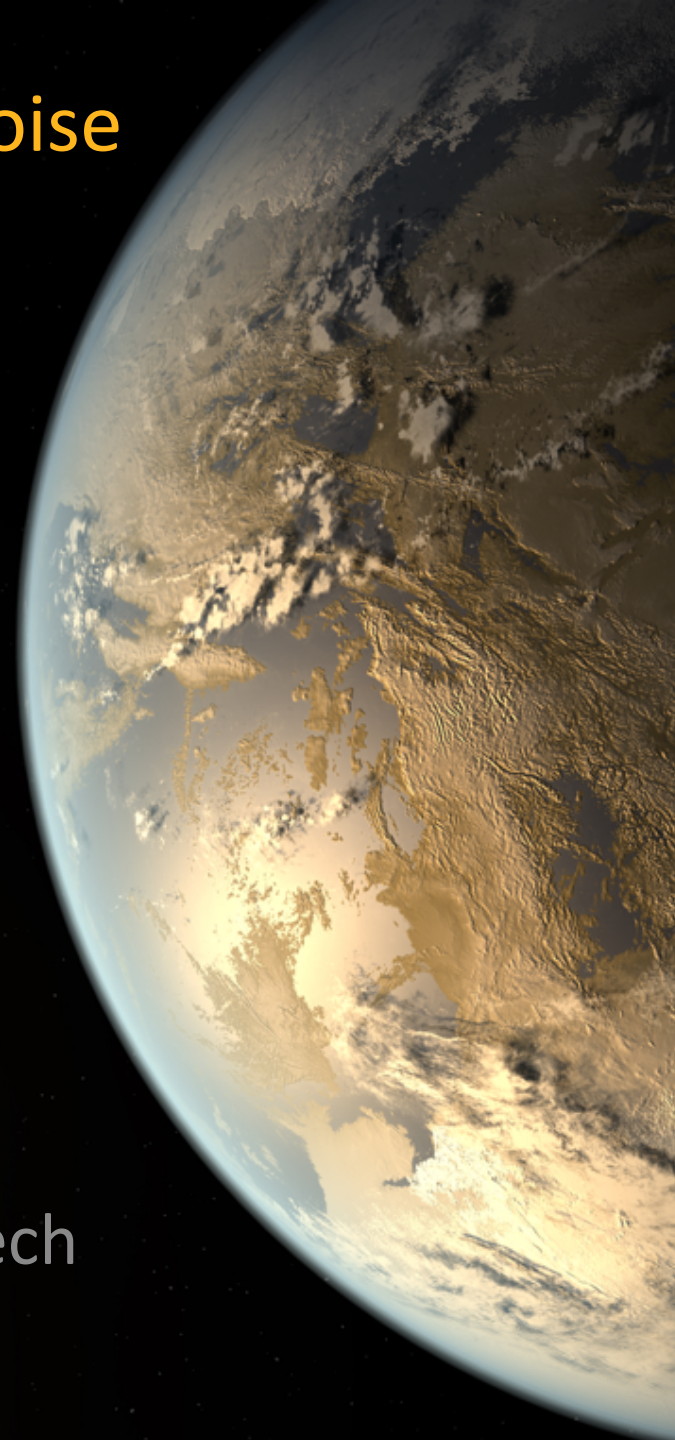


Astrophysical and Instrumental Noise Sources: Transits

Sagan Workshop – July 19 2016

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NASA Exoplanet Science Institute/Caltech



Why do we care about noise?

Take the example of the Kepler mission – the primary goal was determining the occurrence rate of Earth-like planets around sun-like stars

That's hard! Earth creates a 85ppm deep transit

Mission design has to account for all the known sources of noise – error budget of 20ppm in 6.5h

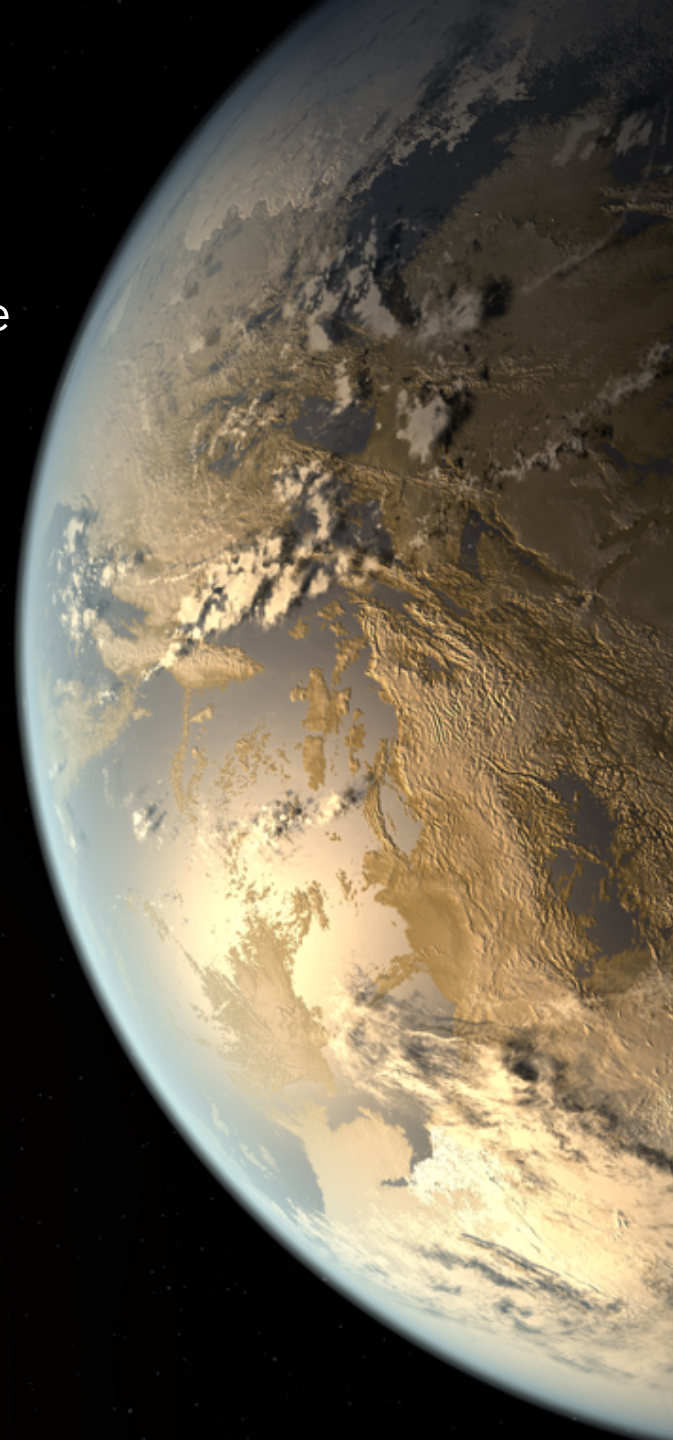
How big a telescope do we need to build?

How faint a star can we look at?

What kind of stars can we look at?

How expensive a detector do we need to buy?

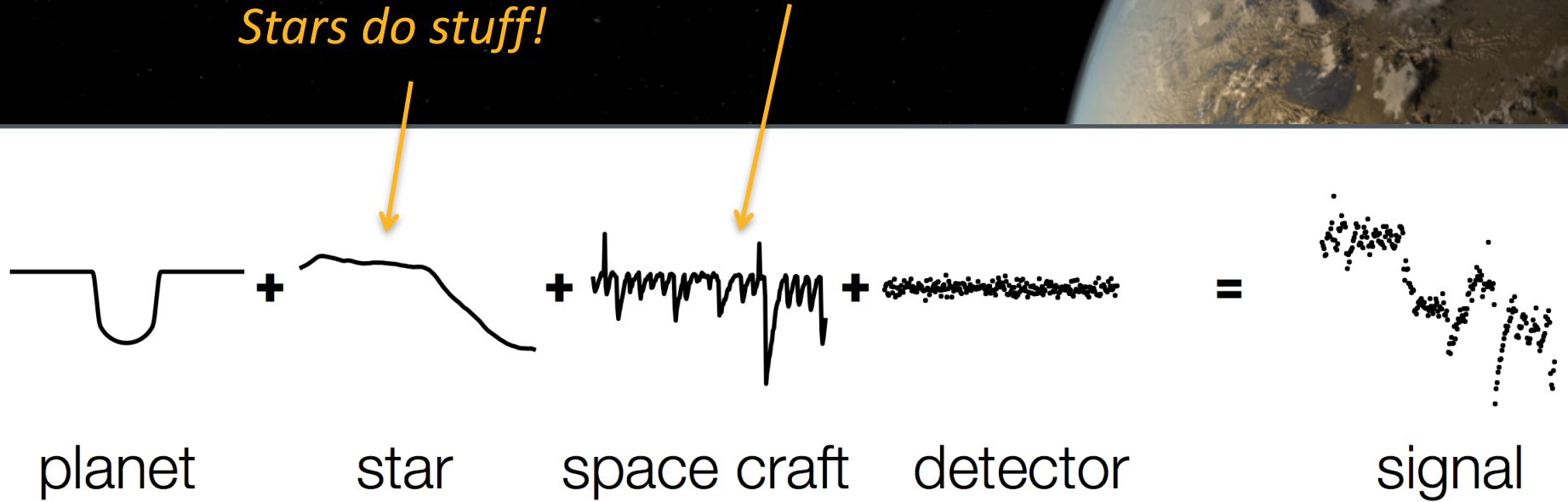
What is the overall noise floor achievable?



Overview

Stars do stuff!

Spacecraft do stuff!



Credit: Dan Foreman-Mackay, Davos

Overview

Telescopes do stuff!

Atmospheres do stuff!

Stars do stuff!

atmosphere

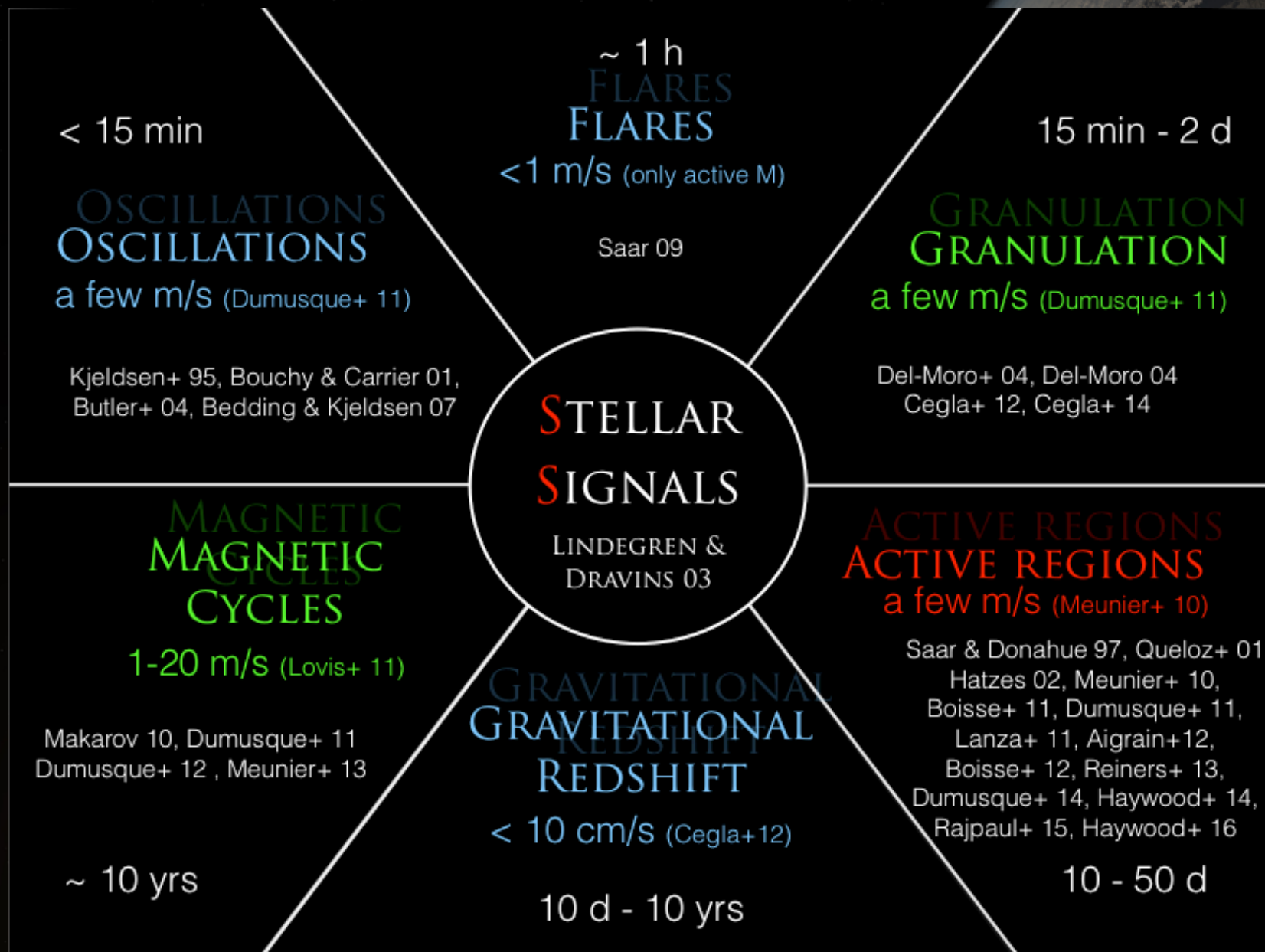


(Planets do stuff, too!)

Detectors do stuff!

Credit: Dan Foreman-Mackay, Davos

Stars do stuff...



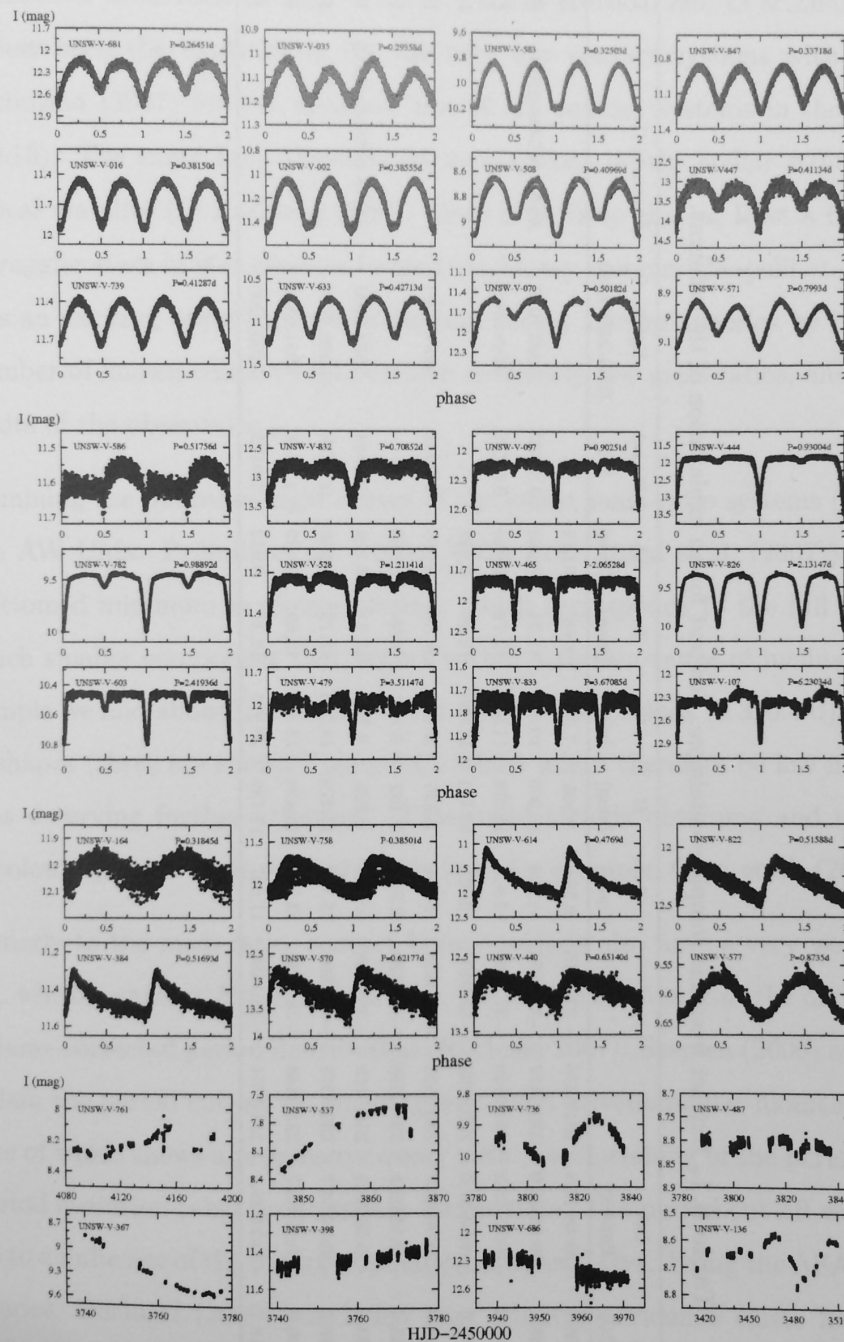
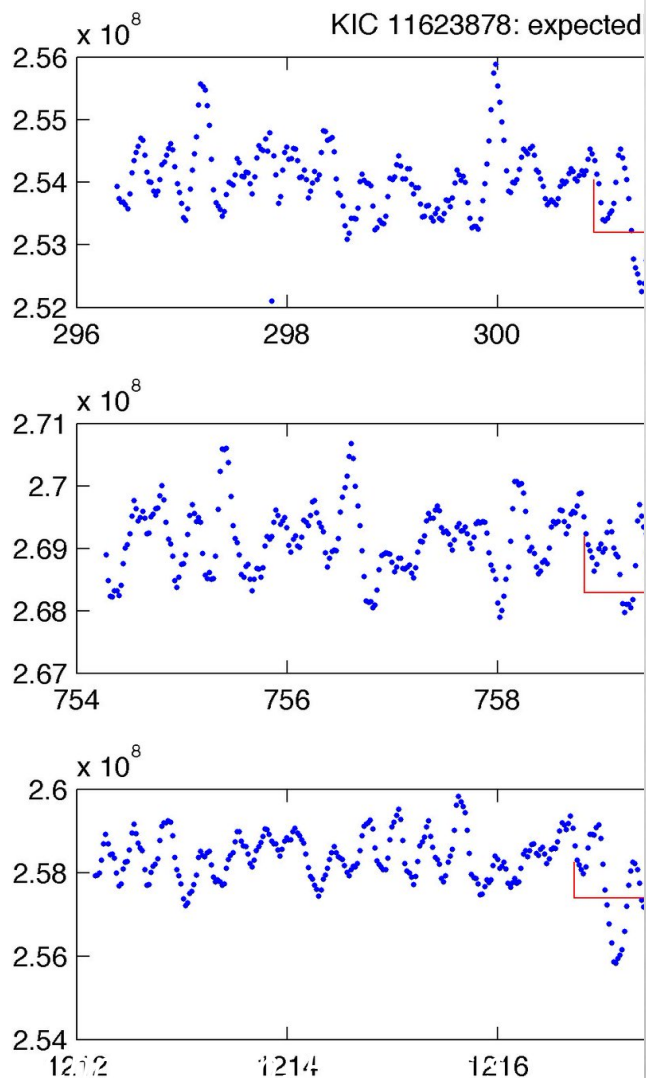
Credit: Xavier Dumusque

Stars do stuff...

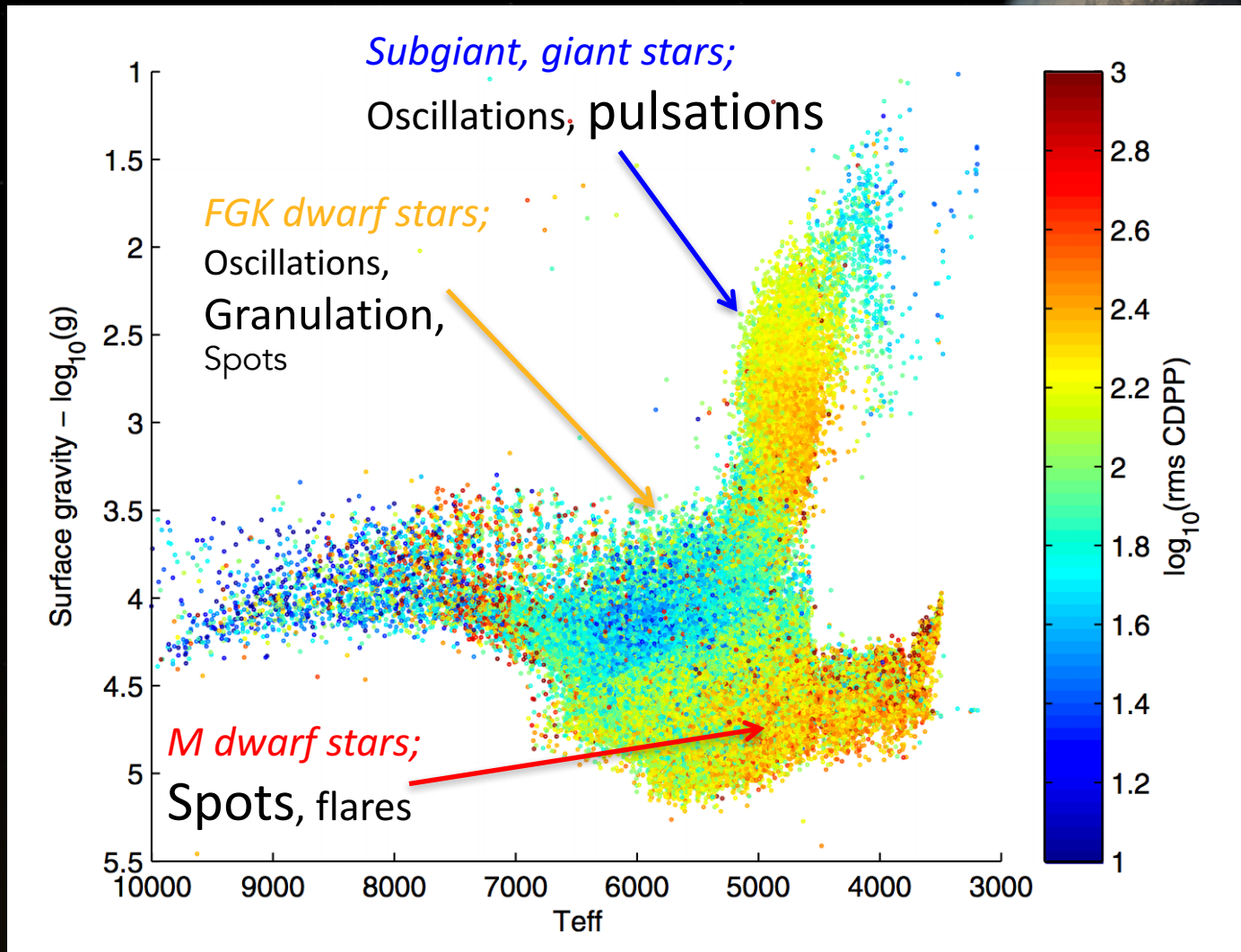
Credit: M

Osc

Intensity (shifted)



Different stars do different stuff...

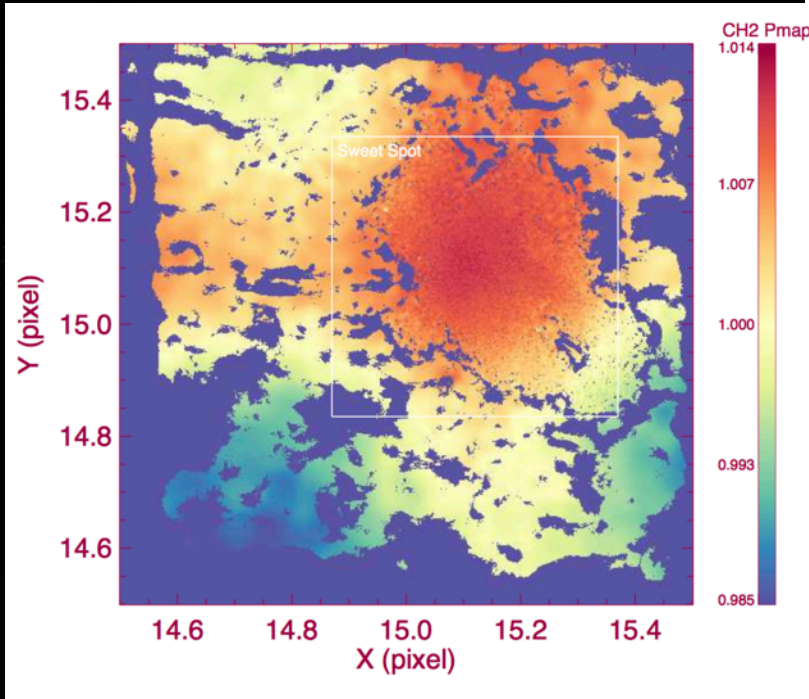


Christiansen+2012

Telescopes do stuff...

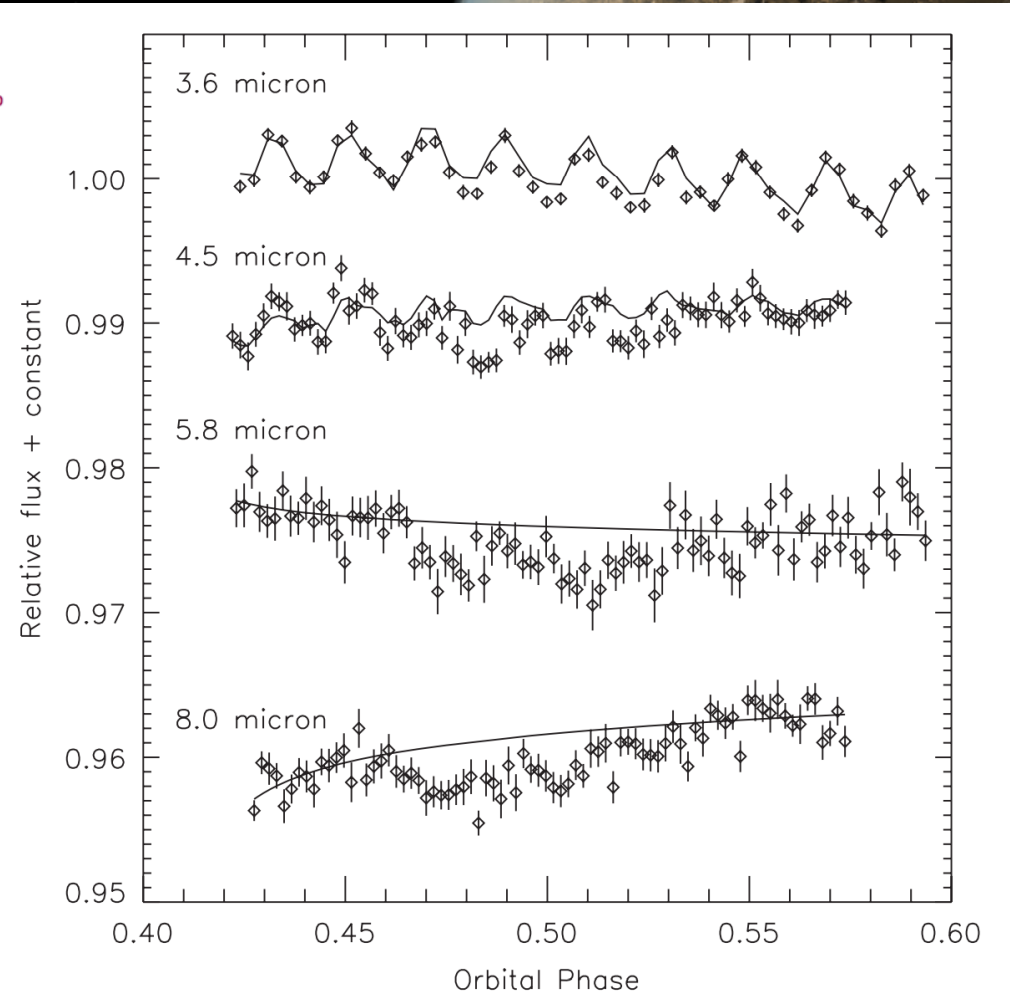
They typically have pointing jitter

- Intra-pixel variations, e.g. Spitzer, K2 (not Kepler!)



irachpp.spitzer.caltech.edu

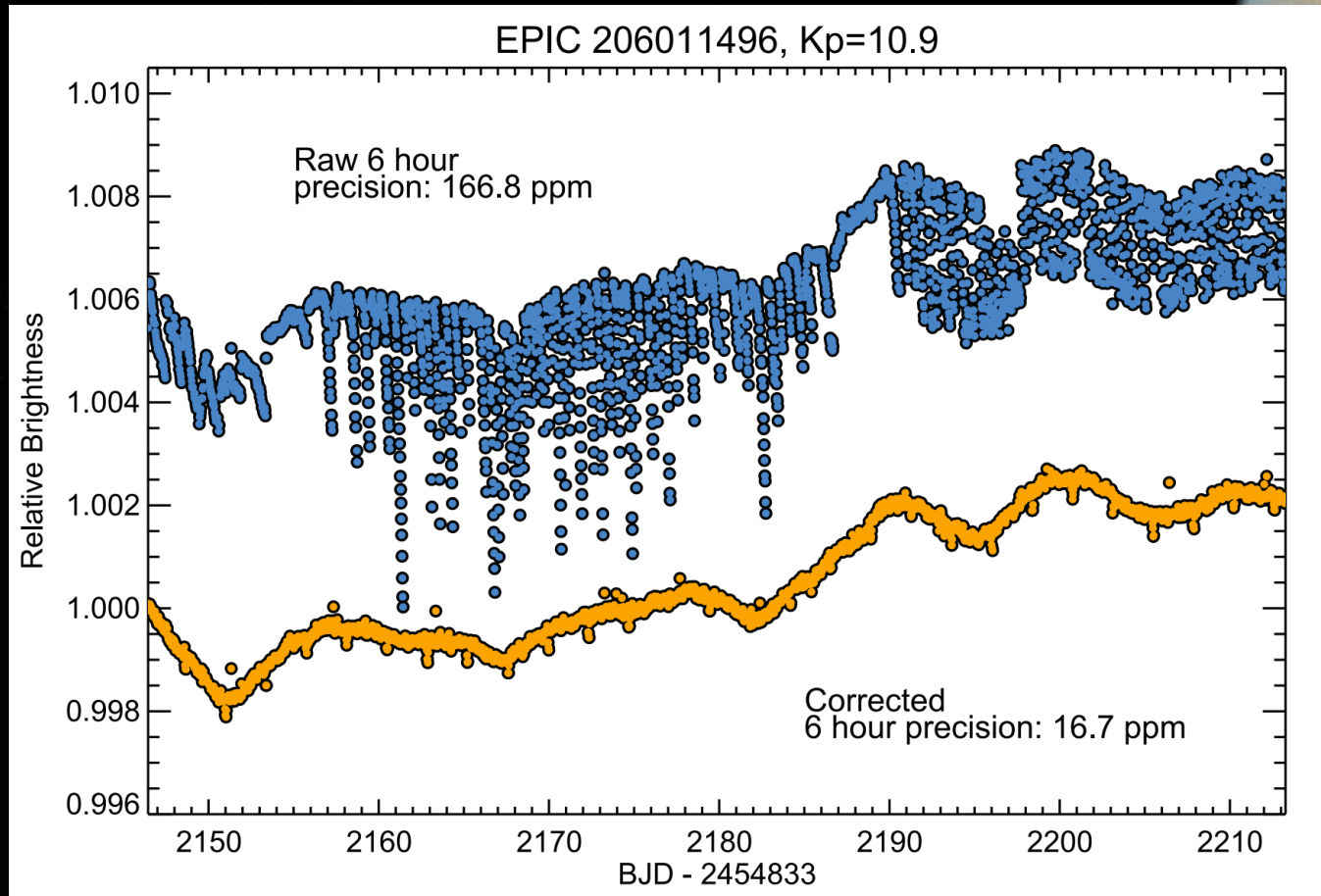
Christiansen+2010



Telescopes do stuff...

They typically have pointing jitter

- Intra-pixel variations, e.g. Spitzer, K2 (not Kepler!)

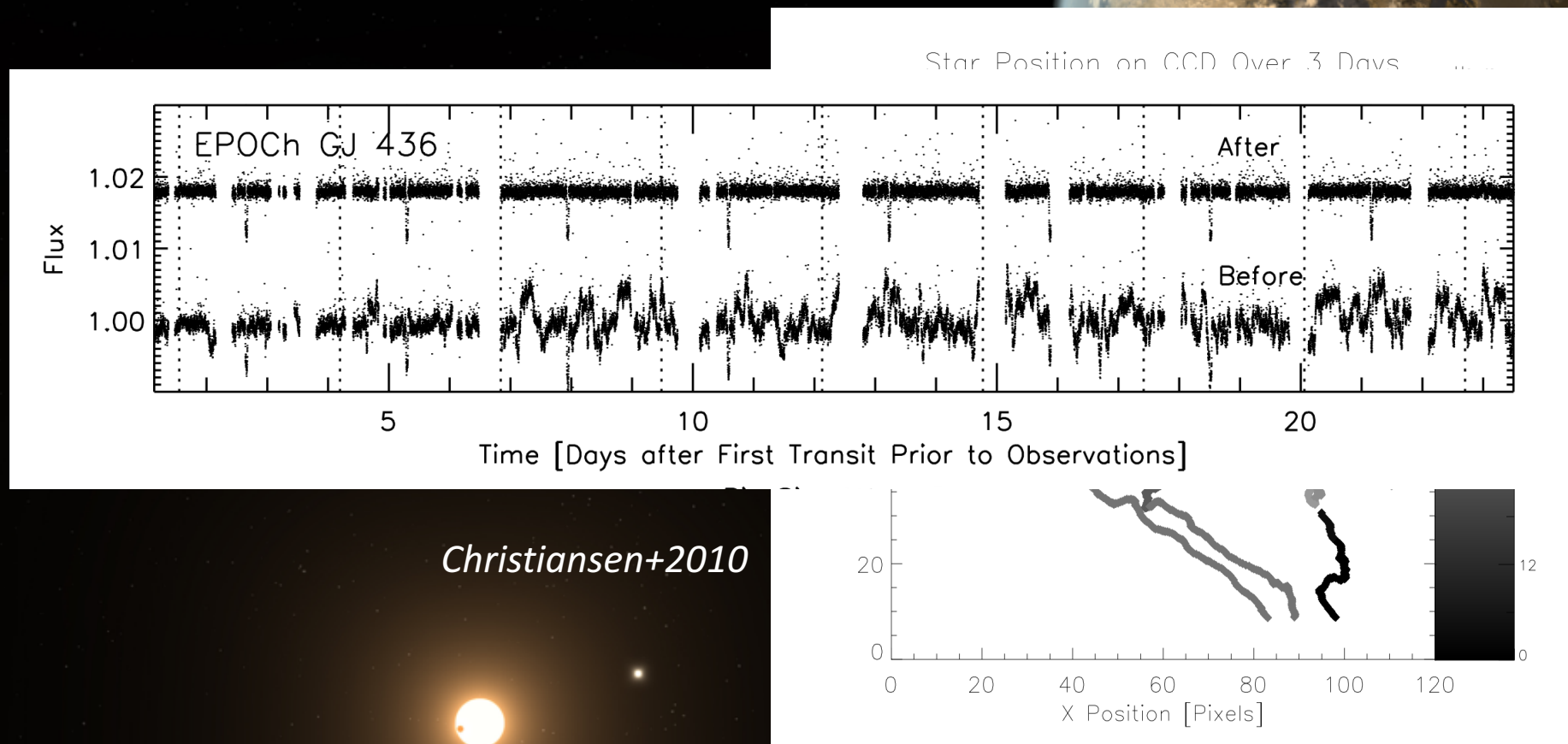


Vanderburg+2016

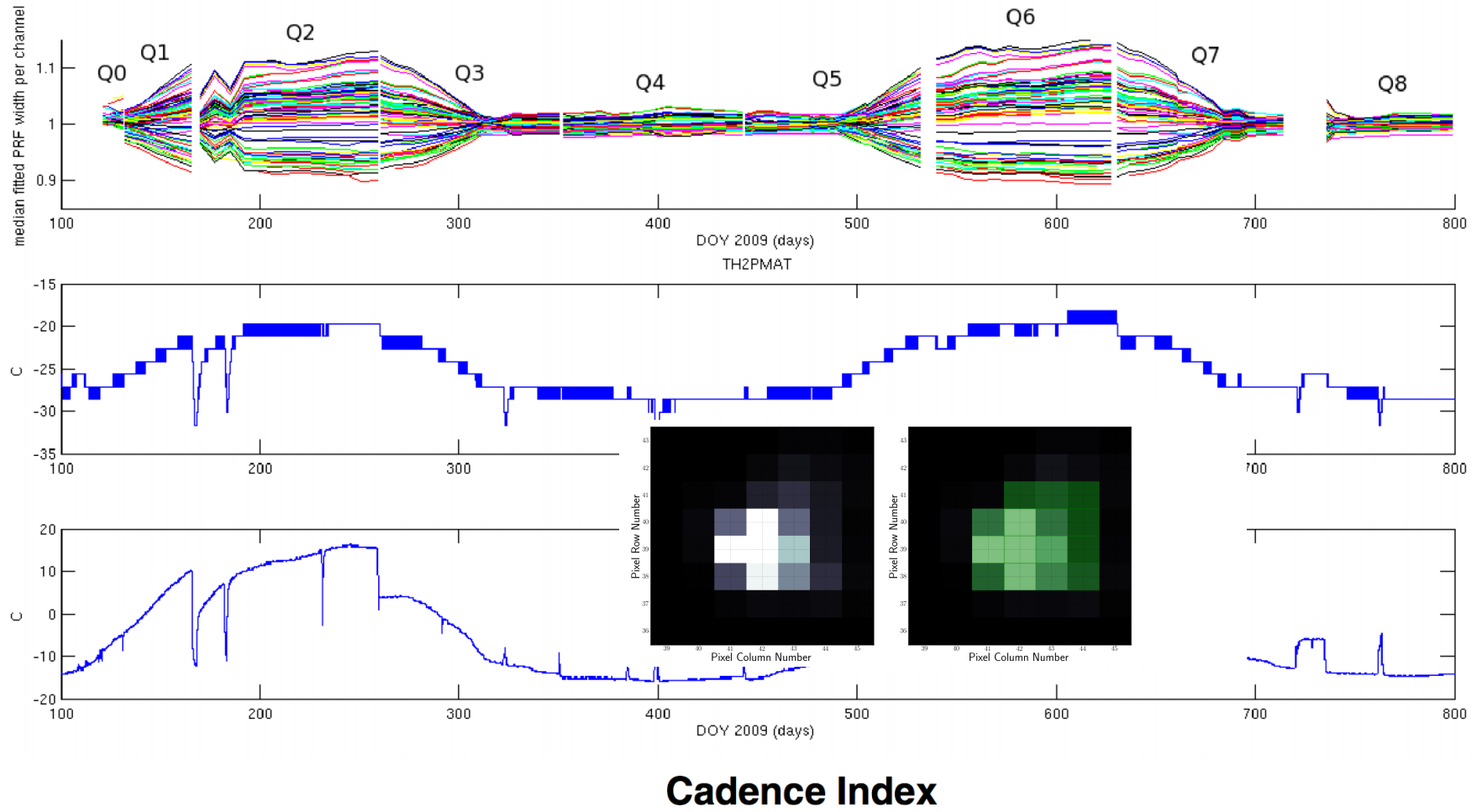
Telescopes do stuff...

They typically have pointing jitter

- Intra-pixel variations, e.g. Spitzer, K2 (not Kepler!)
- Inter-pixel variations, e.g. EPOCH

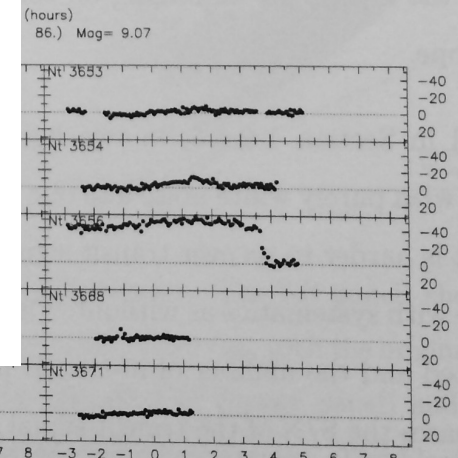
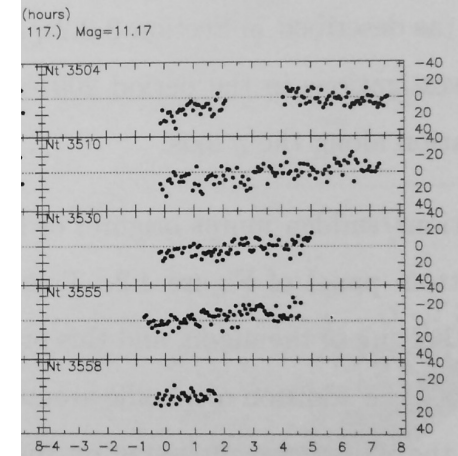
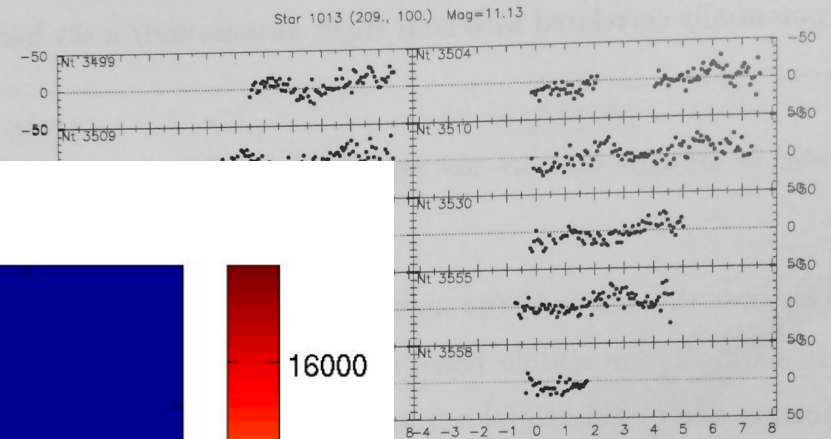
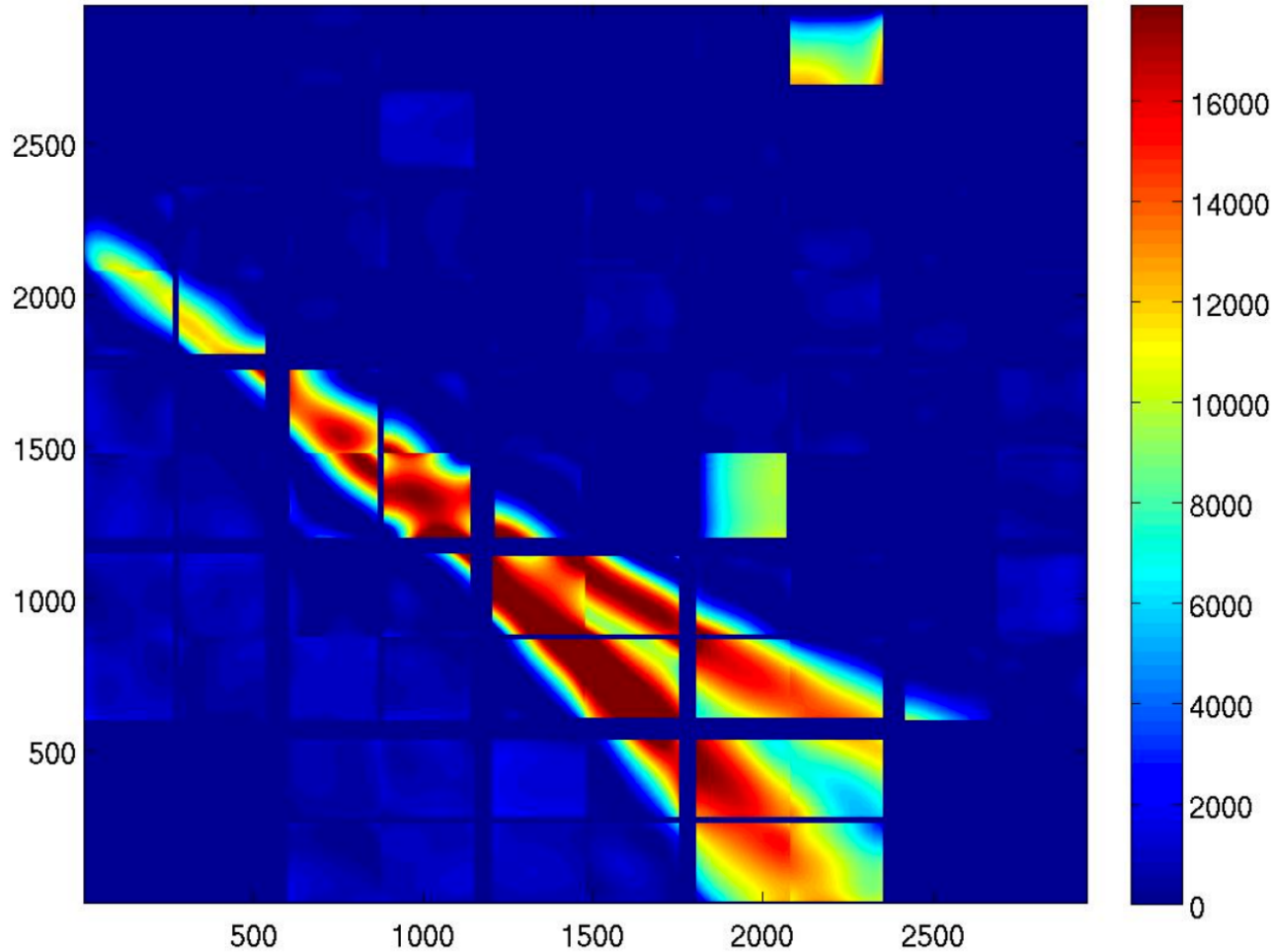


Telescopes do stuff...



The atmosphere does stuff...

Q4 CIN 12783 Arg Event Image, e-/Cadence

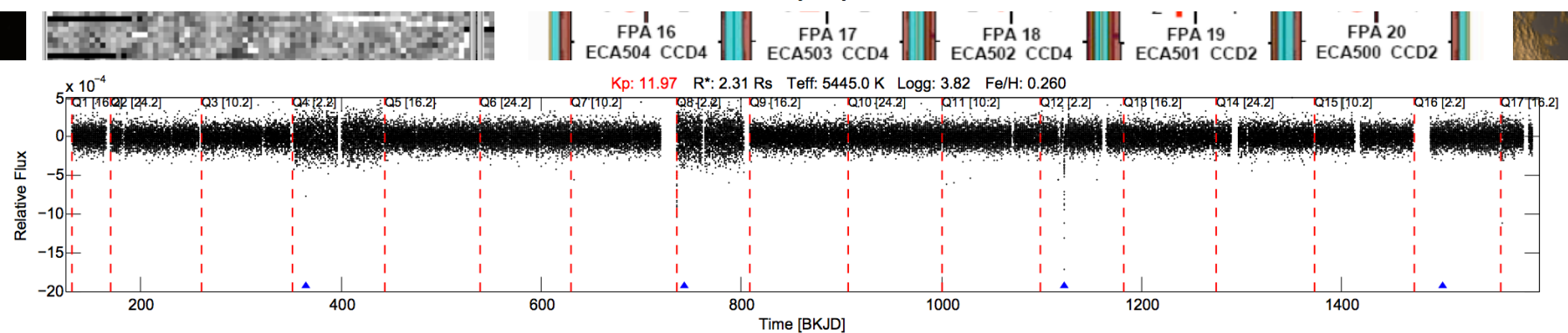
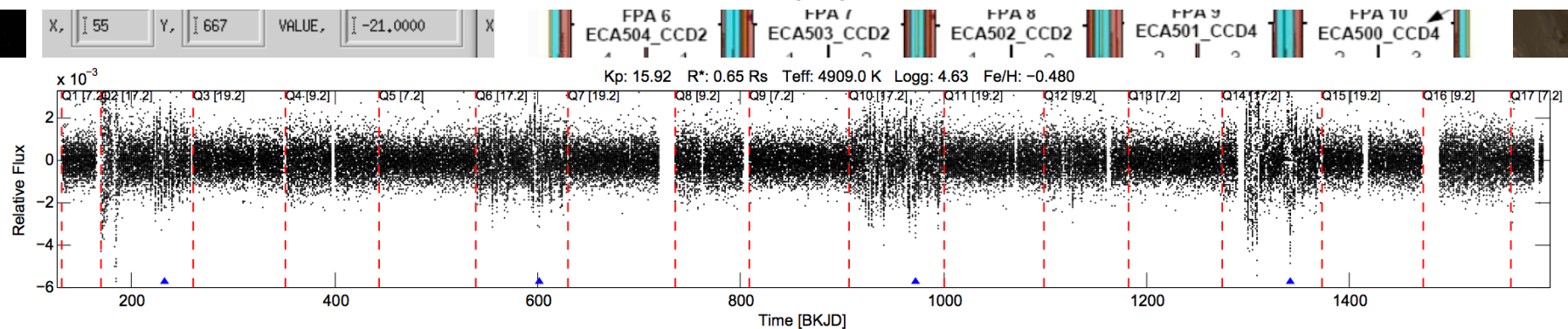
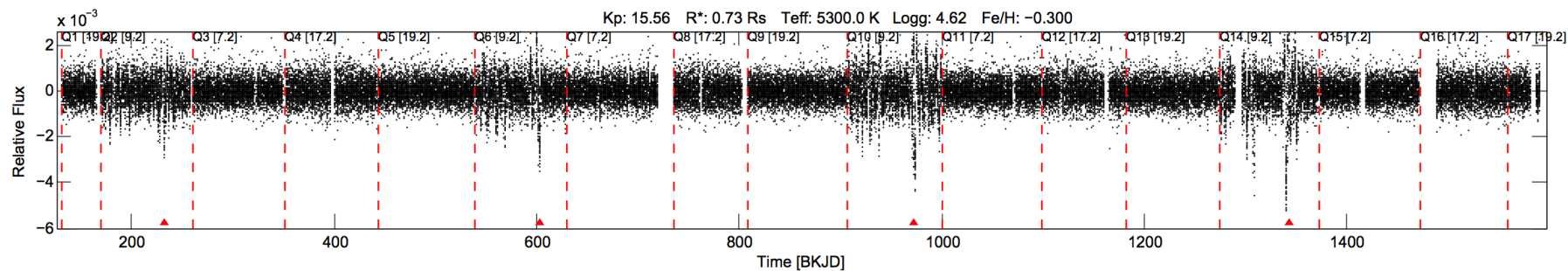


Christiansen+2013

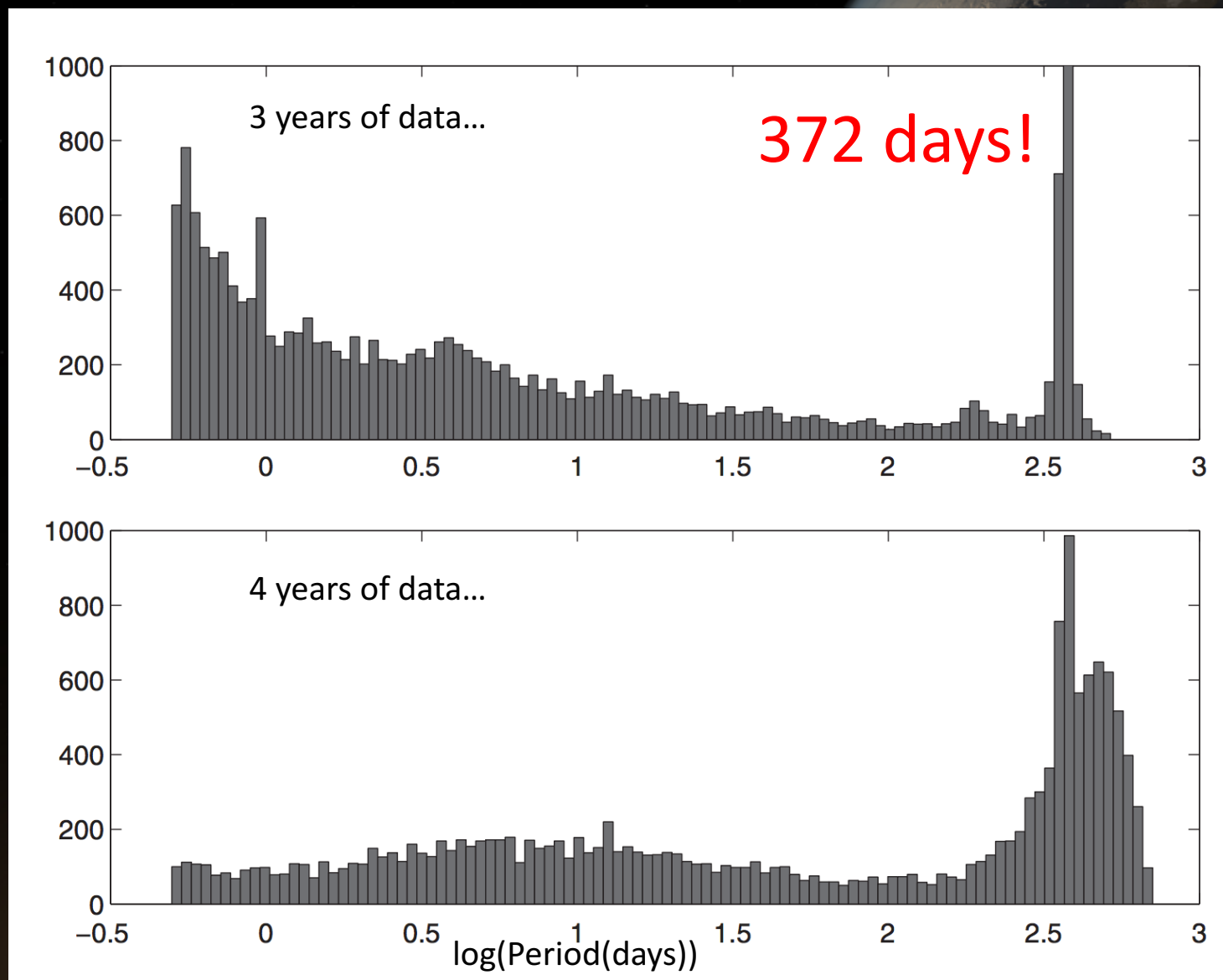


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Detectors do stuff...



Detectors do stuff...



Summary

There is a lot standing between you and a clean transit signal!

You can make clever choices in order to minimise/mitigate/isolate noise sources (or at least the timescales of those noise sources)

- Target selection
- Stability of instrument
- The more the merrier, for treating common mode systematics)

For remaining (and sometimes unavoidable) noise sources, exoplaneteers have been relying on increasingly sophisticated noise models (e.g. Gaussian process) – see rest of #sagan2016!

