Astronomy outreach, amateur astronomy and exoplanet research

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Why are we into astronomy ?

It's fun
The night sky is beautiful
What is out there ?

Astronomy's big questions

How did the universe form galaxies, planets ?
Are we alone ? Other life forms in the universe ?

Why are we into astronomy ?

Astronomy is not very useful on the short term

Astronomers won't make cars better, find cure for deseases etc...
Some parts of astronomy are useful on the short term:

- Identify asteroids that may impact Earth
- Predict solar storms, impact of astronomical effects on climate changes

Very little private funding in astronomical research is motivated by economic profit
(astronomers don't work for banks and car makers)

Astronomy (amateur and prof.) is motivated by curiosity (of public and amateurs)

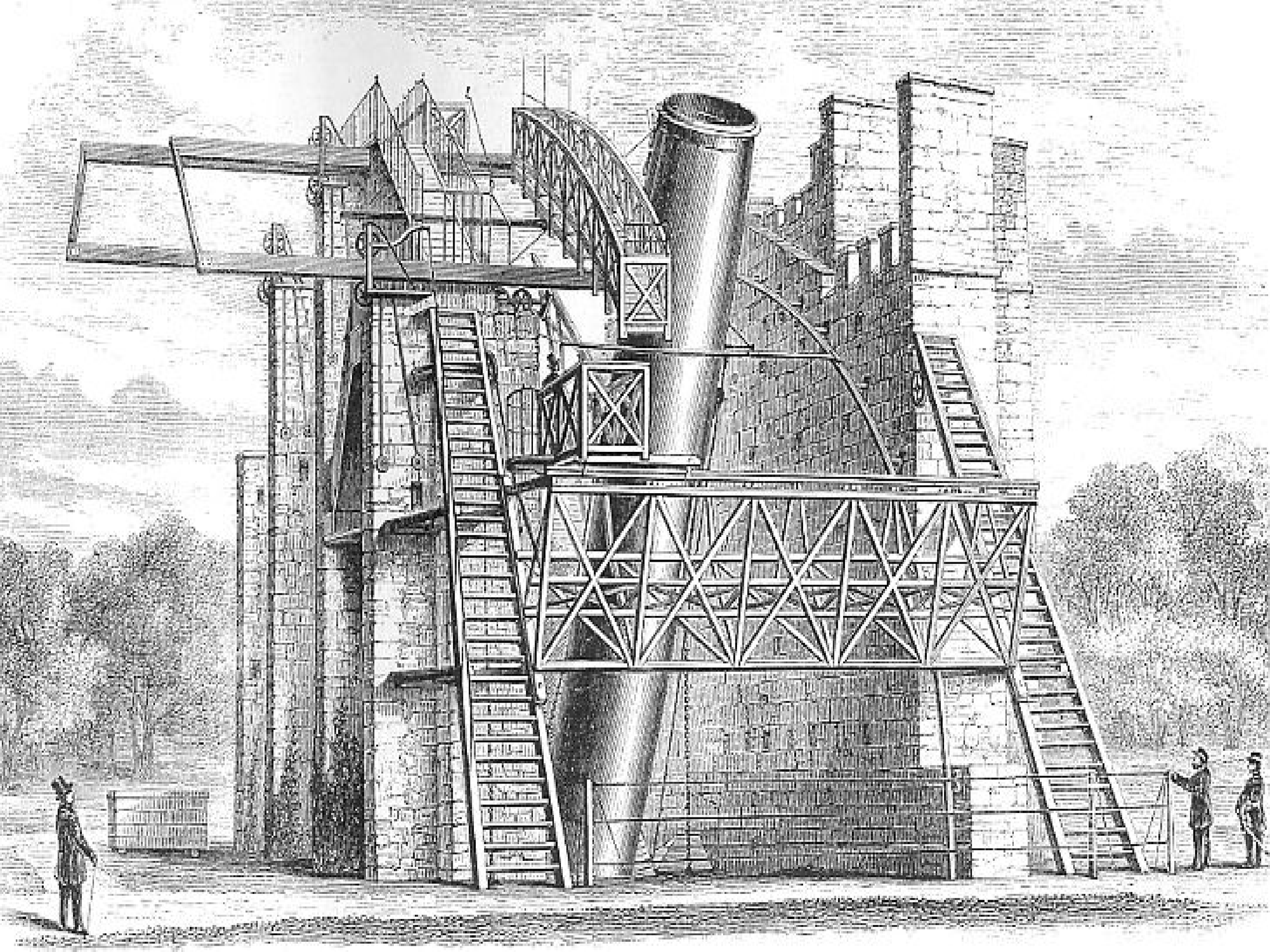
Why professional astronomy ?
Relationship between public, amateurs and astronomers

Some projects require too much resources for amateur astronomers → governments fund people/projects to work on specific astronomy problems

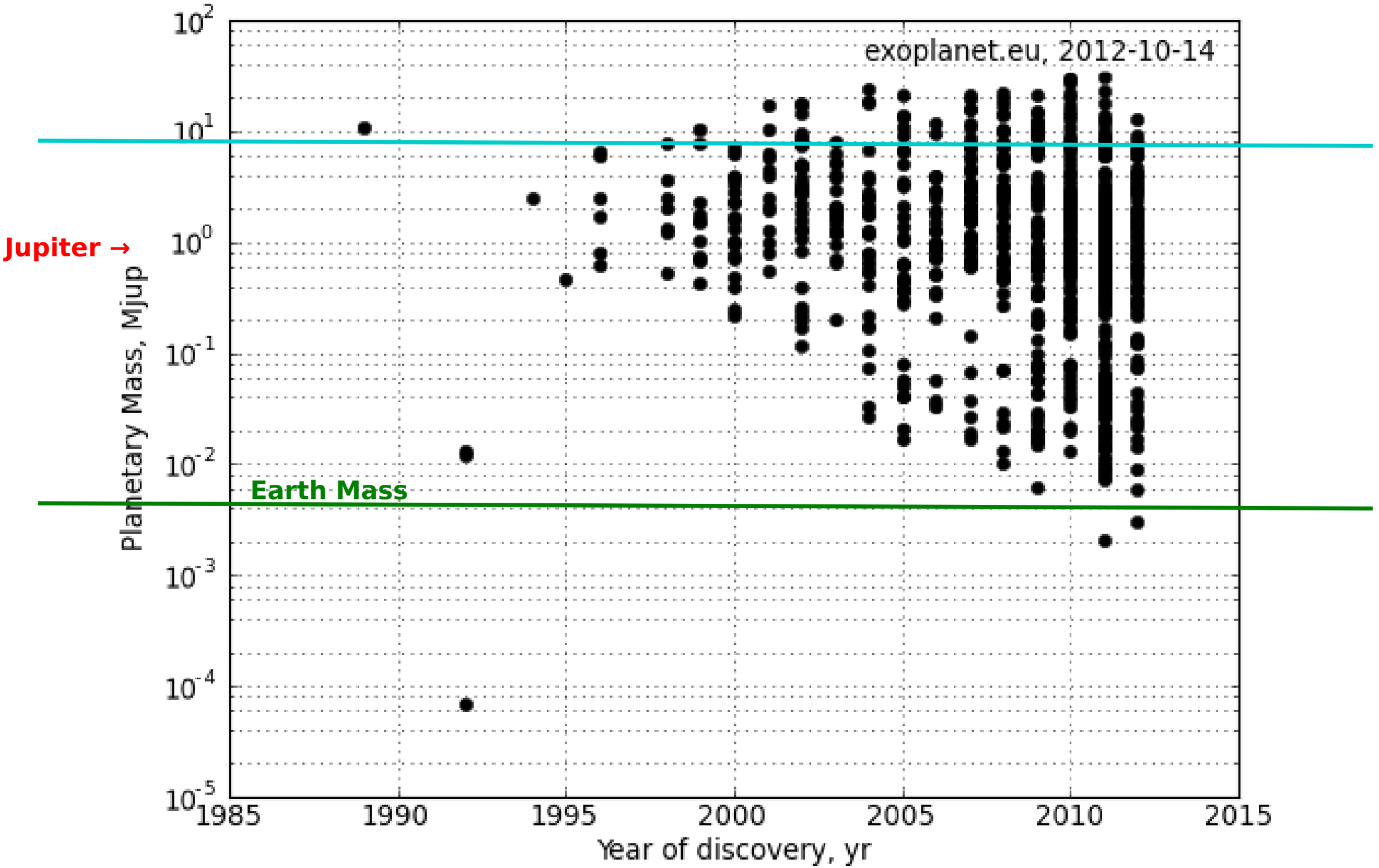
Origins of professional astronomy: boundary between amateurs & professional astromy often fuzzy

Public and amateurs curiosity funds astronomical research

Outreach efforts and amateur astronomers are at the reason astronomical research is possible



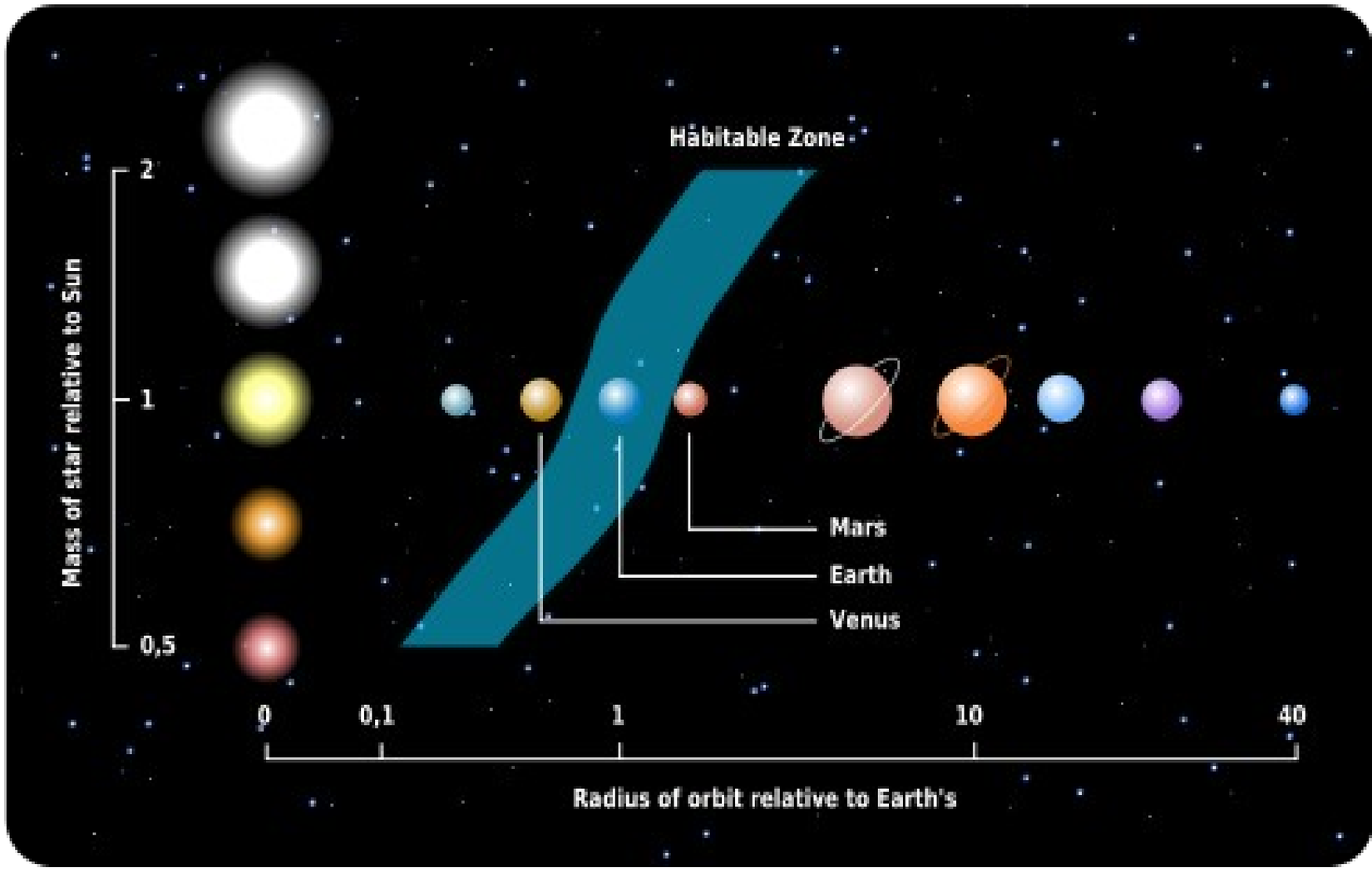
Exoplanets discoveries (confirmed exoplanets only)



Exoplanets

839 exoplanets confirmed belonging to 662 exoplanetary systems

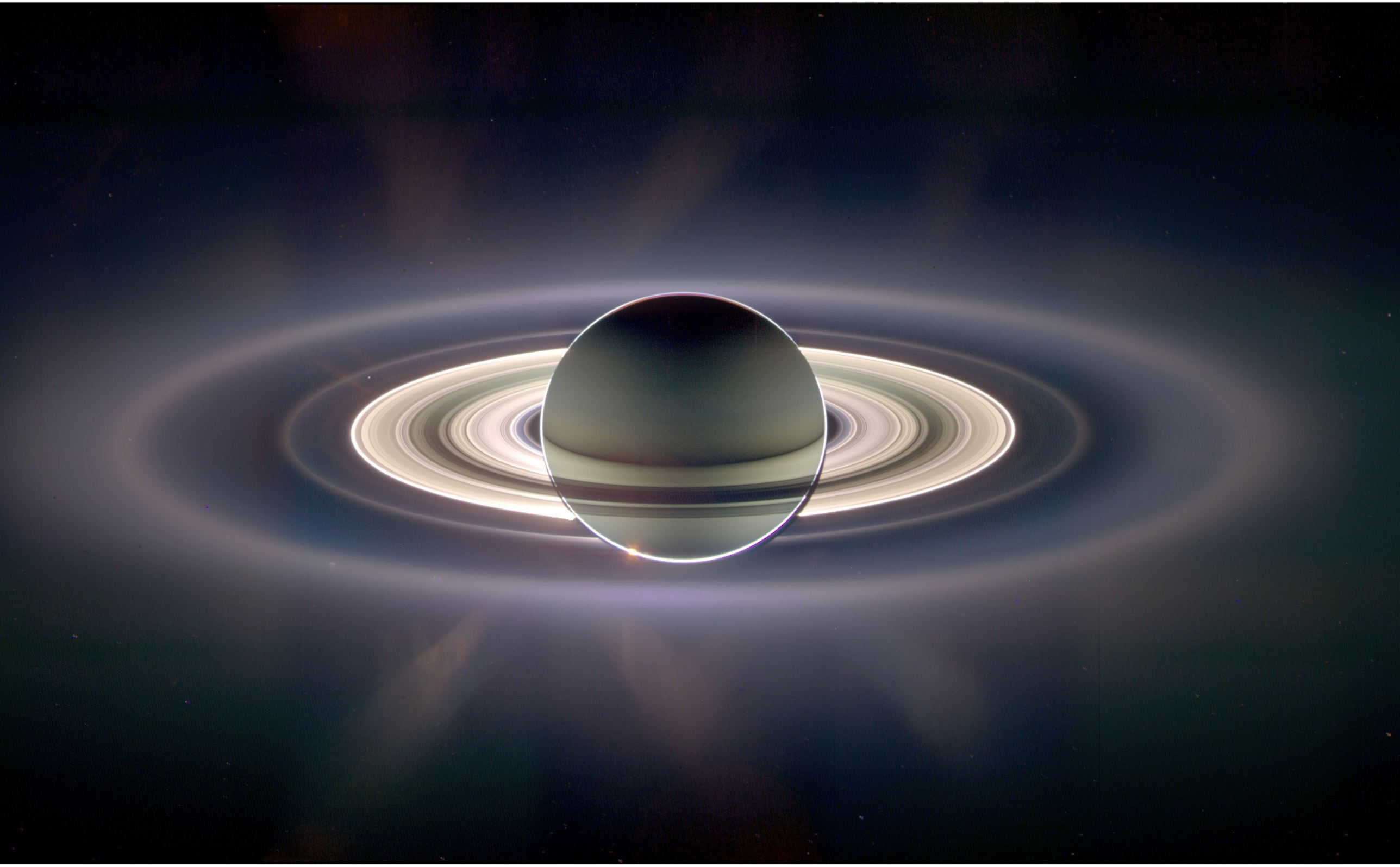
Almost all planets are indirectly detected... we do not know much about them

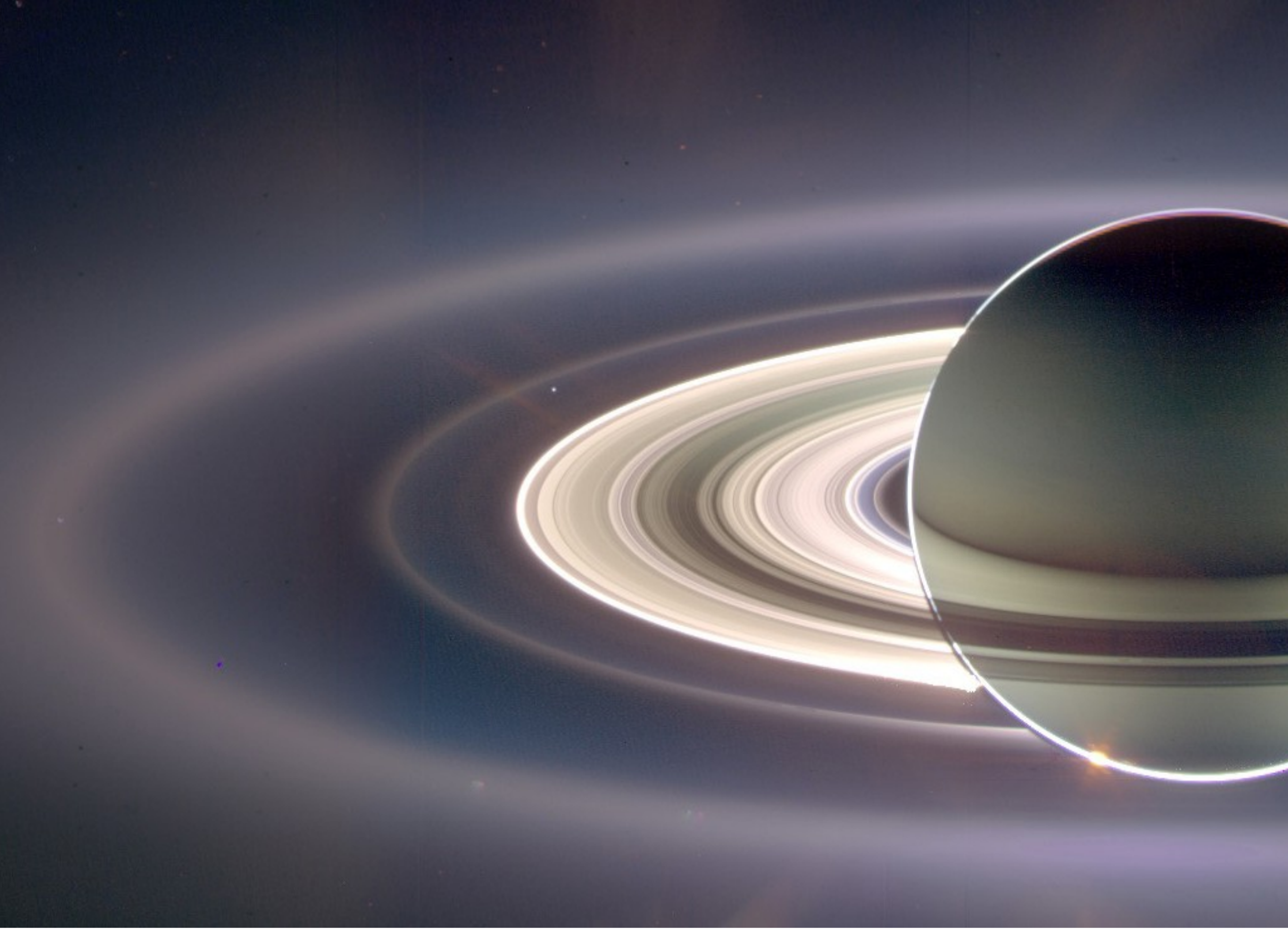


Most planets are ~Jupiter mass. Potentially habitable planets are very difficult to detect with current techniques

→ we need tools to detect and characterize low-mass planets that are **potentially habitable**
This is challenging: planet flux/mass/size is a tiny fraction of star flux/mass/size

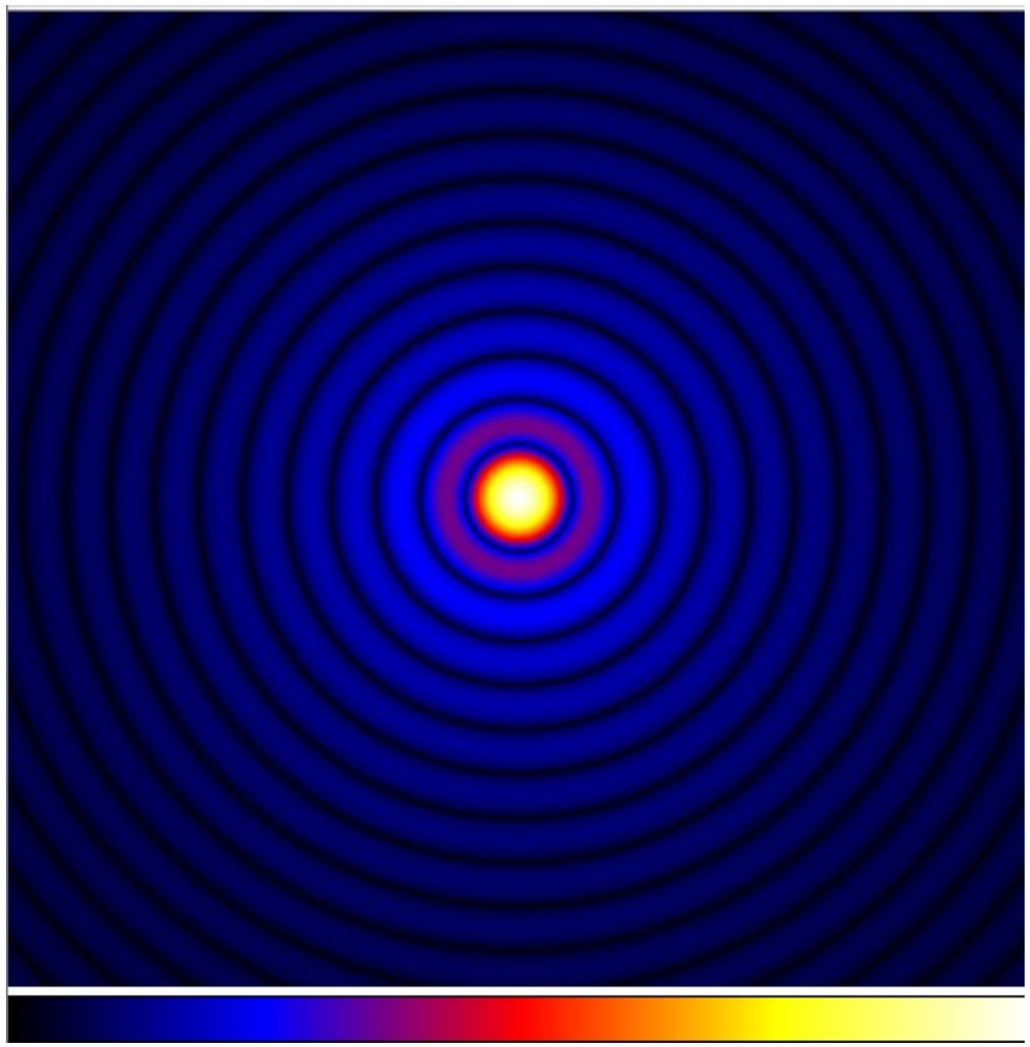
Conventional telescopes won't work !

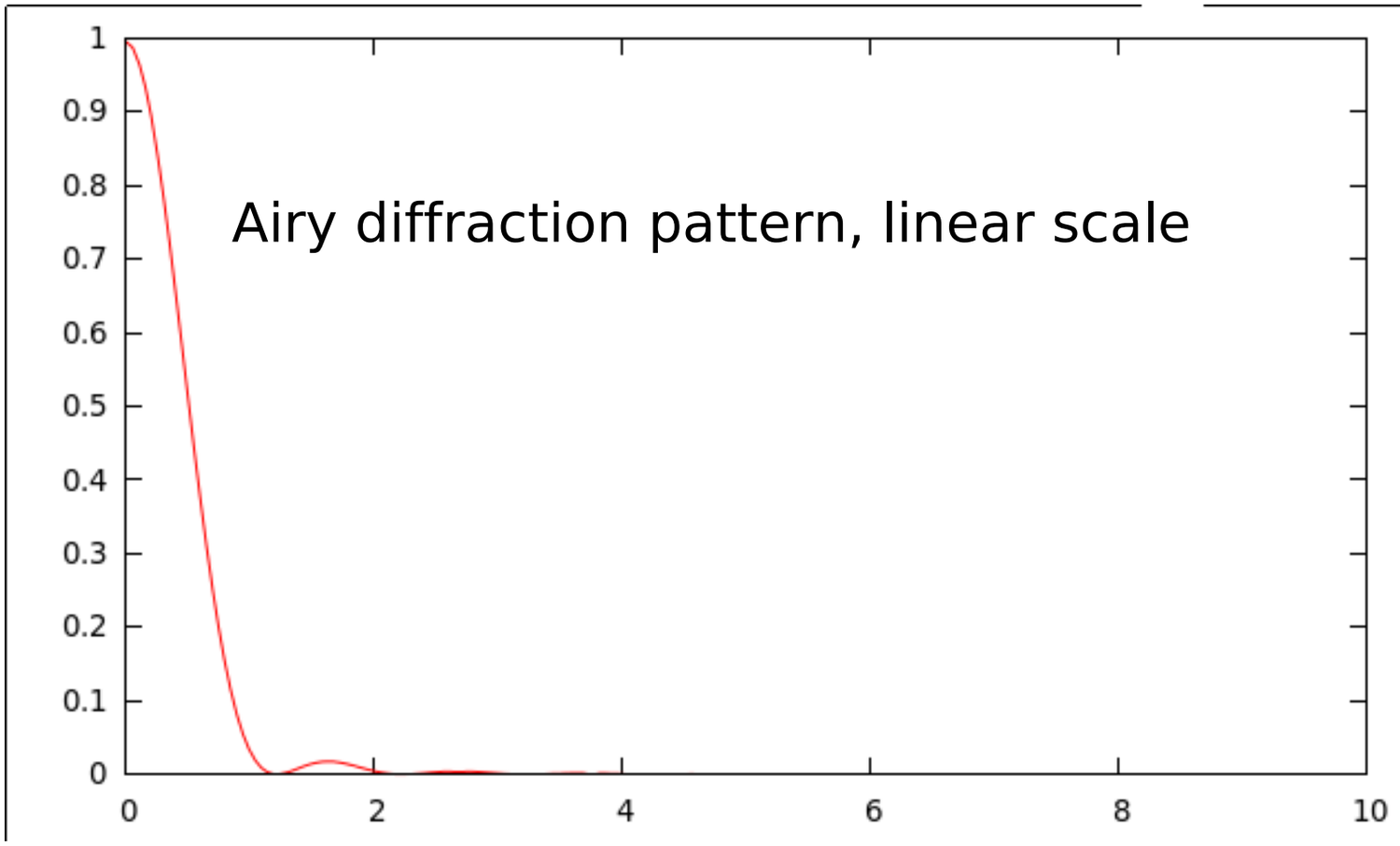


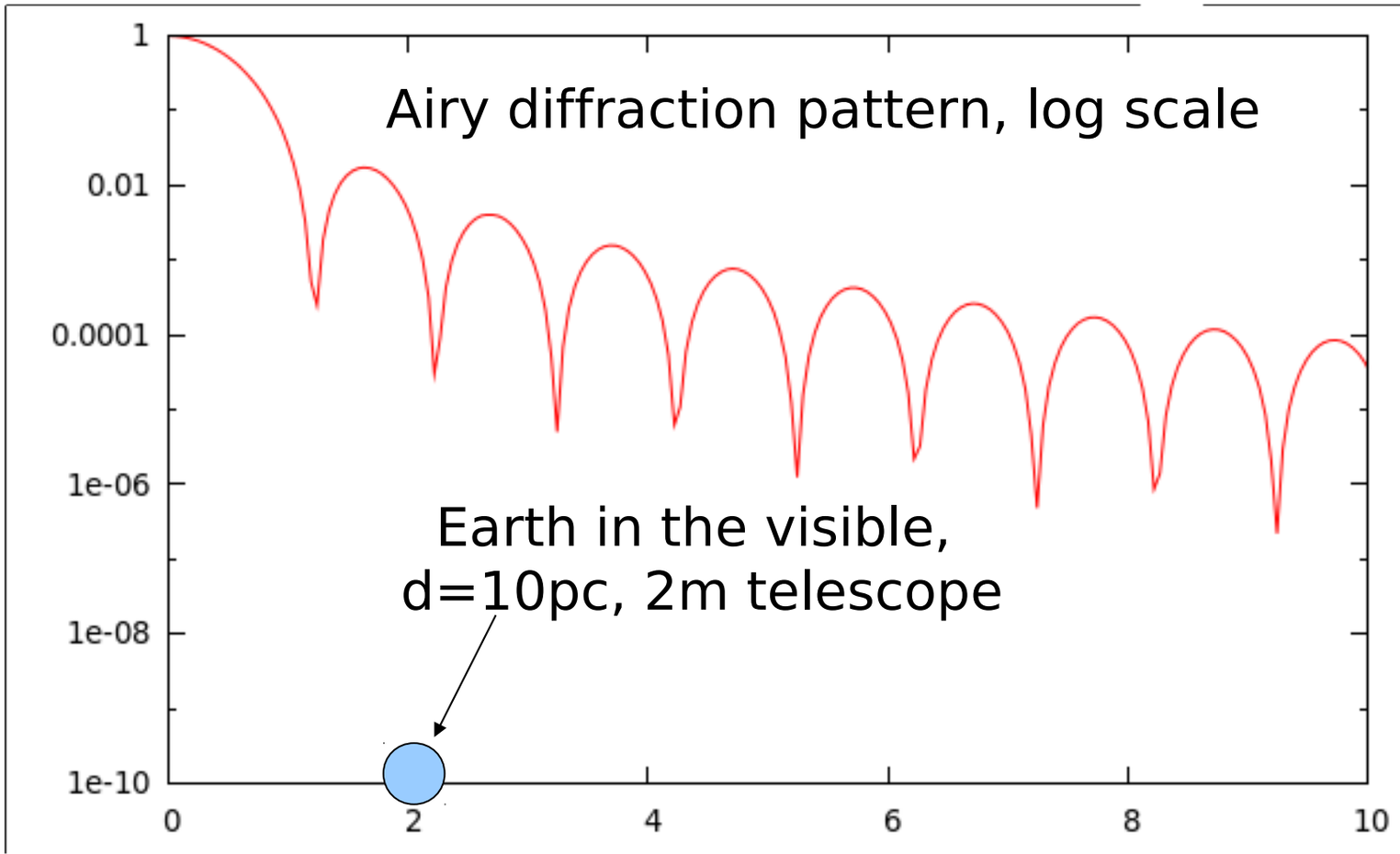


Why coronagraphy ?

Conventional imaging systems are not suitable for high contrast (even if perfect) due to diffraction

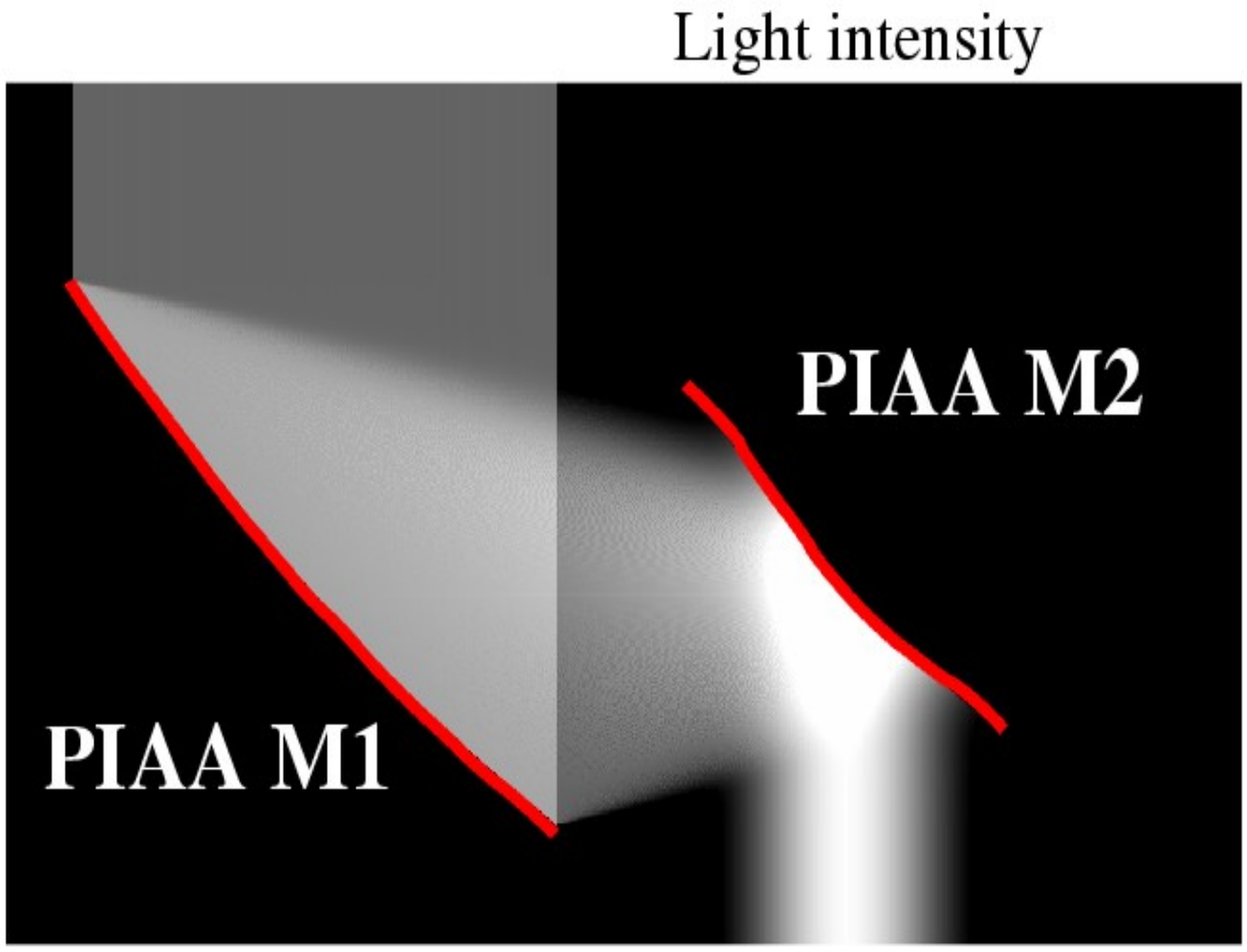






Phase-Induced Amplitude Apodization Coronagraph (PIAAC)

Lossless apodization by aspheric optics.

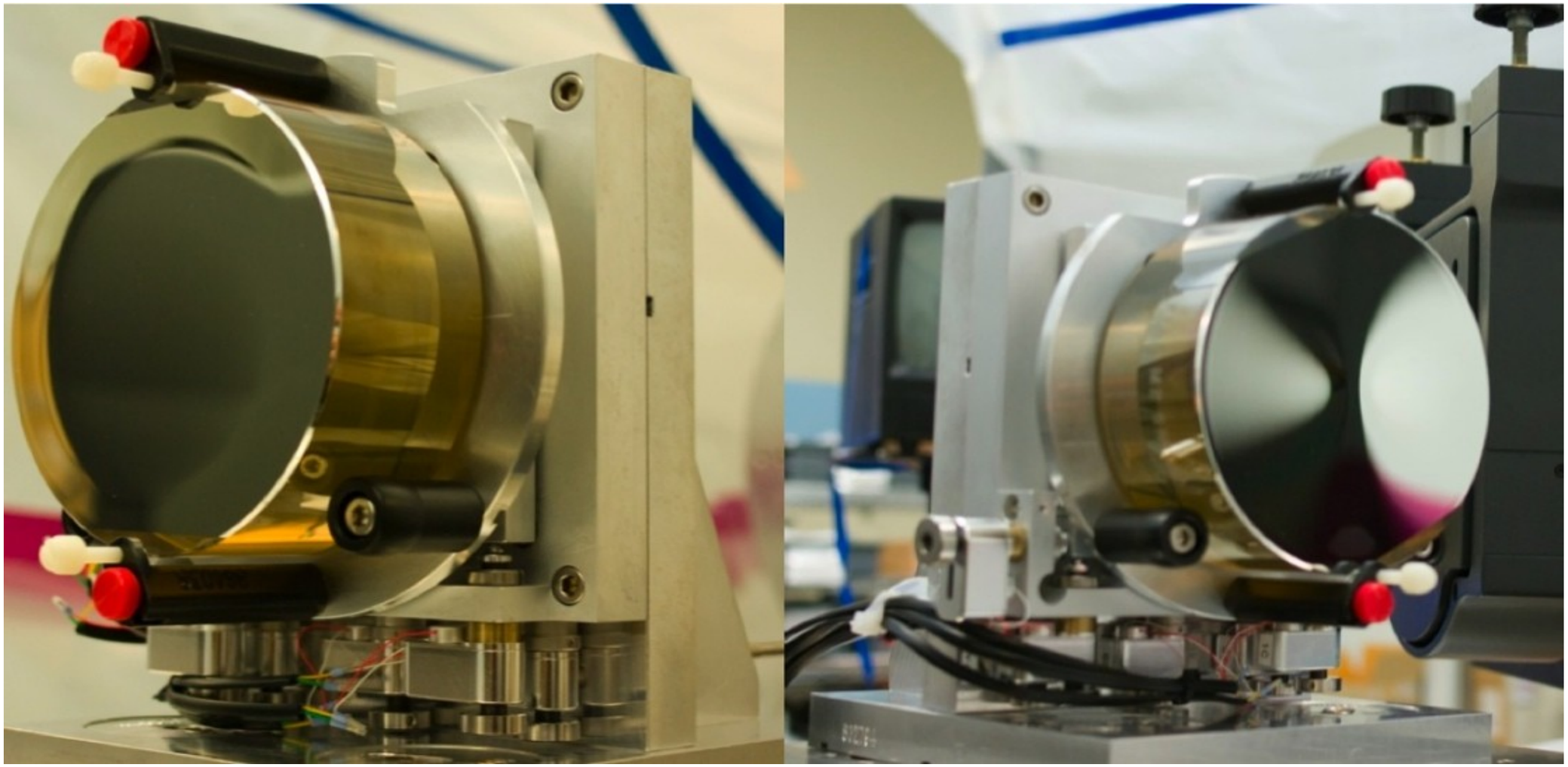


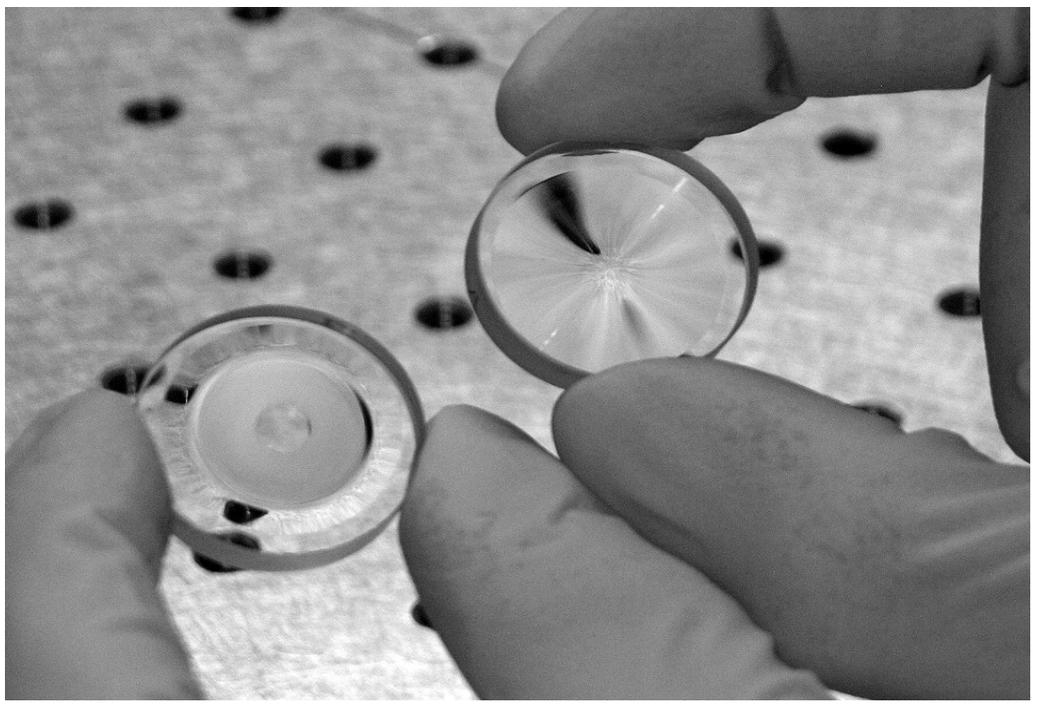
No loss in angular resolution or sensitivity
Achromatic (with mirrors)
Small inner working angle

→ Gain ~x2 in telescope diameter over previous concepts

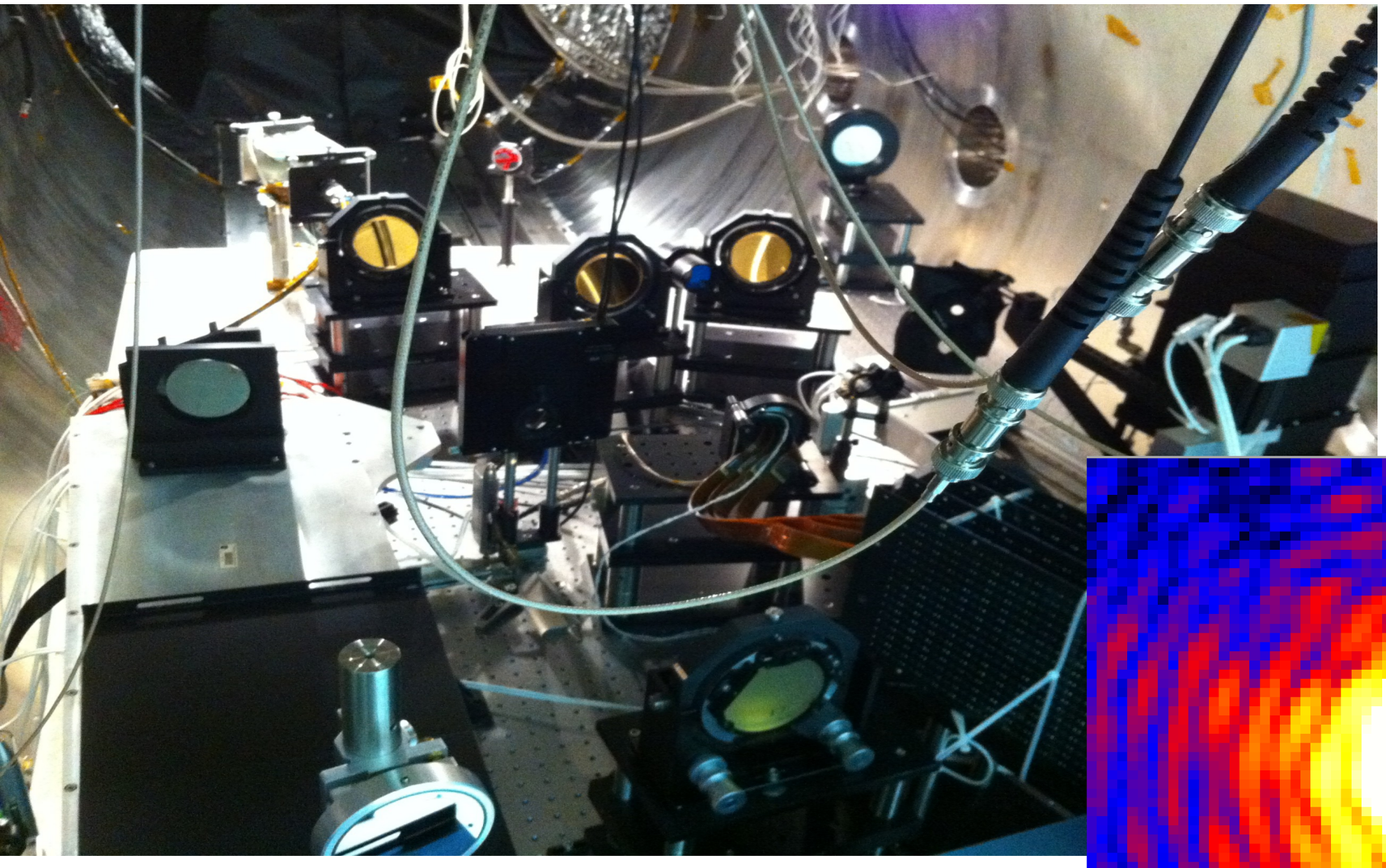
Guyon, Belikov, Pluzhnik, Vanderbei, Traub, Martinache ... 2003-present

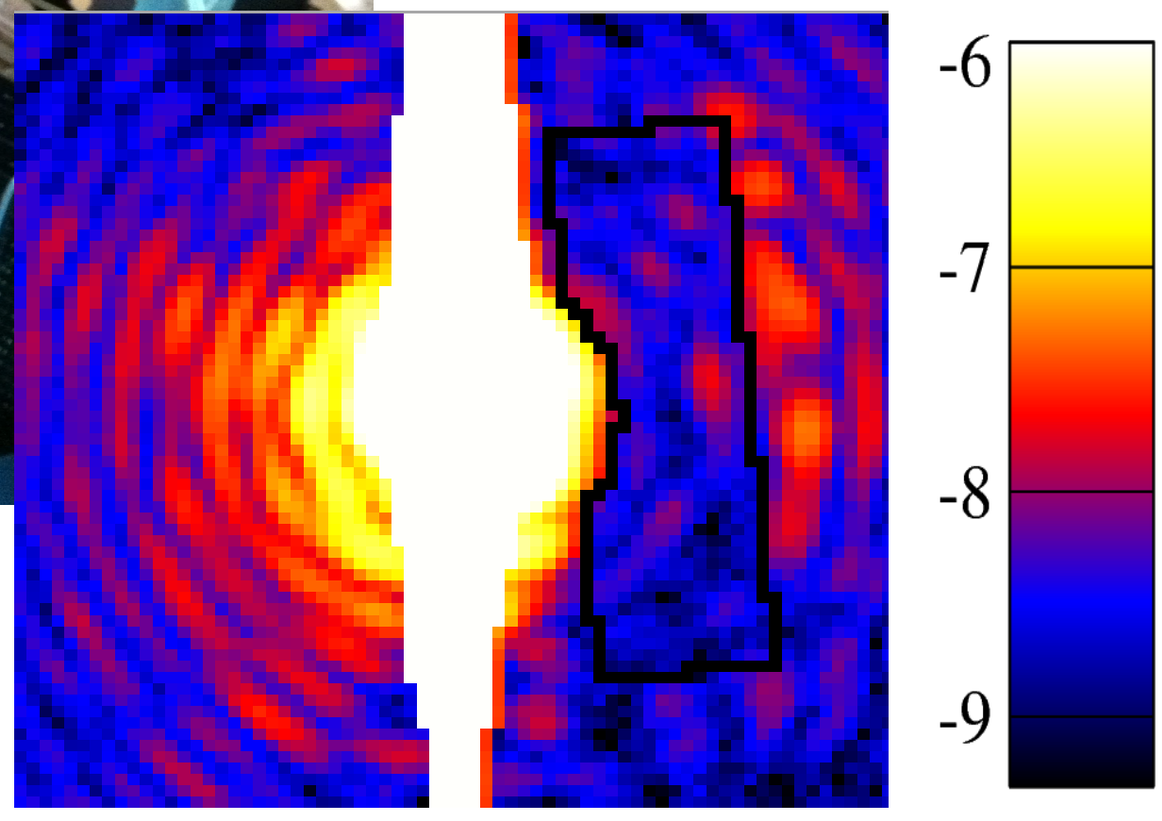
PIAA optics





NASA JPL vacuum testbed

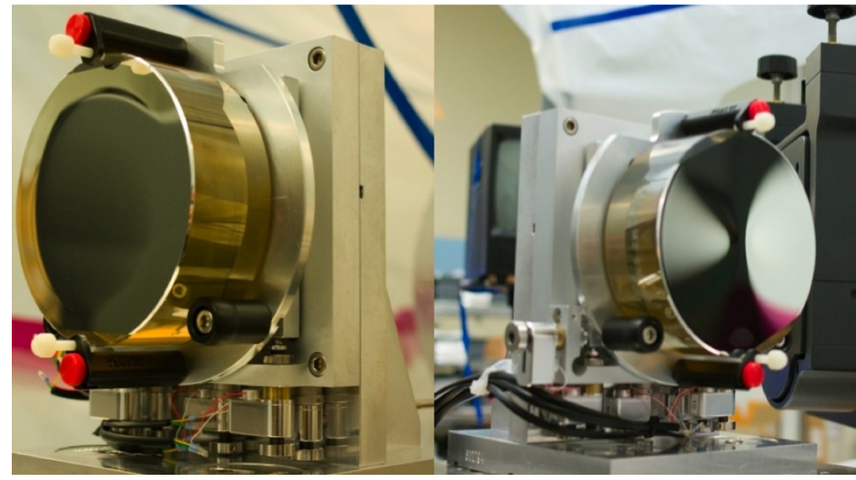


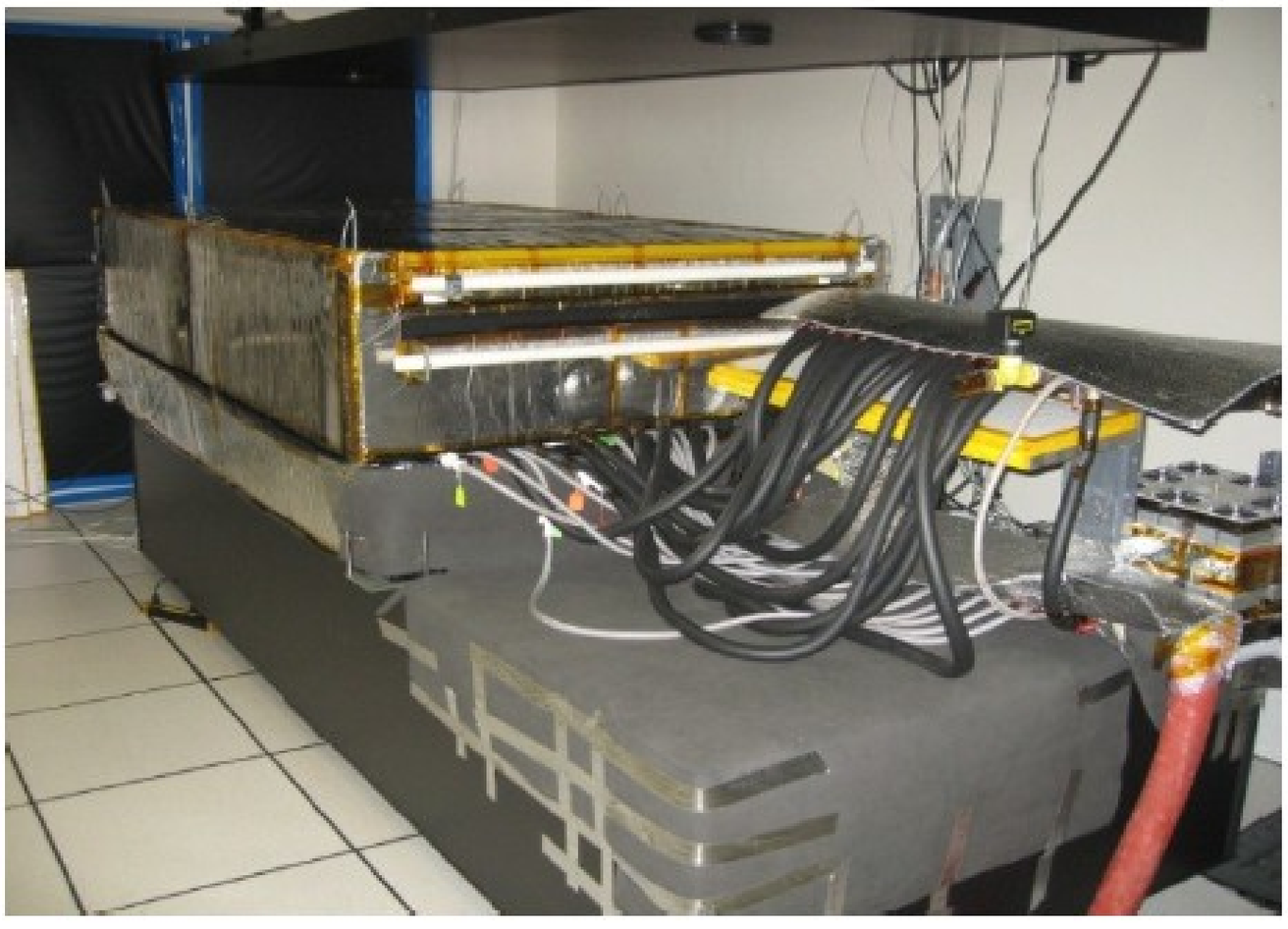


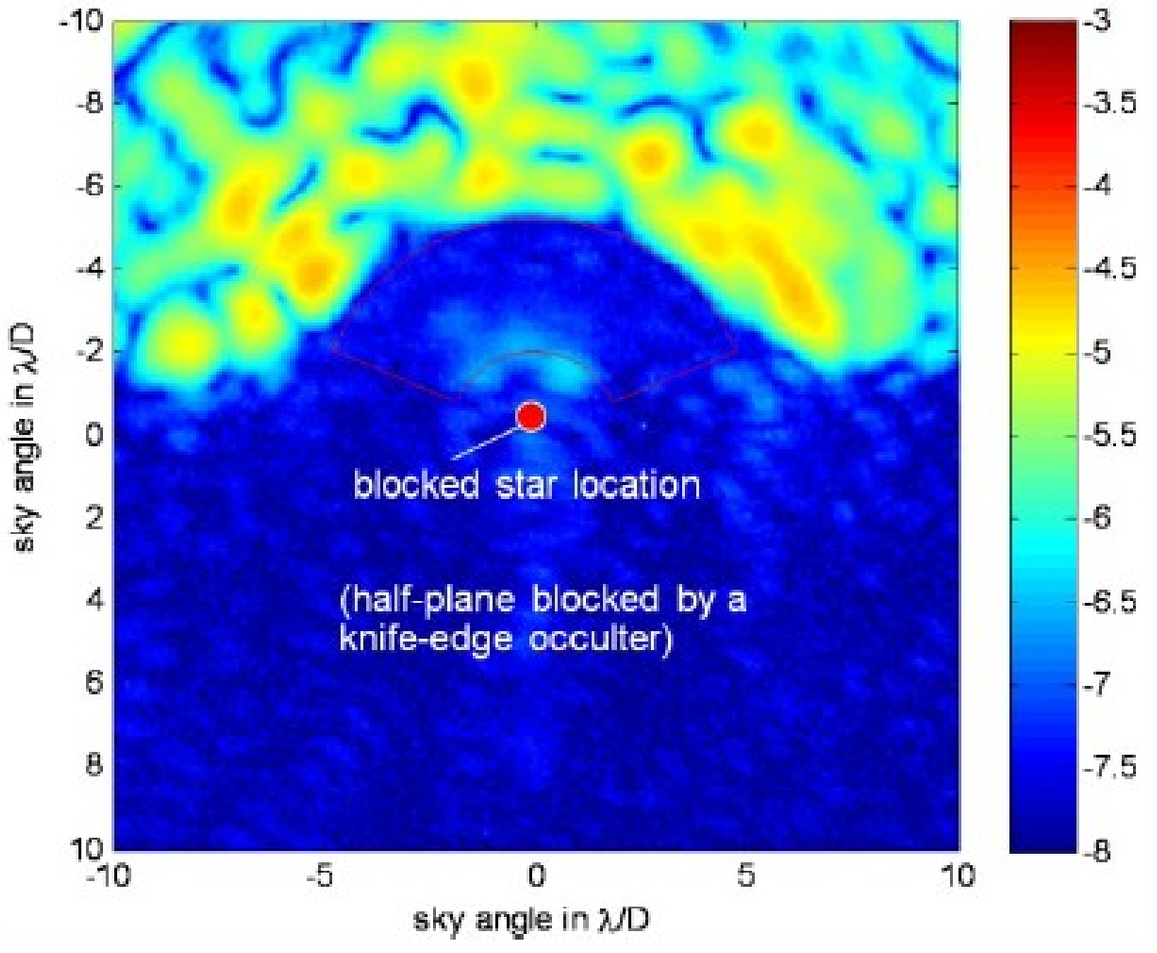
PIAA is reaching few x1e-9 contrast at 2 lambda/D separation

NASA Ames testbed

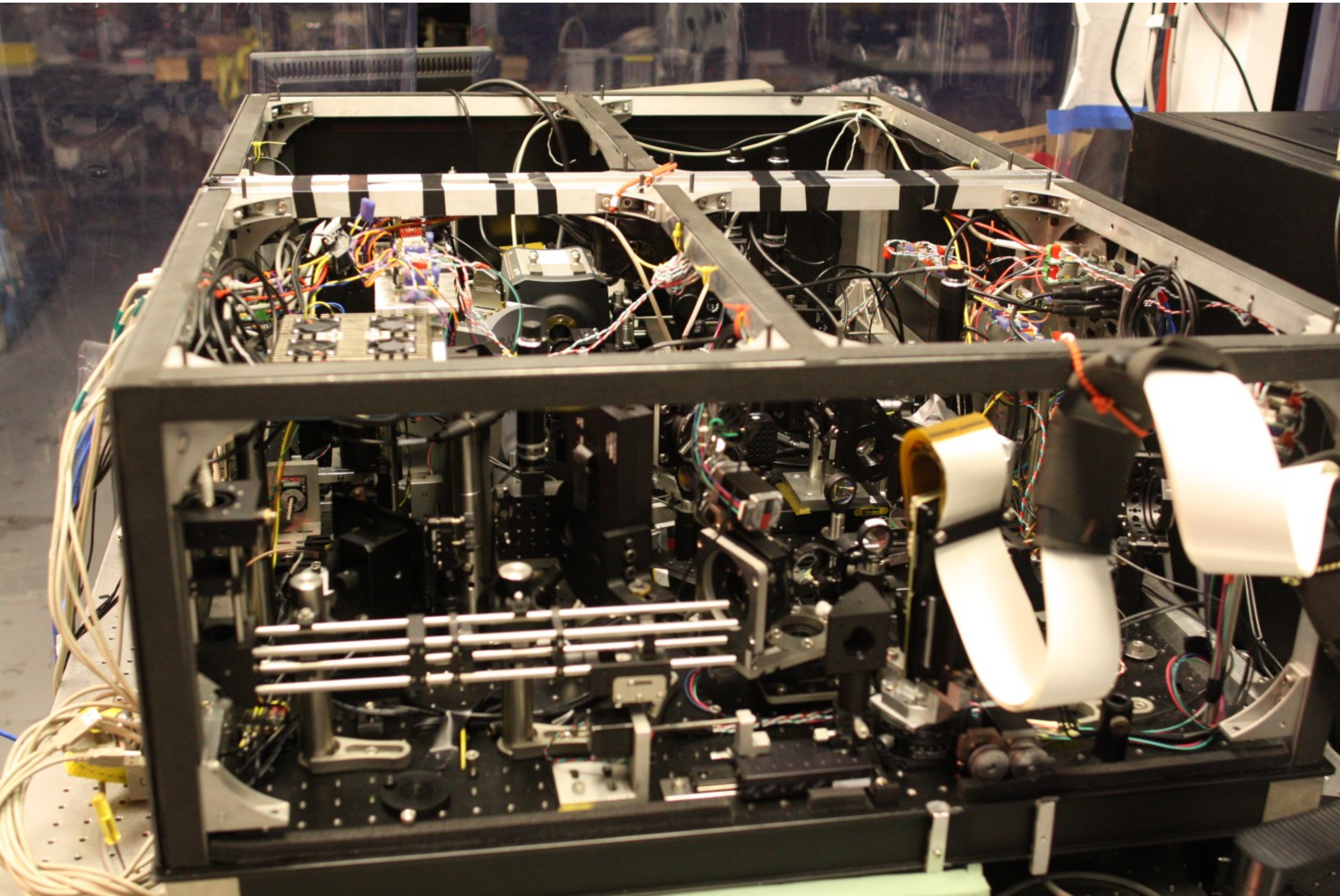
Contrast ratio with PIAA already reaching ~1e-6 at 1.2 l/D in visible





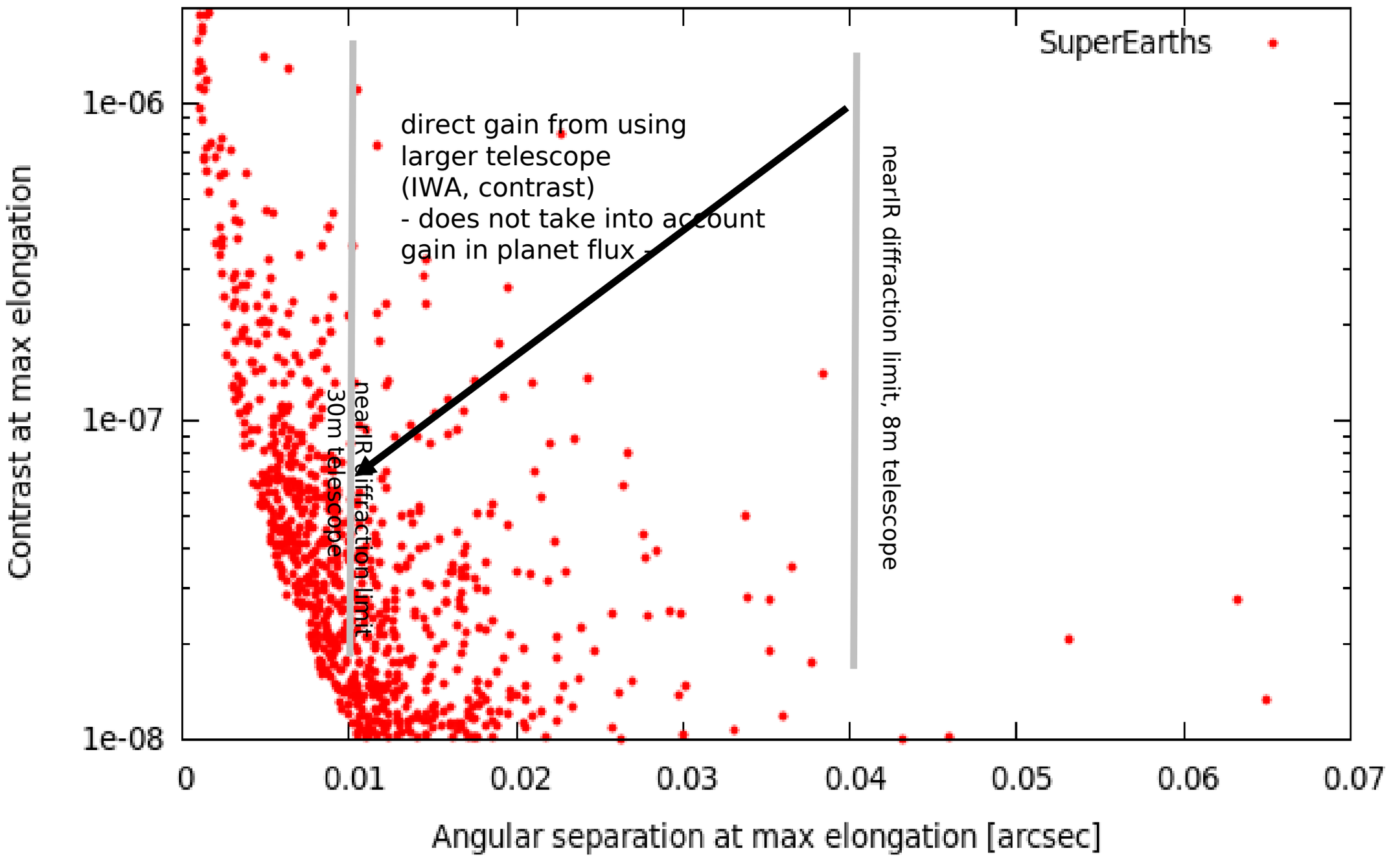


The Subaru Coronagraphic Extreme-AO (SCExAO) system

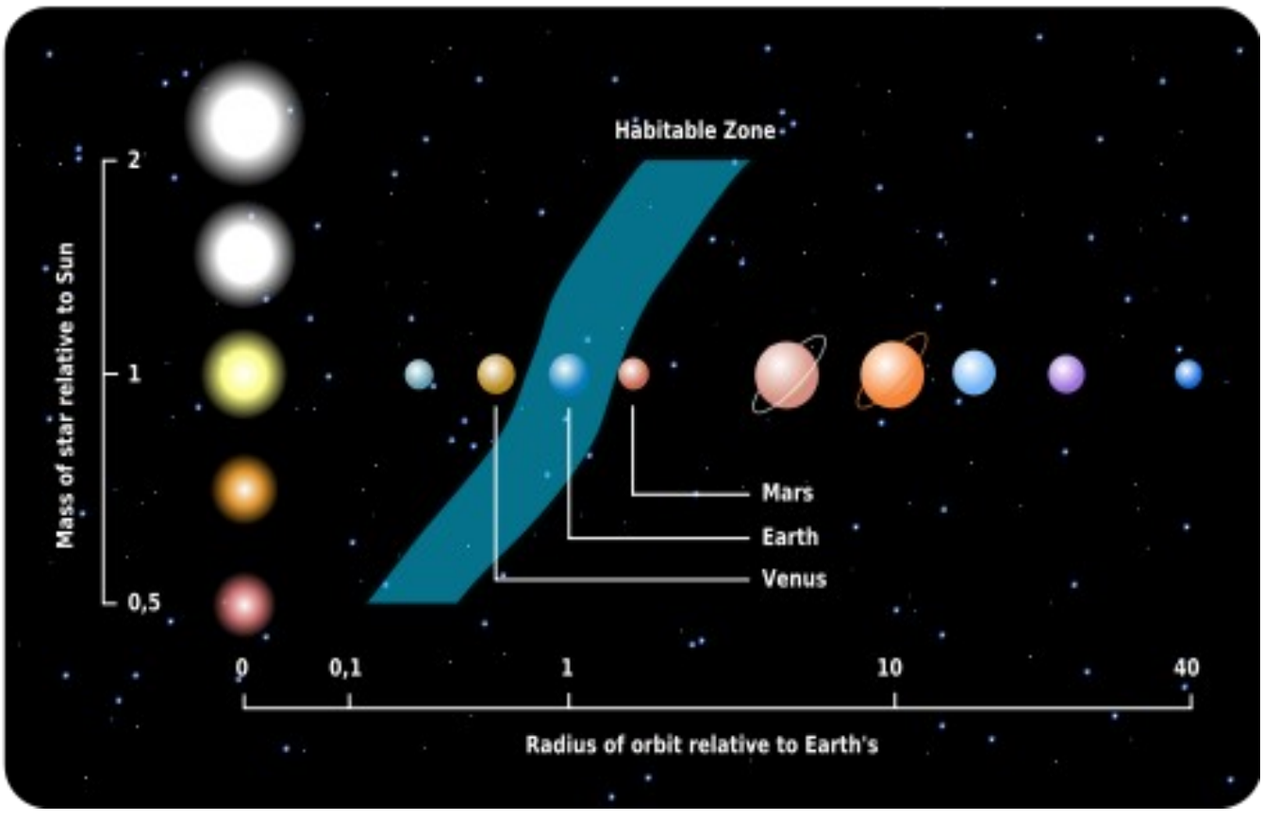


Reflected light planets with Extermely Large Telescopes

Assuming that each star has a SuperEarth (2x Earth diameter) at the 1AU equivalent HZ distance
(assumes Earth albedo, contrast and separation for max elongation)

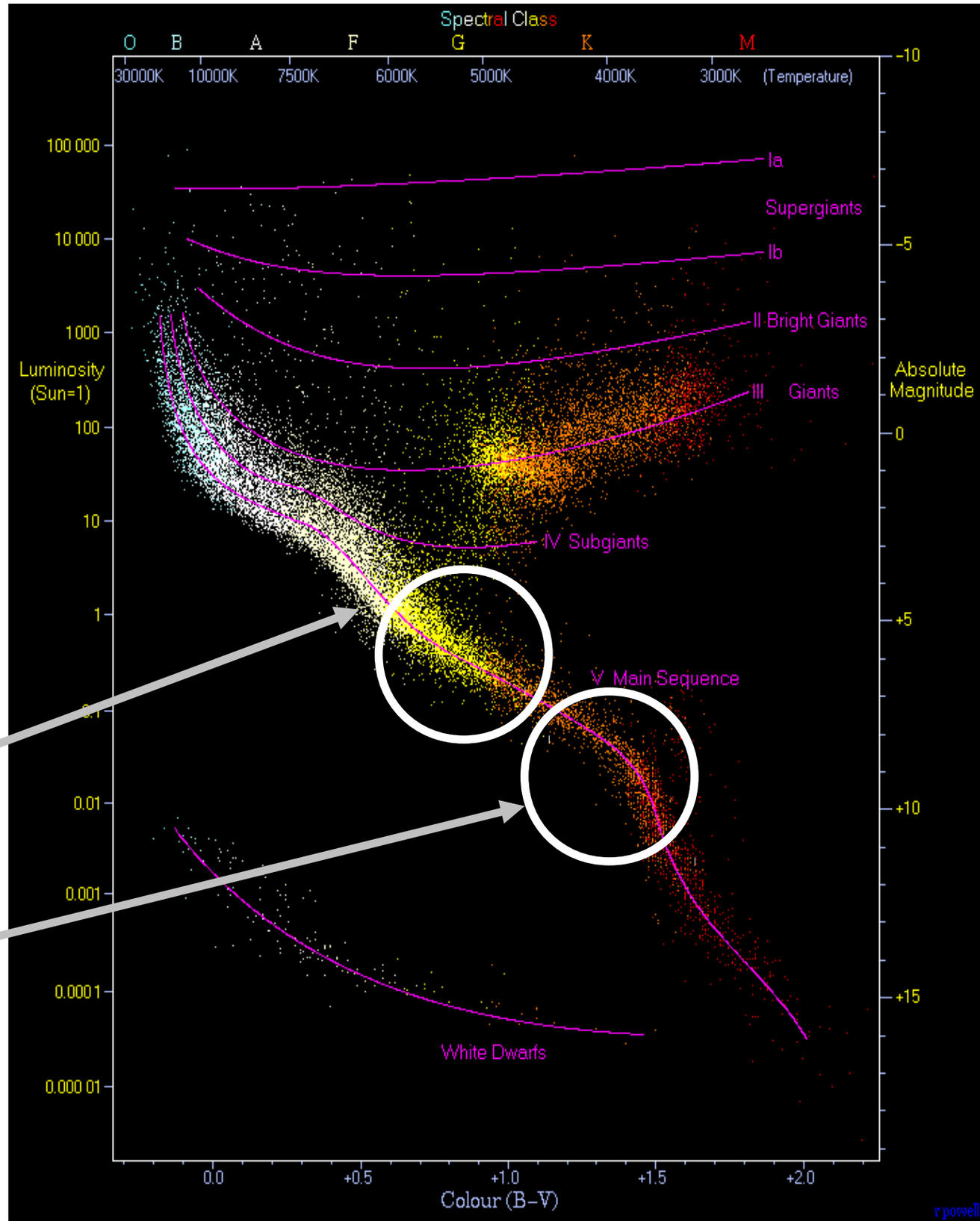


Habitable planets spectroscopy

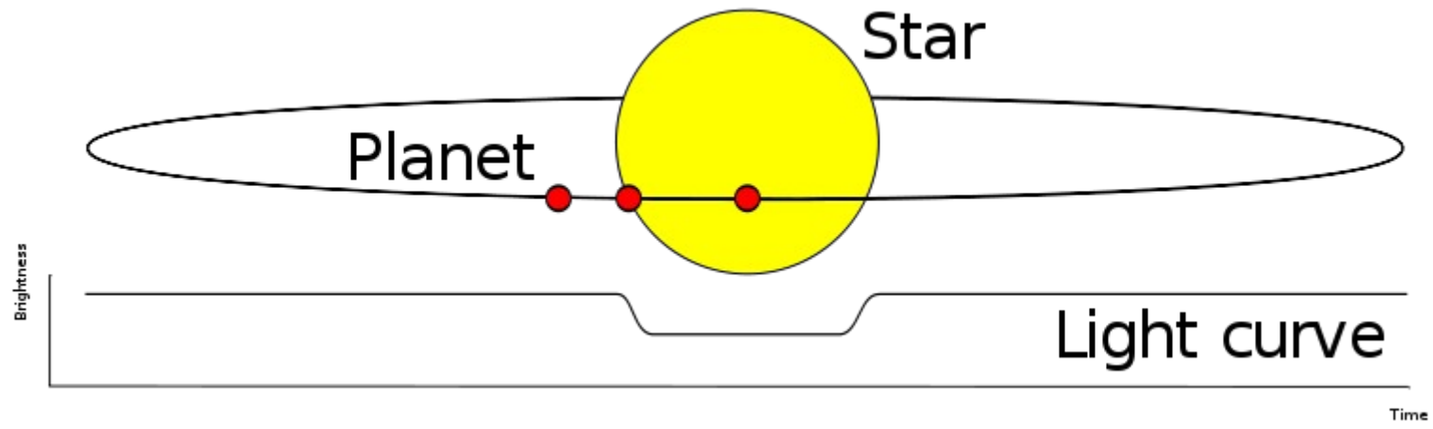


Space (~4m telescope):
F-G-K type stars, visible light
(~203x)

Ground (ELT):
M type stars, nearIR
(~ 202x)



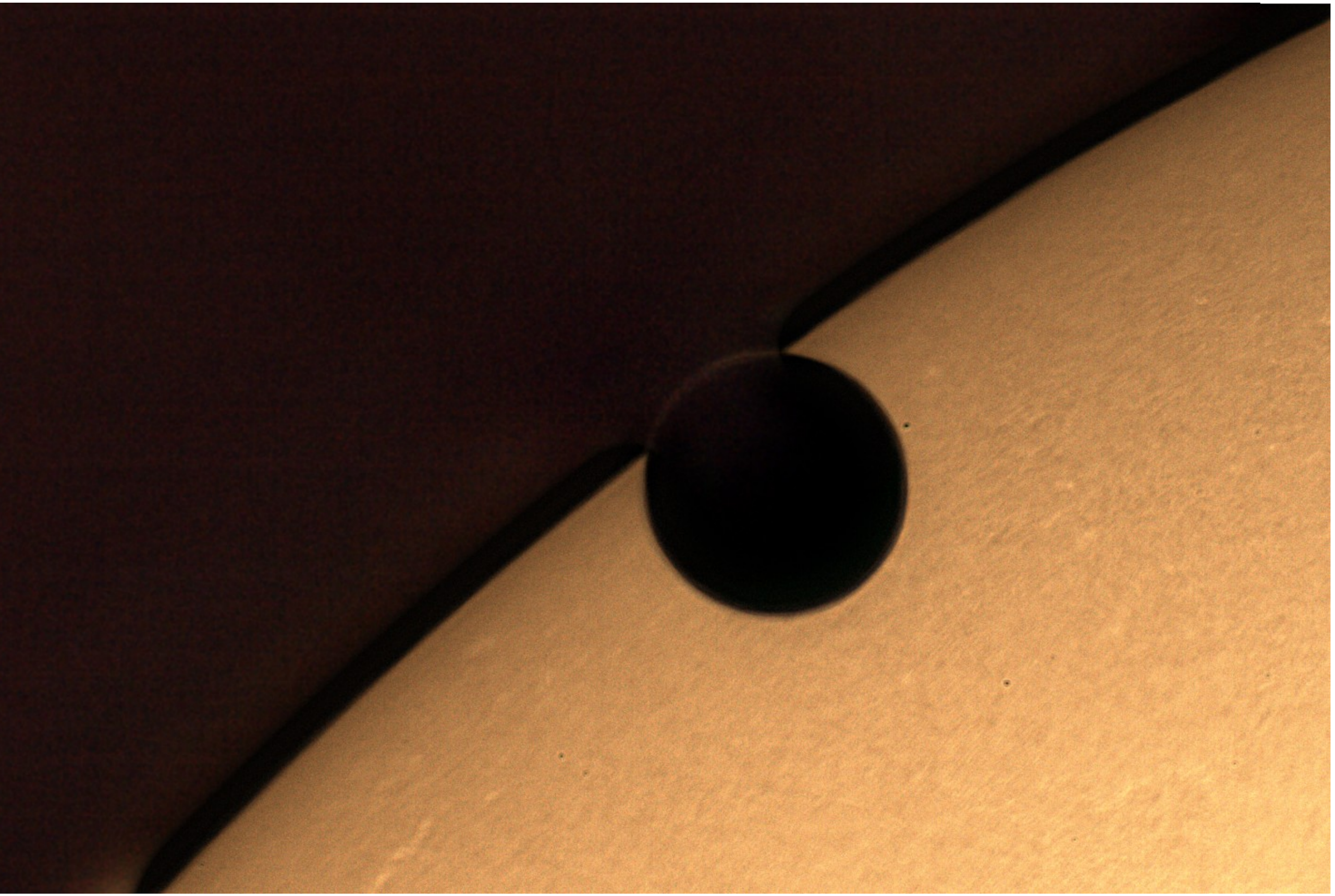
Can amateur astronomers participate in exoplanet research ?



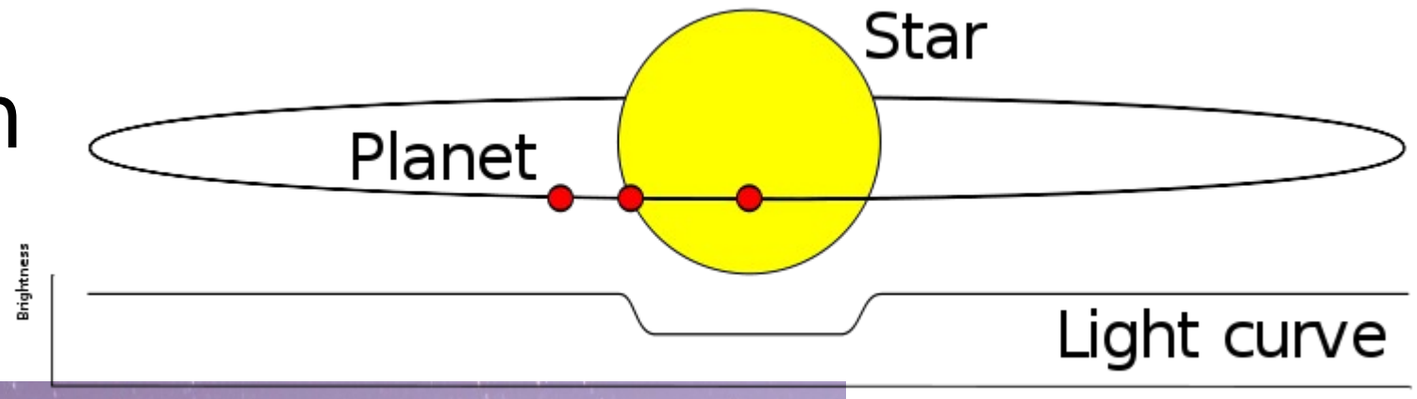
Exoplanet transit:
Monitor a lot of stars for a long time, wait for periodic dimmings

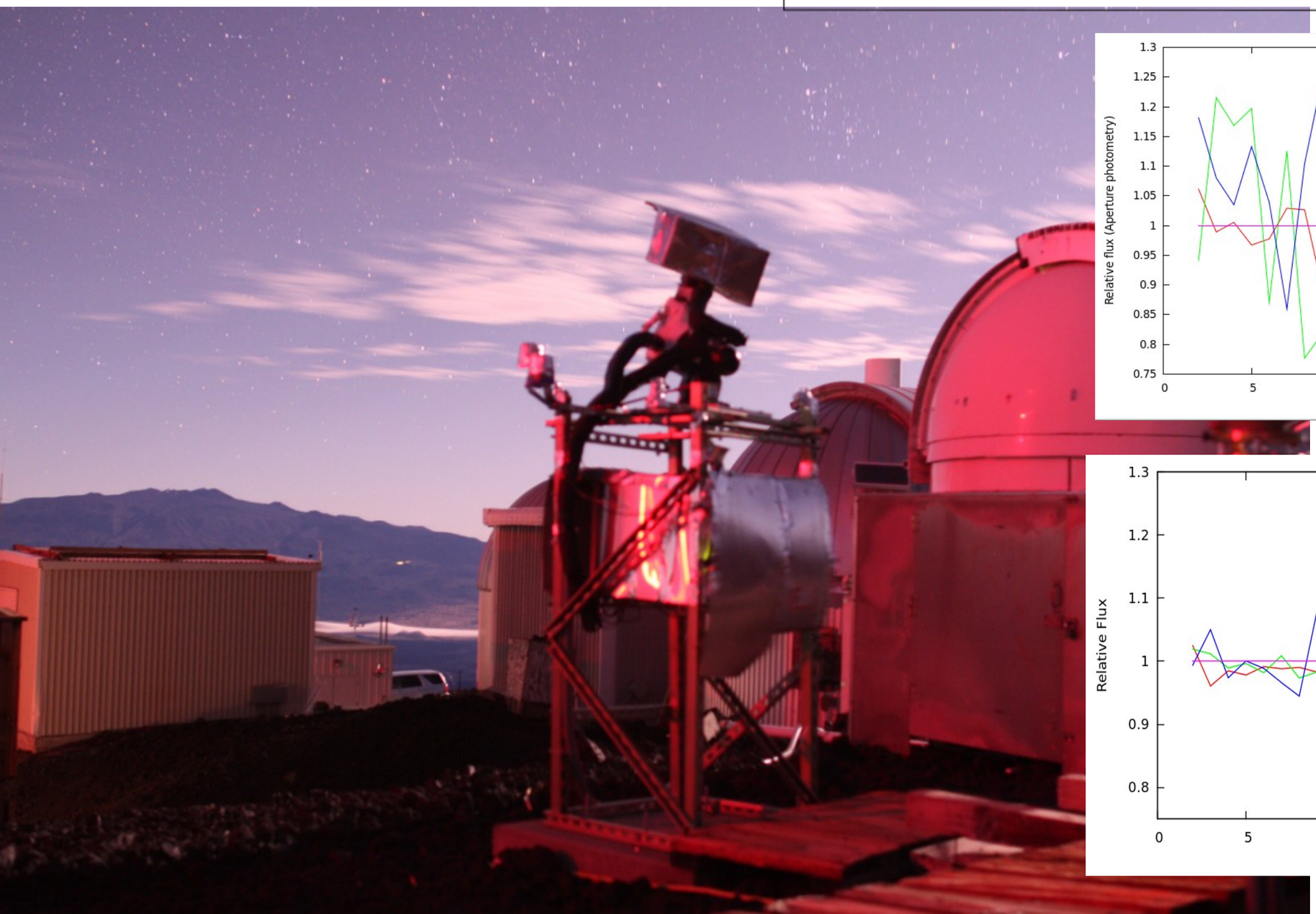
Amateur astronomers, public : lots of eyes, lots of small telescopes
→ can participate to exoplanet research with transit technique

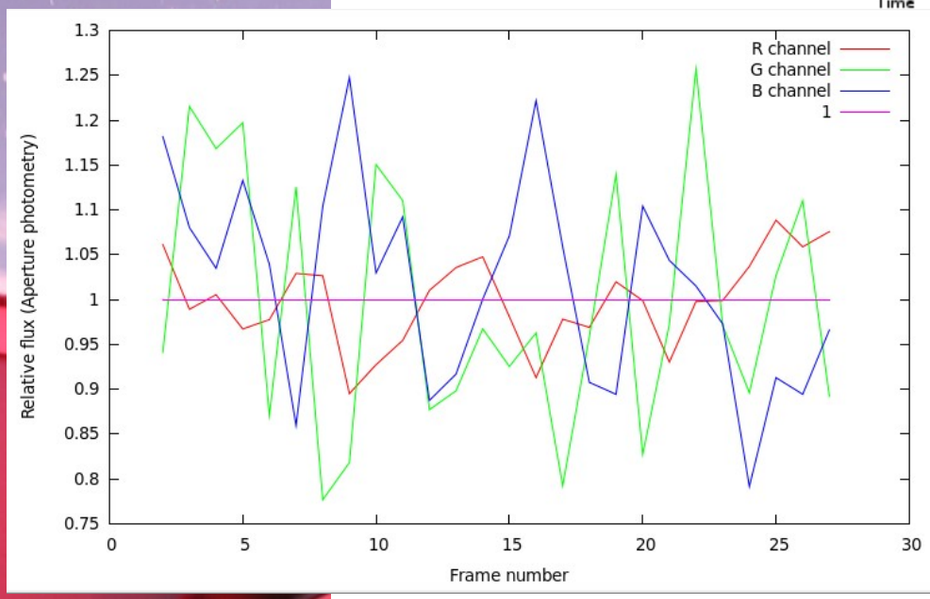
See for example Planet Hunters program using Kepler data
Amateur astronomers have discovered exoplanets by looking at Kepler data

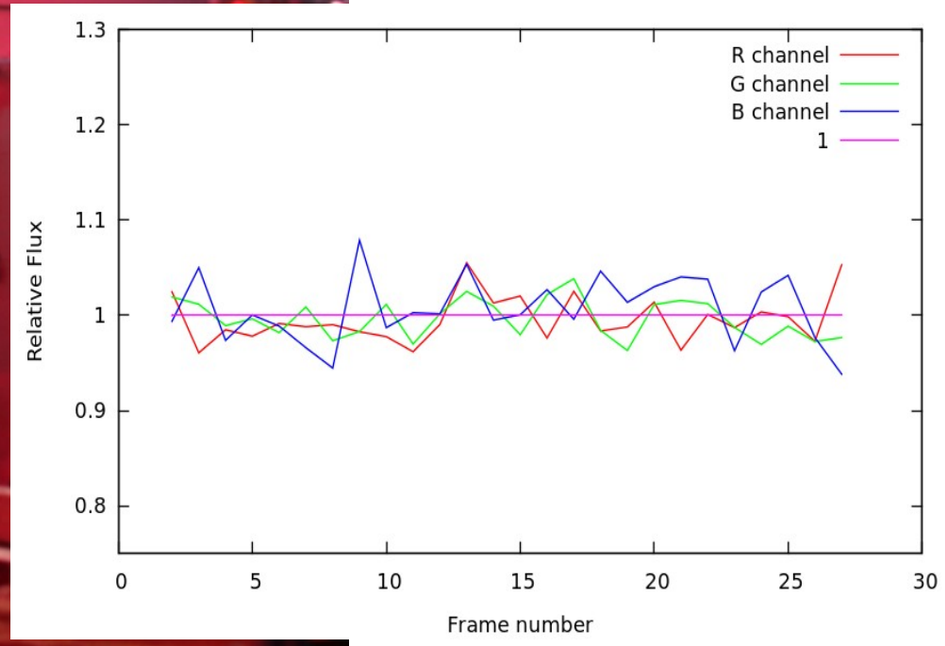


Exoplanet transit with commercial DSLRs









Transit Field #1 (in Cygnus), camera 2 (Sept 11, 2012 UT)

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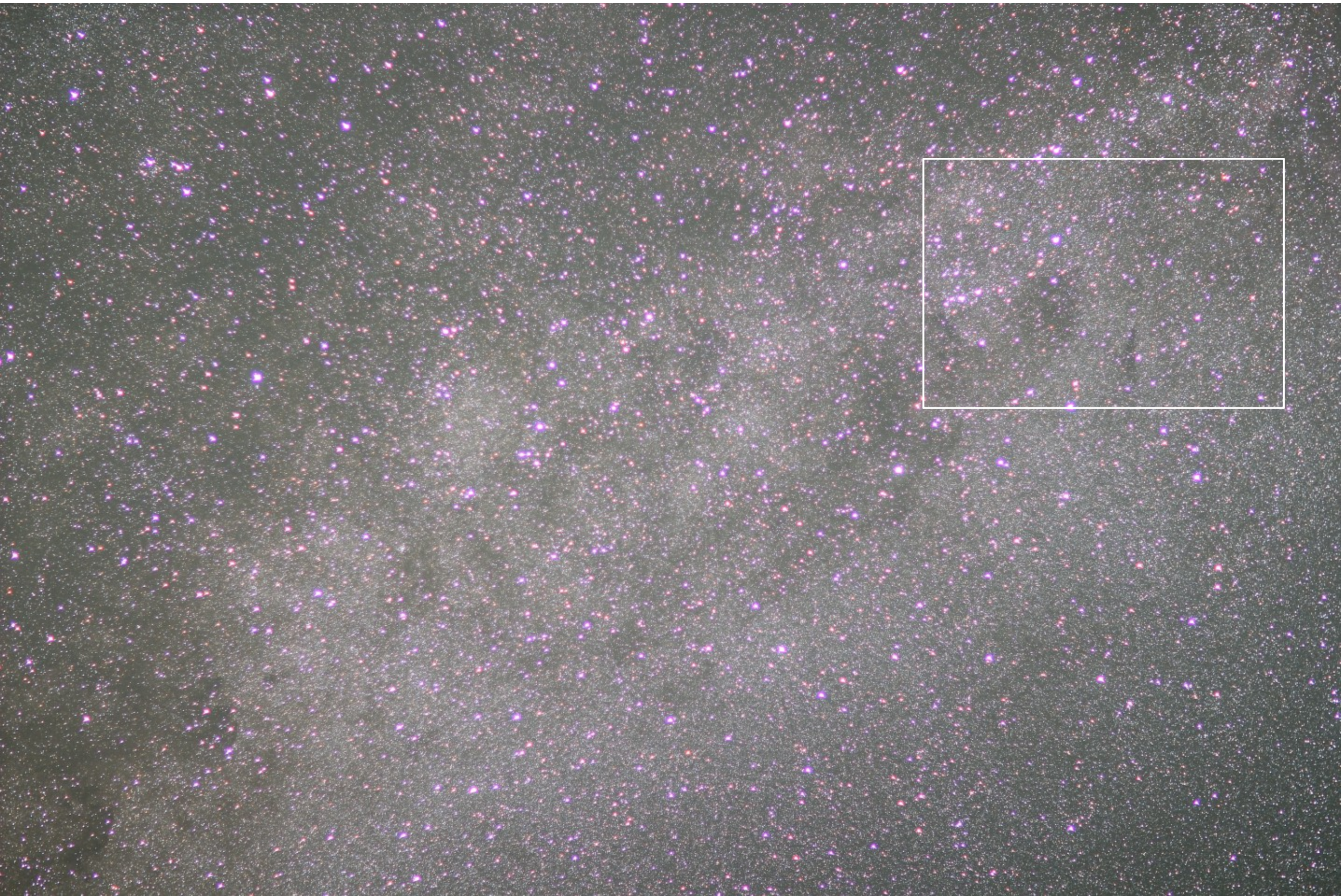

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