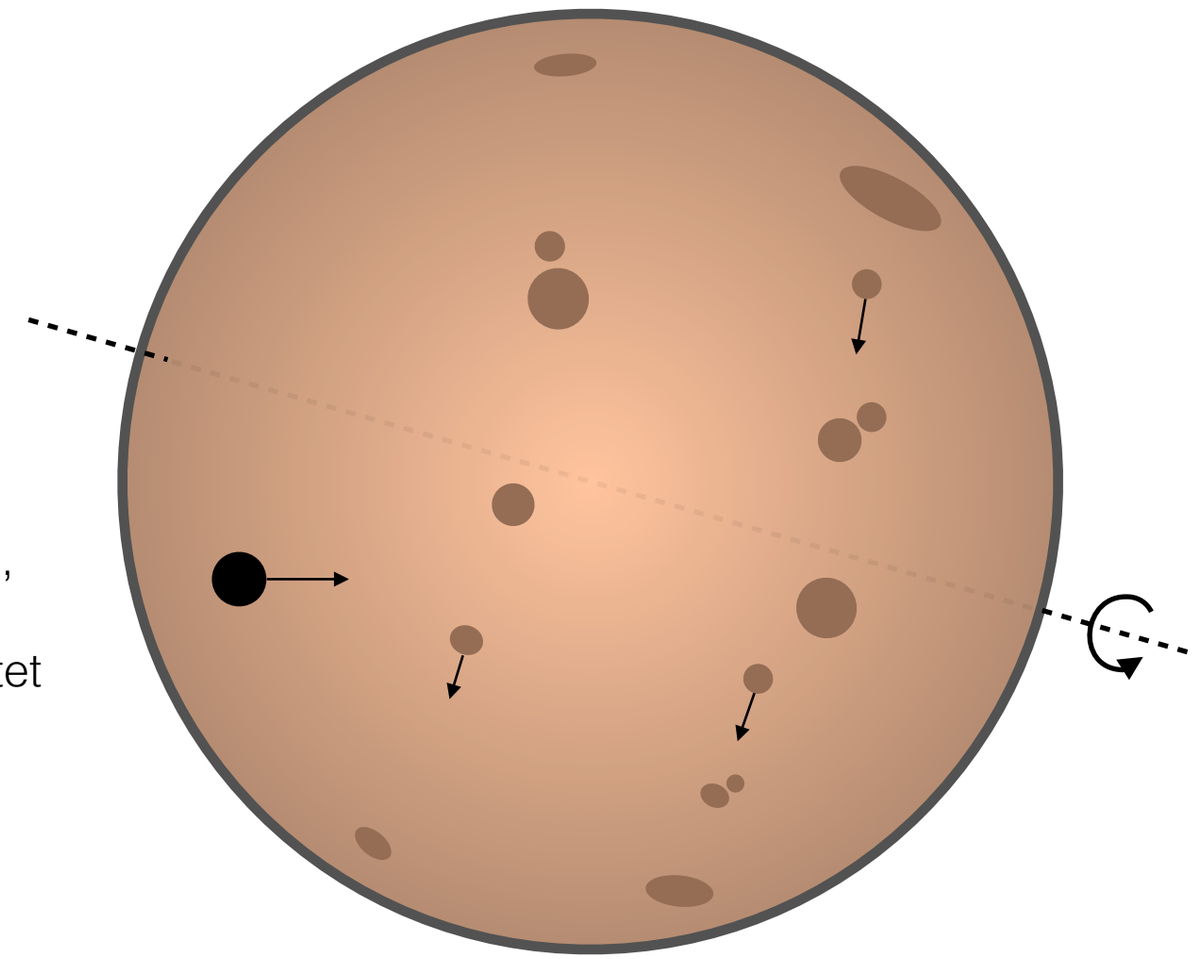
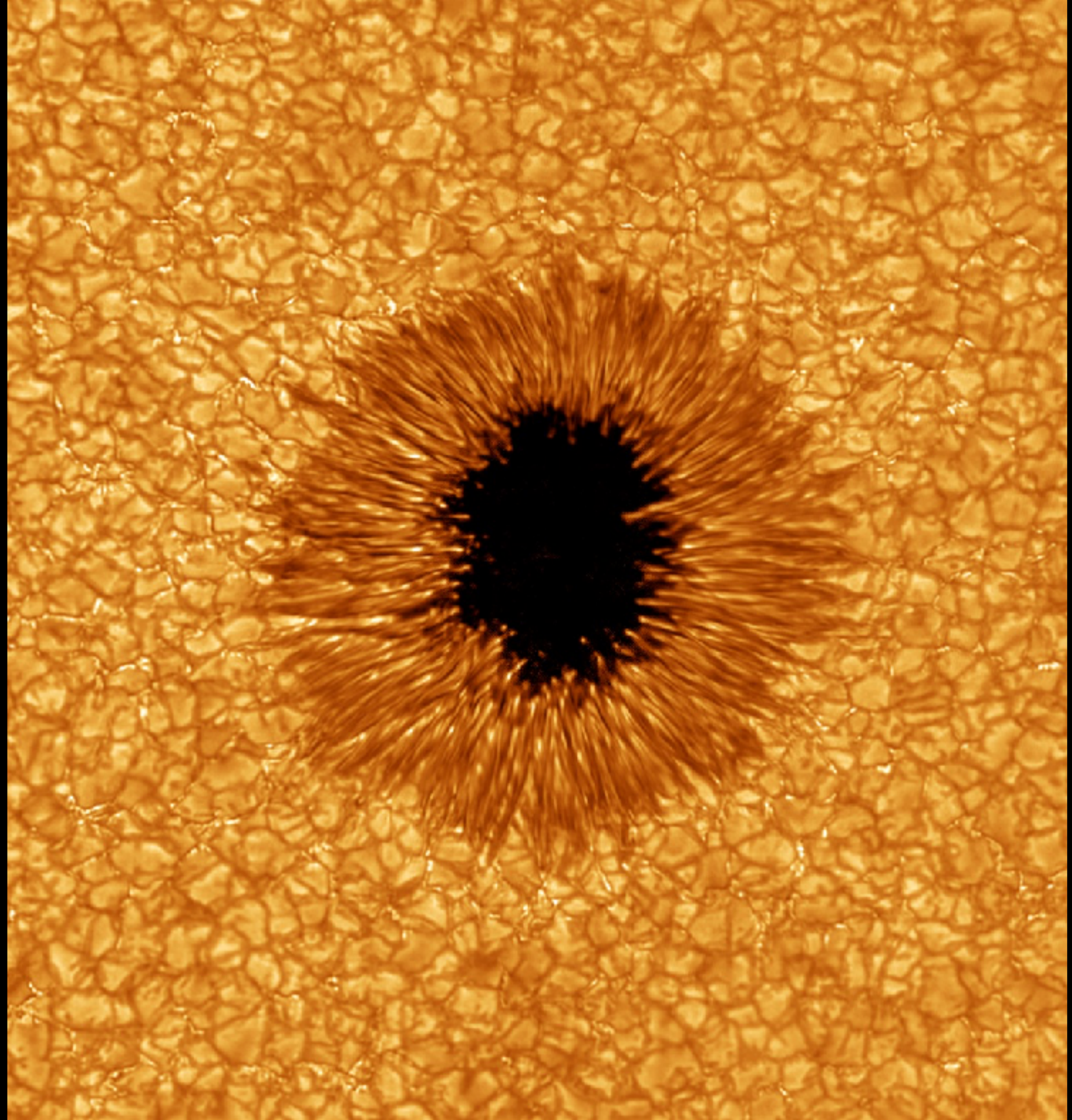
The spots and chromospheric activity of **HAT-P-11**

Brett Morris
PhD Candidate
University of Washington



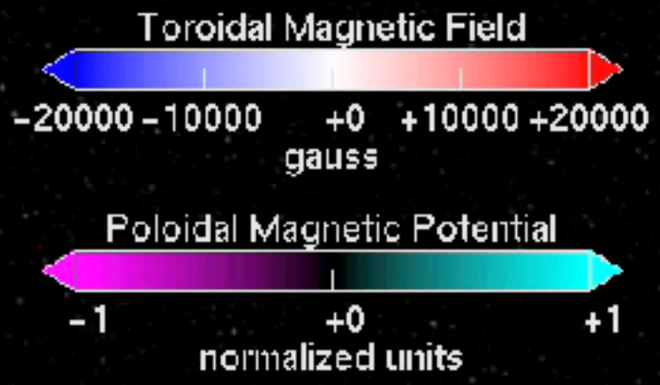
with **Suzanne L. Hawley, Eric Agol**, Leslie Hebb, James Davenport, Andrew Howard, Howard Isaacson, Charli Sakari, Graeme Rohn, Ben Montet

UW astrobiology



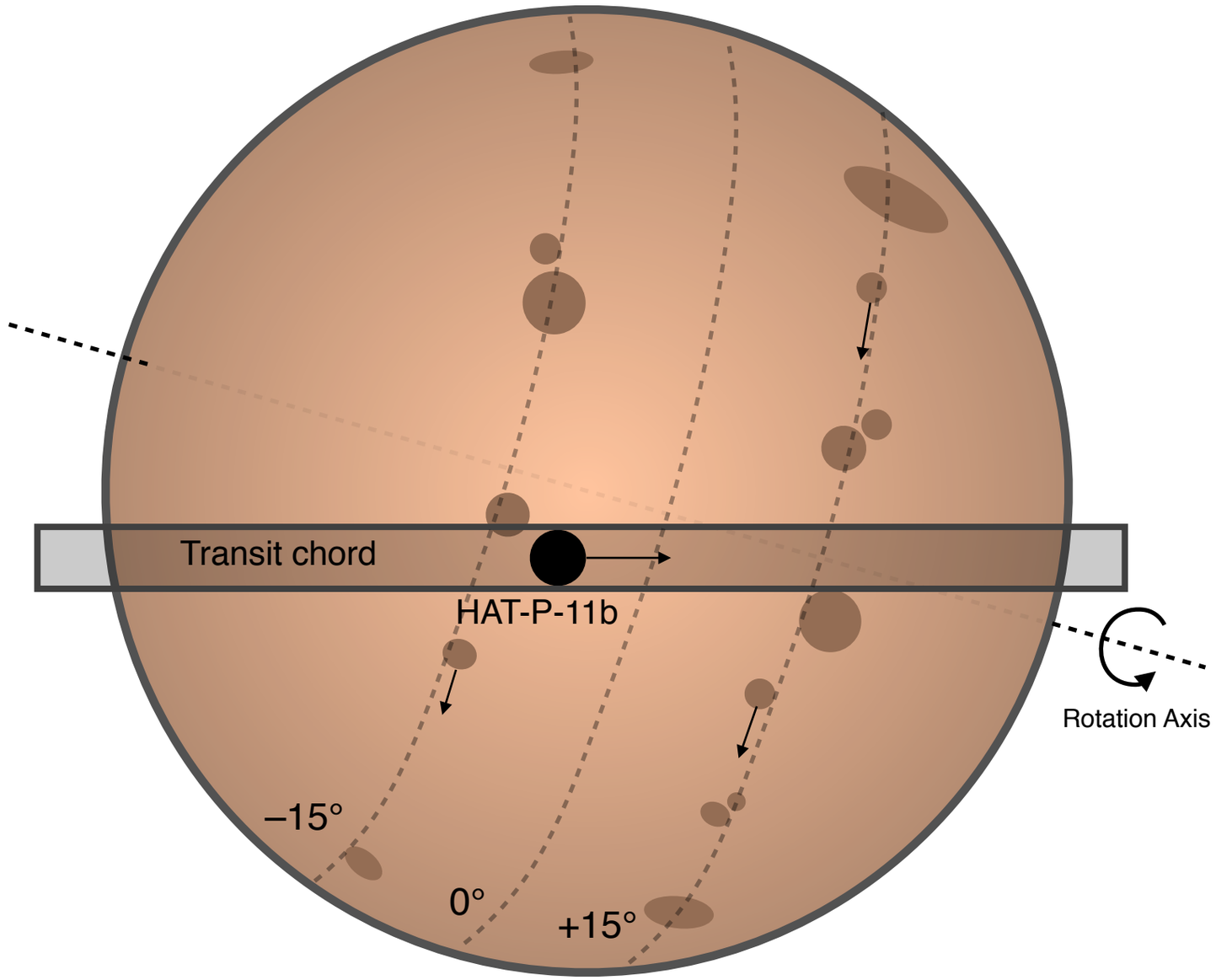
Big Bear
Solar Observatory

Starspot = tip of the iceberg



HAT-P-11: Active planet host

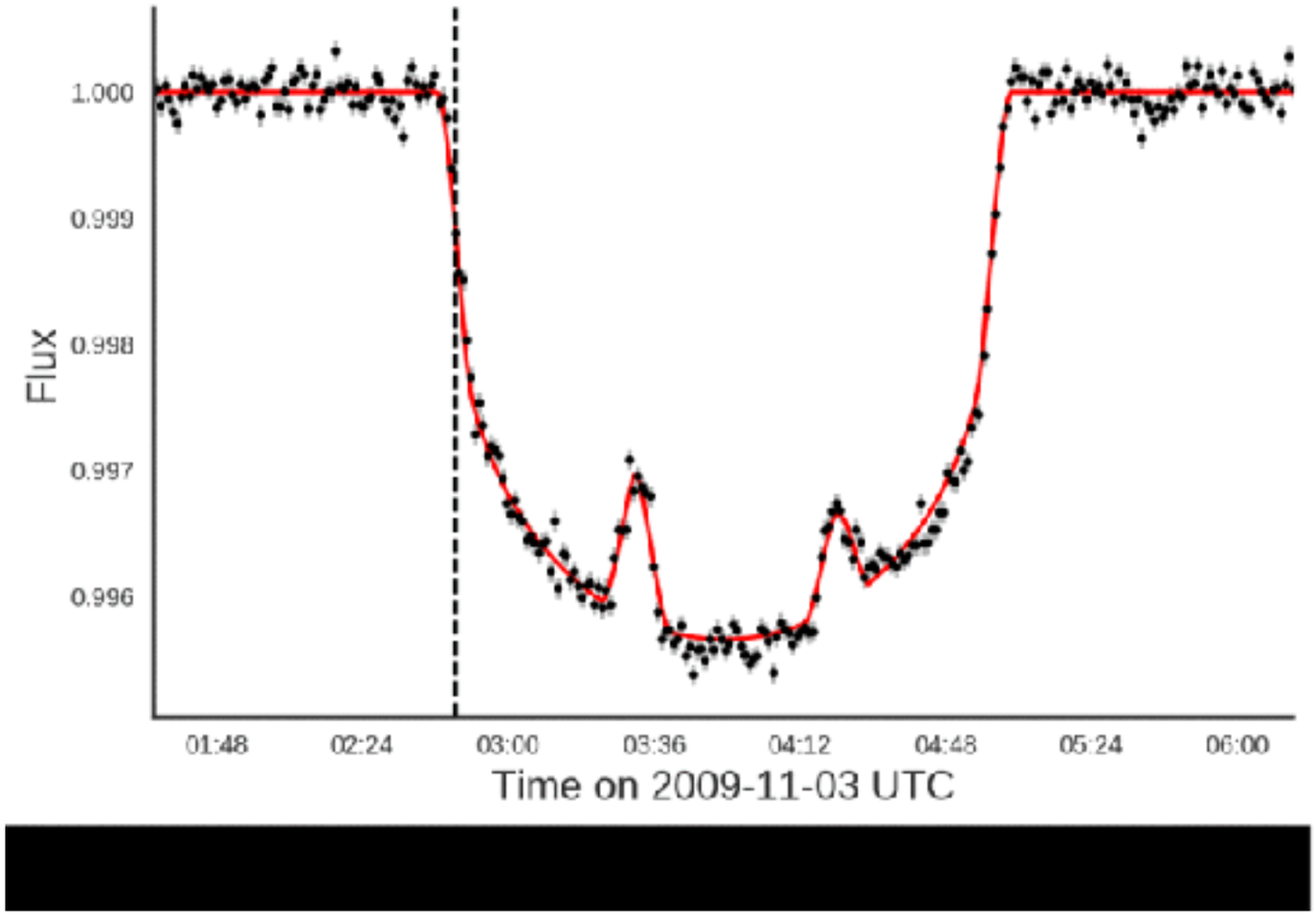
K4 dwarf (4780 K)
Rotation period: 29 d
Hosts hot Neptune
Planet period: 5 d
Orbit misaligned

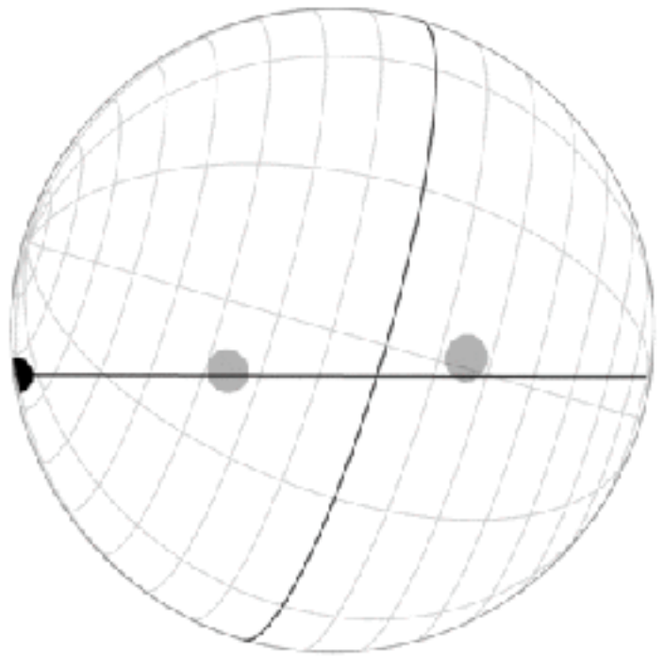


Morris et al. 2017

HAT-P-11: Active planet host

Transiting planets as *little coronagraphs*



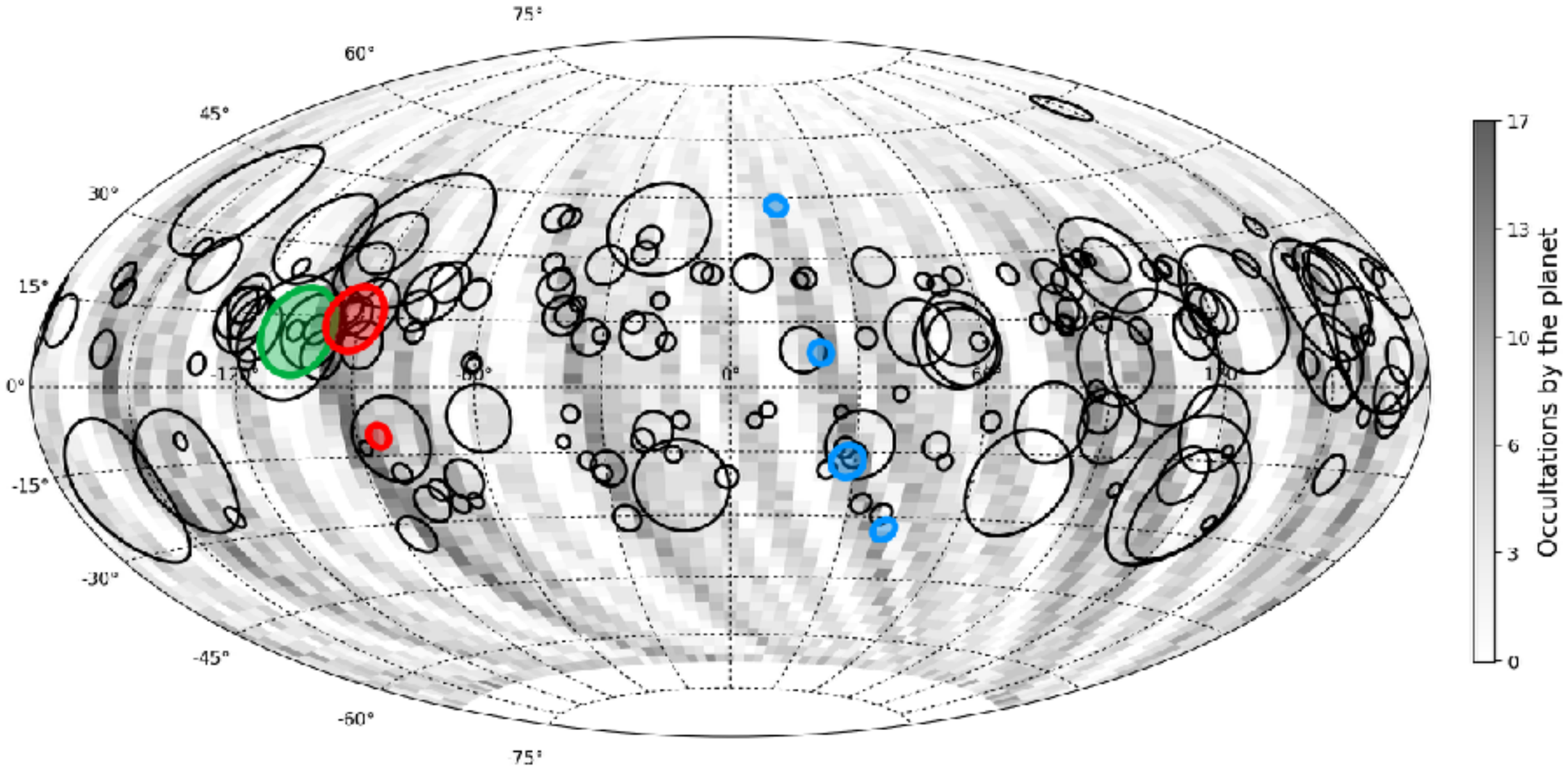


Spot occultation amplitude, time = f(spot positions, radii)

Morris et al. 2017a

HAT-P-11: Active planet host

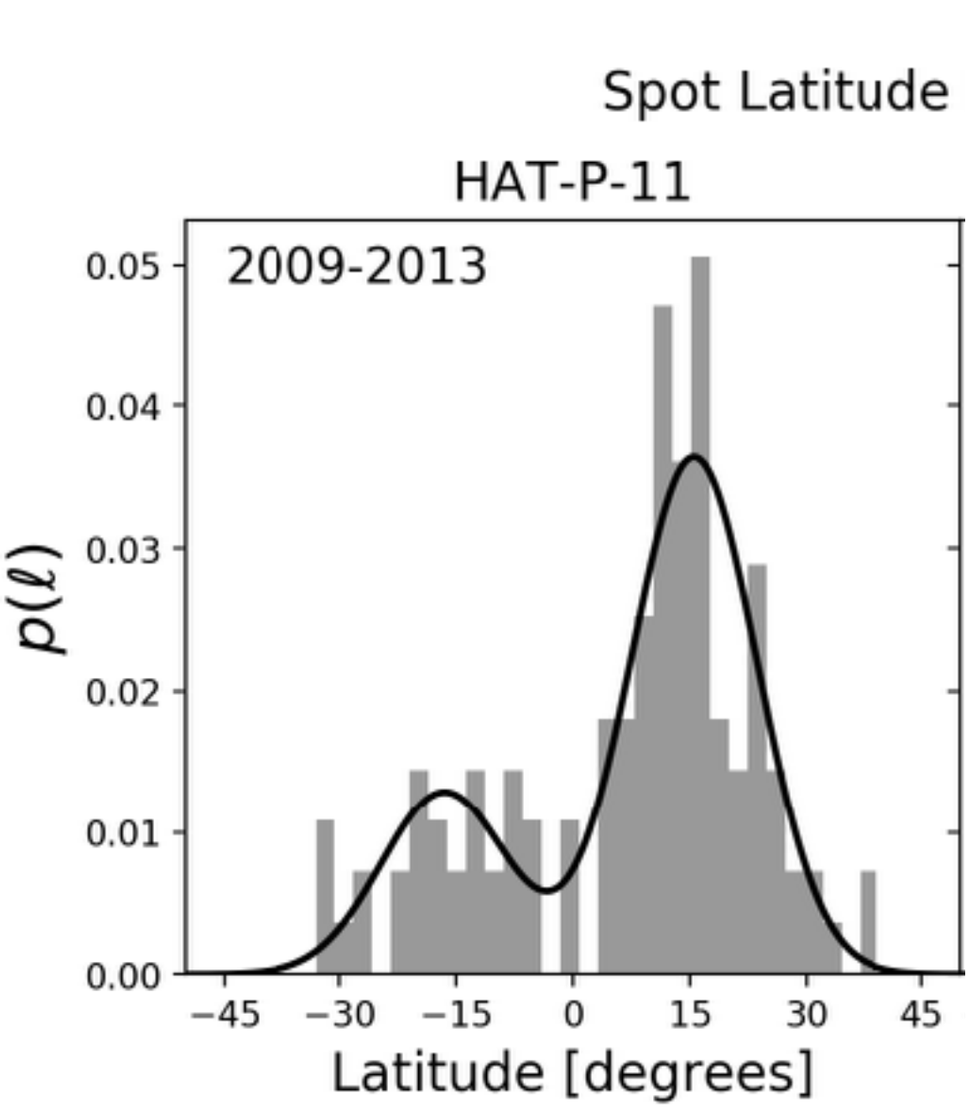
Cumulative Spot Map

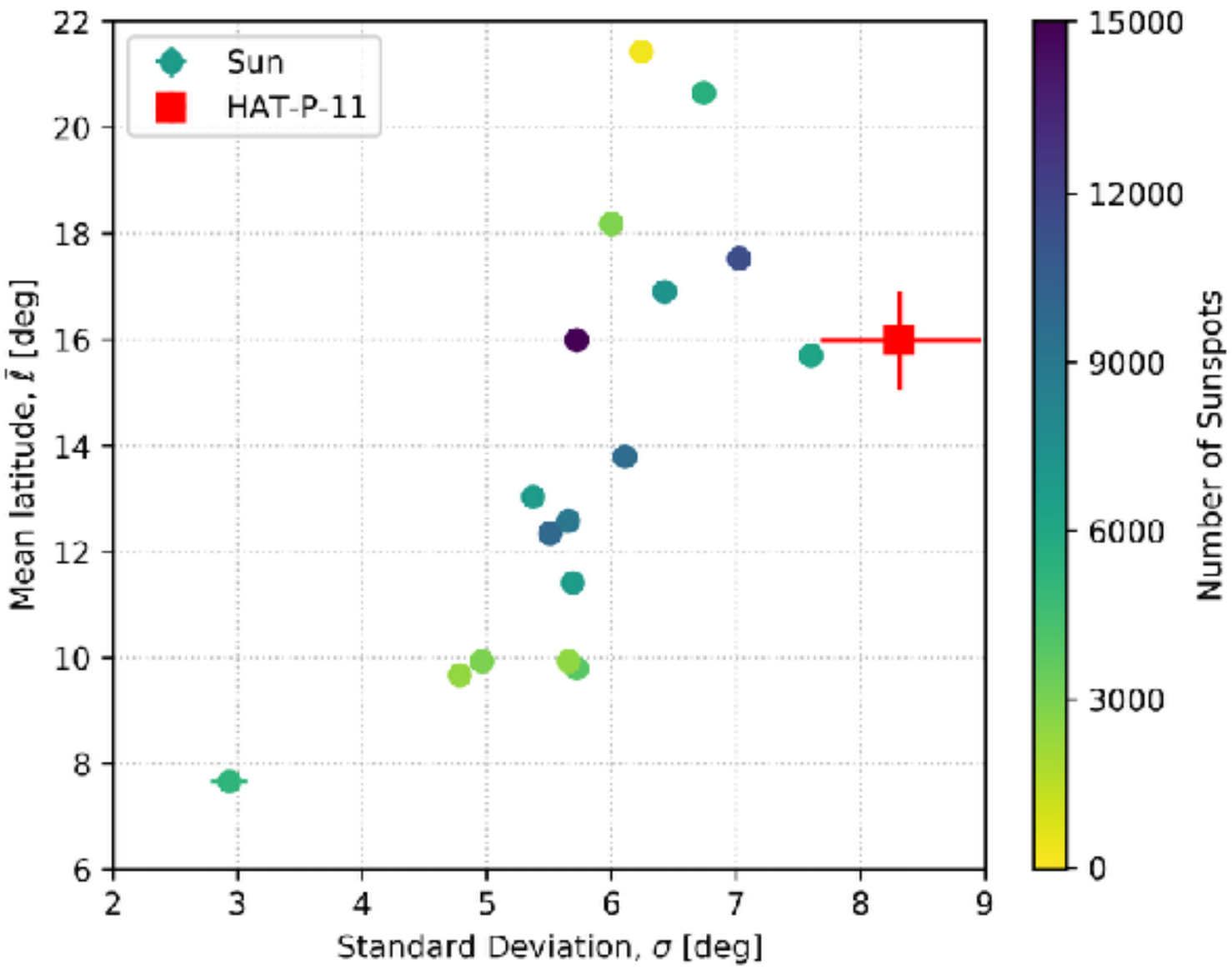


Morris et al. 2017a

HAT-P-11: Active planet host

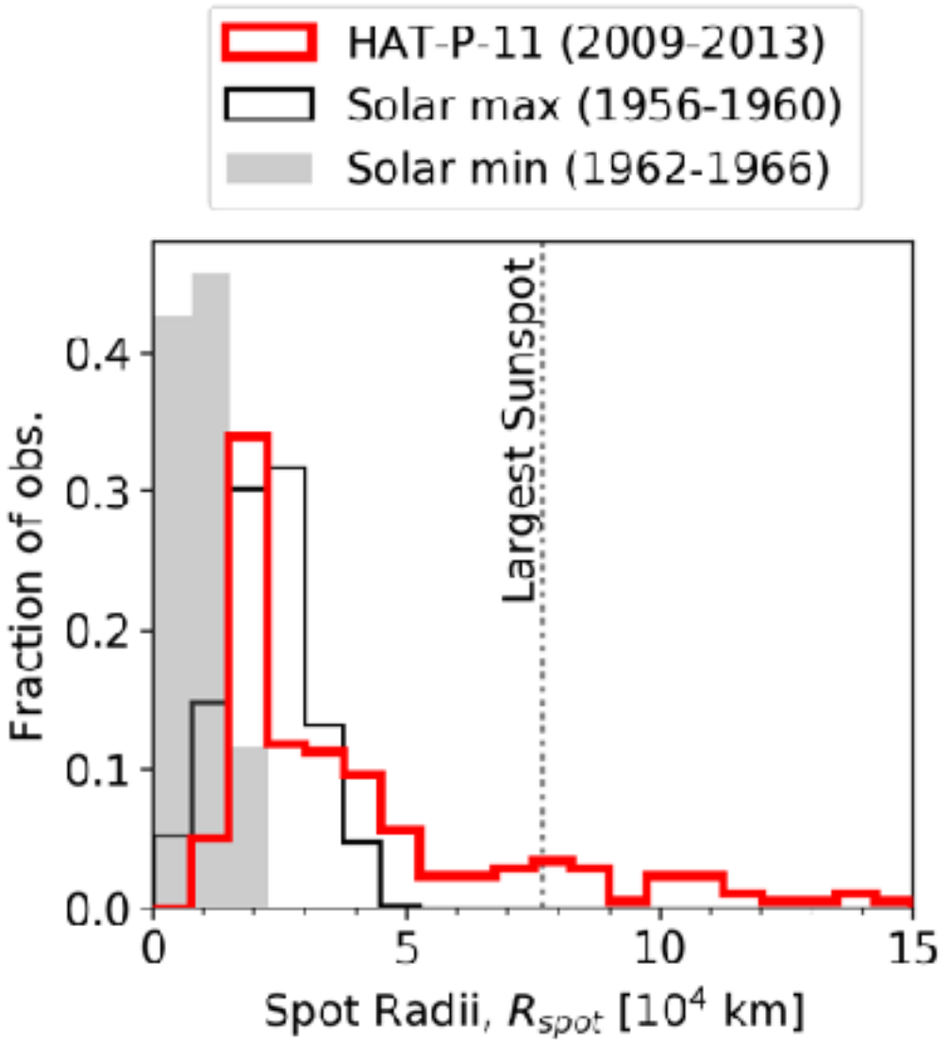
Sun-like active latitudes



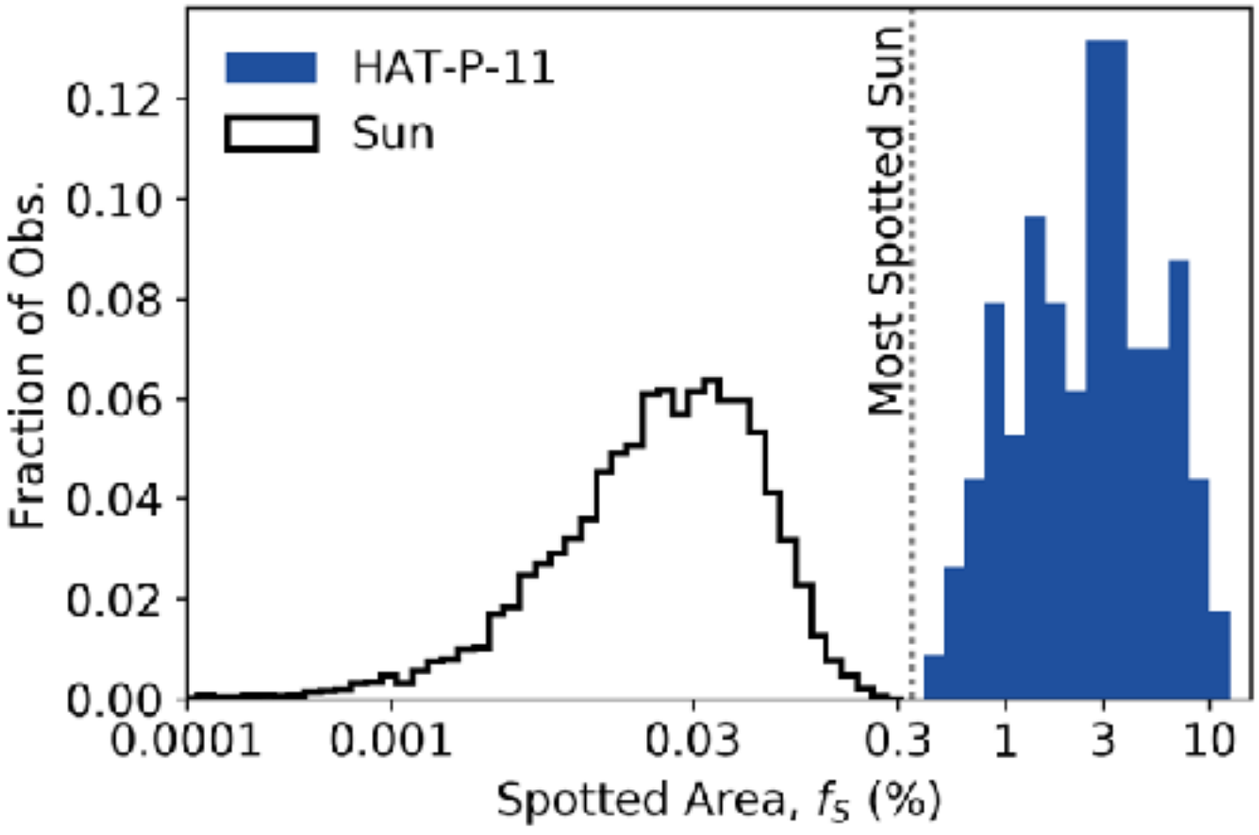


Morris et al. 2017a

HAT-P-11: Active planet host



Most spots have similar sizes to sunspots at solar maximum

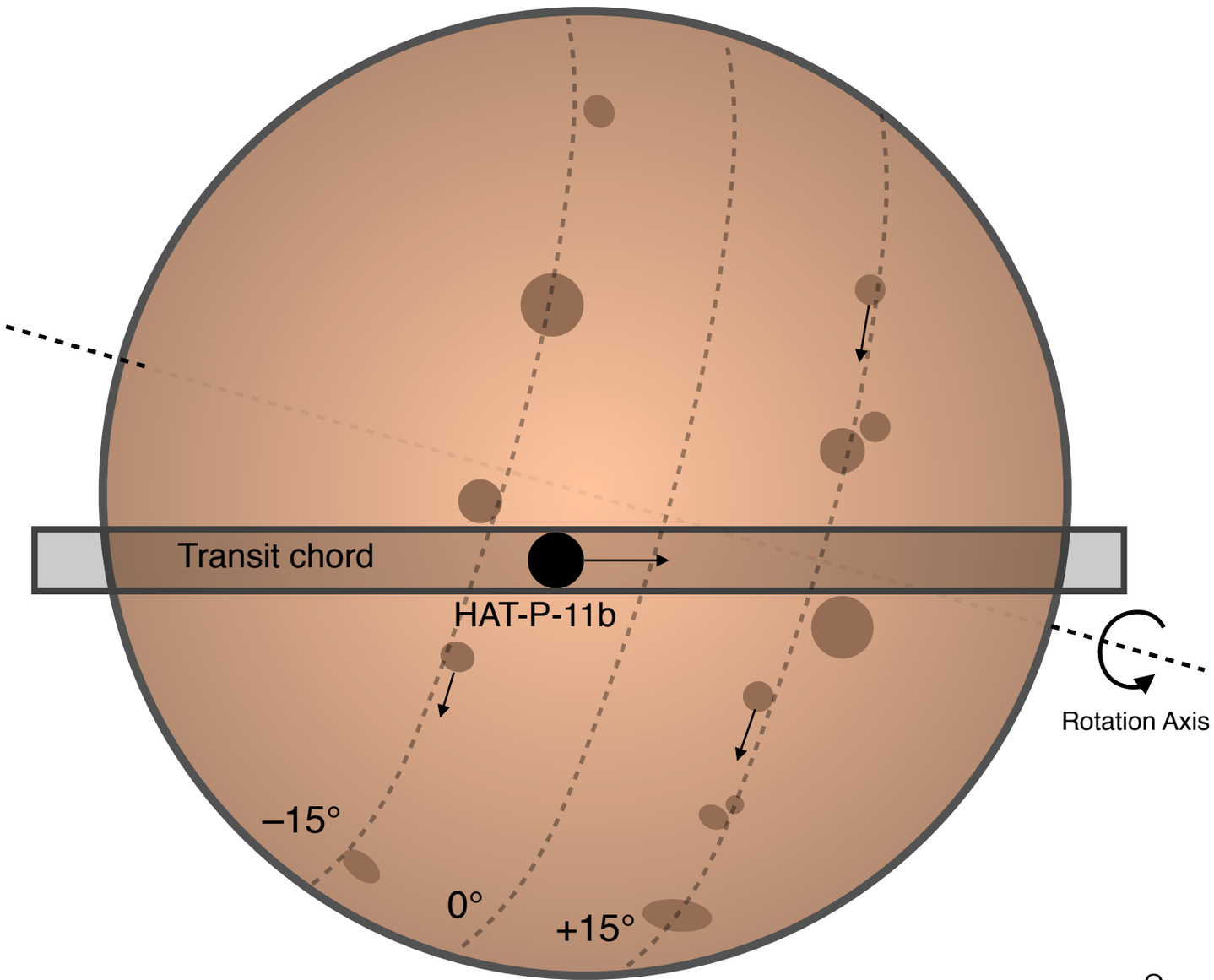


Spotted area ~ 100x solar

Morris et al. 2017a

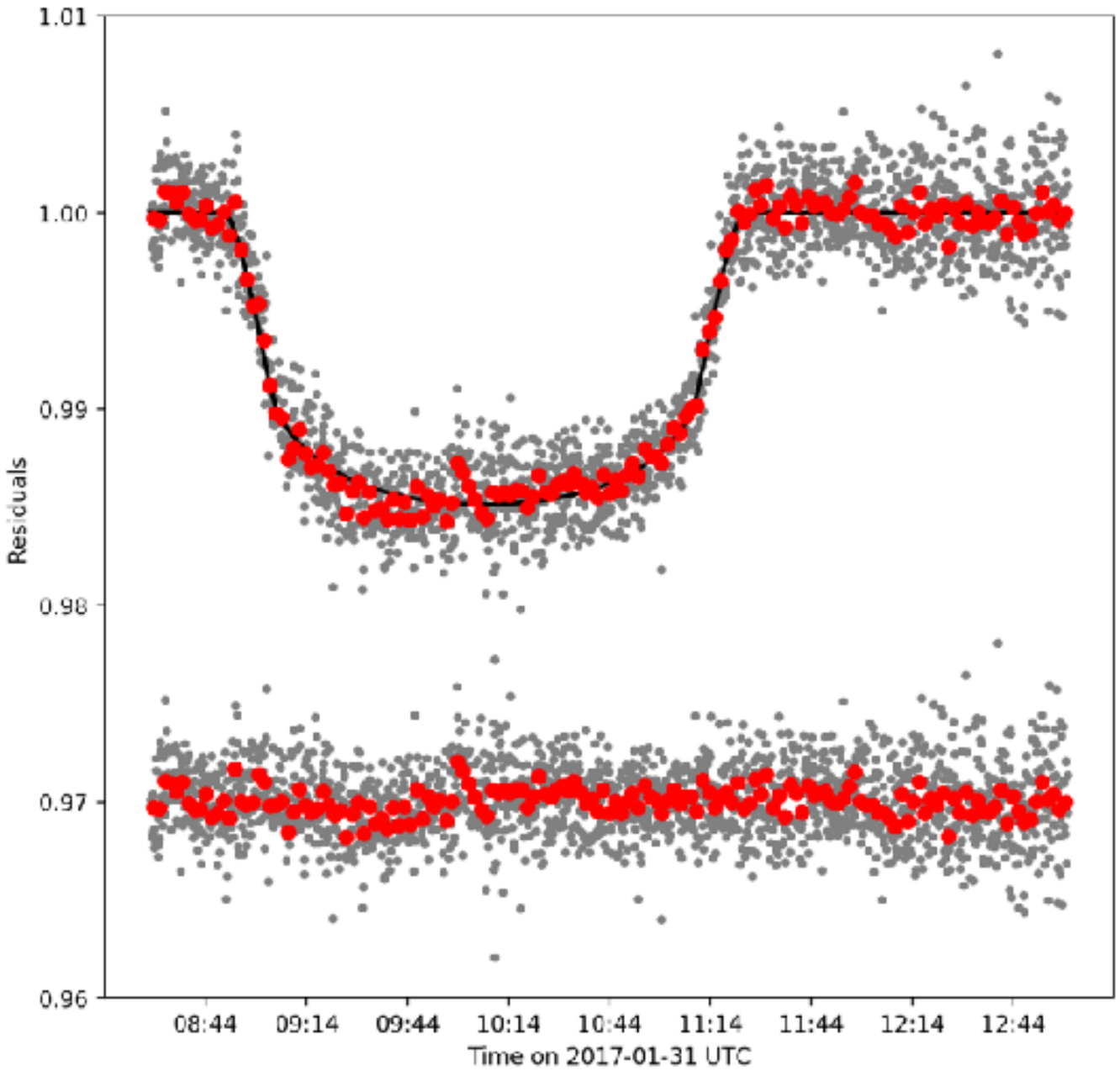
Starspots of HAT-P-11 via photometry

- Active latitudes: 16° latitude, like the Sun at maximum
- Starspot sizes similar to sunspots at maximum
- Spot area coverage 100x greater than solar



WASP-85A: Spot occultations from the ground

ARCTIC imager + *holographic diffuser*

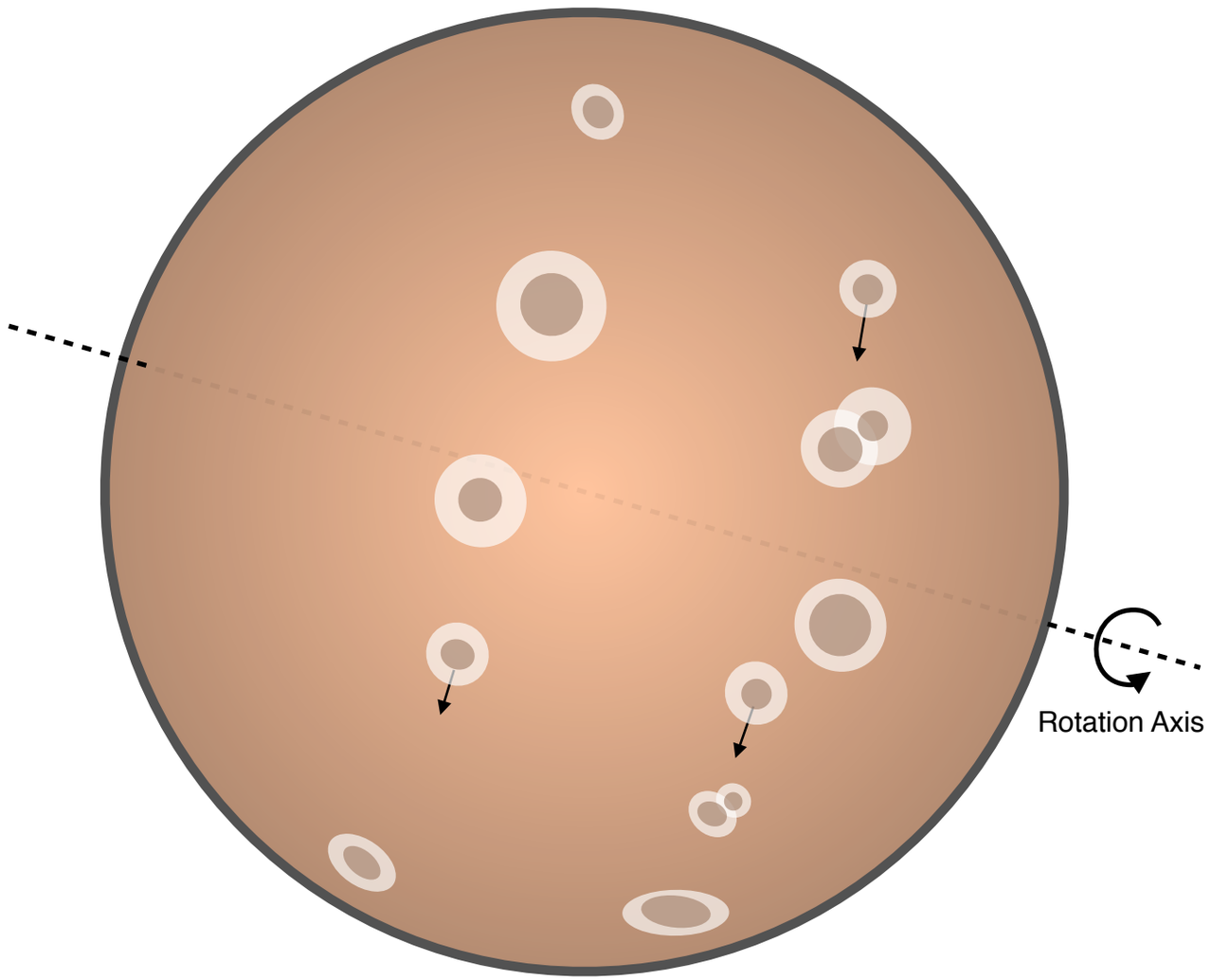


V=11.2, G5 star
1 min -> **689 ppm**!

Stefánsson et al. (2017)

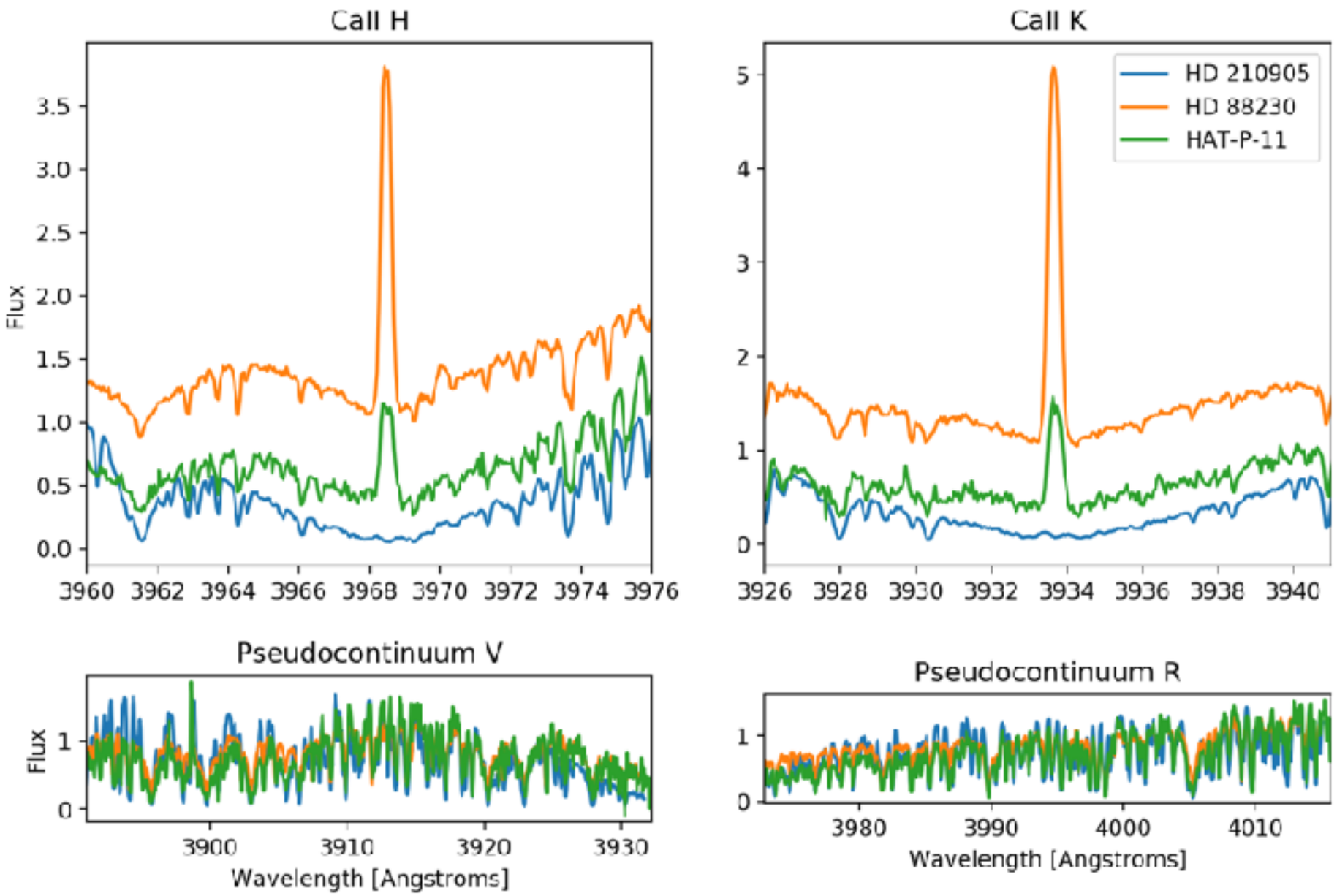
Chromospheric Activity: HAT-P-11

- Activity cycle period?
- Is the activity of HAT-P-11 typical among similar stars?



ARC Echelle Spectrograph

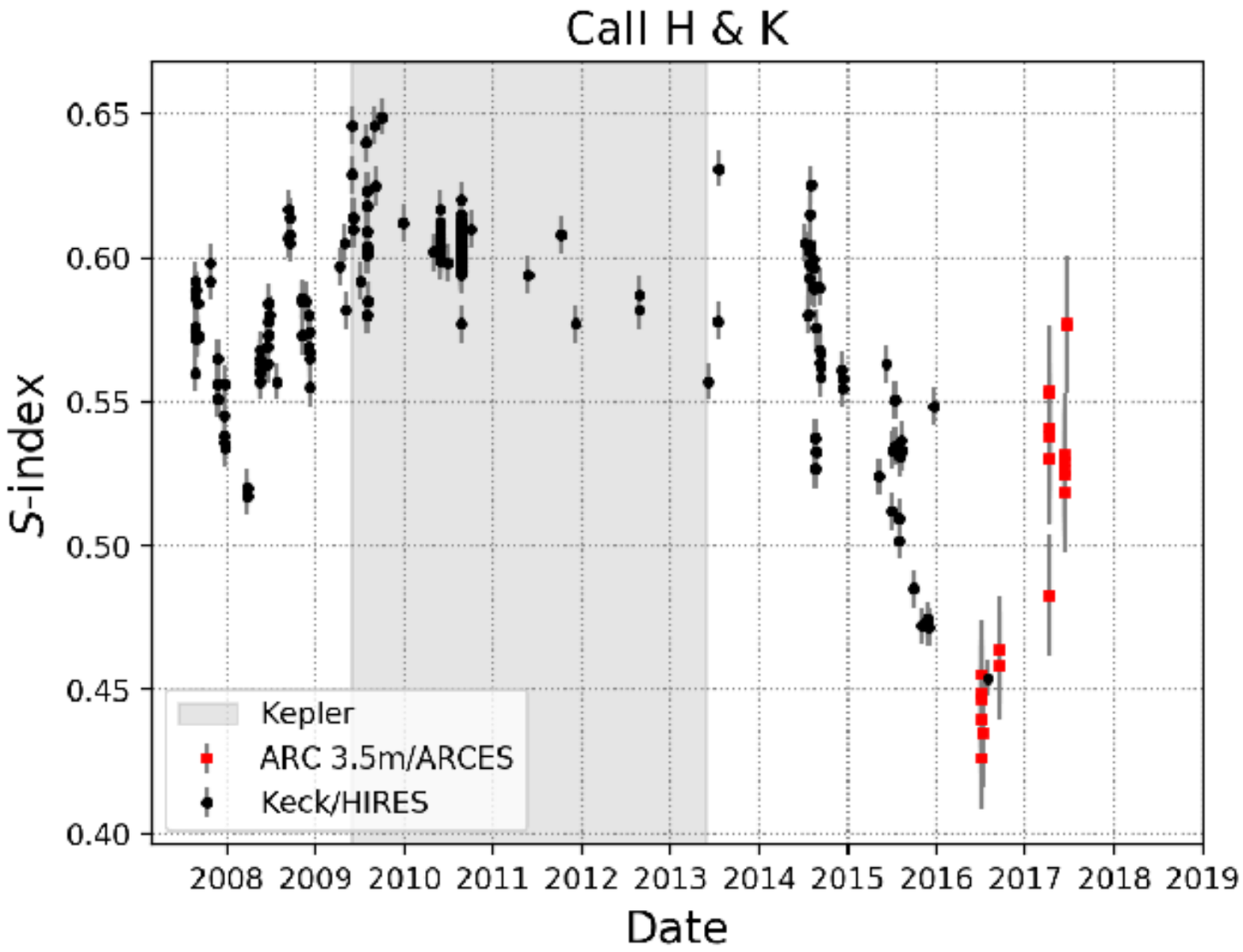
ARC 3.5 m telescope at Apache Point Observatory
New Mexico, USA



Morris et al. 2017b

Activity through time

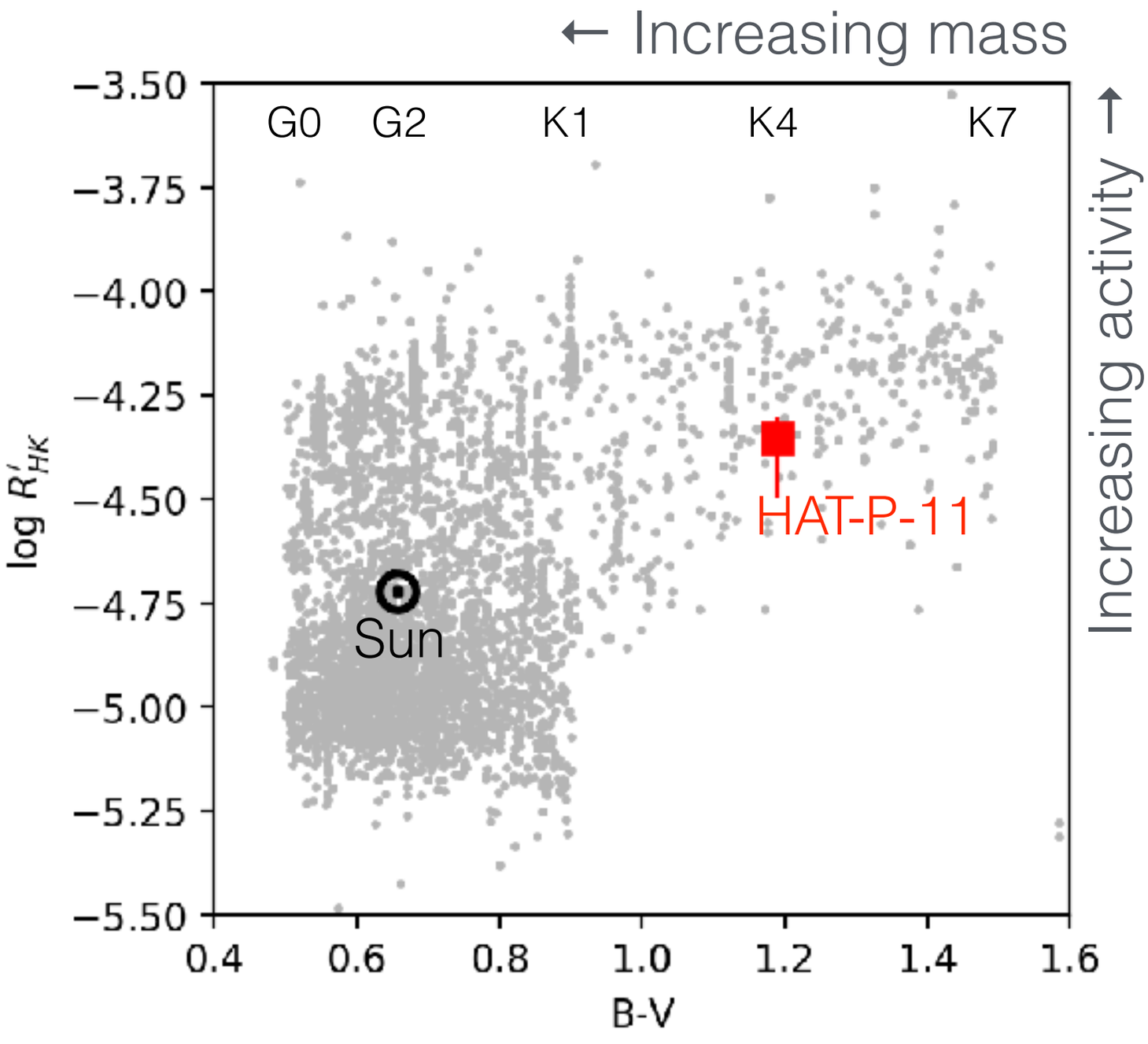
Sun-like activity cycle, P > 10 years



Morris et al. 2017b

Keck spectra from Howard Isaacson & Andrew Howard

Is the activity of HAT-P-11 normal?



Morris et al. 2017b

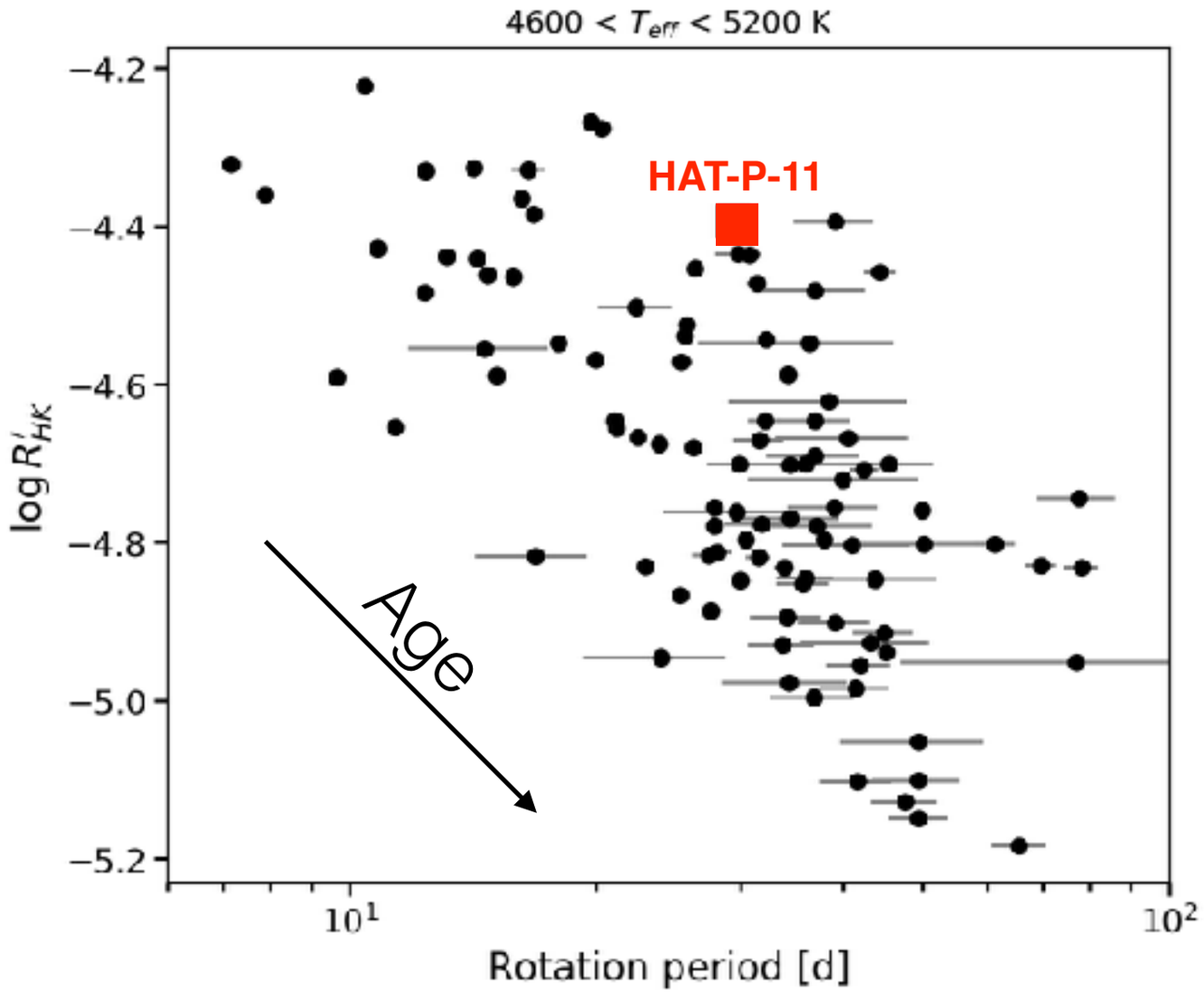
- HAT-P-11 is more active than the Sun, as are most mid-K stars
- HAT-P-11 is relatively inactive compared to all K stars

Duncan et al. (1991), Wright et al. (2004), Isaacson and Fischer (2010)

Is the activity of HAT-P-11 normal?

- Activity declines as stars age
- HAT-P-11 is relatively **active** compared to mid-K stars with similar rotation periods

Could tides be to blame for the activity?



Morris et al. 2017b

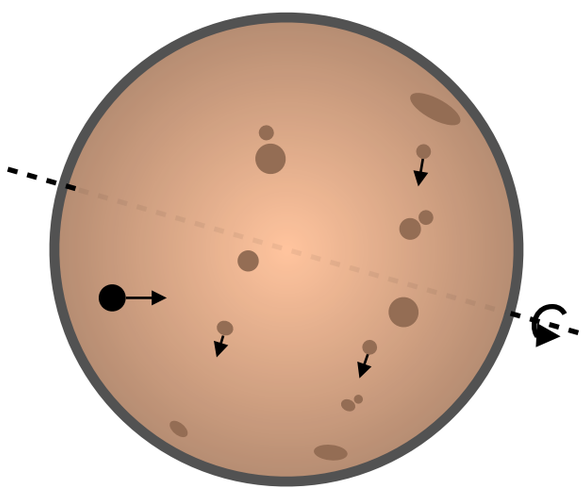
CKS: Petigura et al. 2017, Johnson et al. 2017
Rotation periods: Mazeh et al. 2015

Summary

Brett Morris (@brettmor)
University of Washington

The Starspots of HAT-P-11: Evidence for a Solar-like Dynamo

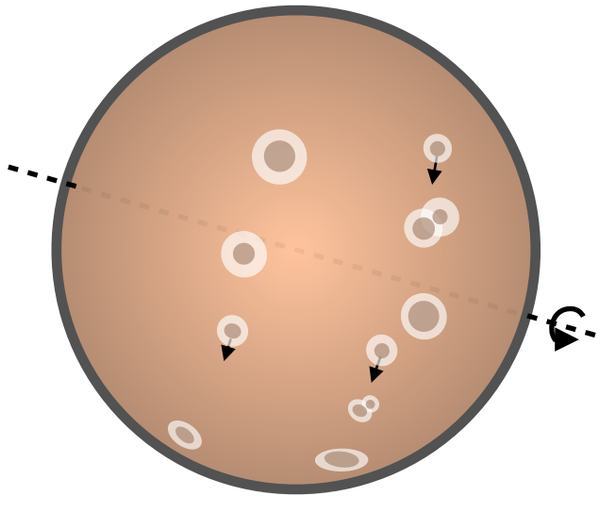
Morris, Hebb et al. (2017), ApJ, arXiv:1708.02583



- Active latitudes: 16° latitude, like the Sun at maximum
- Starspot sizes similar to sunspots at maximum
- Spot area coverage 100x greater than solar

Chromospheric Activity of HAT-P-11: An Unusually Active Planet-Hosting K Star

Morris, Hawley et al (2017), ApJ, arXiv:1709.03913



- Activity cycle P >10 years
- HAT-P-11 is modestly more active than planet hosts of the same rotation period and mass
- Interesting test case for planet-star interactions in polar orbits