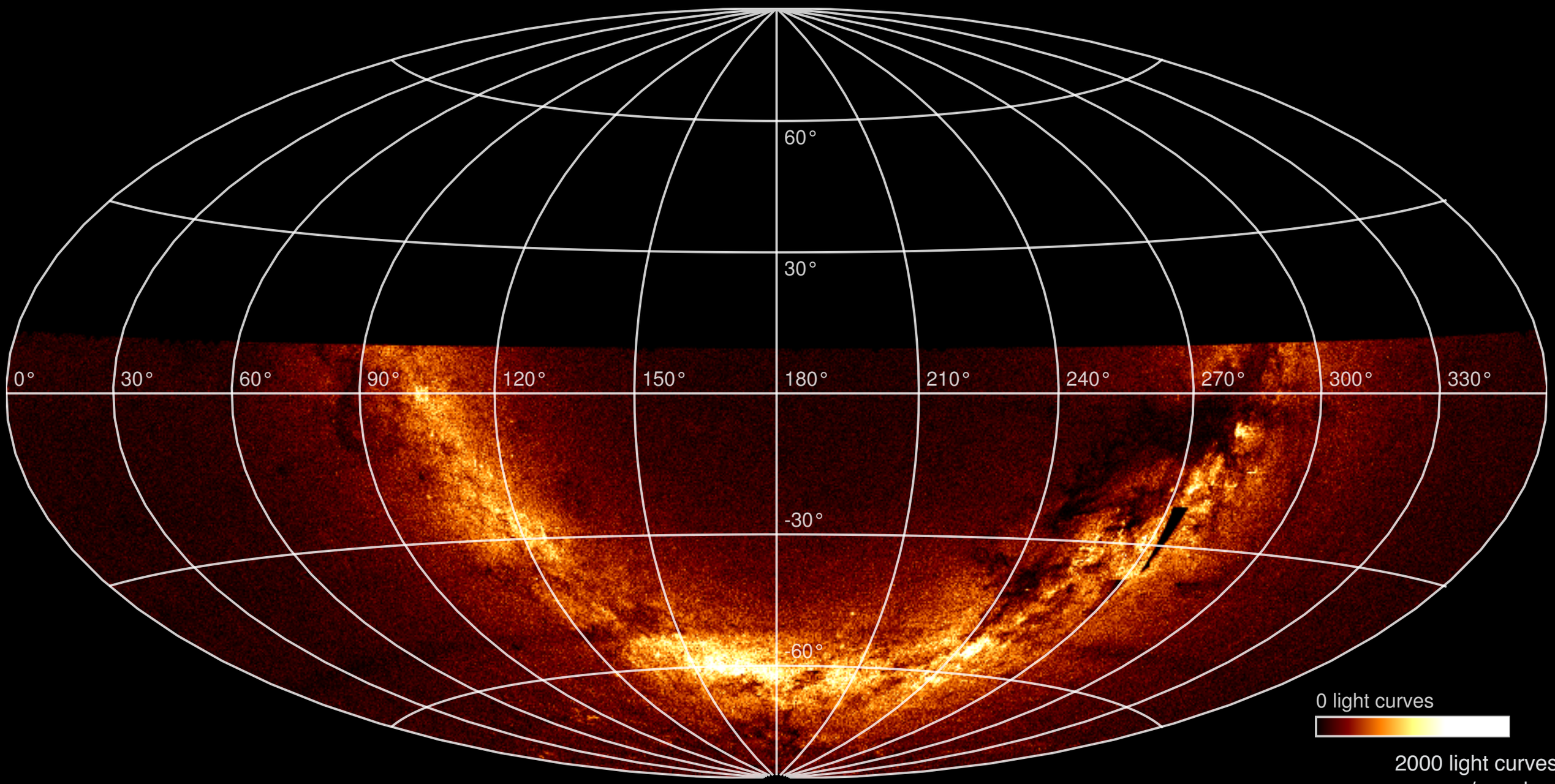
Bright Southern eclipsing binaries



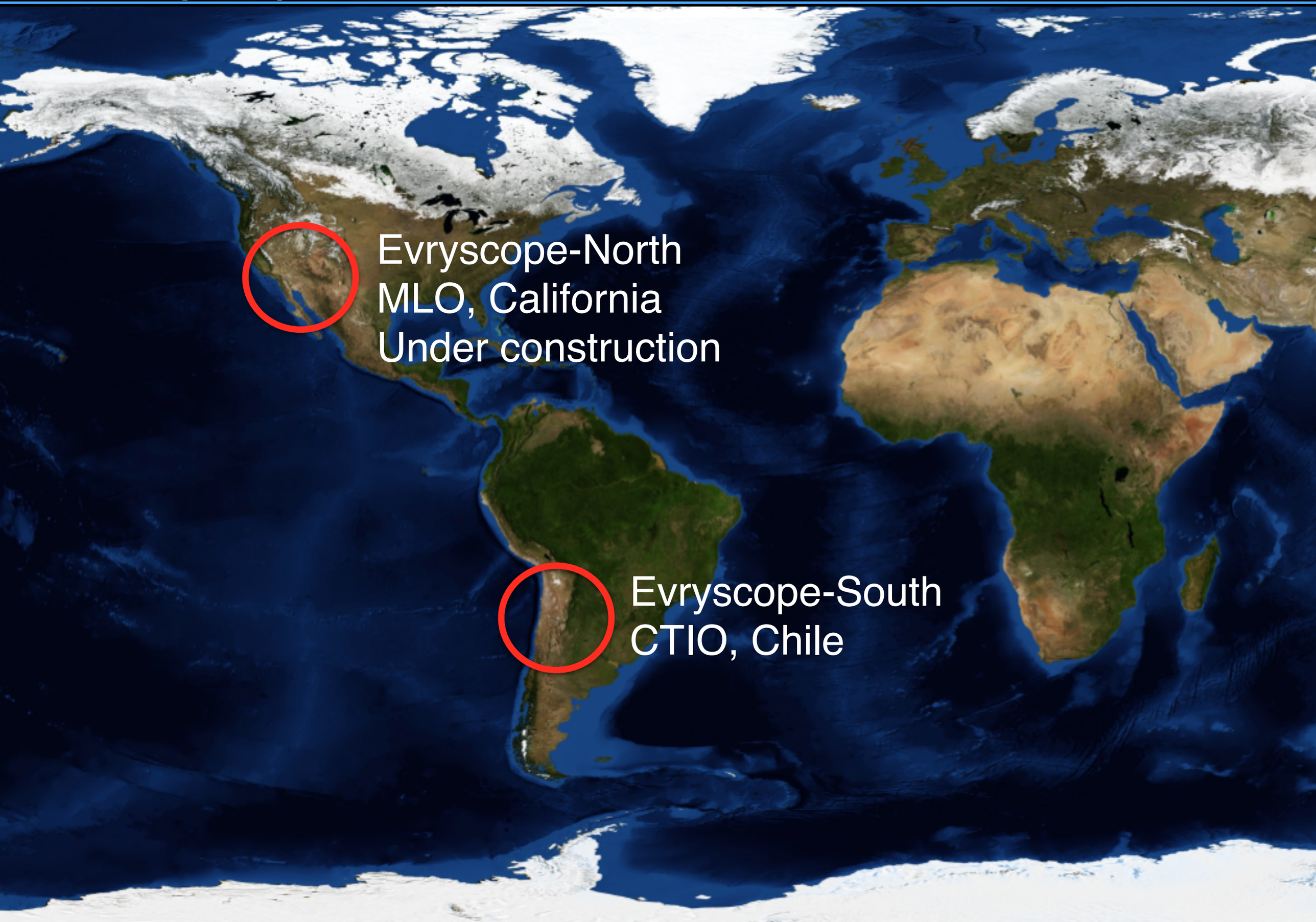
Bright Southern eclipsing binaries

Evryscope DB sky coverage

~1 billion photometric measurements per night
Total imaging data ~1PB/year.



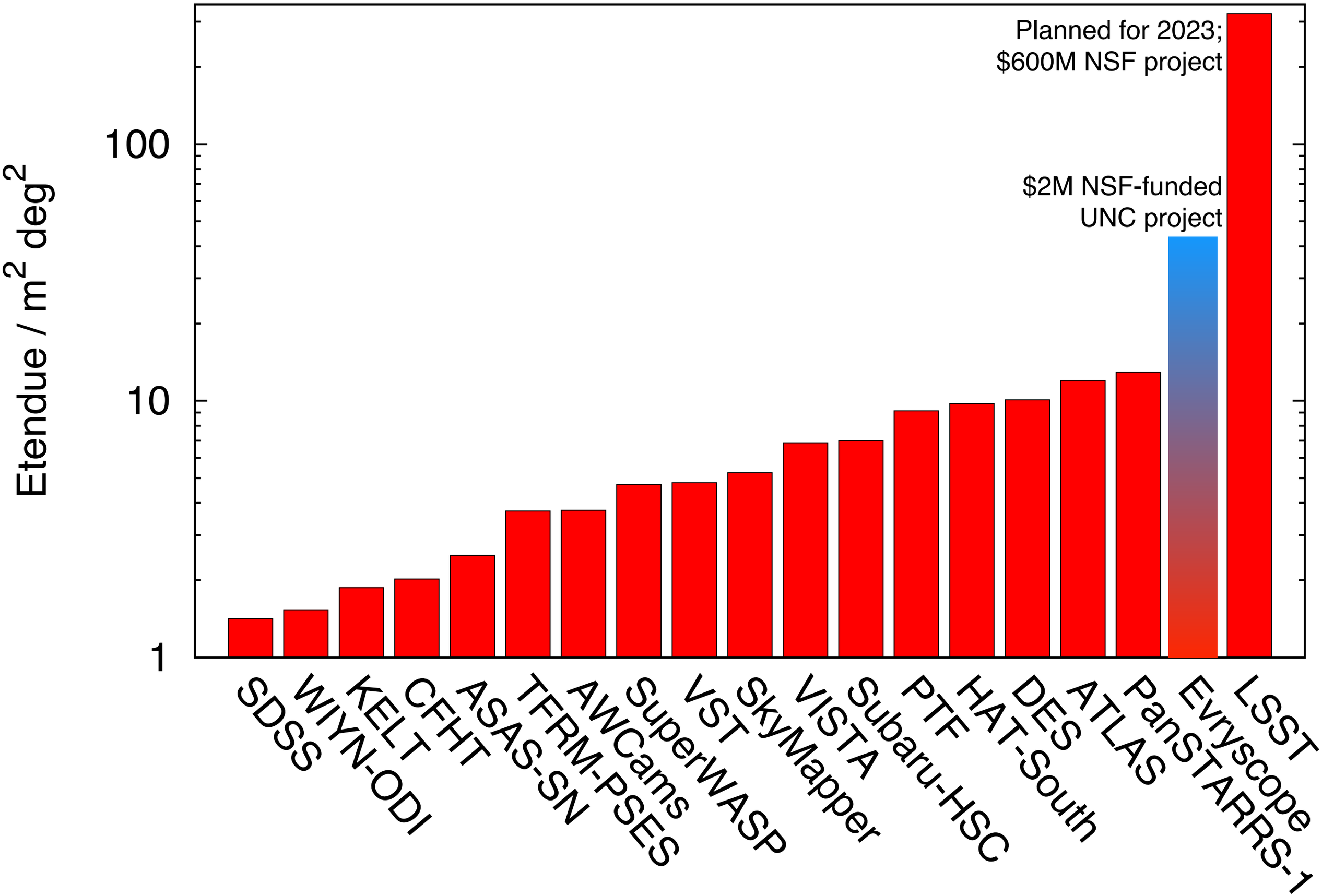
The Evryscopes



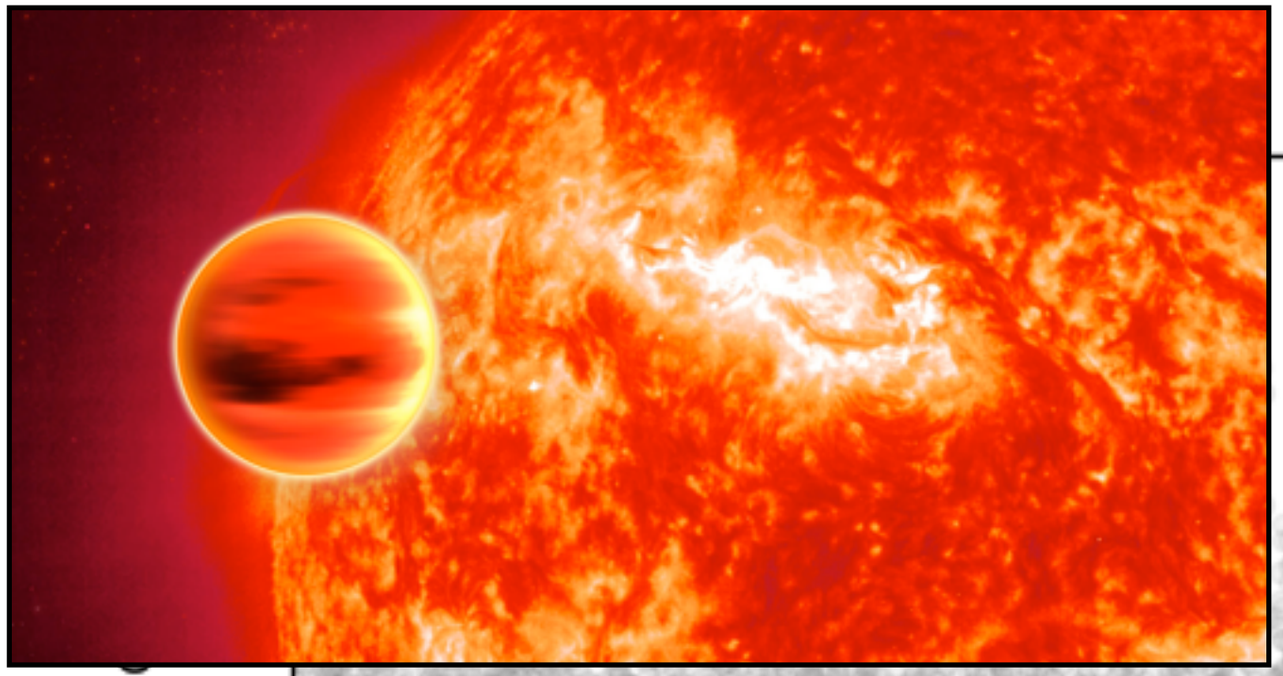
Building Evryscope-North

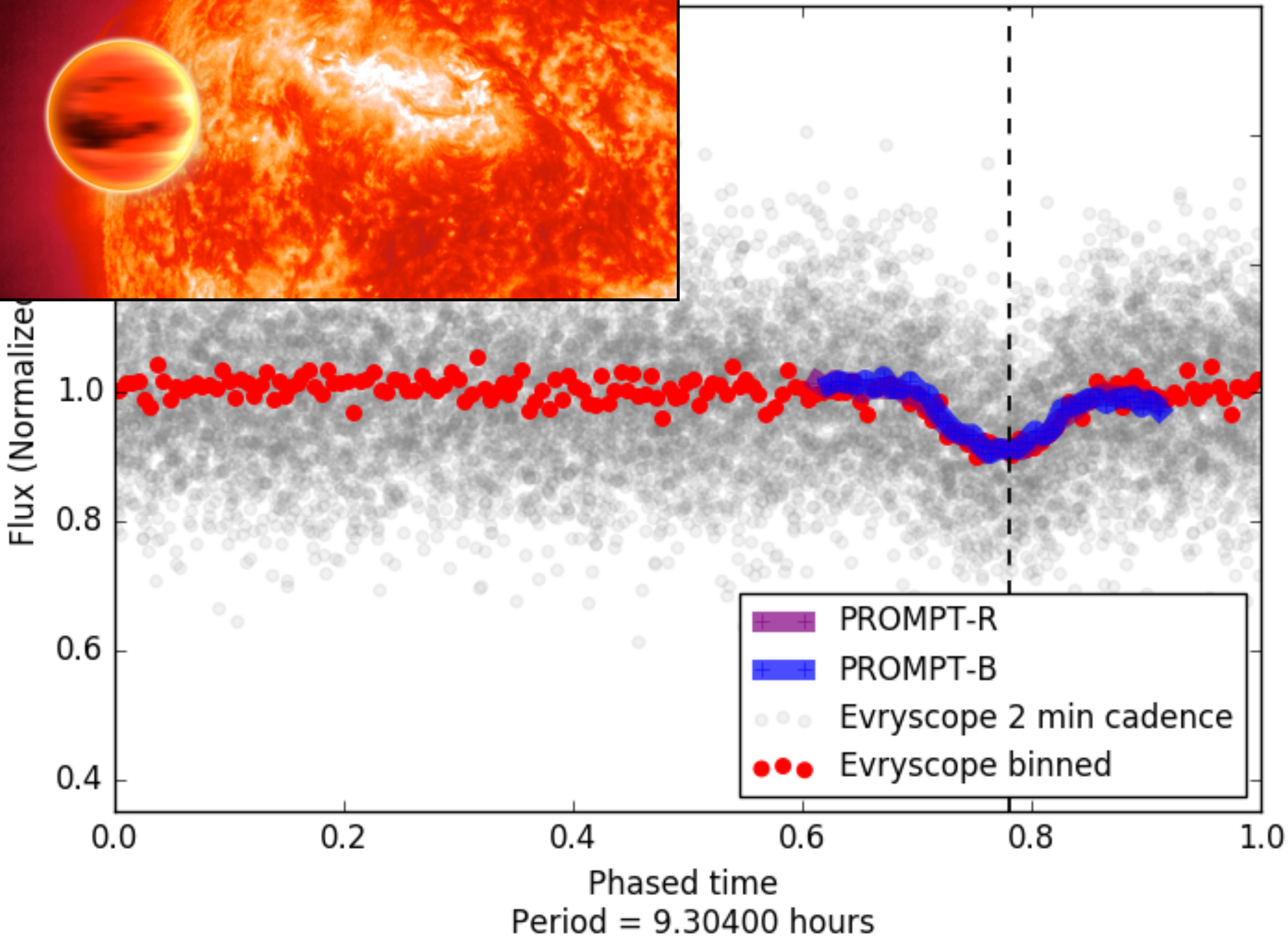
Building Evryscope-North

Optimizing sky area instead of telescope size



New planet candidates





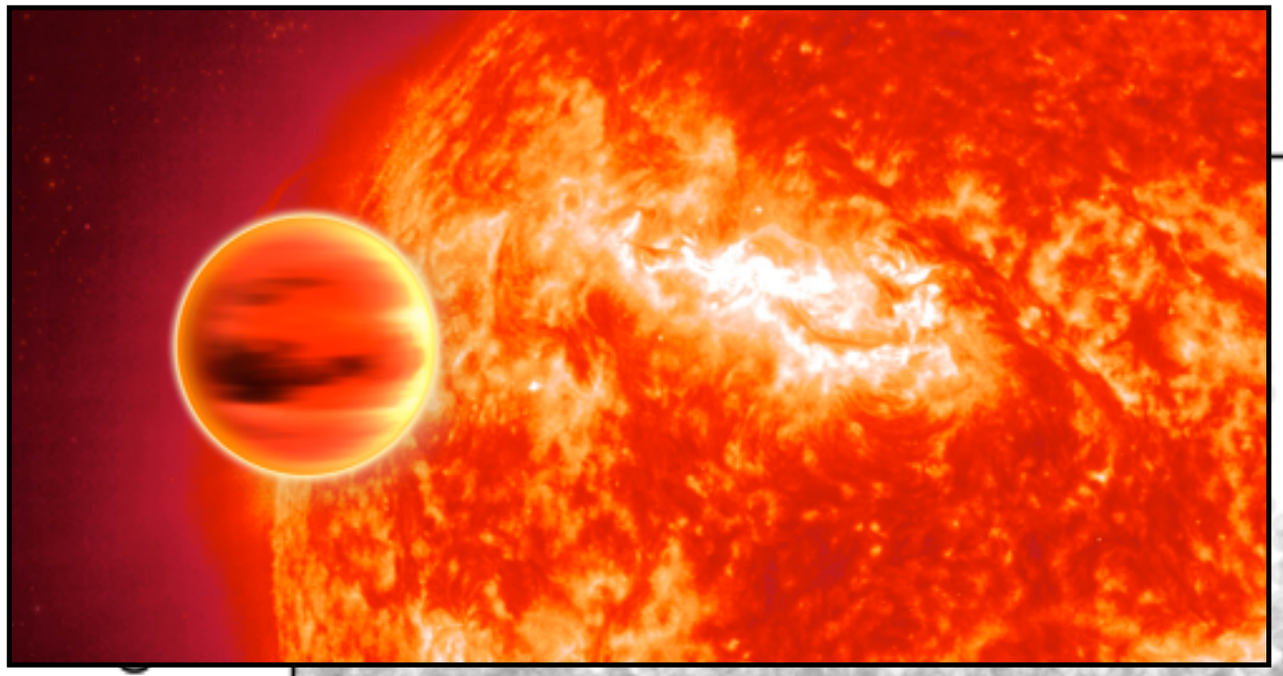
PROMPT array
6 1/2m telescopes

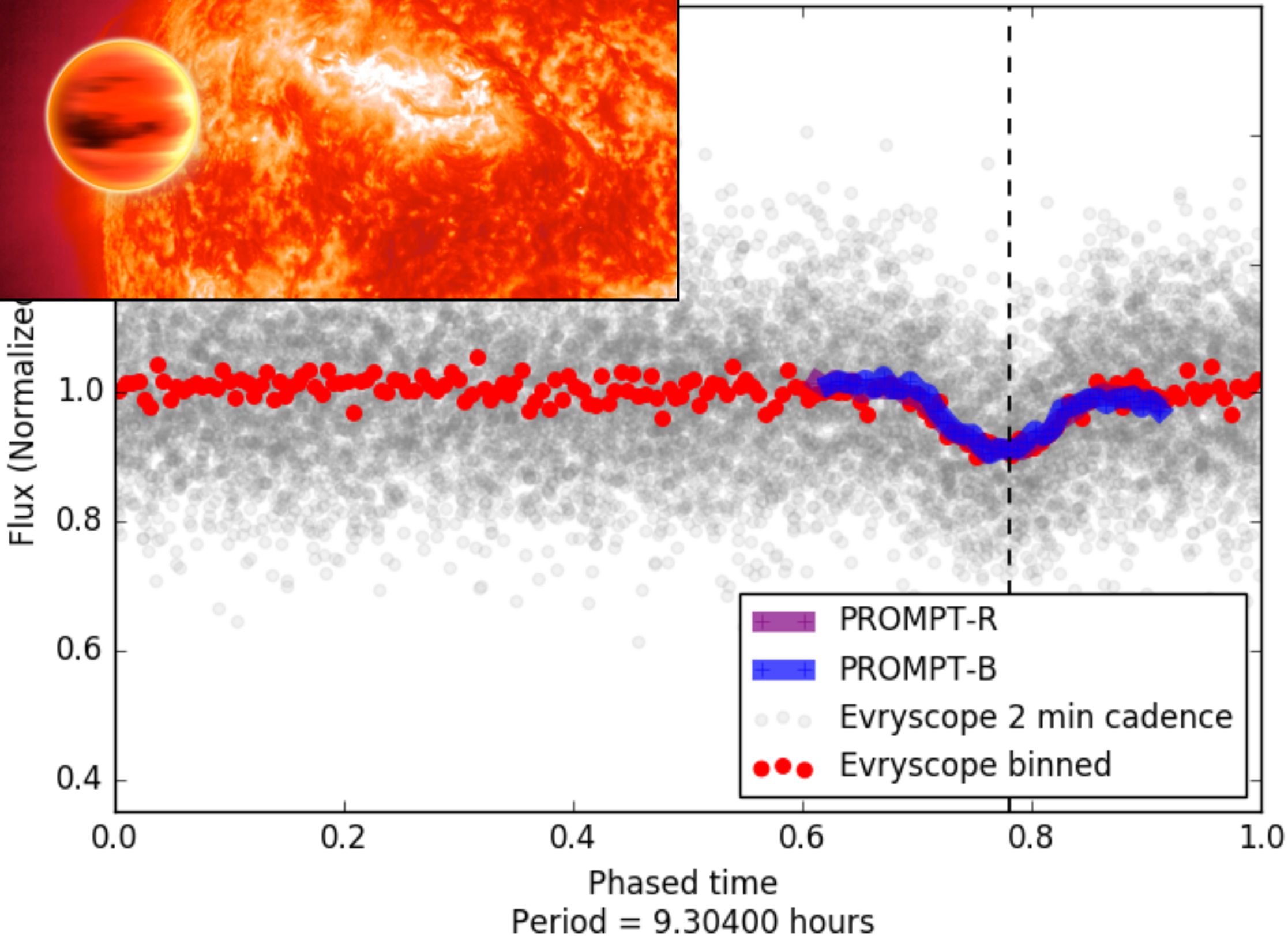
11m SALT
One of the largest optical telescopes in the world

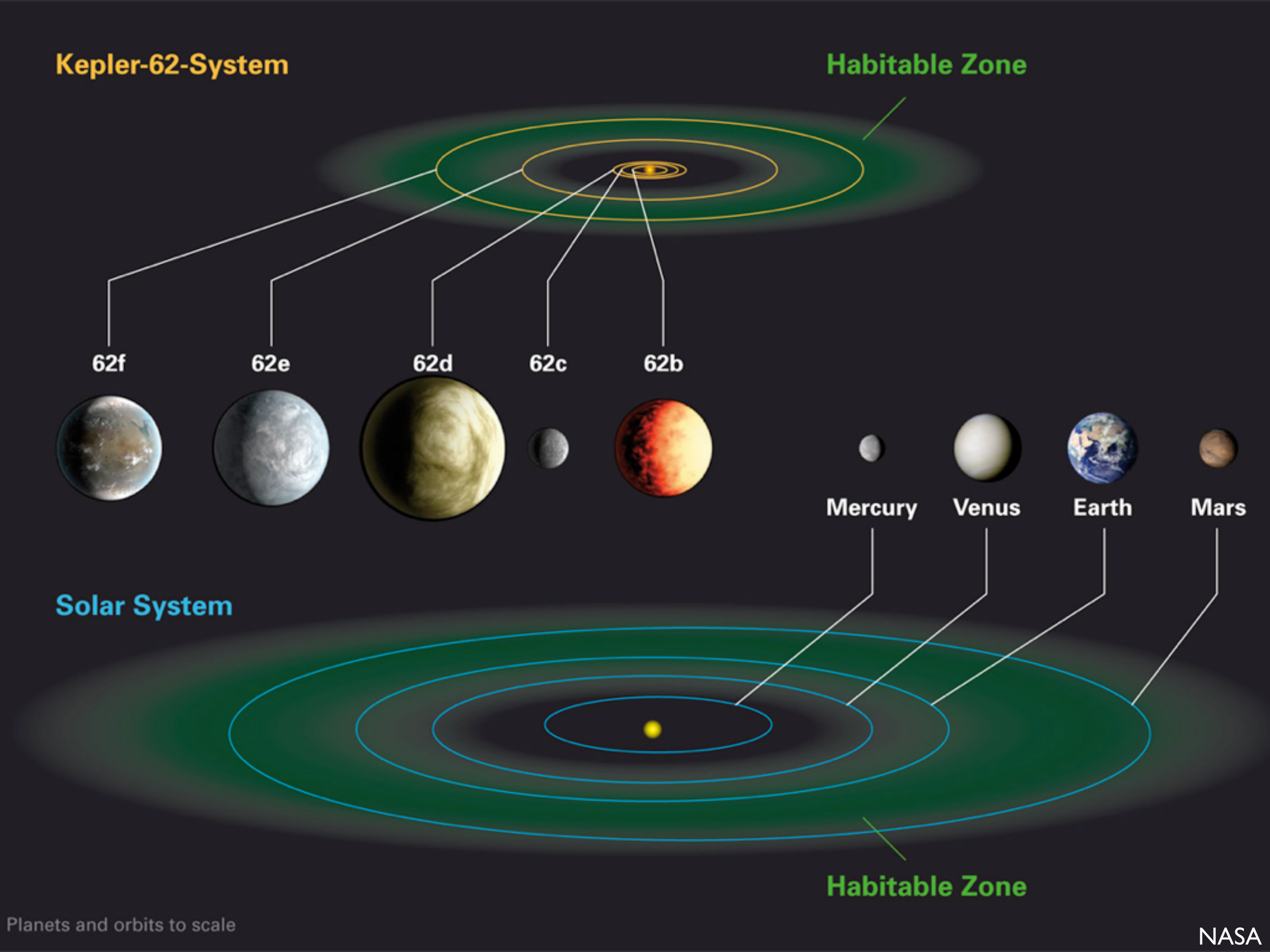
4m SOAR
Spectrographs & high-res imaging

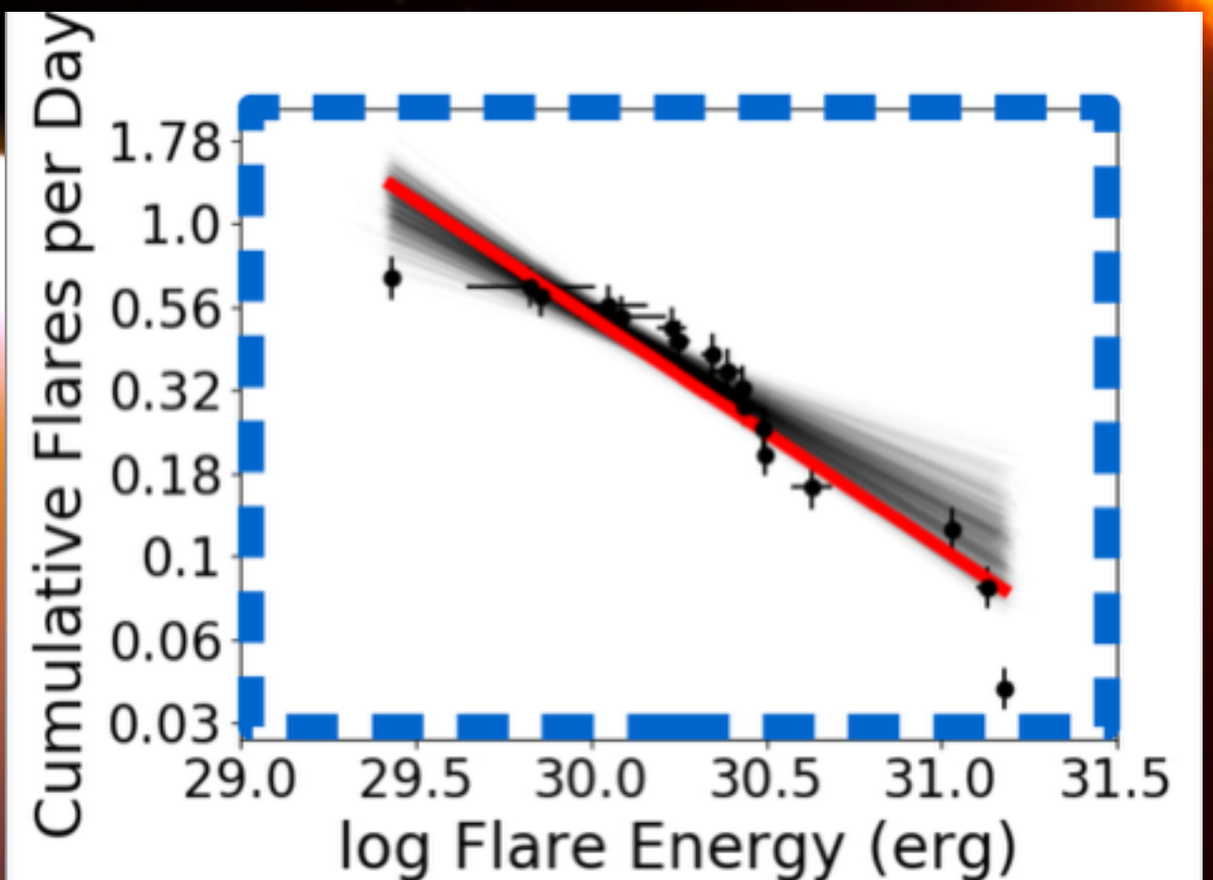
Evryscope:
the first all-sky gigapixel telescope

New planet candidates





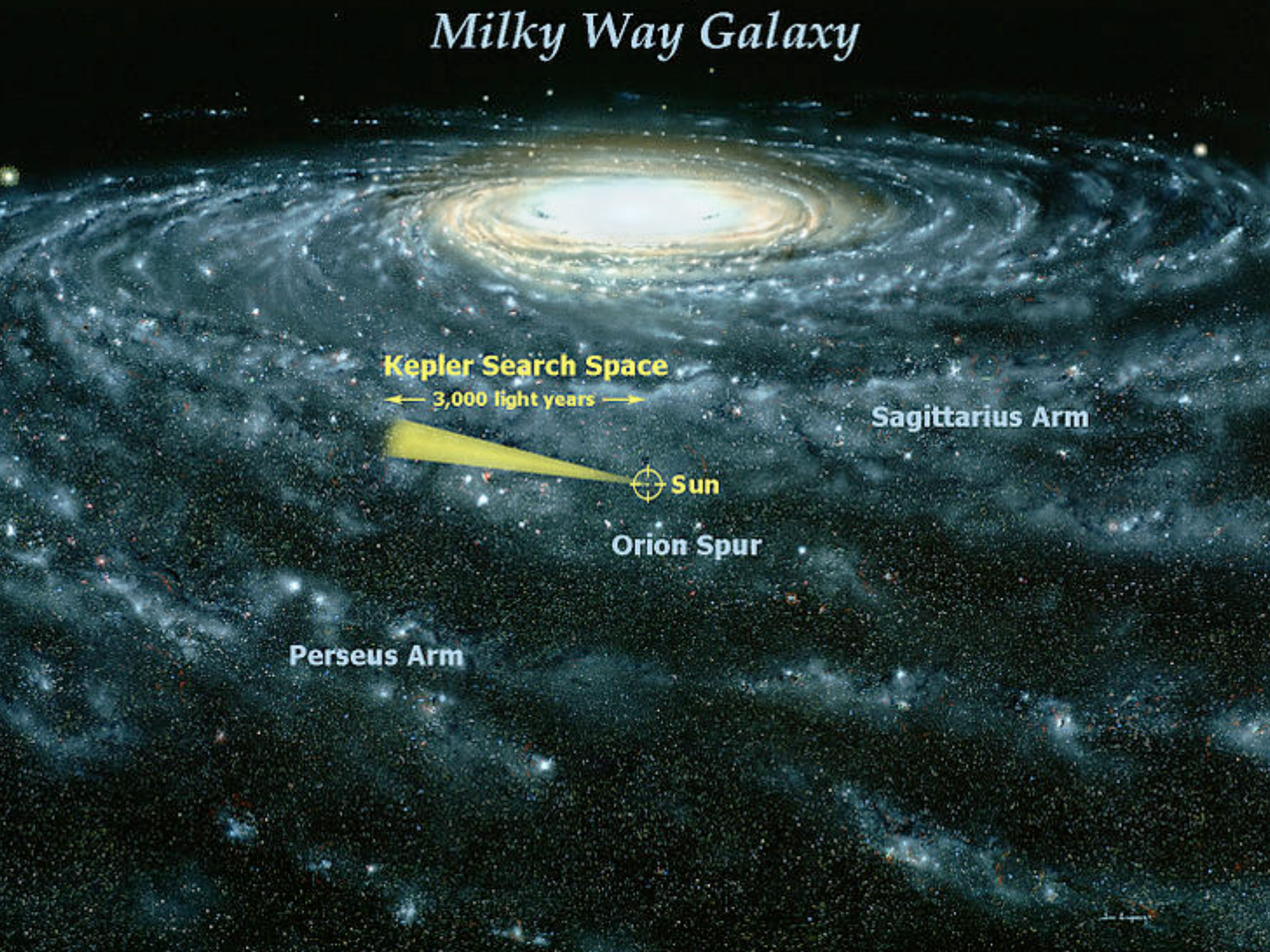

Kepler-62-System
Habitable Zone
62f
62e
62d
62c
62b
Mercury
Venus
Earth
Mars
Solar System
Habitable Zone
Planets and orbits to scale
NASA



Evryscope results suggest an atmosphere-disrupting superflare every 1-5 years. Ouch.

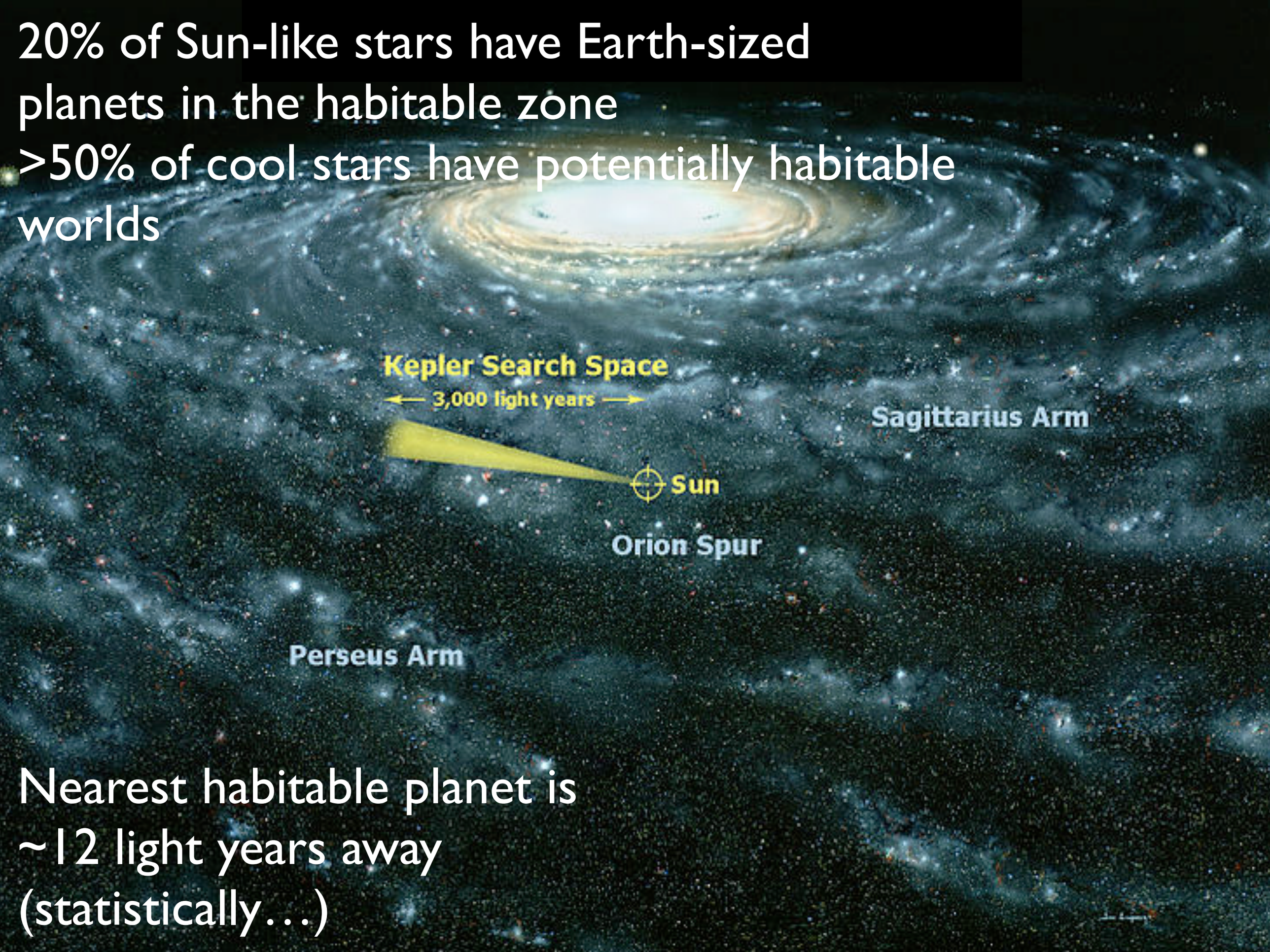
- Spare slides

Milky Way Galaxy



20% of Sun-like stars have Earth-sized planets in the habitable zone

>50% of cool stars have potentially habitable worlds



Nearest habitable planet is ~12 light years away (statistically…)

20% of Sun-like stars have Earth-sized planets in the habitable zone

>50% of cool stars have potentially habitable worlds

Kepler Search Space

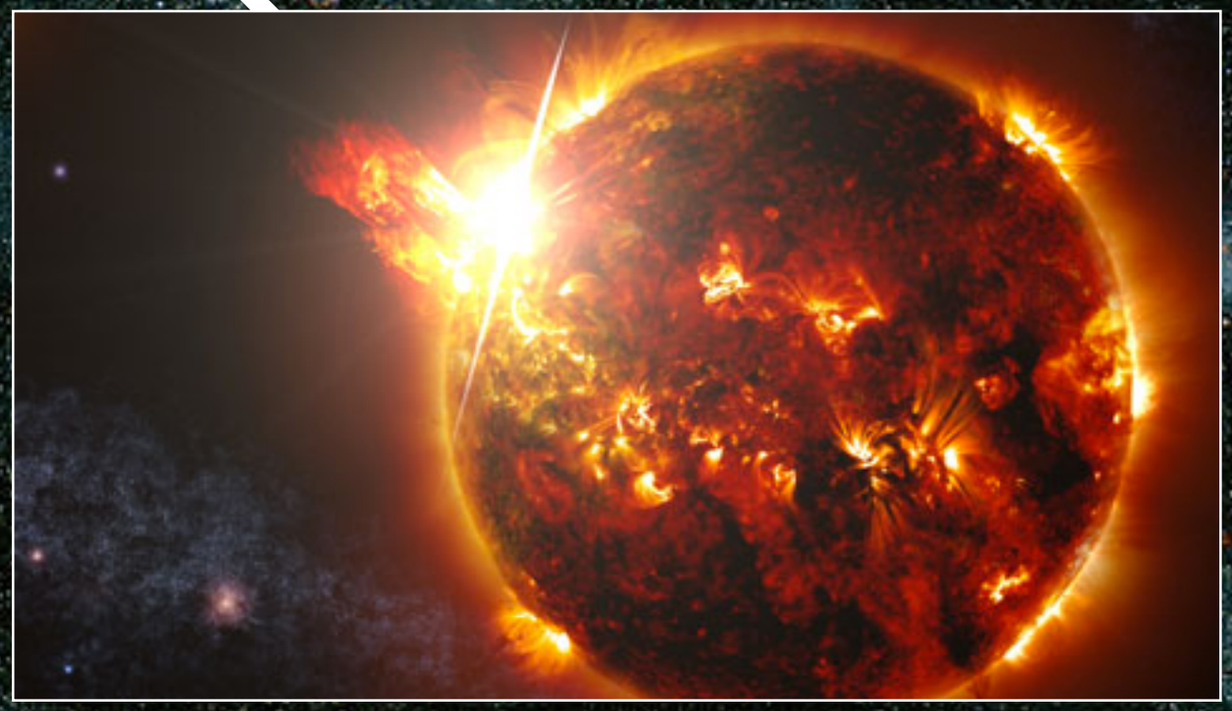
3,000 light years

Sagittarius Arm

Sun

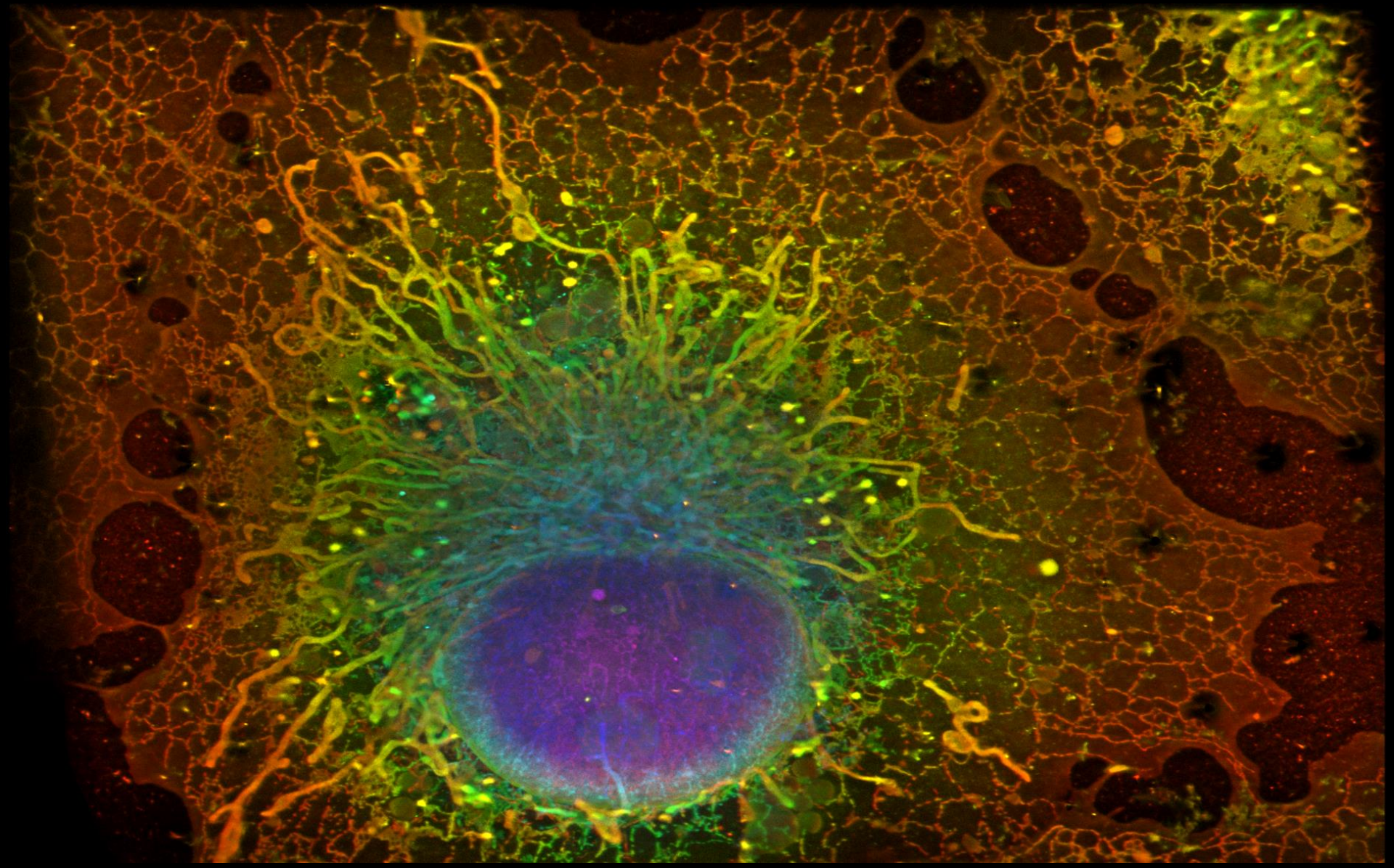
Orion Spur

Perseus Arm



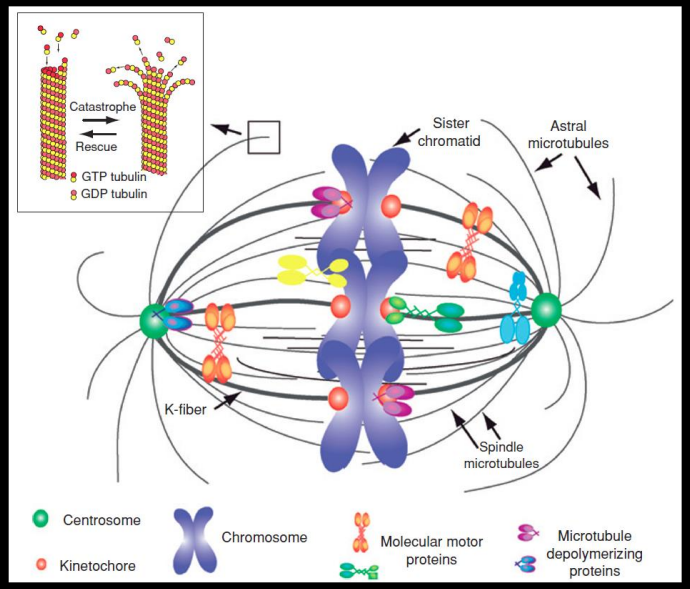
Nearest habitable planet is ~12 light years away (statistically…)

From molecules to organisms: pushing the limits of fluorescence microscopy

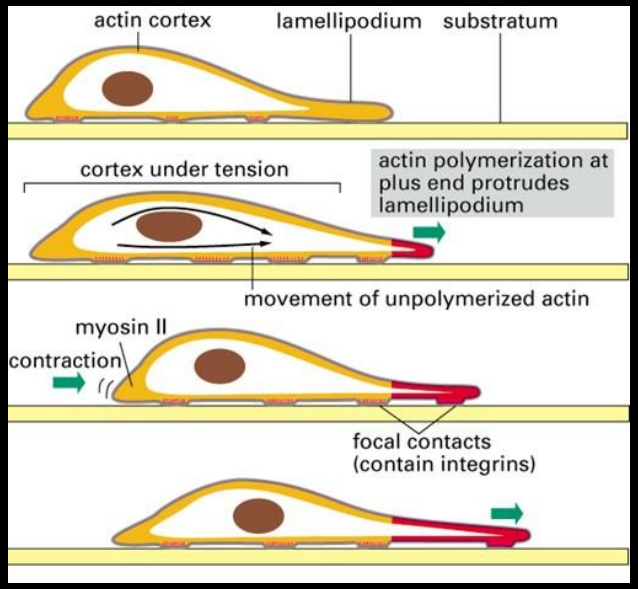


Wesley R. Legant
Departments of Pharmacology and BME
University of North Carolina, Chapel Hill

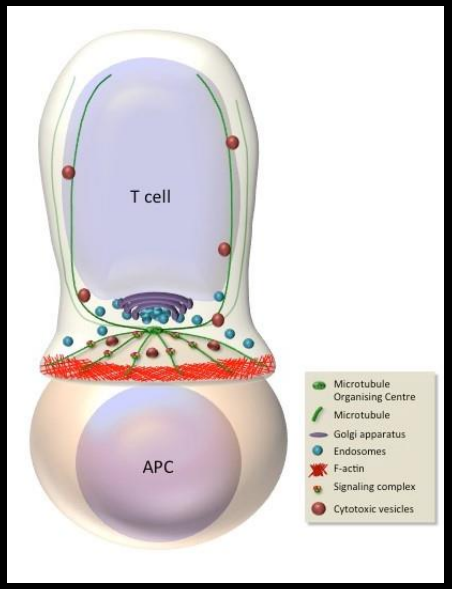
Animated Cell Biology – From Diagrams to Movies



Walczak C.E.. et al., *Int Rev Cytology* 2008

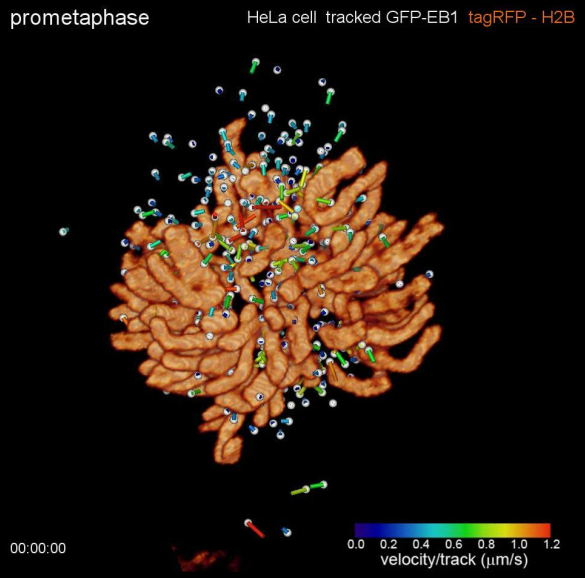


Molecular Biology of the Cell 2002



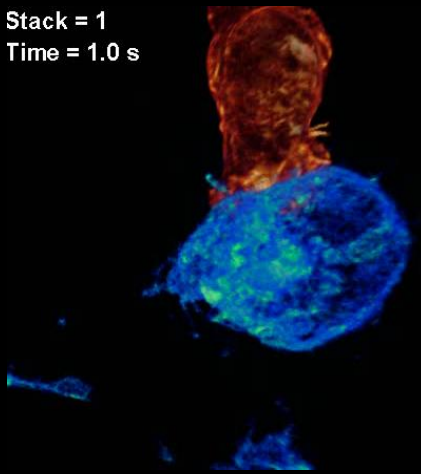
Alcover et al. 2018

Cell Division

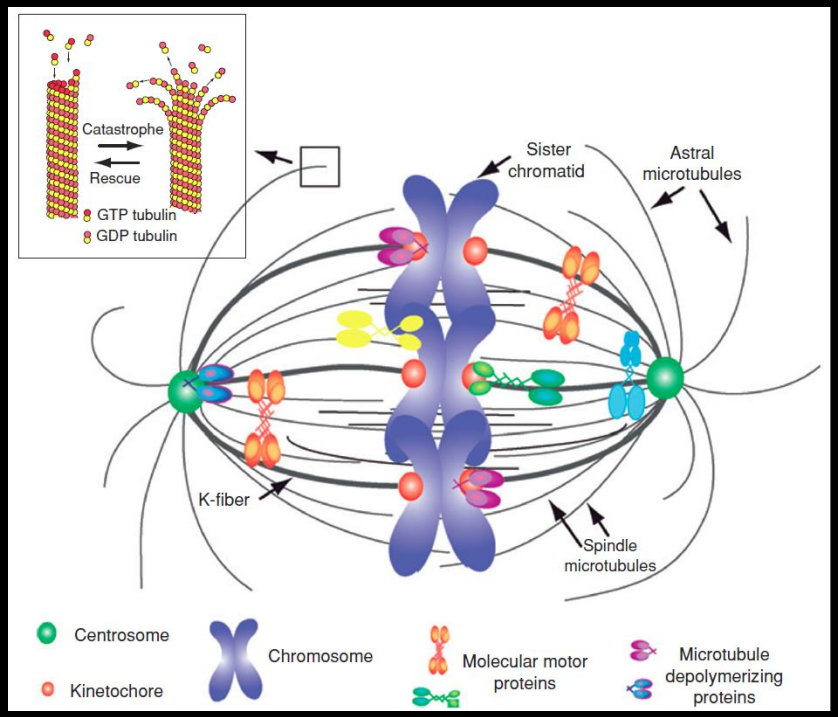


Cell Migration

Immune Function

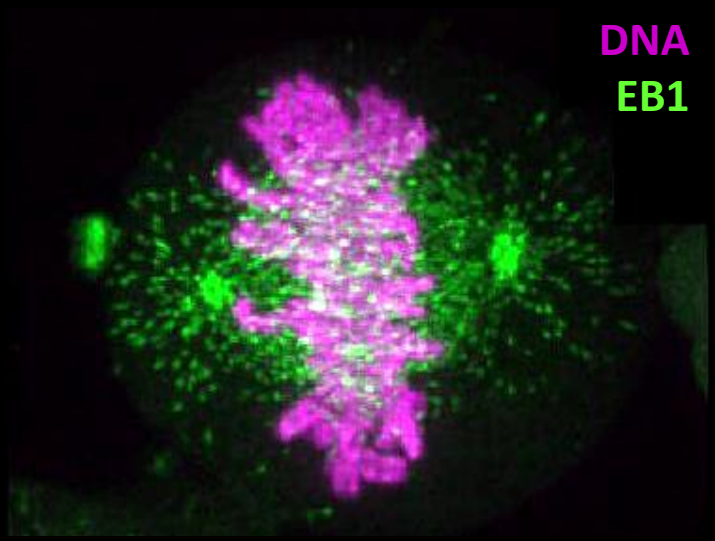


Imaging Cell Division

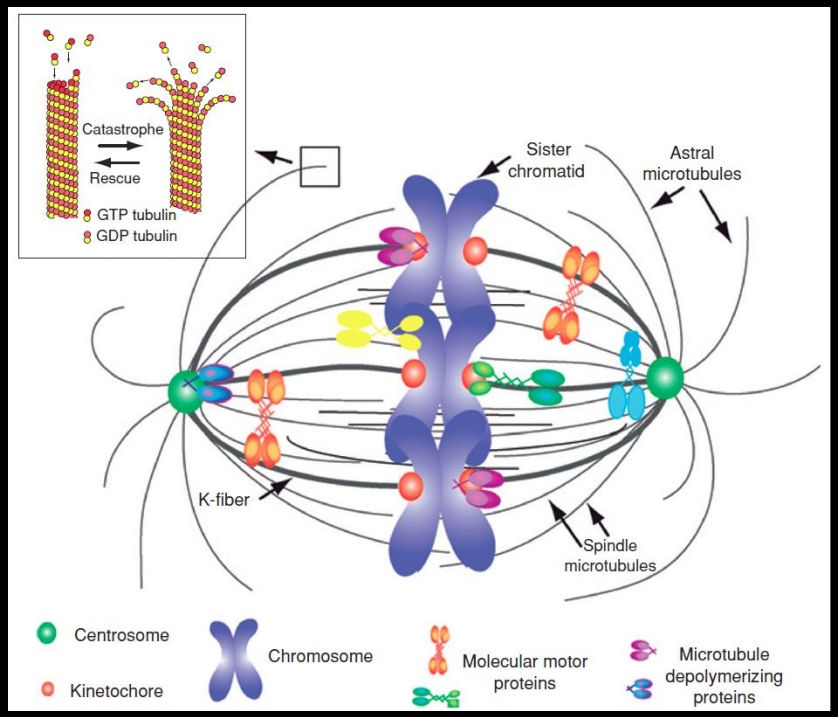


Walczak C.E.. et al., *Int Rev Cytology* 2008

normal

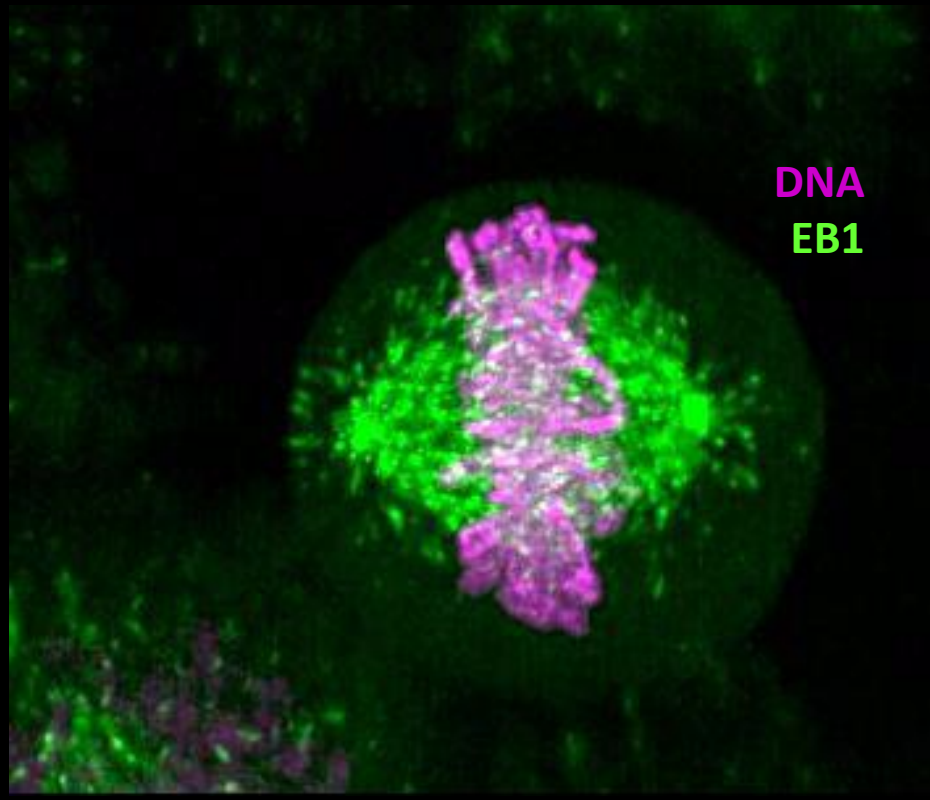


Imaging Cell Division

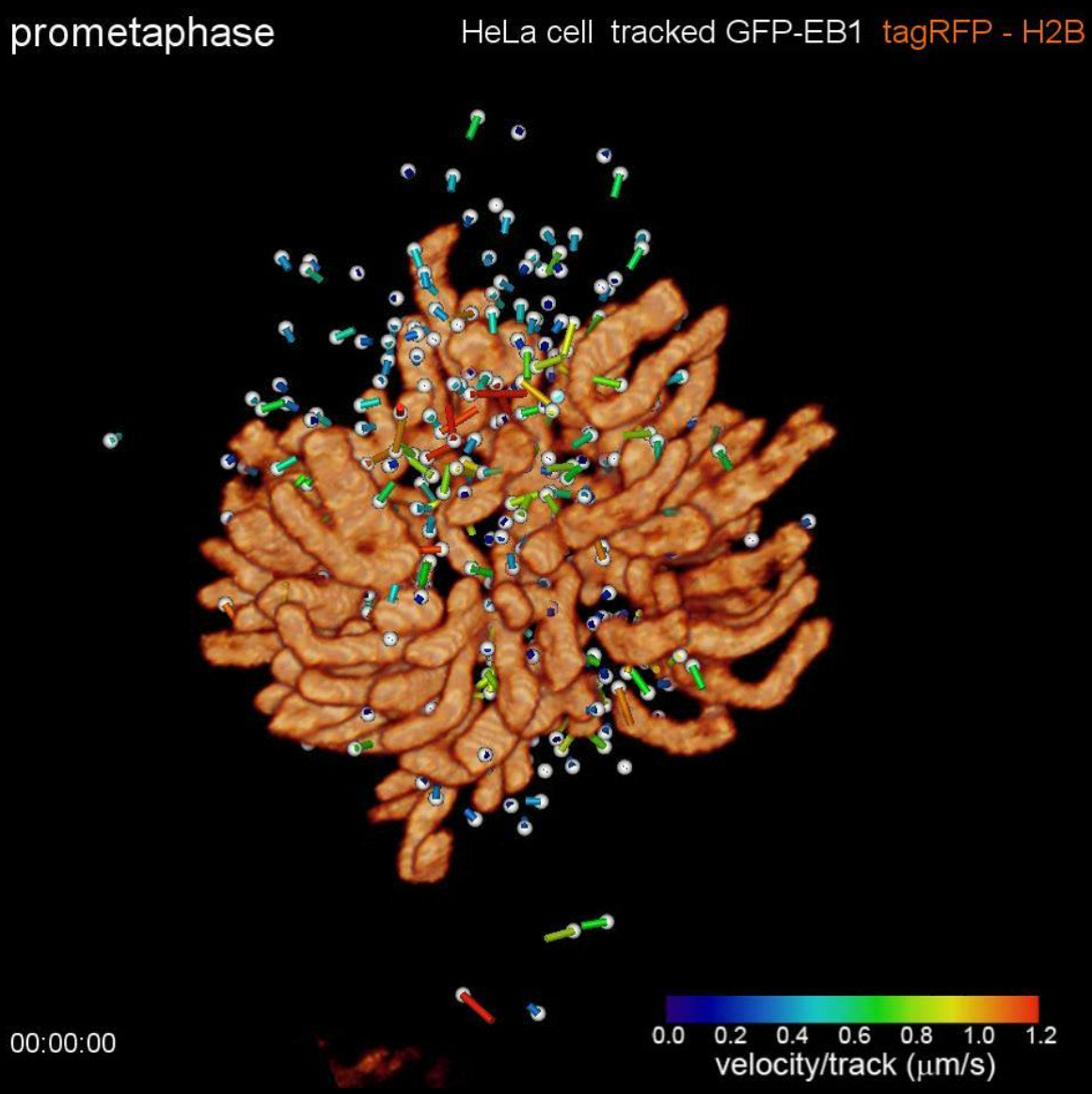


Walczak C.E.. et al., *Int Rev Cytology* 2008

abnormal



Imaging Cell Division



Technology

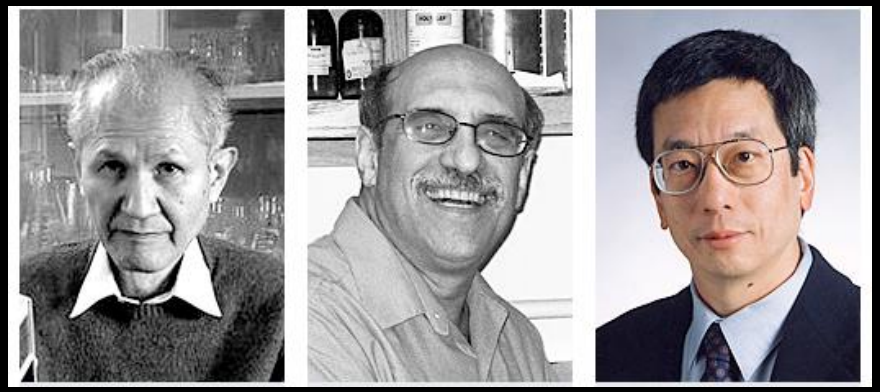
Applications

Collaborations

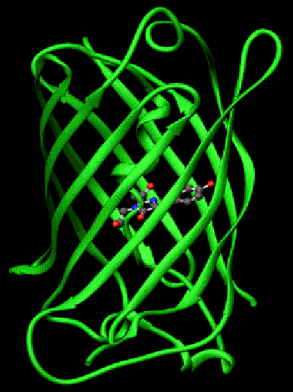
Future

Protein Specific Live Cell Fluorescence Imaging

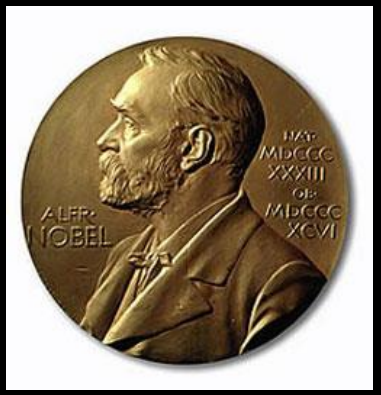
Shimomura, Chalfie, & Tsien



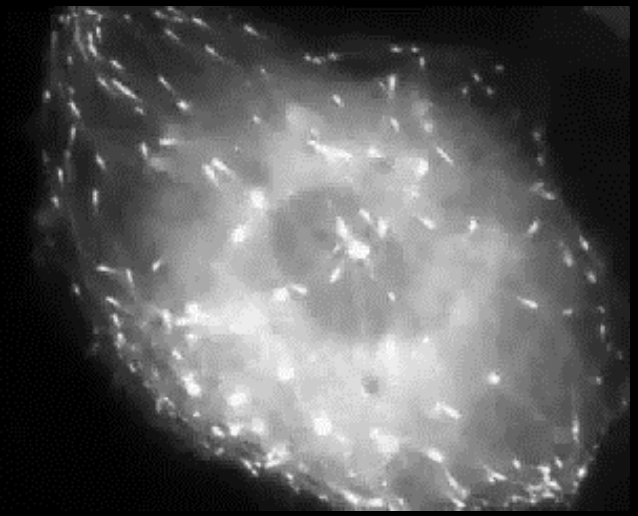
1994: green fluorescent protein



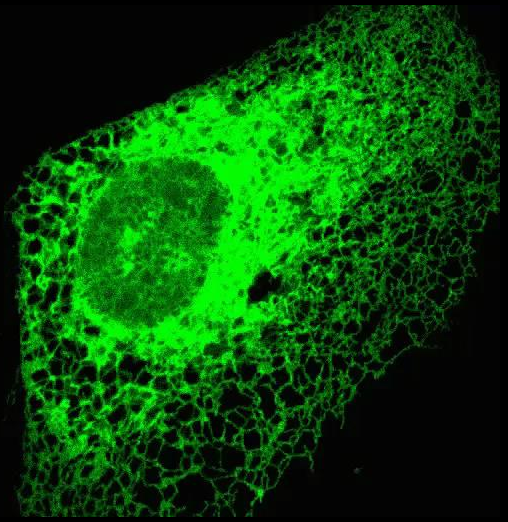
2008: Chemistry Nobel



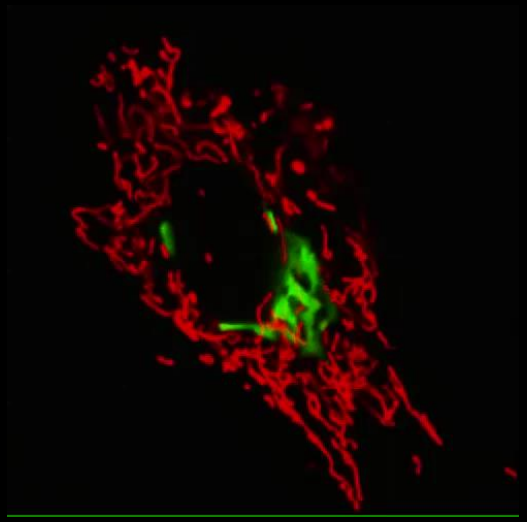
microtubule ends



endoplasmic reticulum

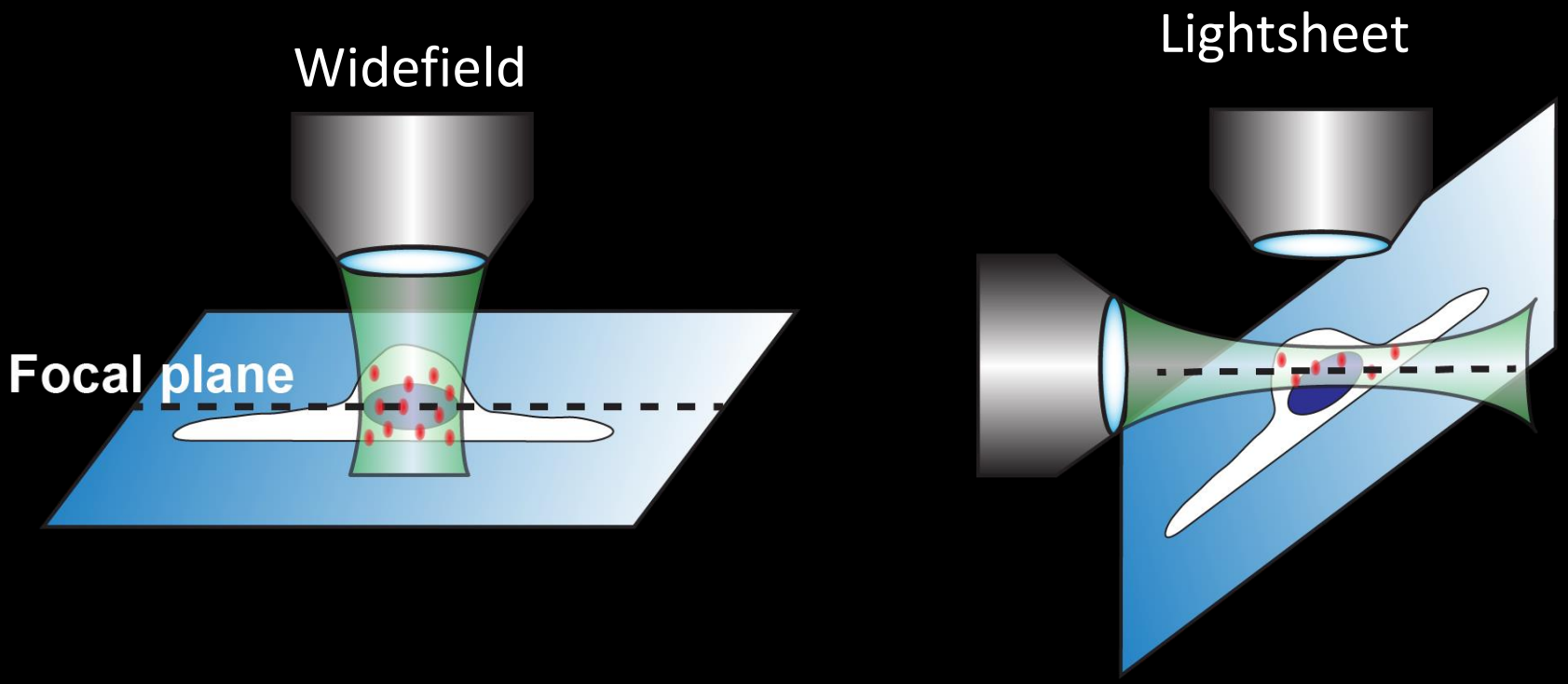


golgi, mitochondria

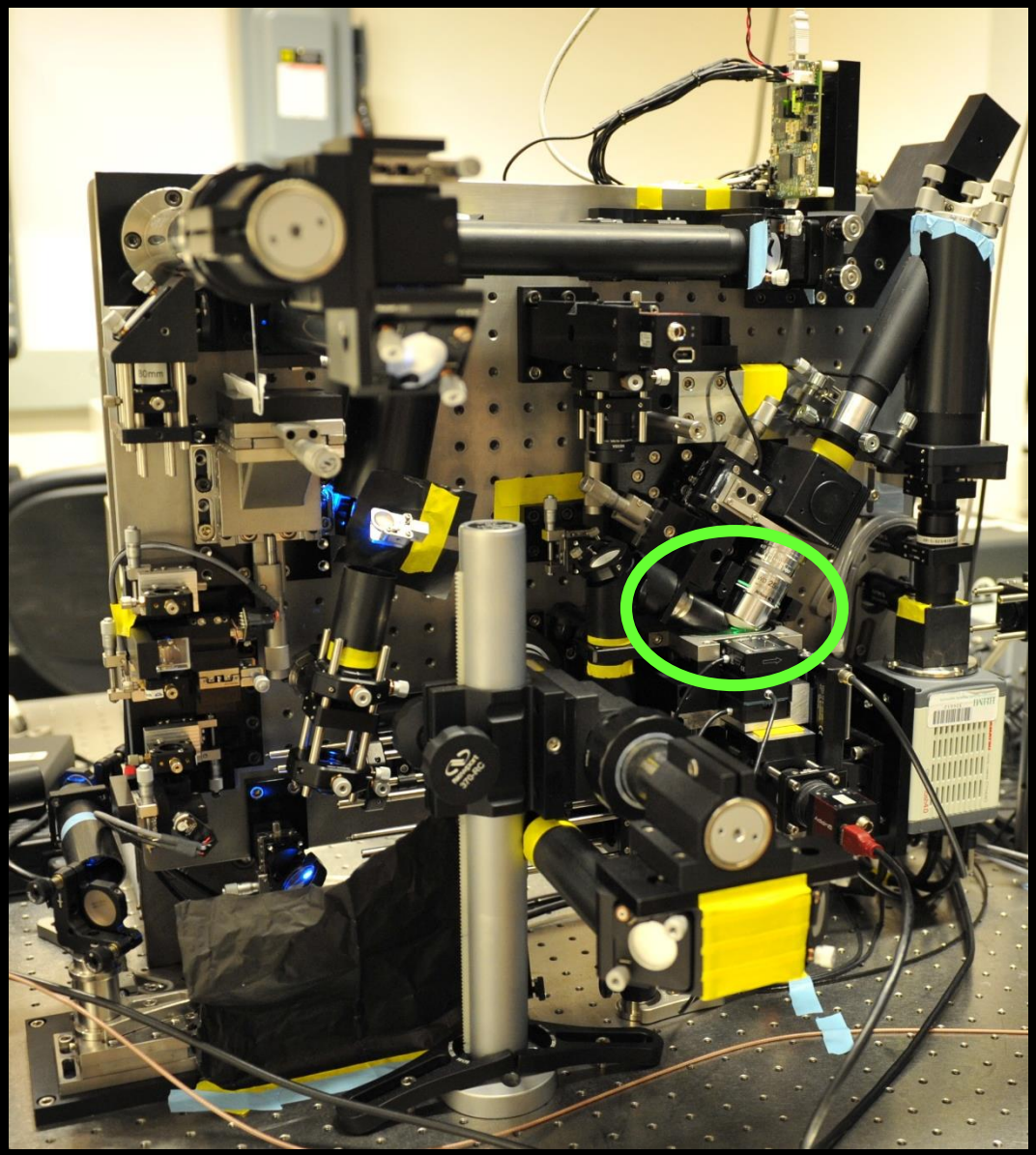


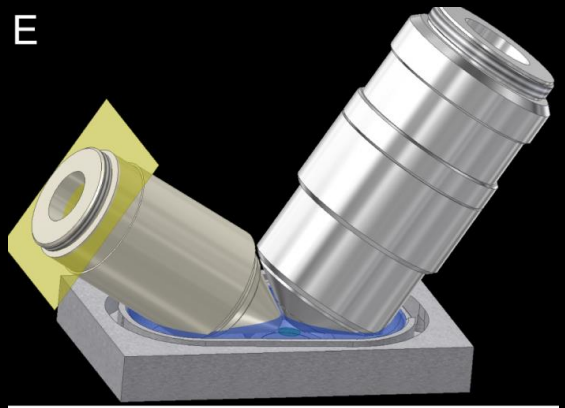
Technology truly enabled by the Nobel Prizes of 2008 and 2009 (GFP and CCDs)

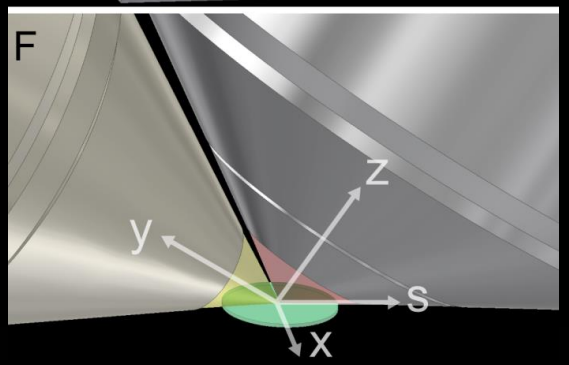
Challenge - Phototoxicity, Background, Speed

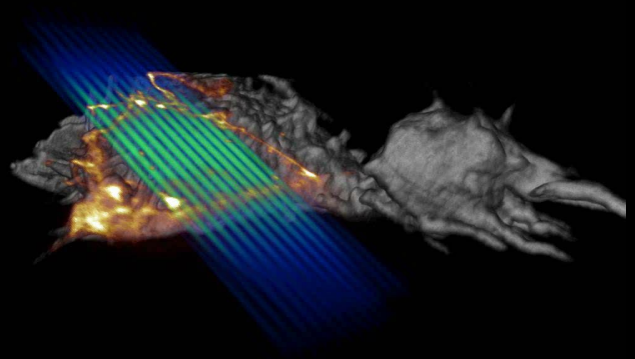


Lattice Light Sheet Microscopy

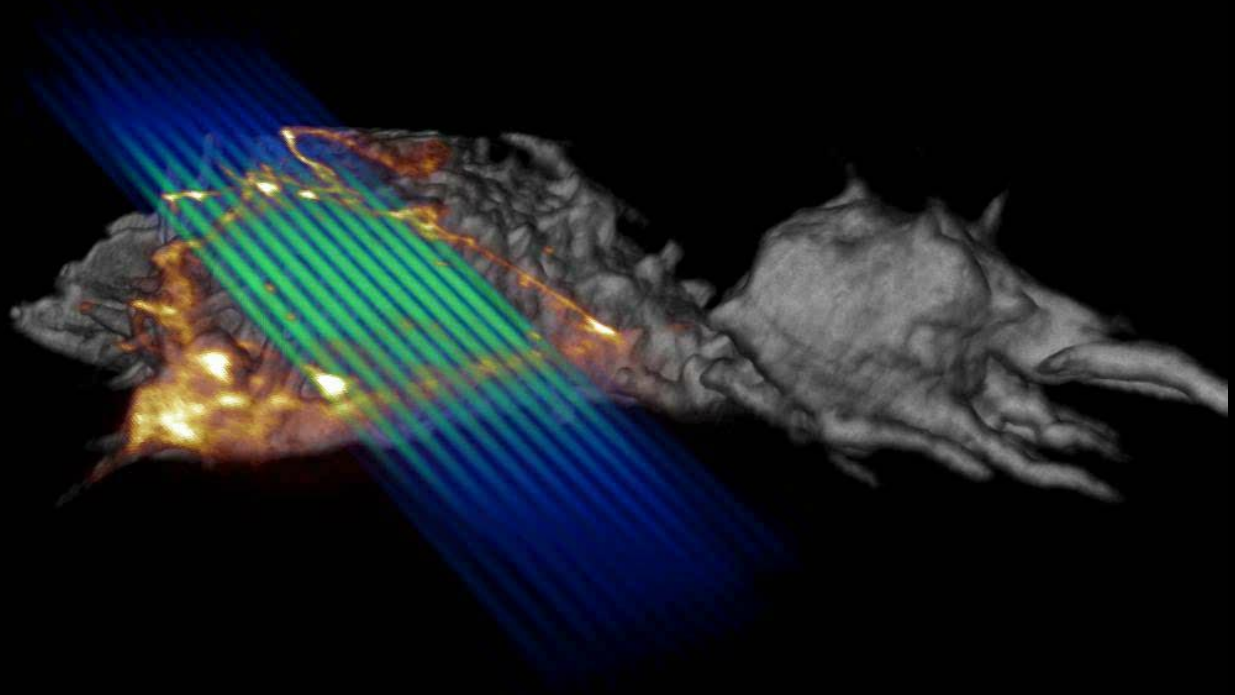








Chen BC.*, Legant W.R.*, Wang K.* *et al., Science* 2014

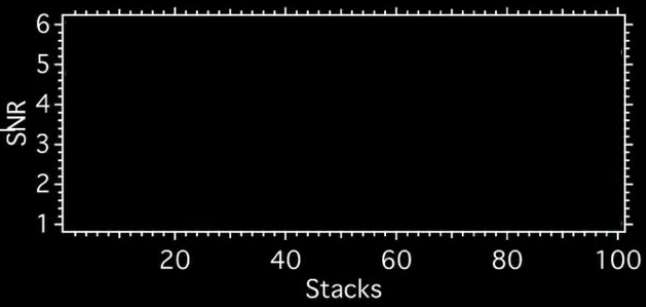


Lattice Light Sheet vs. Commercial Spinning Disc

Spinning Disk

0.3μm z-sampling
50 z-planes /stack
~6 sec interval / stack

Cells gene-edited to express
AP2-eGFP



LLSM

0.3μm z-sampling
Gene-edited AP2-eGFP
100 optical sections /stack
~6 sec interval / stack

Tom Kirchhausen Gokul Upadhyayula

Harvard Medical School

Summary

Lattice light sheet microscopy

(Chen BC*, Legant WR*, Wang K* et al. *Science*, 2014)

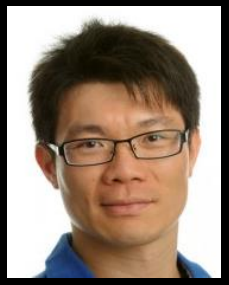
- reduced background fluorescence
- less photodamage

- Full documentation, parts lists, software via RLA through HHMI
- >80 licensees, 5 continents, >30 clone instruments
- 3 patents, commercially licensed

HHMI Janelia Research Campus

Eric Betzig

Kai Wang



Bi-Chang Chen

Wesley Legant

Technology

Applications

Collaborations

Future

How do cells migrate through three-dimensional space?

- development, wound healing

- cancer metastasis

- immune function

- Biochemistry

  - parts list

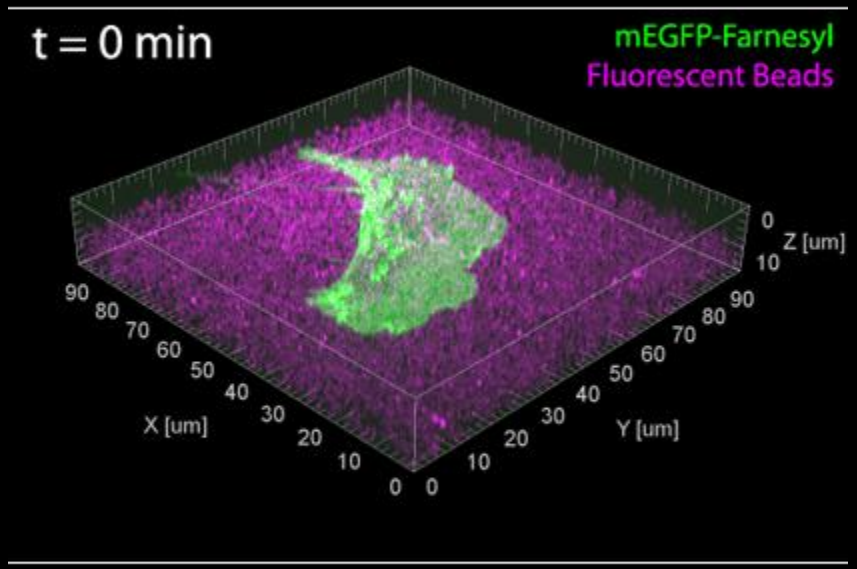
  - interactions

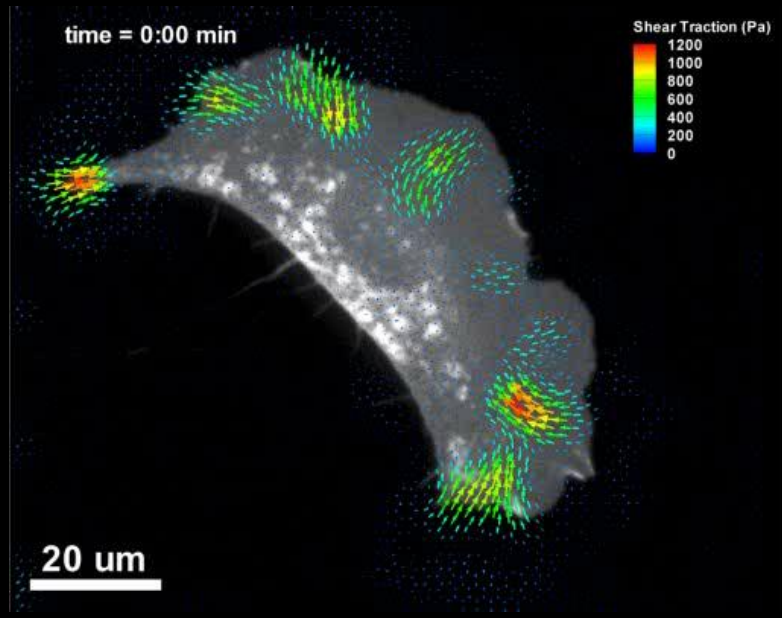
  - functions

3D Cellular Gait Analysis

Current Models of Cell Migration

2D imaging of cells in culture





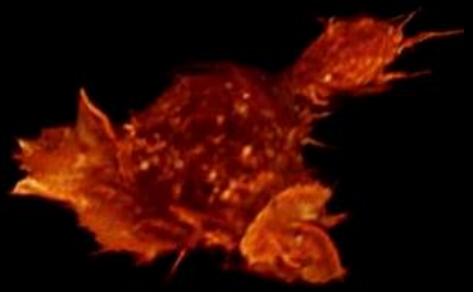
conventional microscopes

Quantitative Measurements of the 3D Cellular Gait

3D imaging of cells on glass

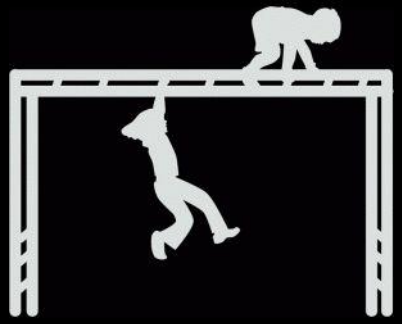
lattice light sheet

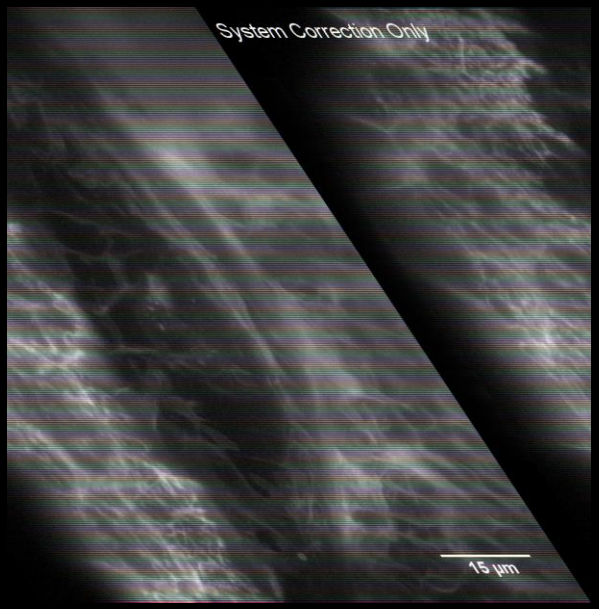
3D imaging of cells in model matrices



lattice light sheet + 3D cell culture

3D imaging of cells in vivo





Liu TL. et al. submitted 2018

lattice light sheet + adaptive optics

Technology

Applications

Collaborations

Future

How do immune cells target diseased/infected cells in the body?

- Infectious disease

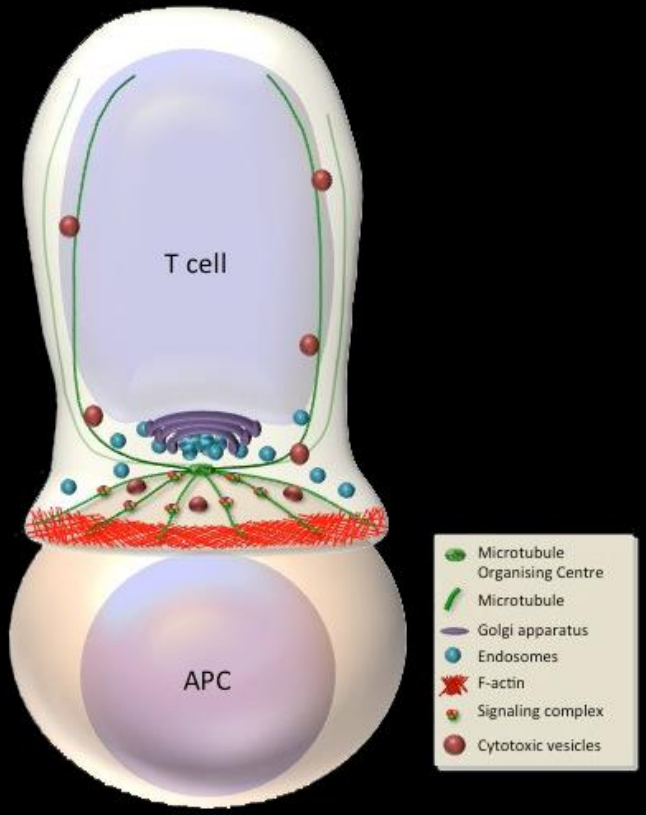
- cancer immunotherapy

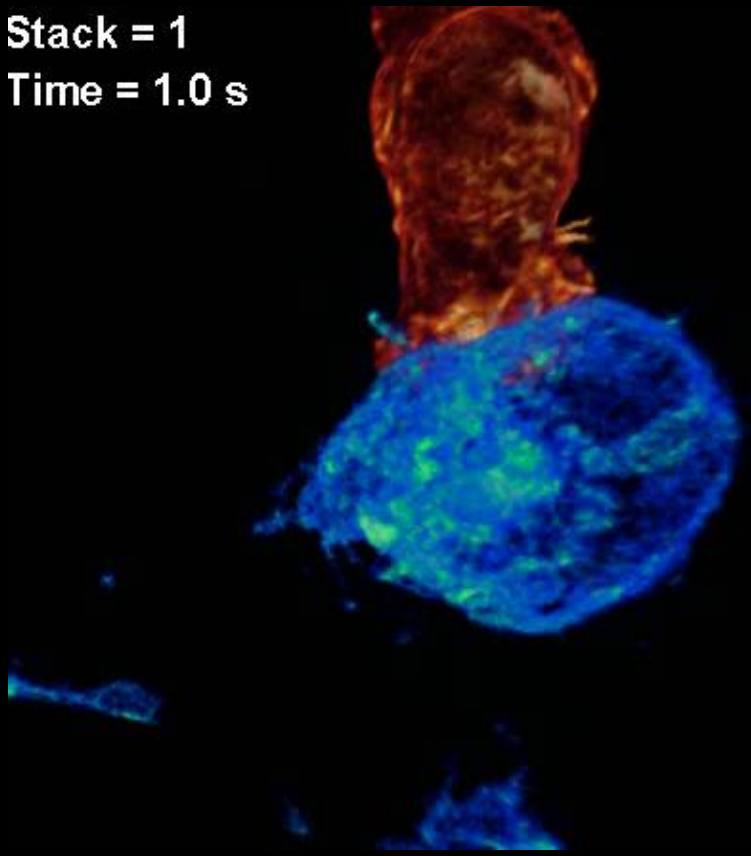
- 714 active/recruiting/pending clinical trials for cancer immunotherapy in the USA[1]
- 35 clinical trials currently at UNC
- 10 year timeline is estimated $30-75 billion in sales[2]
- Not all patients respond and it's often unknown why

How does the specialized structure between a T-cell and target cell form?

1) clinicaltrials.gov
2) Park A., "What if your immune system could be taught to kill cancer?" Time Magazine, 3/24/2016

Imaging the Immune Synapse





https://research.pasteur.fr/en/project/intracellular-vesicle-traffic-drives-immunological-synapse-formation-and-t-cell-activation-inhibition-by-human-immunodeficiency-virus-hiv-1/

Chen BC.*, Legant W.R.*, Wang K.* *et al., Science* 2014

HHMI Janelia

Wesley Legant

NIH/HHMI Janelia

Alex Ritter

Jennifer Lippincott-Schwartz

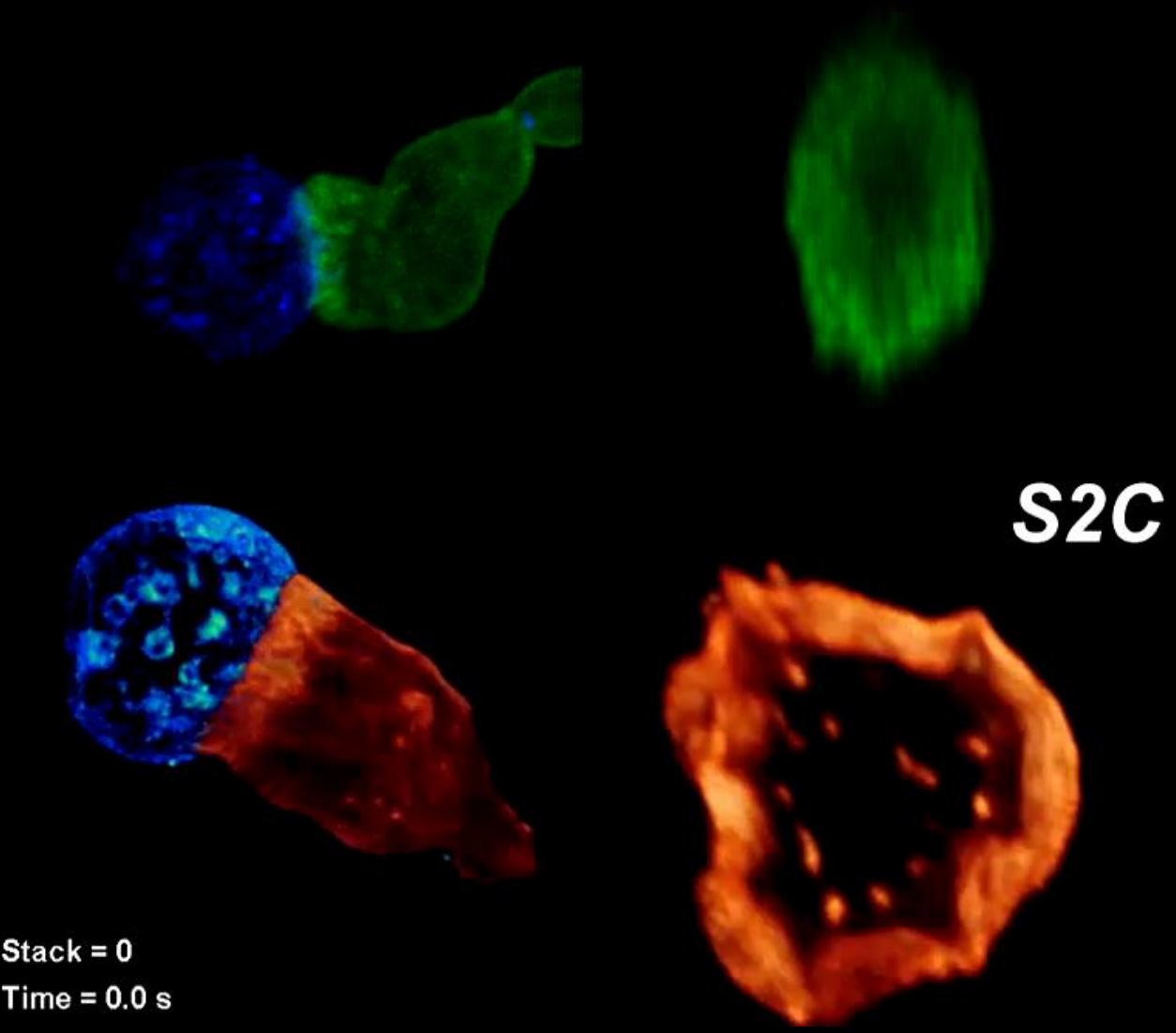
University of Cambridge

Gillian Griffiths

Imaging the Immune Synapse

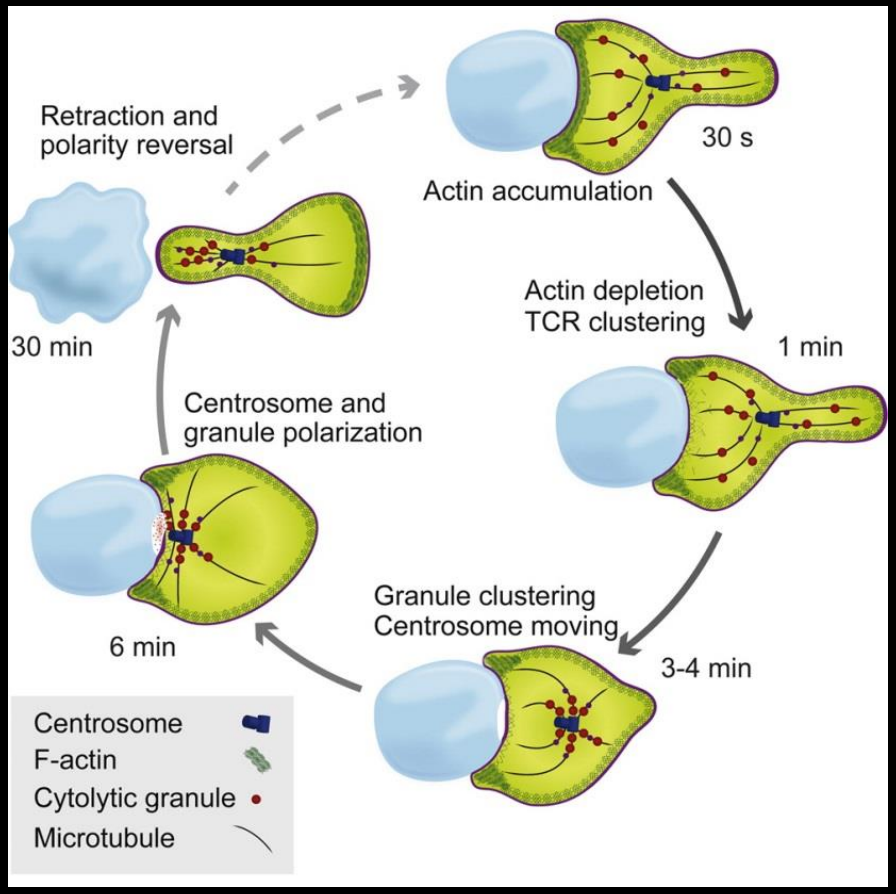
Commercial Spinning Disc Confocal

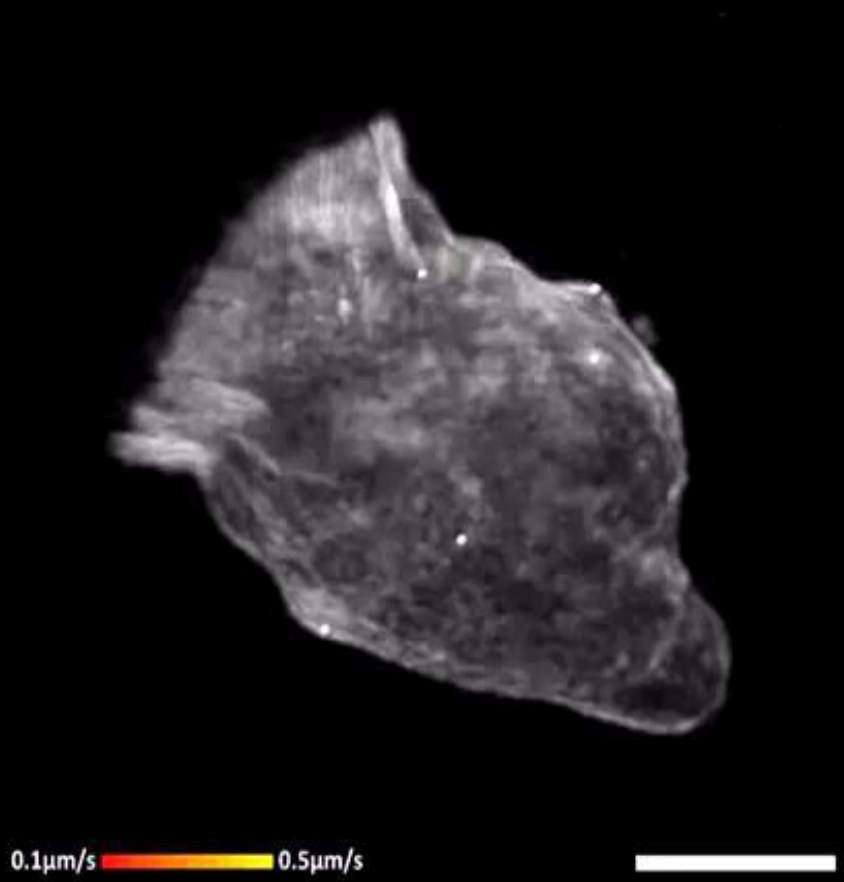
Lattice Light Sheet



Ritter A. *et al., Immunity* 2015

Imaging the Immune Synapse





Ritter A. *et al., Immunity* 2015

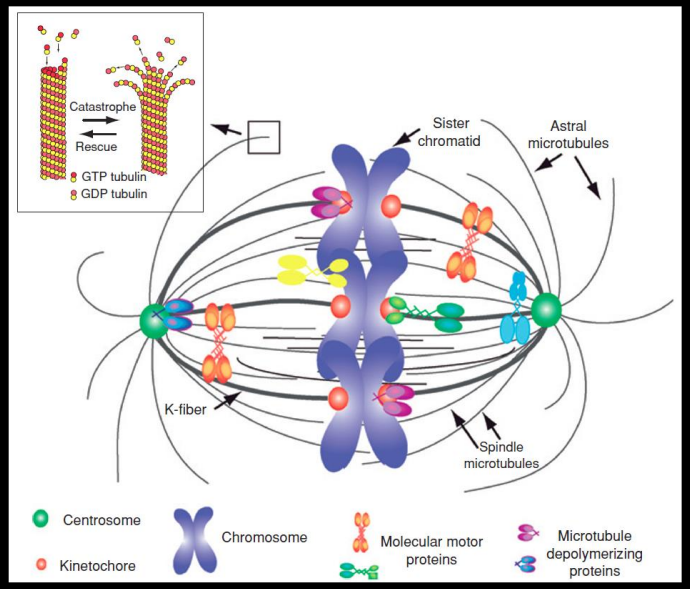
Technology

Applications

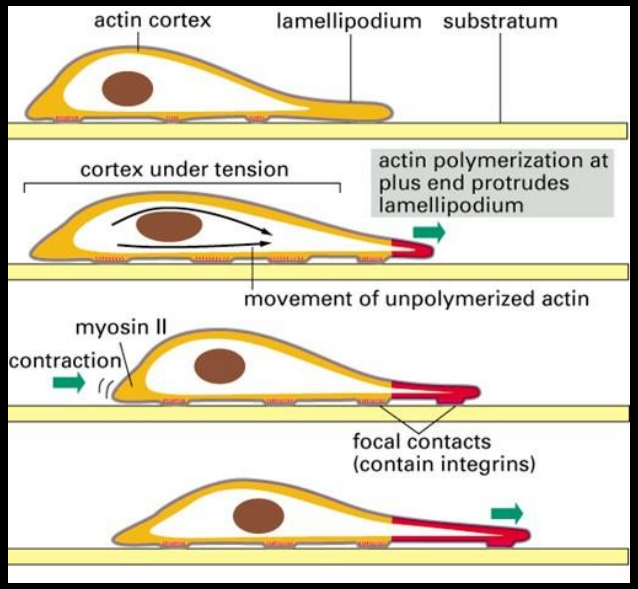
Collaborations

Future

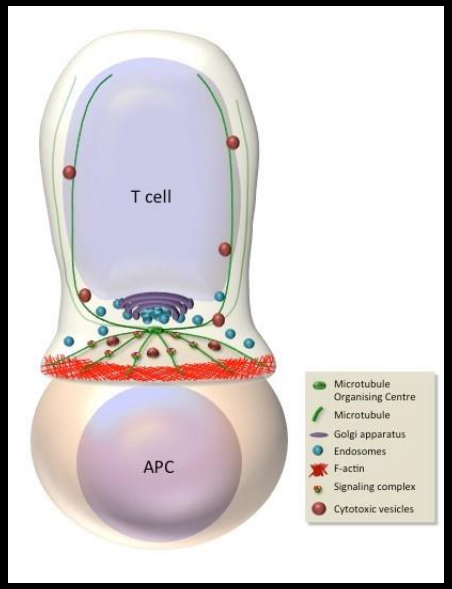
Animated Cell Biology – from Diagrams to Movies



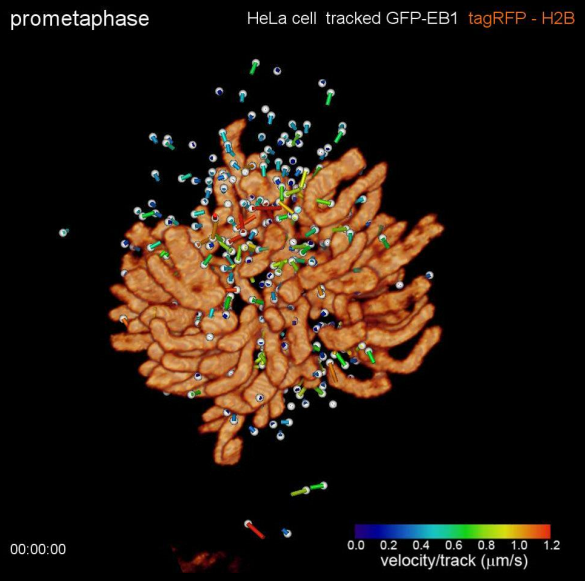
Walczak C.E.. et al., *Int Rev Cytology* 2008

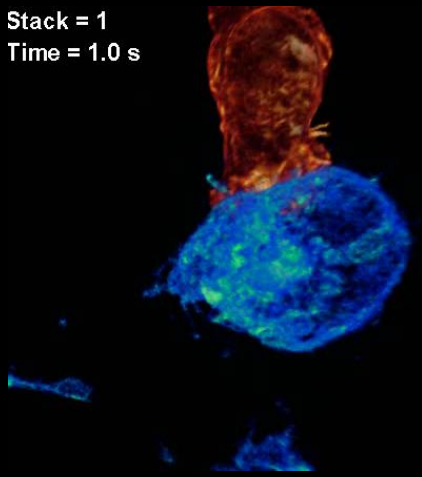


Molecular Biology of the Cell 2002

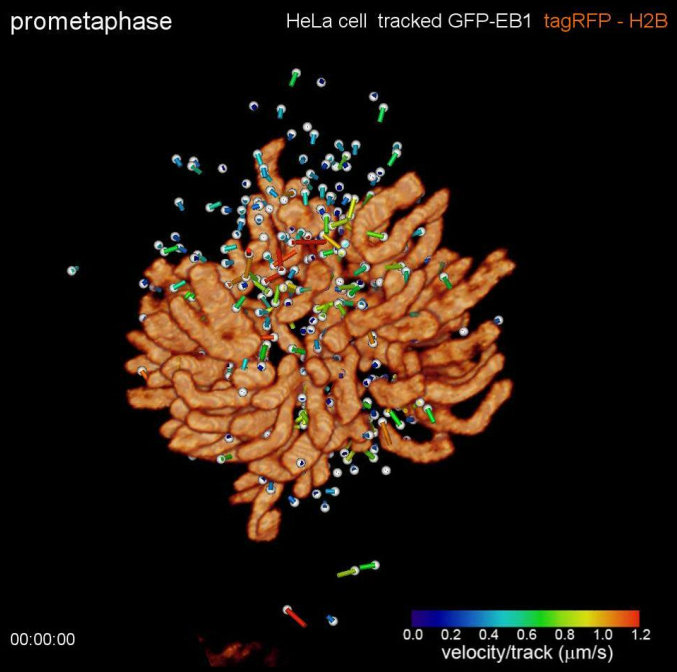


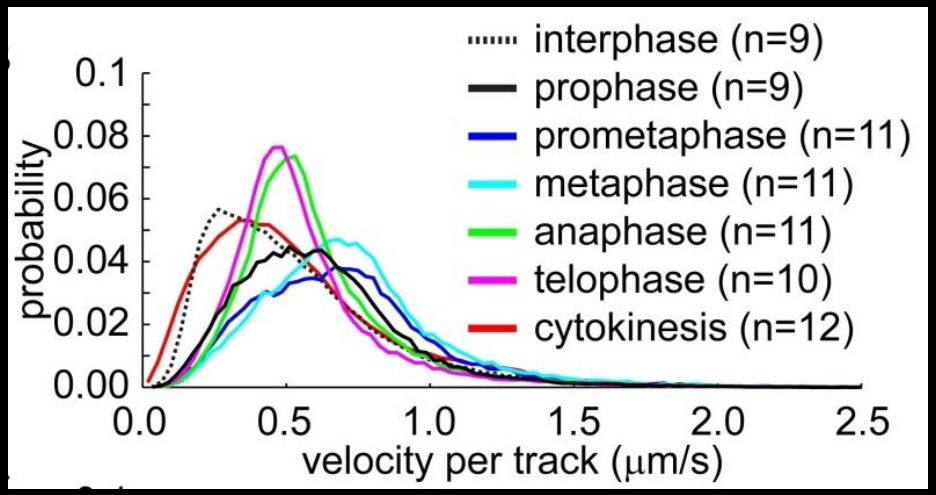
Alcover et al. 2018



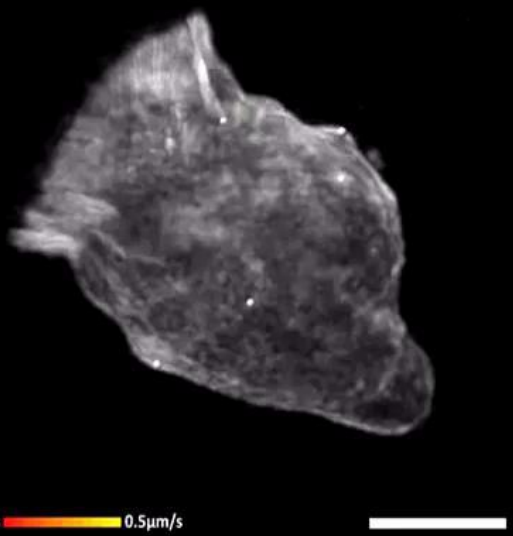


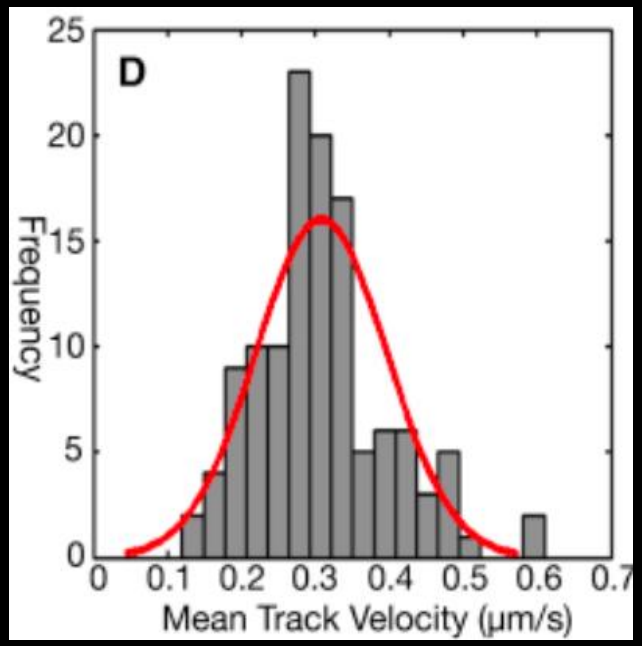
Quantitative Imaging – from Movies to Diagrams





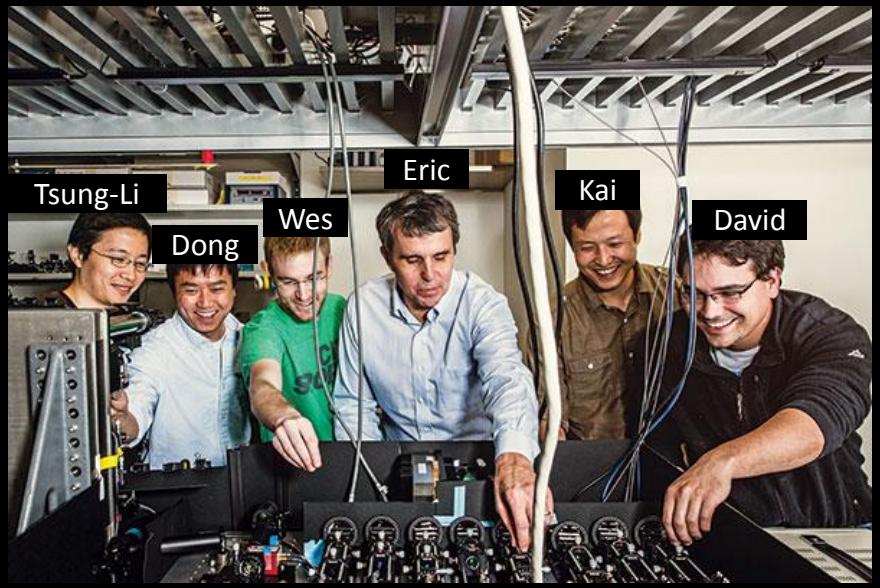
Code modified from Applegate K.T. *et al. J Struct Biol,* 2011



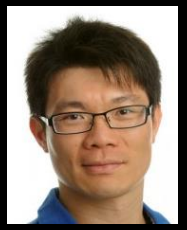


Ritter A. *et al., Immunity* 2015

Acknowledgements



Dan Milkie



Bi-Chang Chen

Janelia Research Campus

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As of January 2018

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