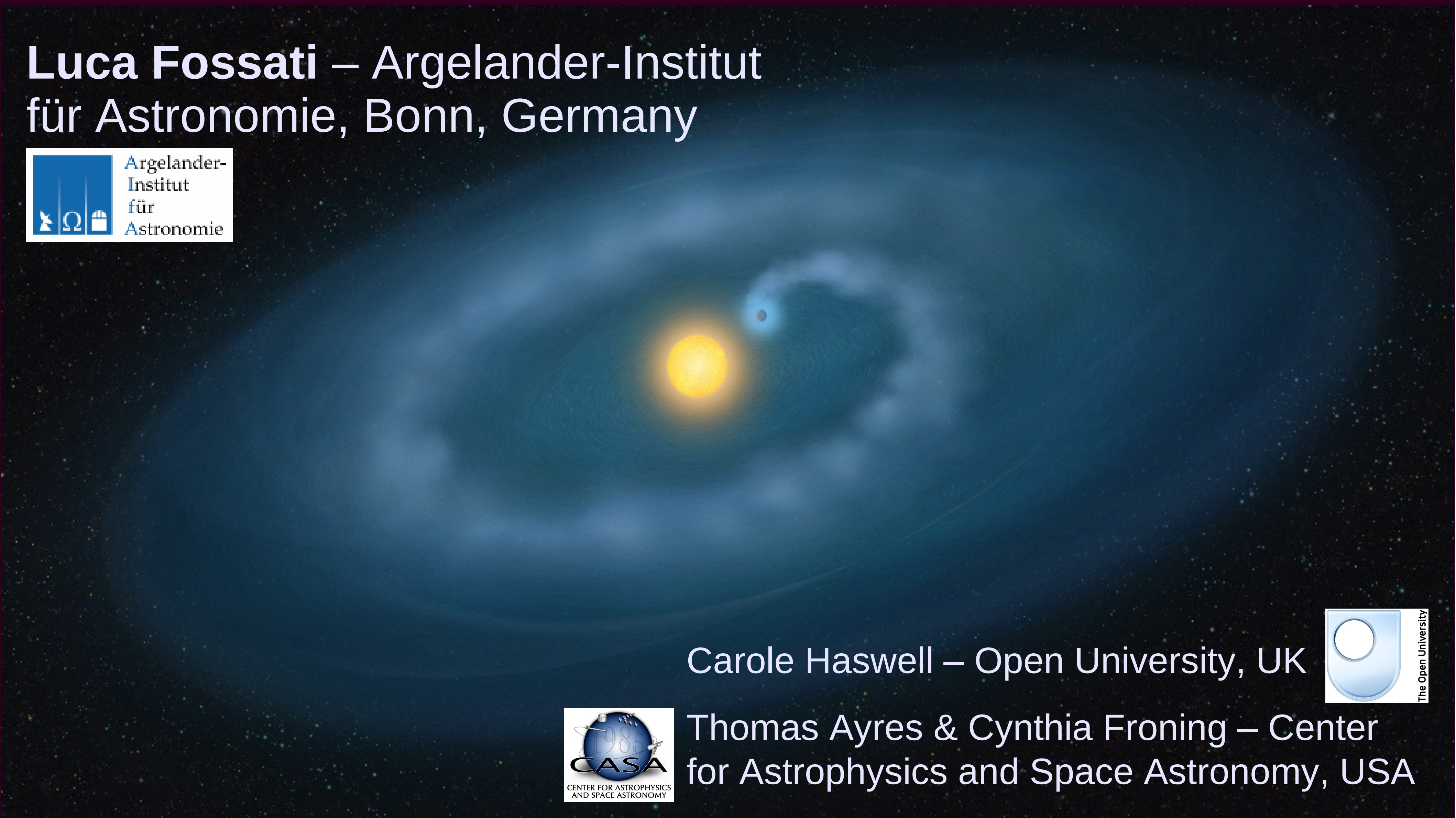
Near-UV HST observations of the transiting exoplanet WASP-12b



Luca Fossati – Argelander-Institut für Astronomie, Bonn, Germany

Argelander-Institut für Astronomie

Carole Haswell – Open University, UK

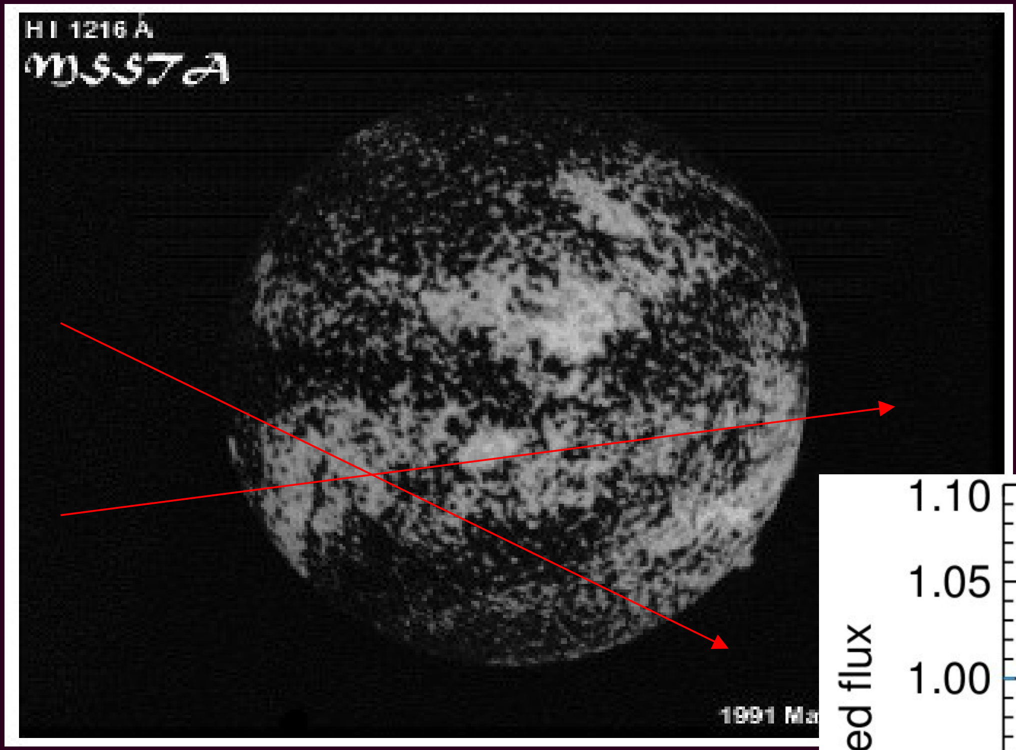
The Open University

Thomas Ayres & Cynthia Froning – Center for Astrophysics and Space Astronomy, USA

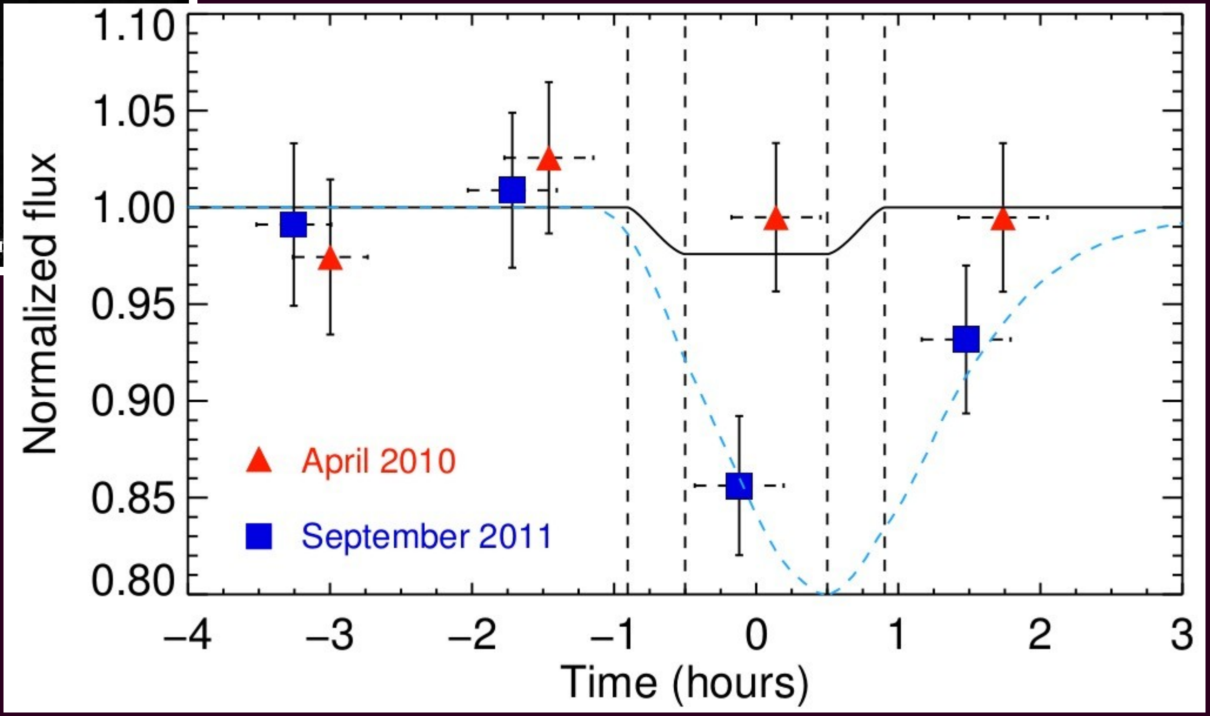
CASA CENTER FOR ASTROPHYSICS AND SPACE ASTRONOMY

NUV vs. FUV

Sun in Ly alpha light



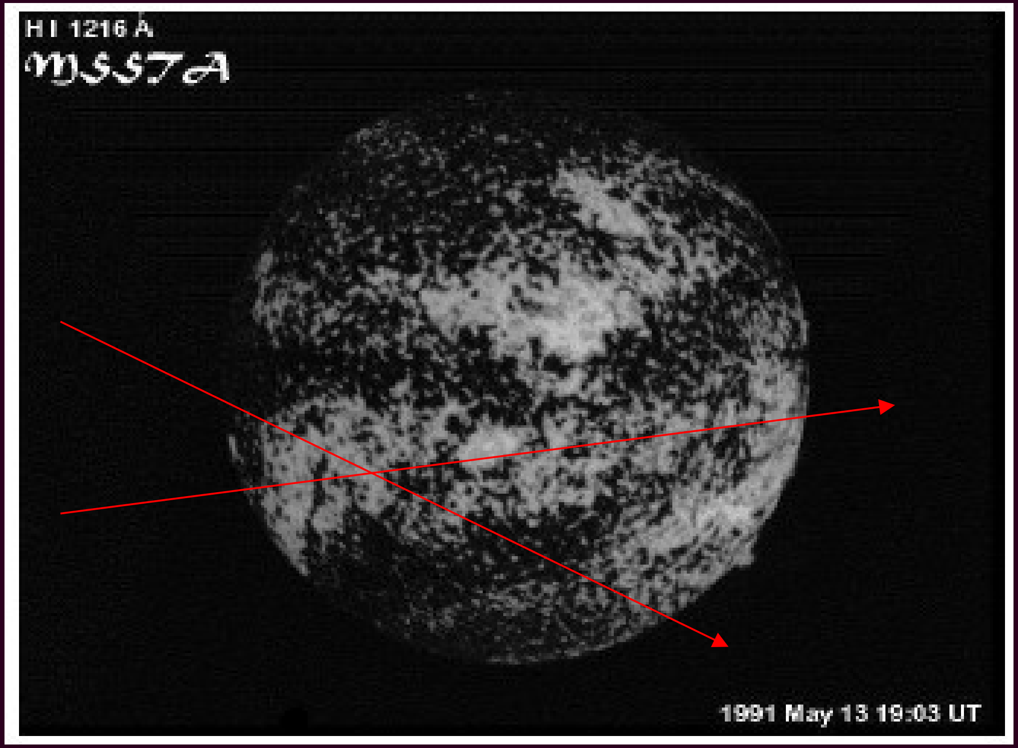
Transit occurring on top of a very spotted stellar surface



HST/STIS: HD 189733b
Lecavelier des Etangs et al. 2012

NUV vs. FUV

Sun in Ly alpha light



Transit occurring on top of a very spotted stellar surface

Late-type stars are much brighter in the near-UV, than in the far-UV.

E.g.:
FUV – HD209458 (V=7.6)
S/N ~ 5 in 1 Angstrom bin in 480 seconds

NUV – WASP-12 (V=11.7)
S/N ~ 8 in 1 Angstrom bin in 120 seconds

NUV allows one to reach higher S/N with shorter exposure times, even on faint targets.

The WASP-12 system

The star:

V*mag*: 11.7

T*eff*: 6250+/-100 K

[Fe/H]: 0.32+/-0.15

Fossati et al. 2010b

The orbit:

Period: 1.09 days

SM Axis: 0.02 AU ~ ~1 stellar diameter

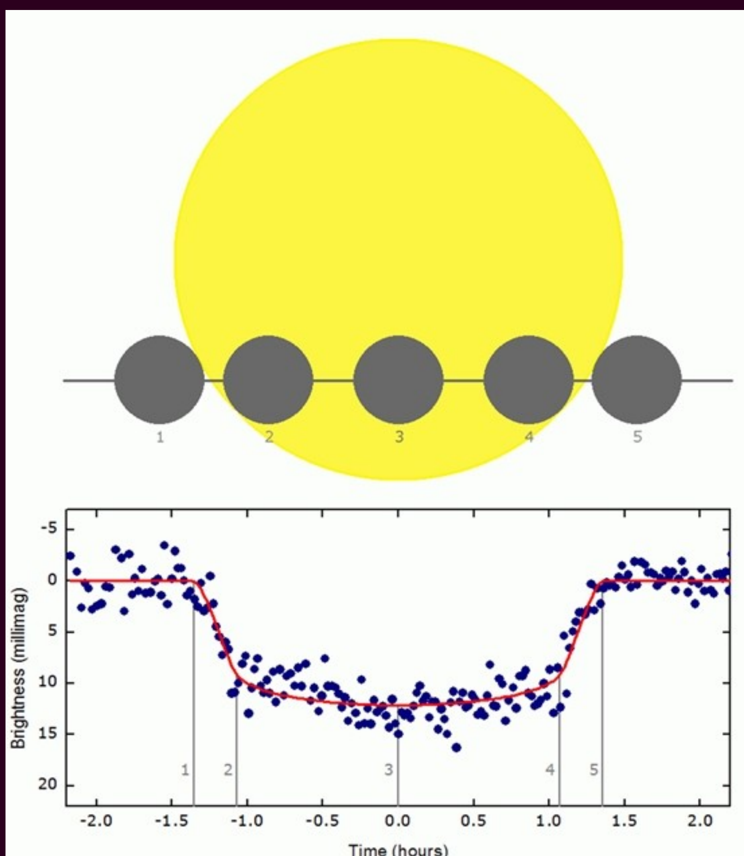
The planet:

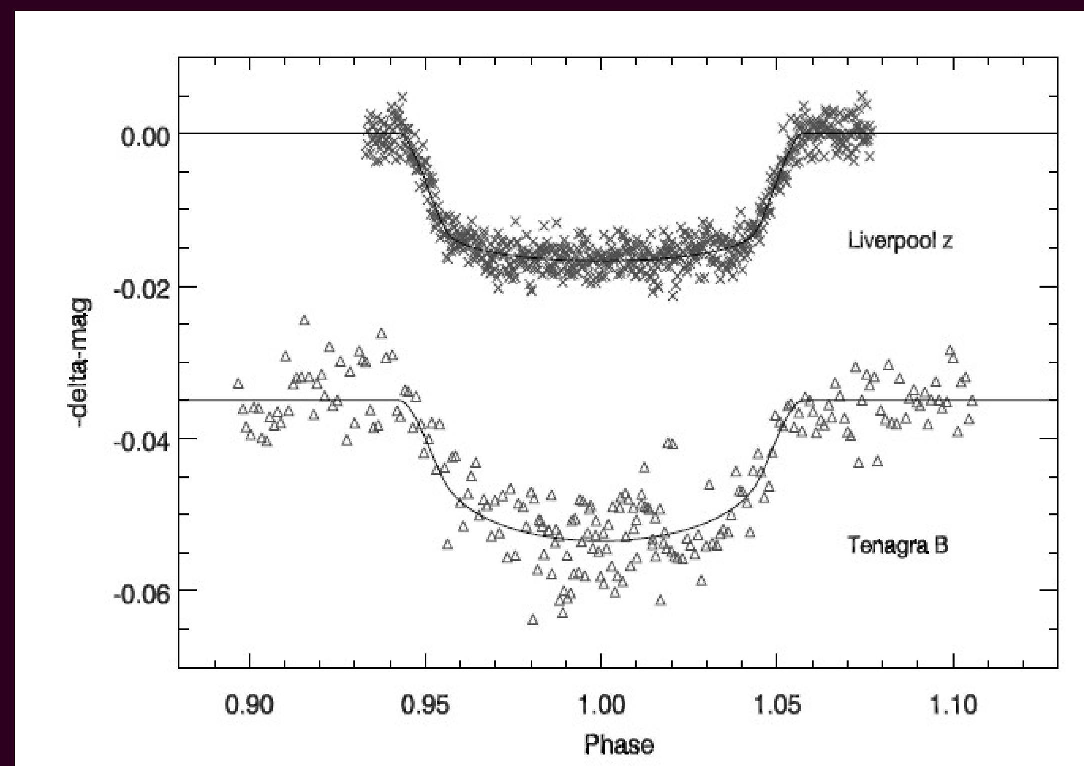
Mass: 1.41+/-0.10 M_J

Radius: 1.79+/-0.09 R_J

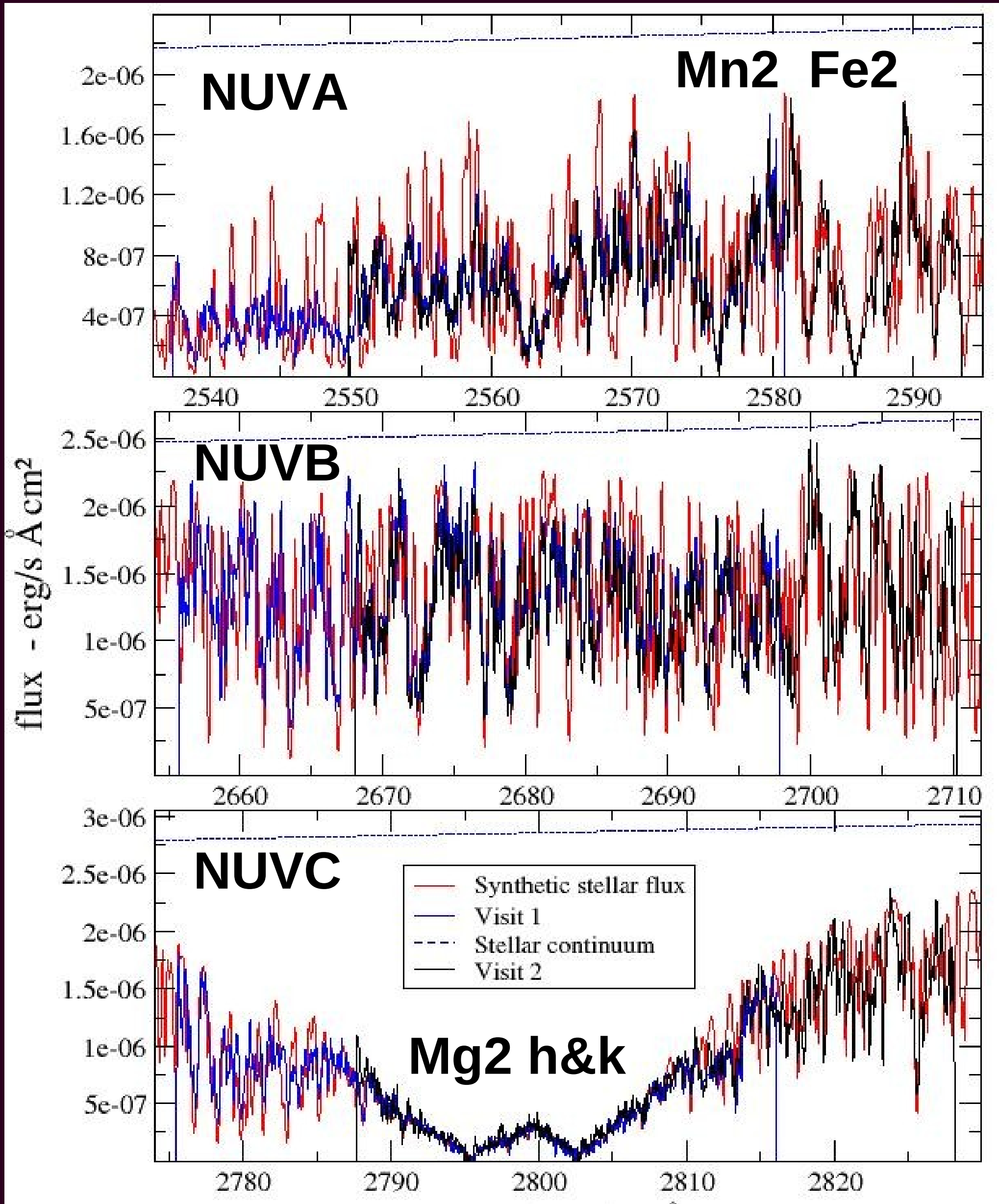
T*eq*: 2516+/-36 K

Hebb et al. 2009





The COS/HST observations



Fossati et al. 2010a

COS – NUV (TIME-TAG)

GRISM: G285M/2676

NUVA: 2539 - 2580 Å

NUVB: 2655 - 2696 Å

NUVC: 2770 - 2811 Å

GRISM: G285M/2695

NUVA: 2551 - 2594

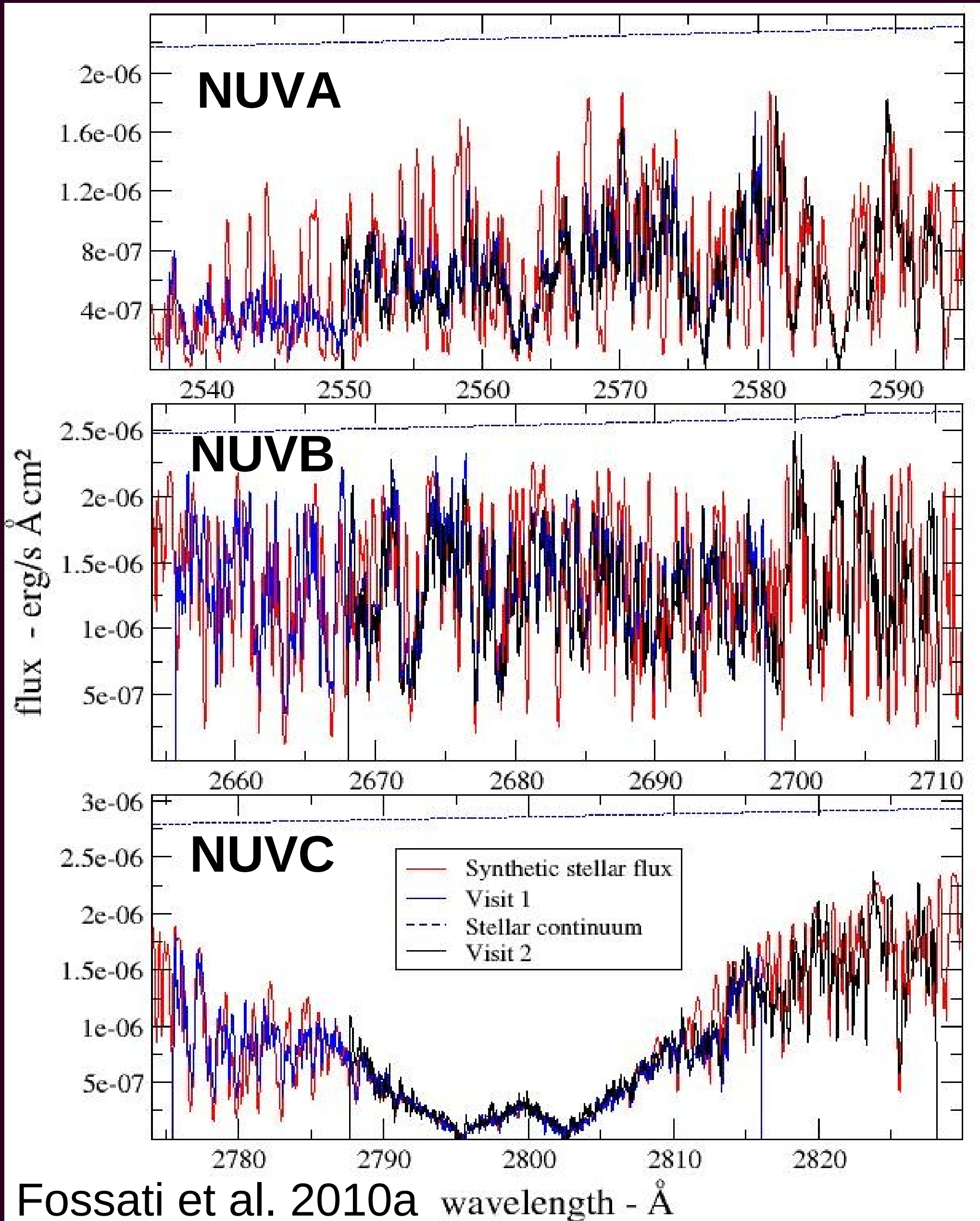
NUVB: 2669 - 2711

NUVC: 2789 – 2829

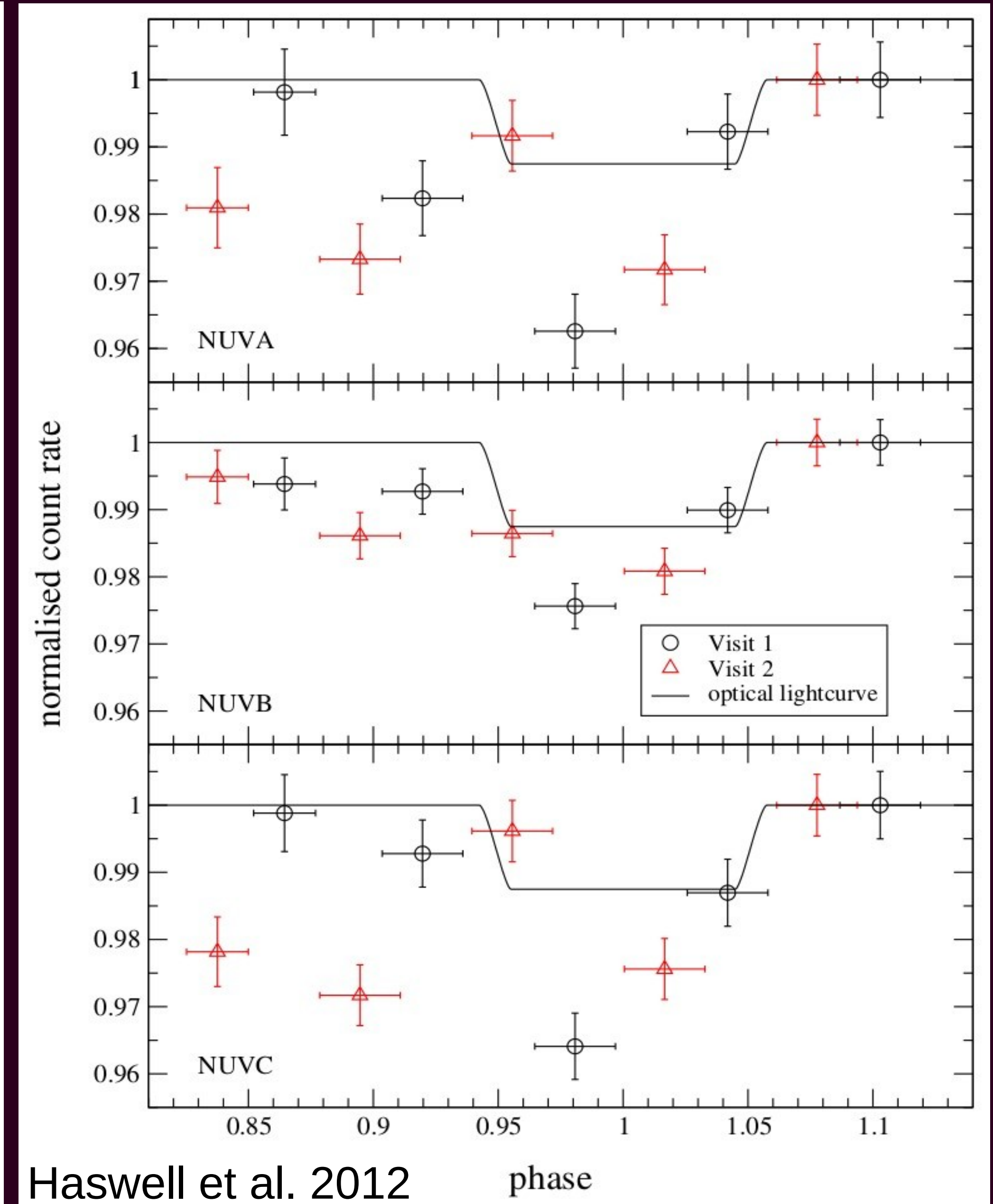
R ~ 20 000 SNR ~ 8 – 10

5 + 5 HST orbits ~ 3000 sec

The wavelength dependent transit light curve



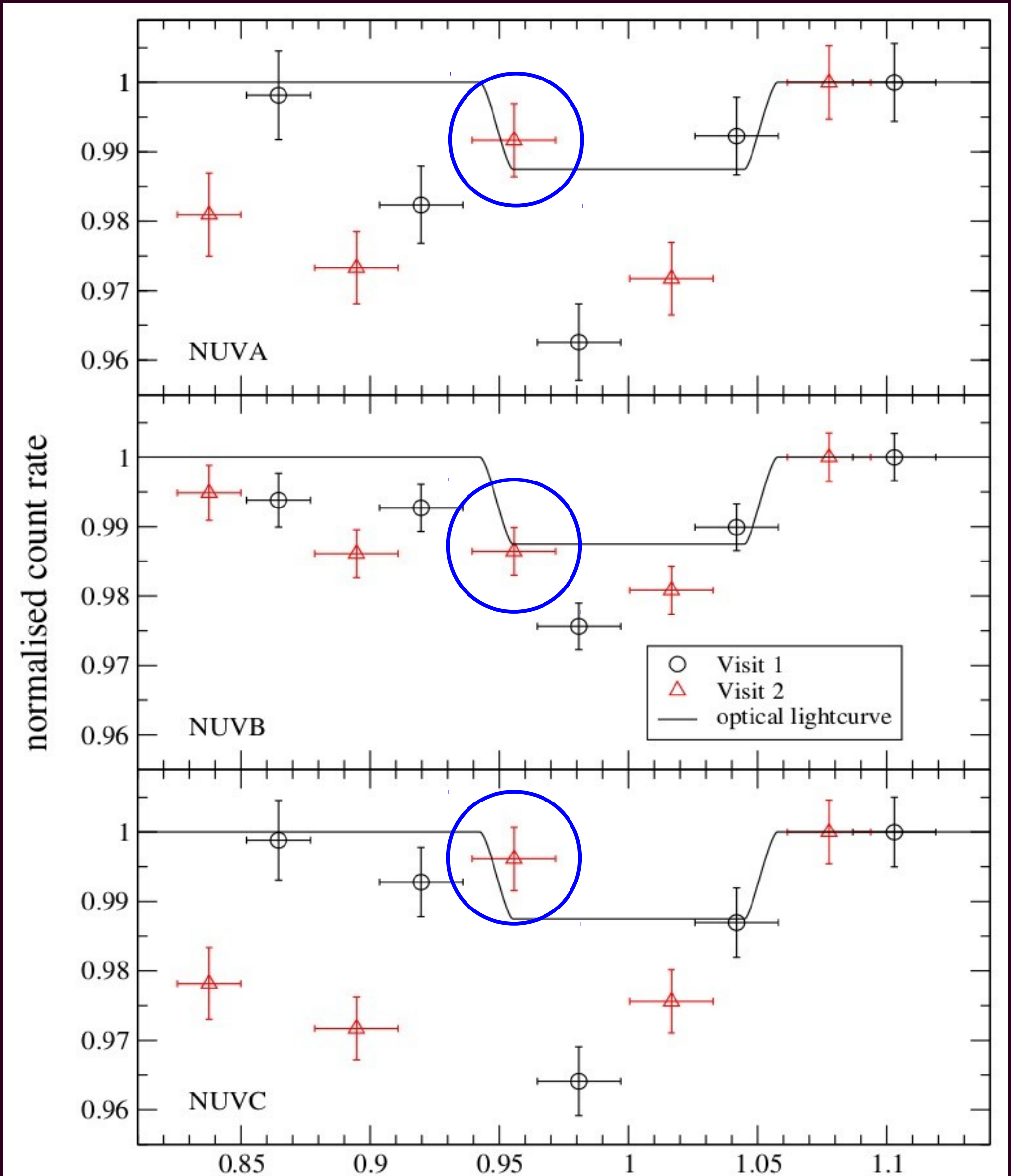
Fossati et al. 2010a



Haswell et al. 2012

The wavelength dependent transit light curve

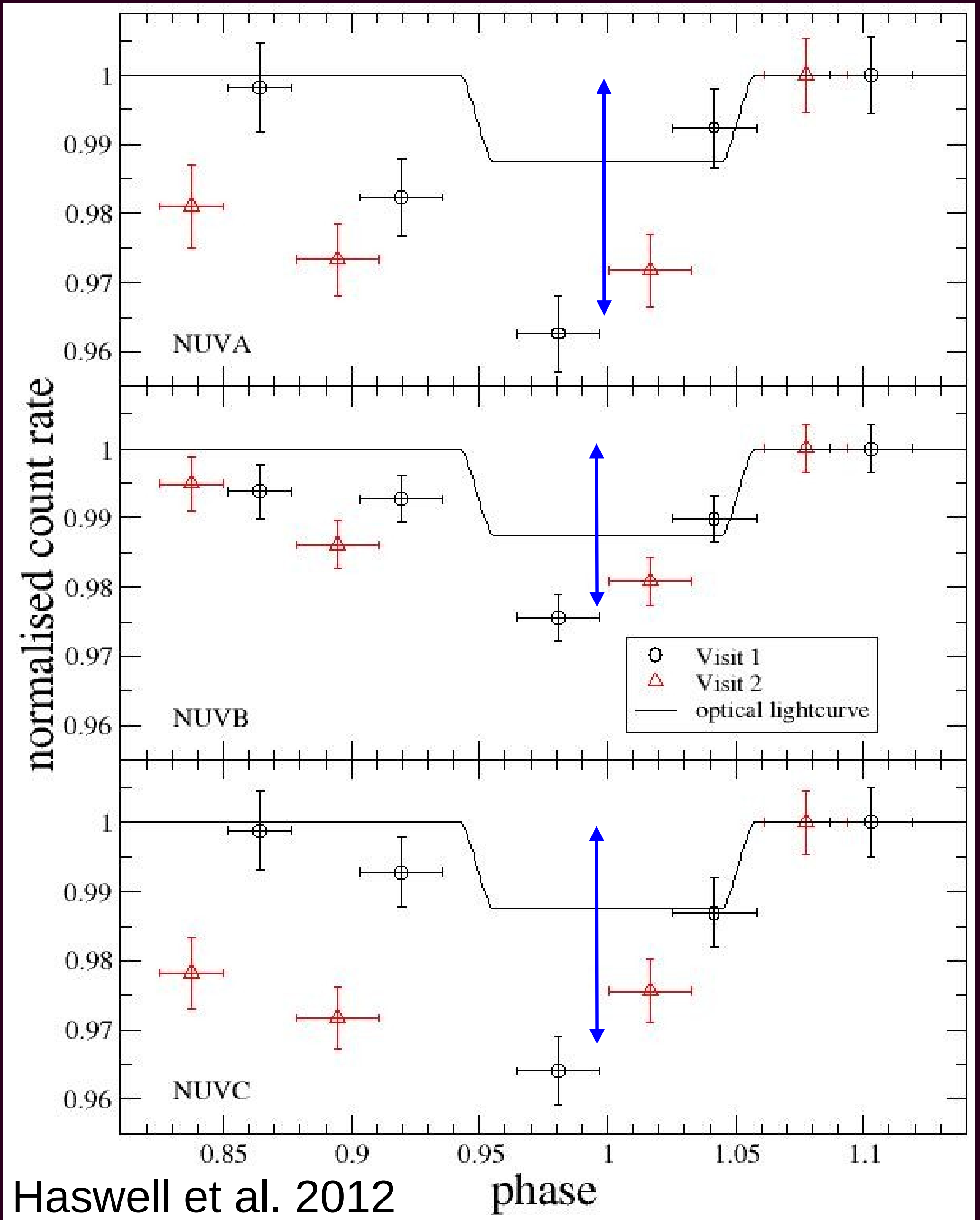
Probable stellar flare (see Haswell et al. 2012), though other explanations are possible.



Haswell et al. 2012

The wavelength dependent transit light curve

Detection of the planet transit in the near-UV

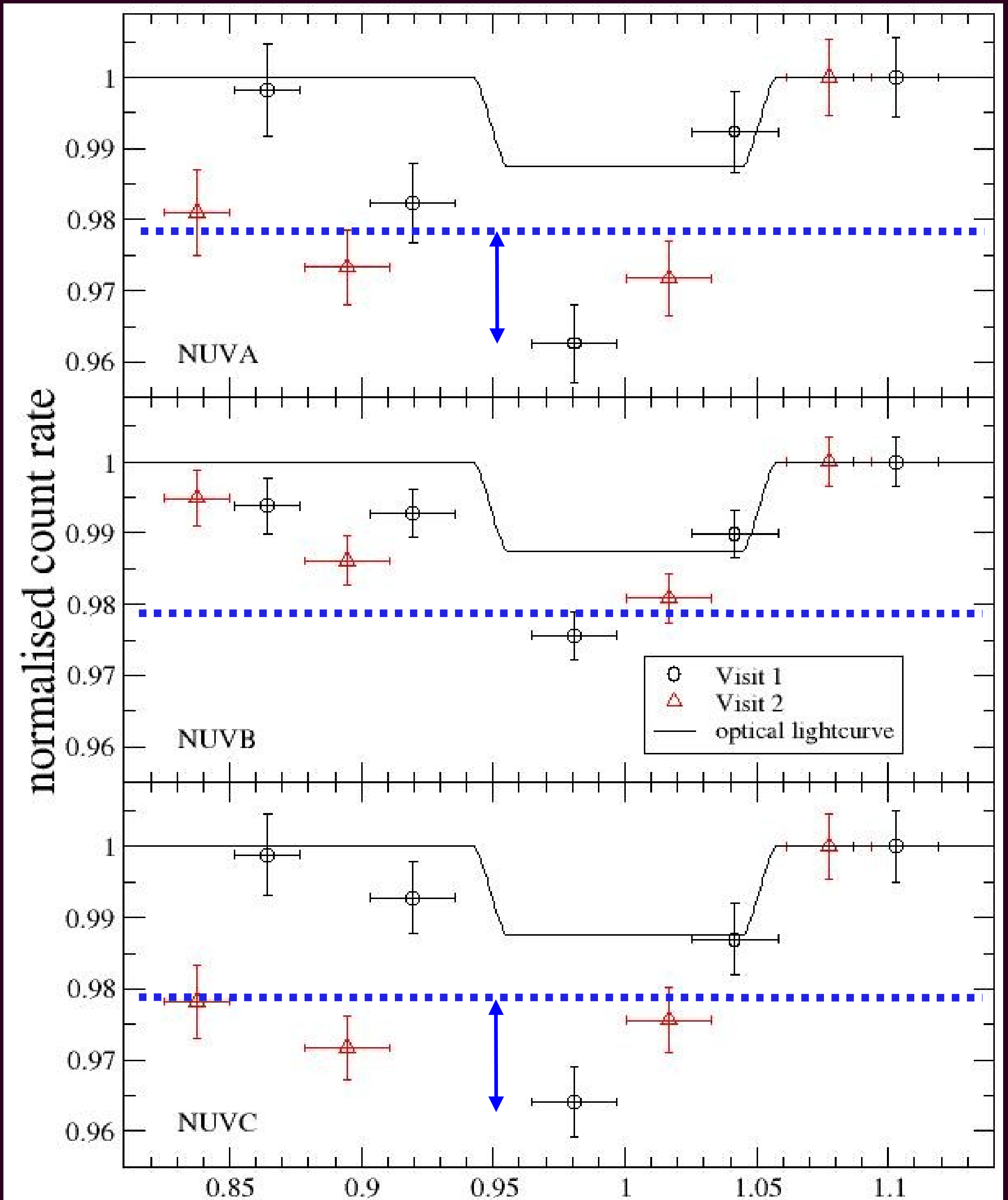


Haswell et al. 2012

The wavelength dependent transit light curve

Detection of the planet transit in the near-UV

Planet radius exceeds the planet Roche lobe → planet is evaporating



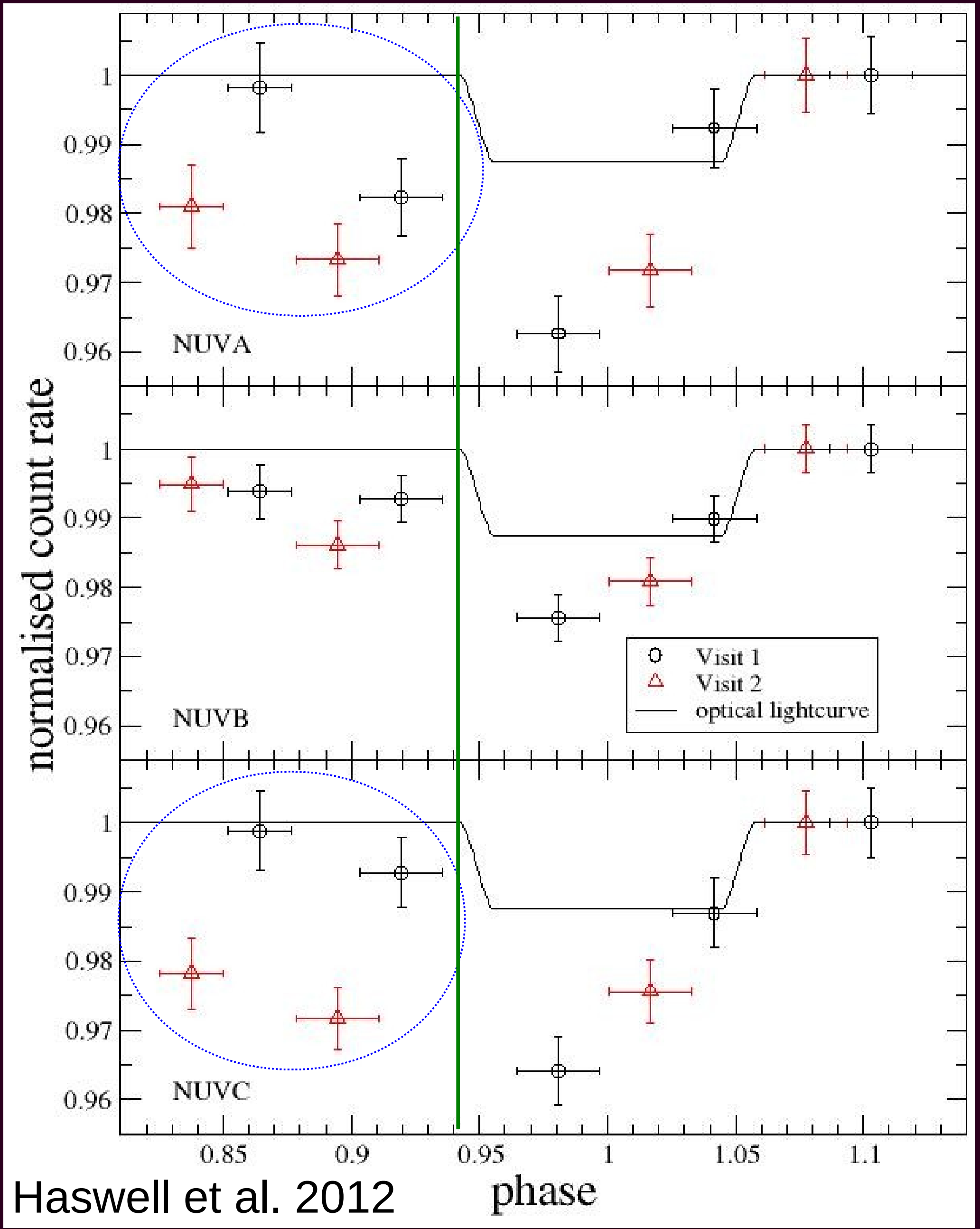
Haswell et al. 2012

The wavelength dependent transit light curve

Detection of the planet transit in the near-UV

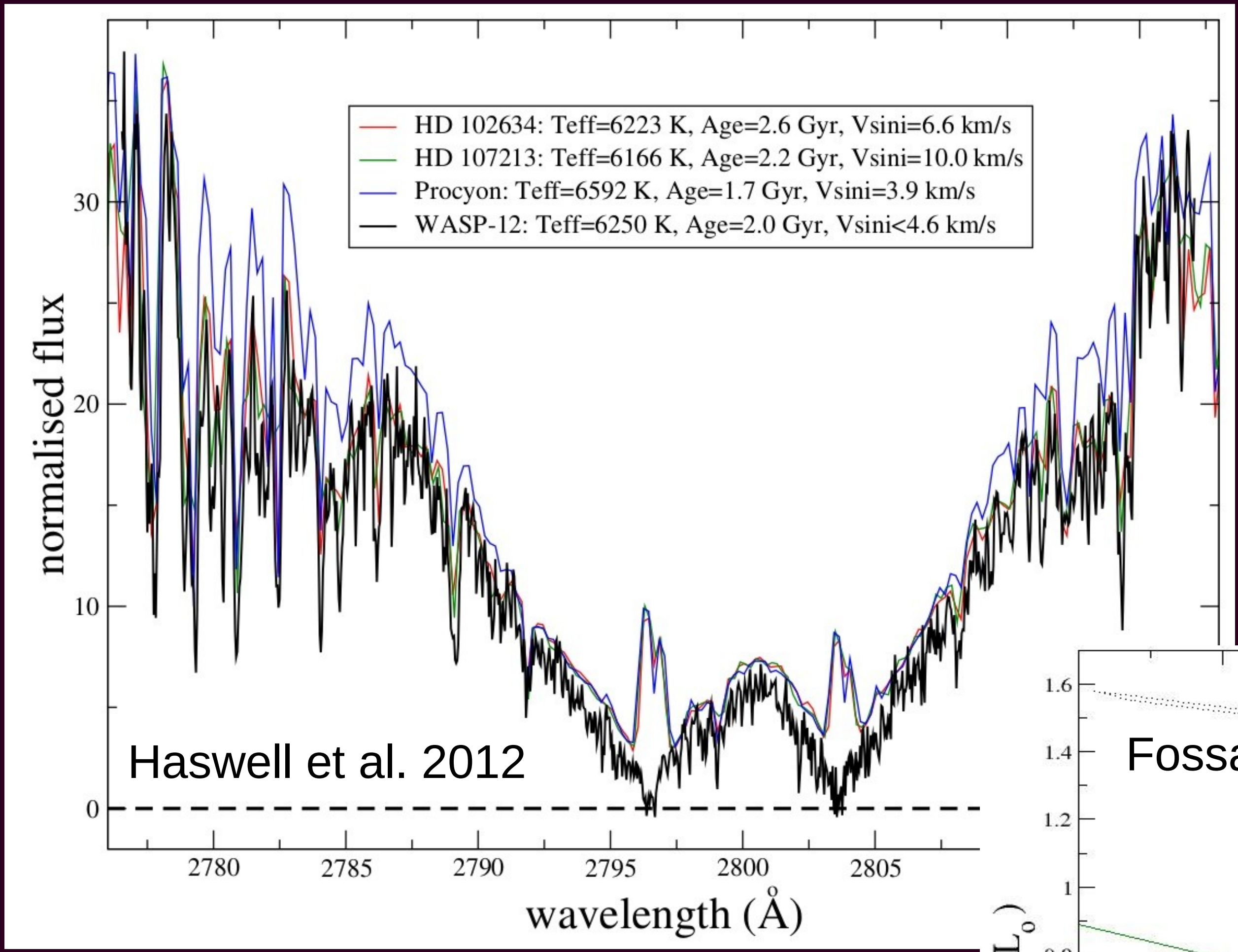
Planet radius exceeds the planet Roche lobe → planet is evaporating

Detection of an early-ingress, variable with time
– Lai et al. 2010
– Vidotto et al. 2010 & 2011
– Llama et al. 2011
– Bisikalo et al. 2012

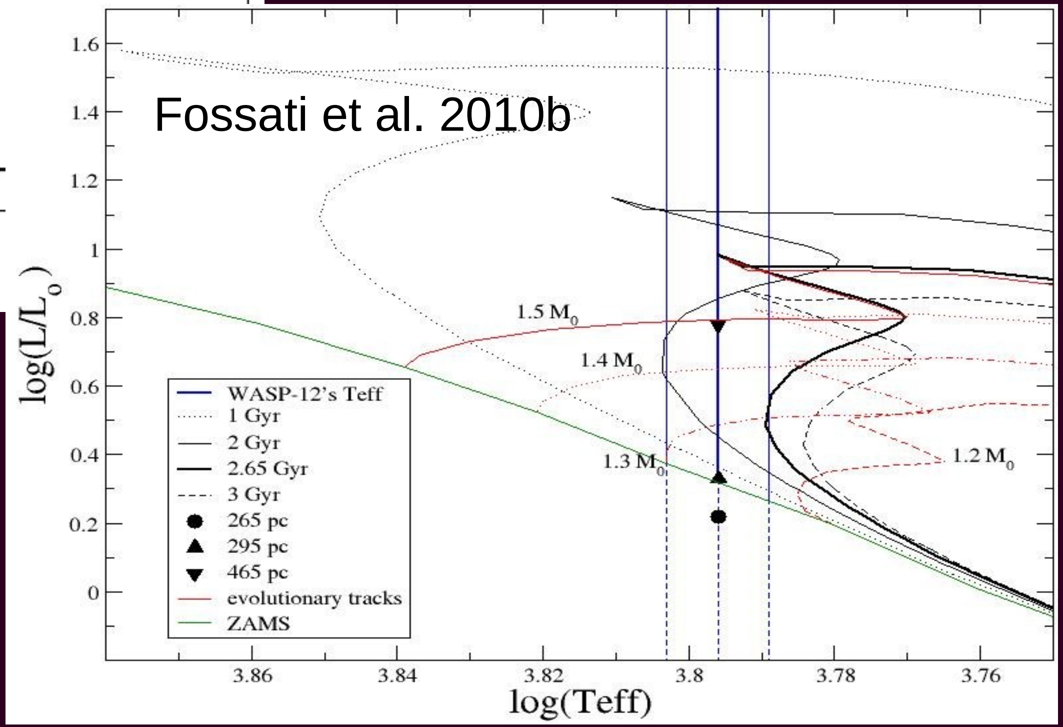


Haswell et al. 2012

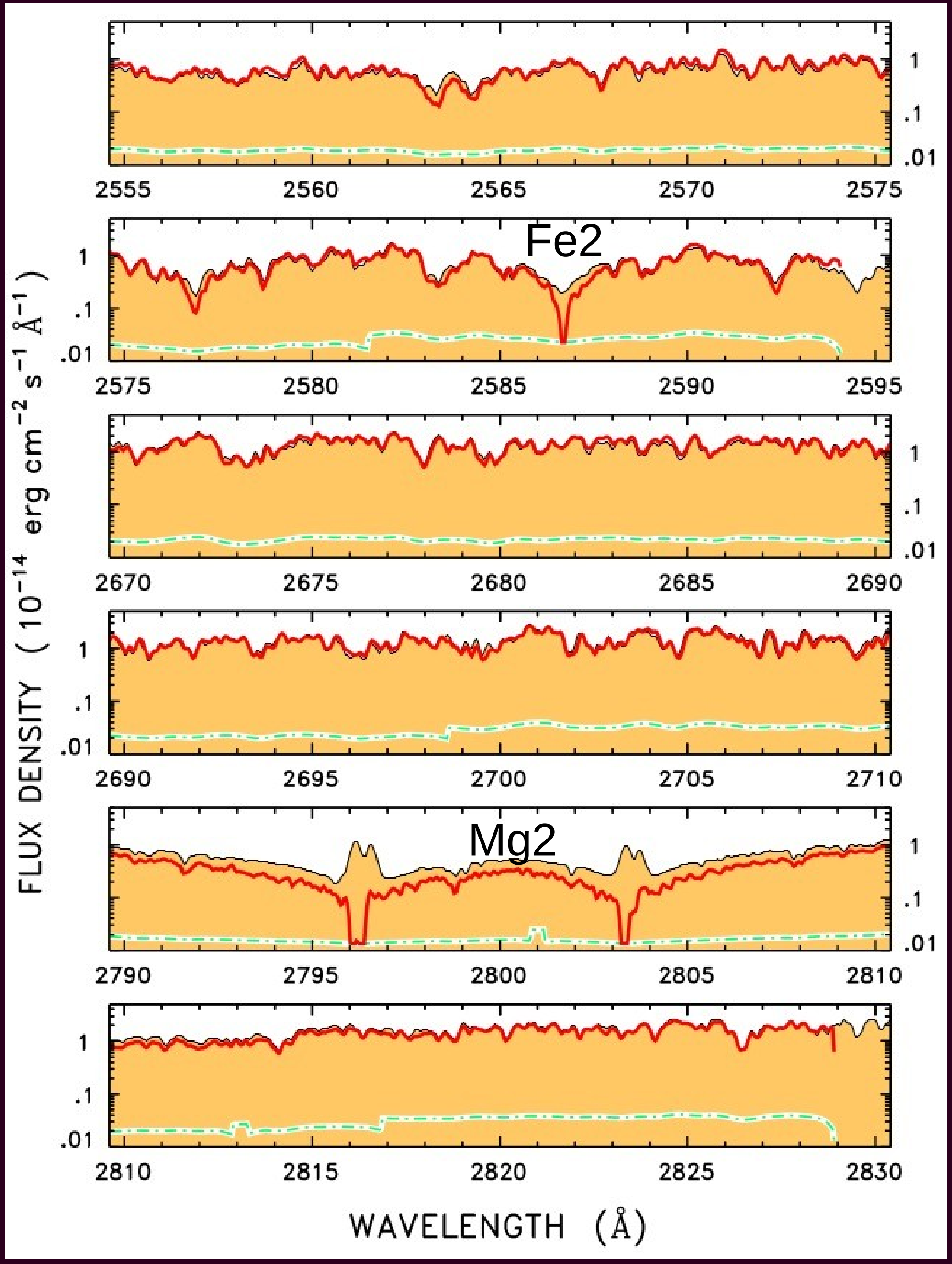
Anomalous stellar activity



Age < 2.65 Gyr

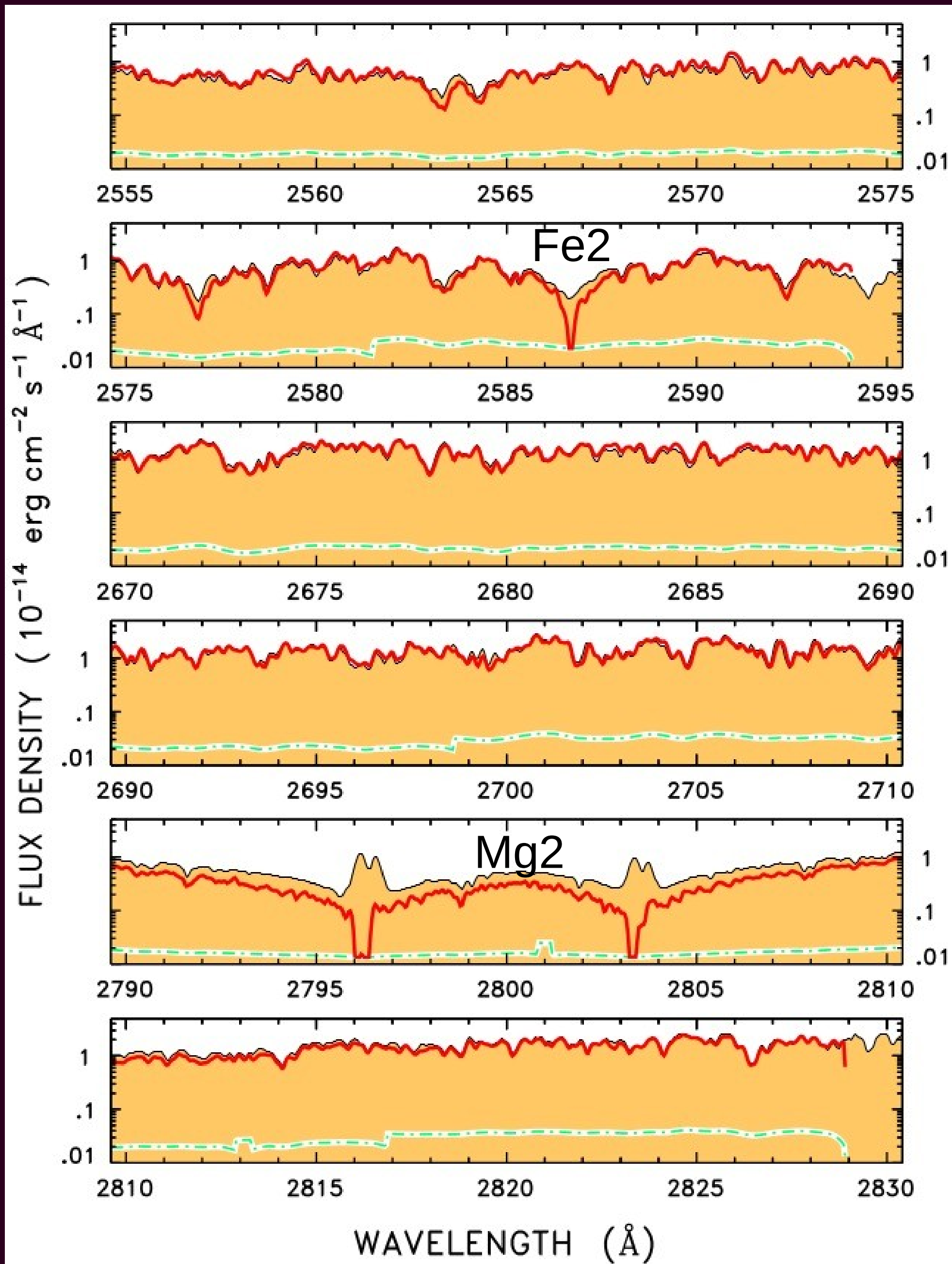


Anomalous stellar activity



Haswell et al. 2012

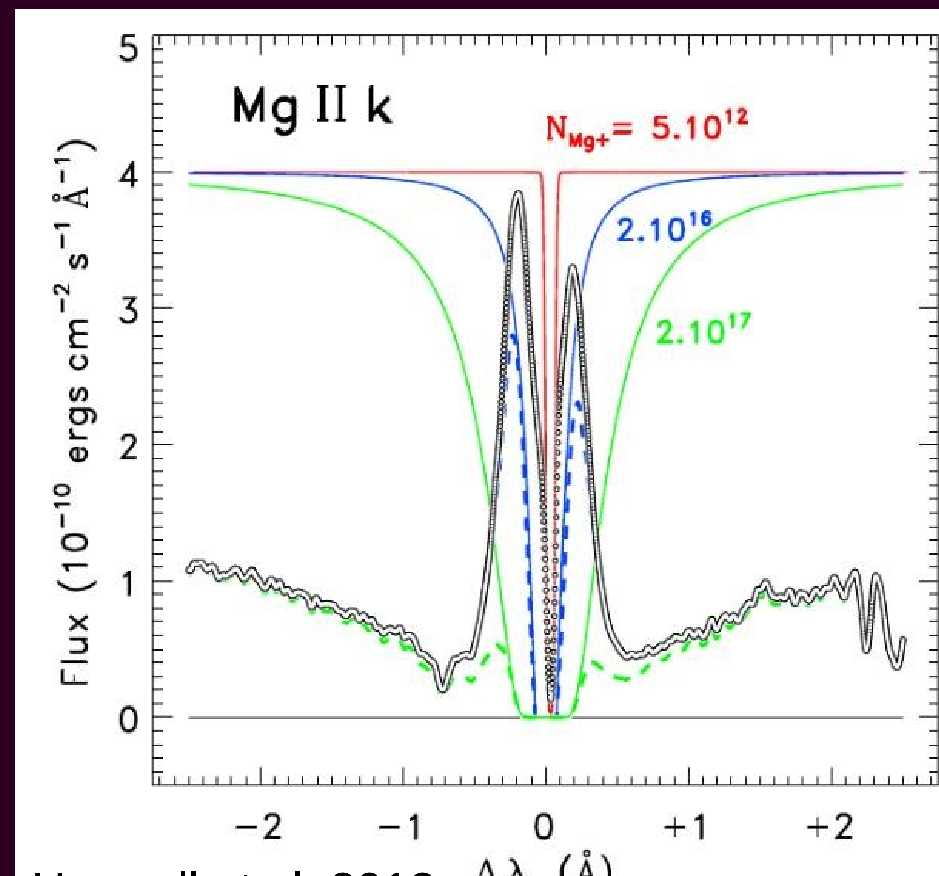
Anomalous stellar activity



Comparison with Alpha Cen

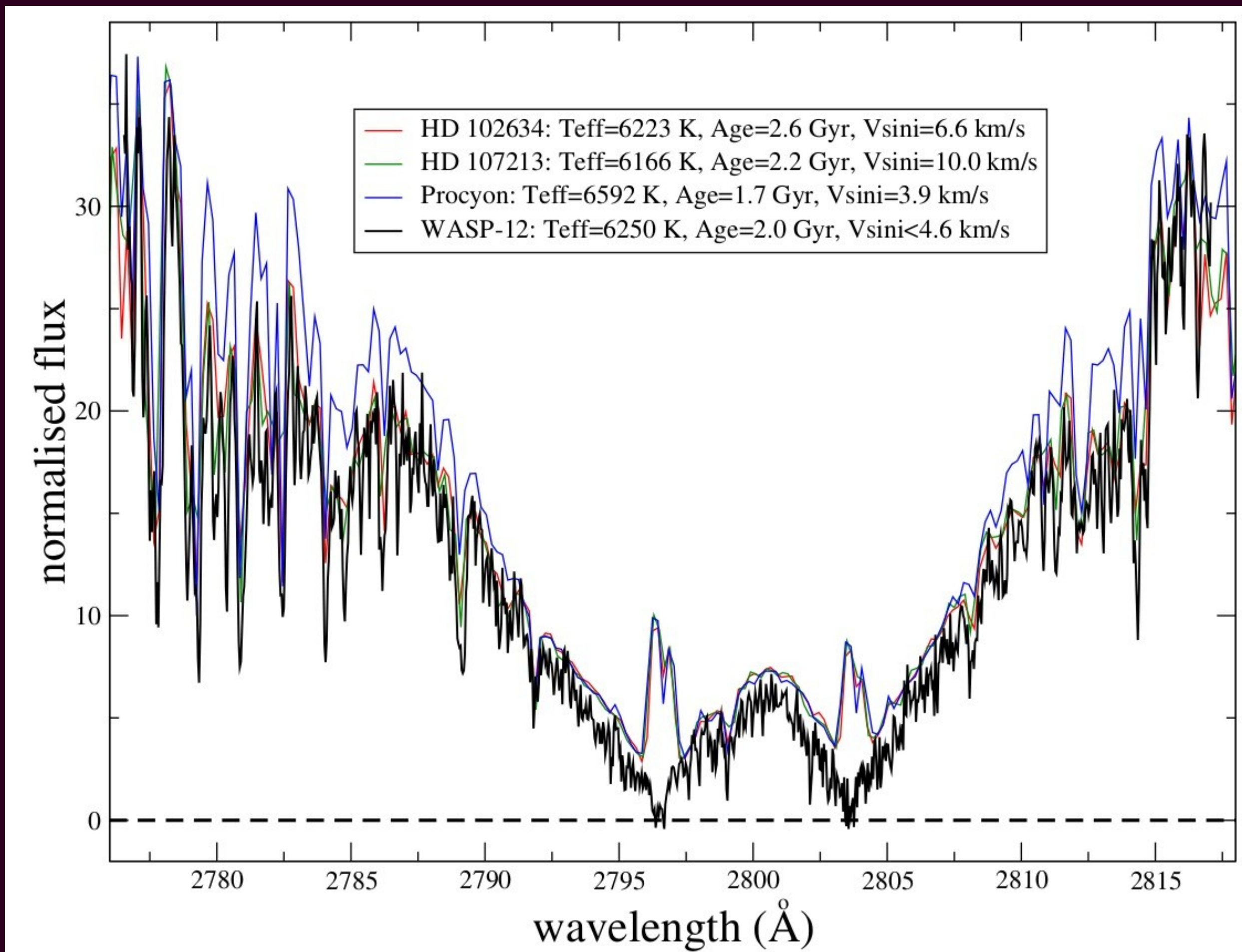
Column density required to absorb the whole emission:

$N_{Mg+} = 2.x10^{17}$!!!



Haswell et al. 2012

Anomalous stellar activity



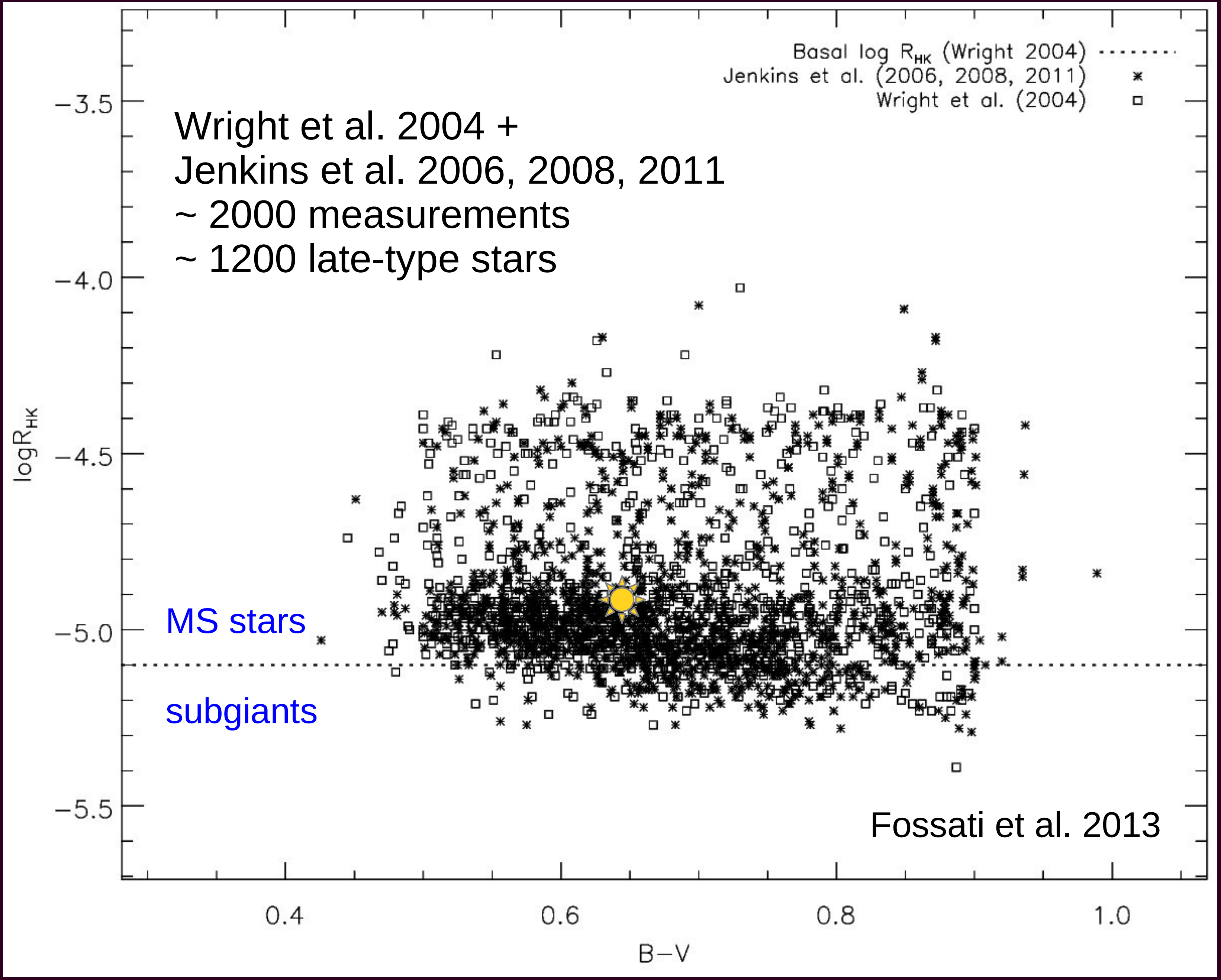
What can cause the anomalous Mg2 line cores?

– unprecedented anomalous low activity

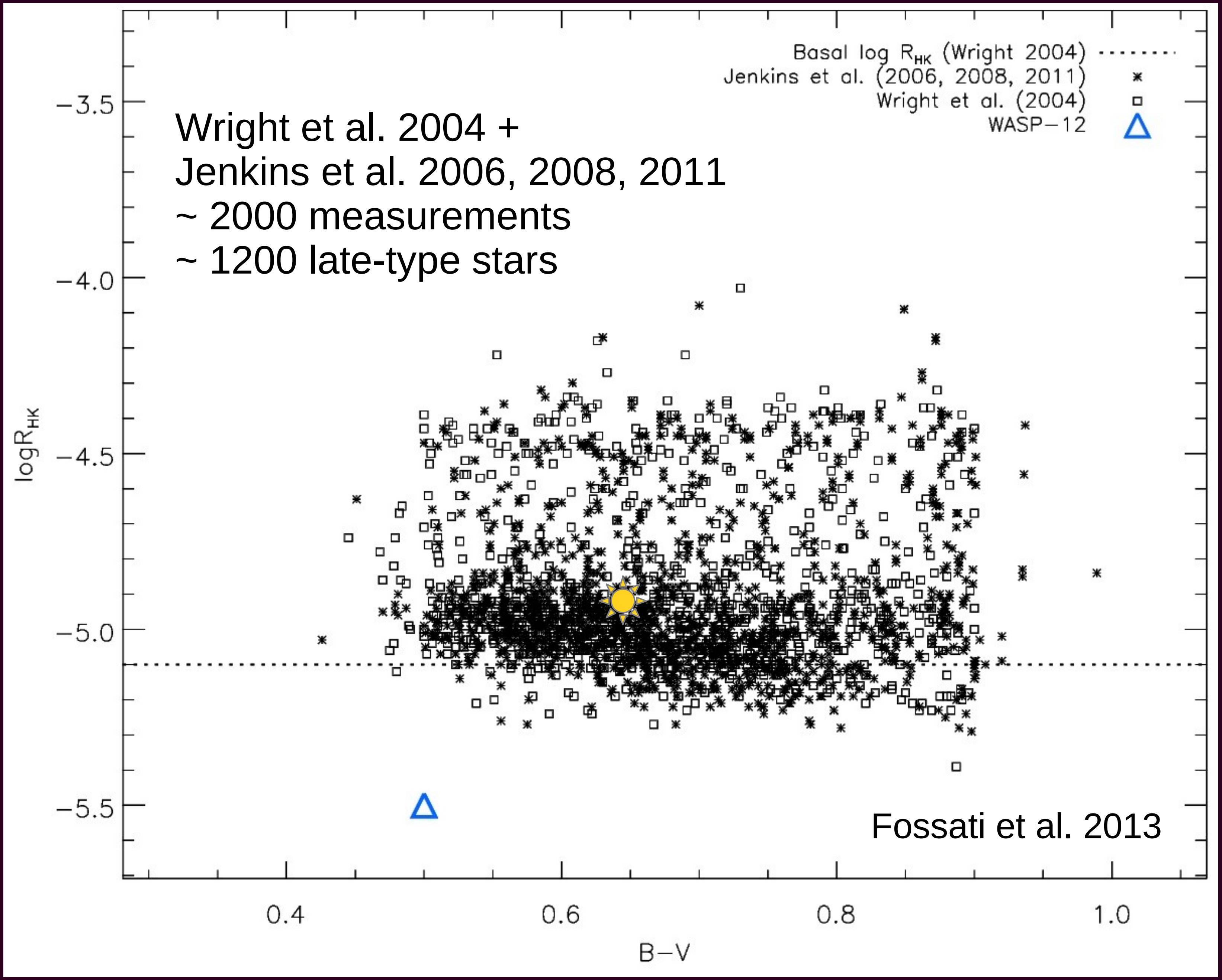
– ISM absorption

– absorption from material local to the system

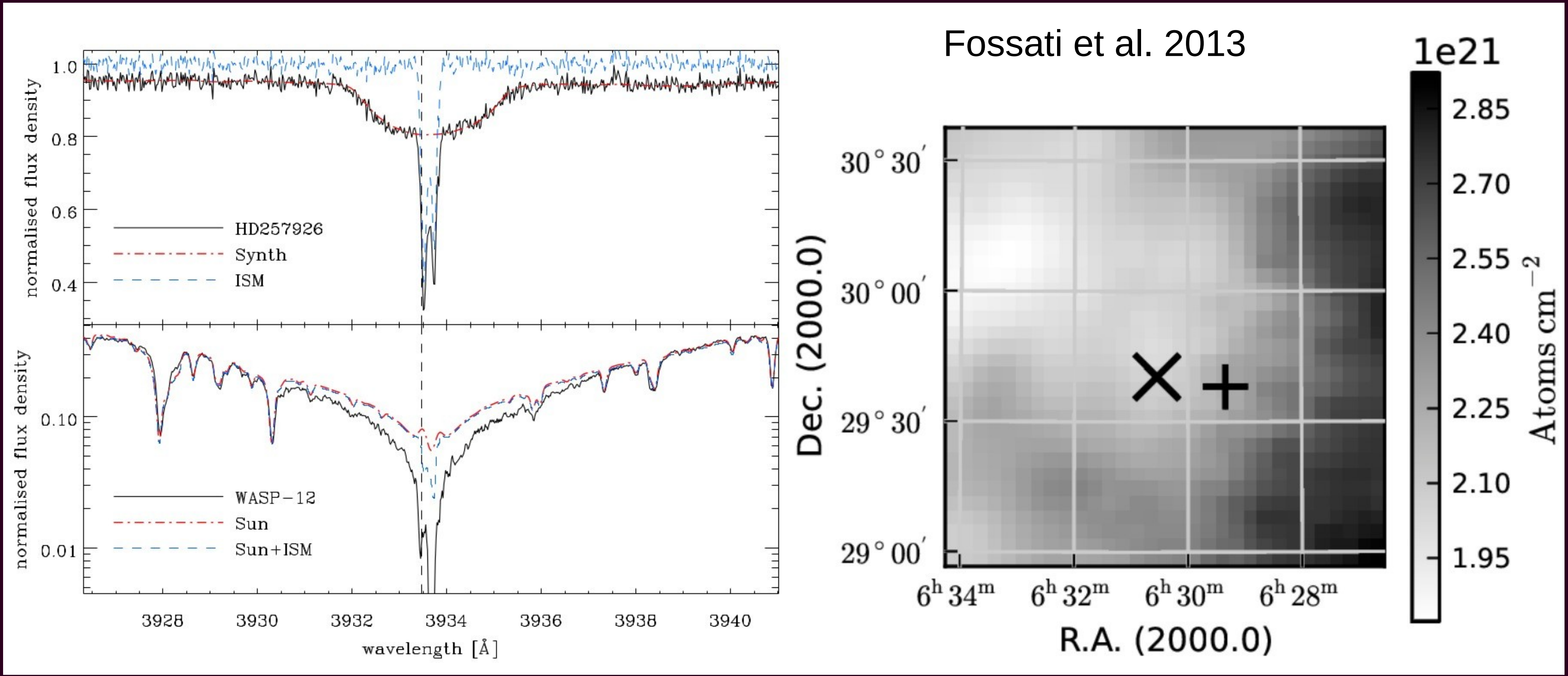
Anomalous stellar activity: intrinsic low activity



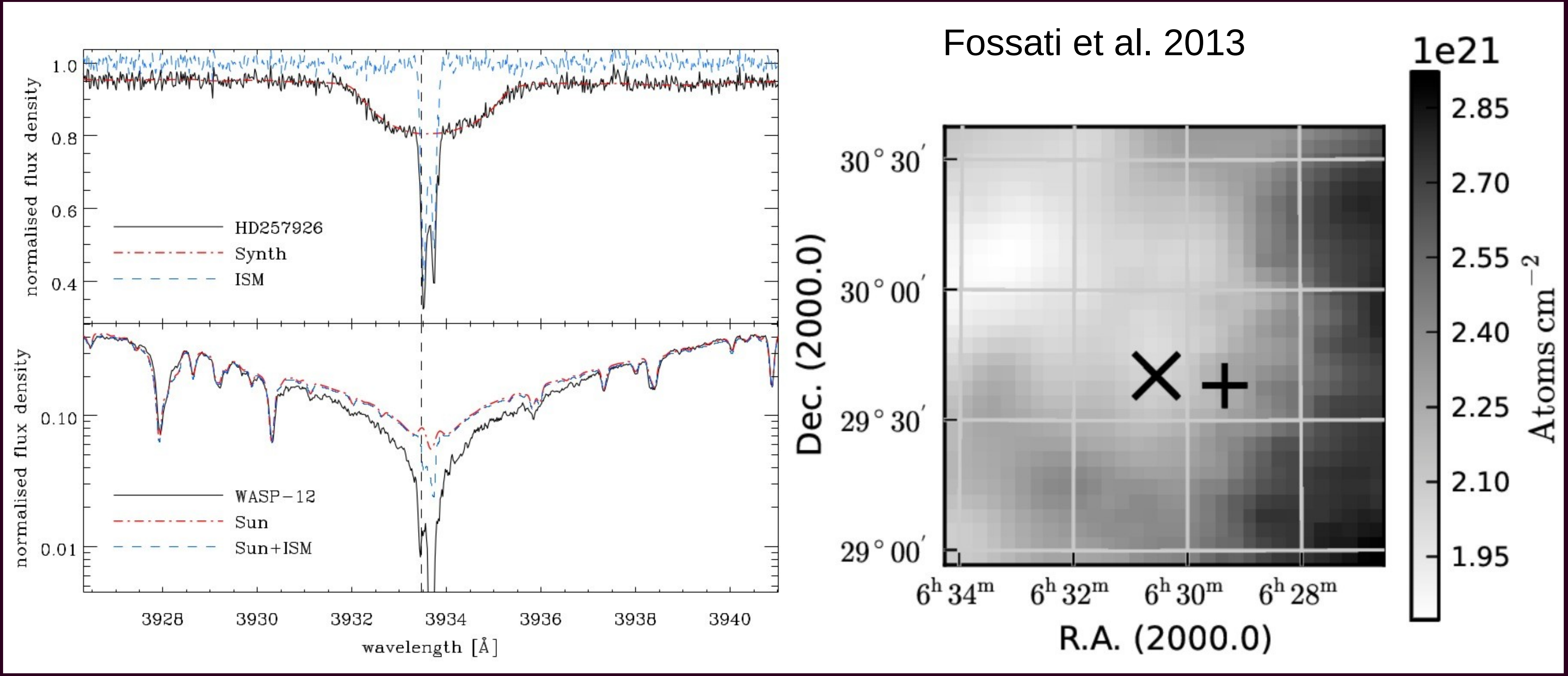
Anomalous stellar activity: intrinsic low activity



Anomalous stellar activity: ISM absorption



Anomalous stellar activity: ISM absorption

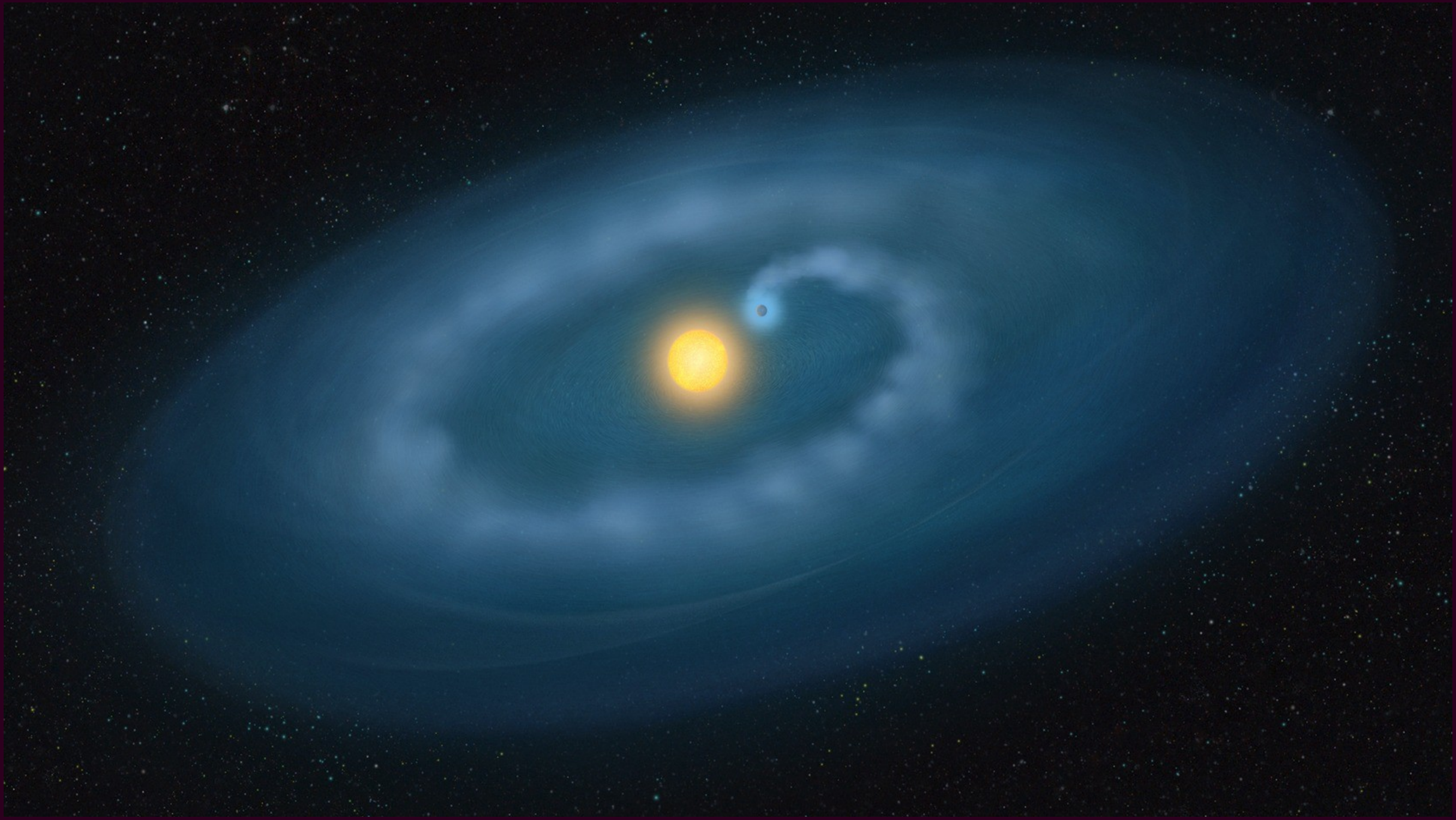


– A low activity level is not the origin of the anomaly

– ISM absorption is not enough to be the origin of the anomaly

Anomalous stellar activity

The only other available solution is an optically thick circumstellar cloud/torus of material, presumably lost by the planet.

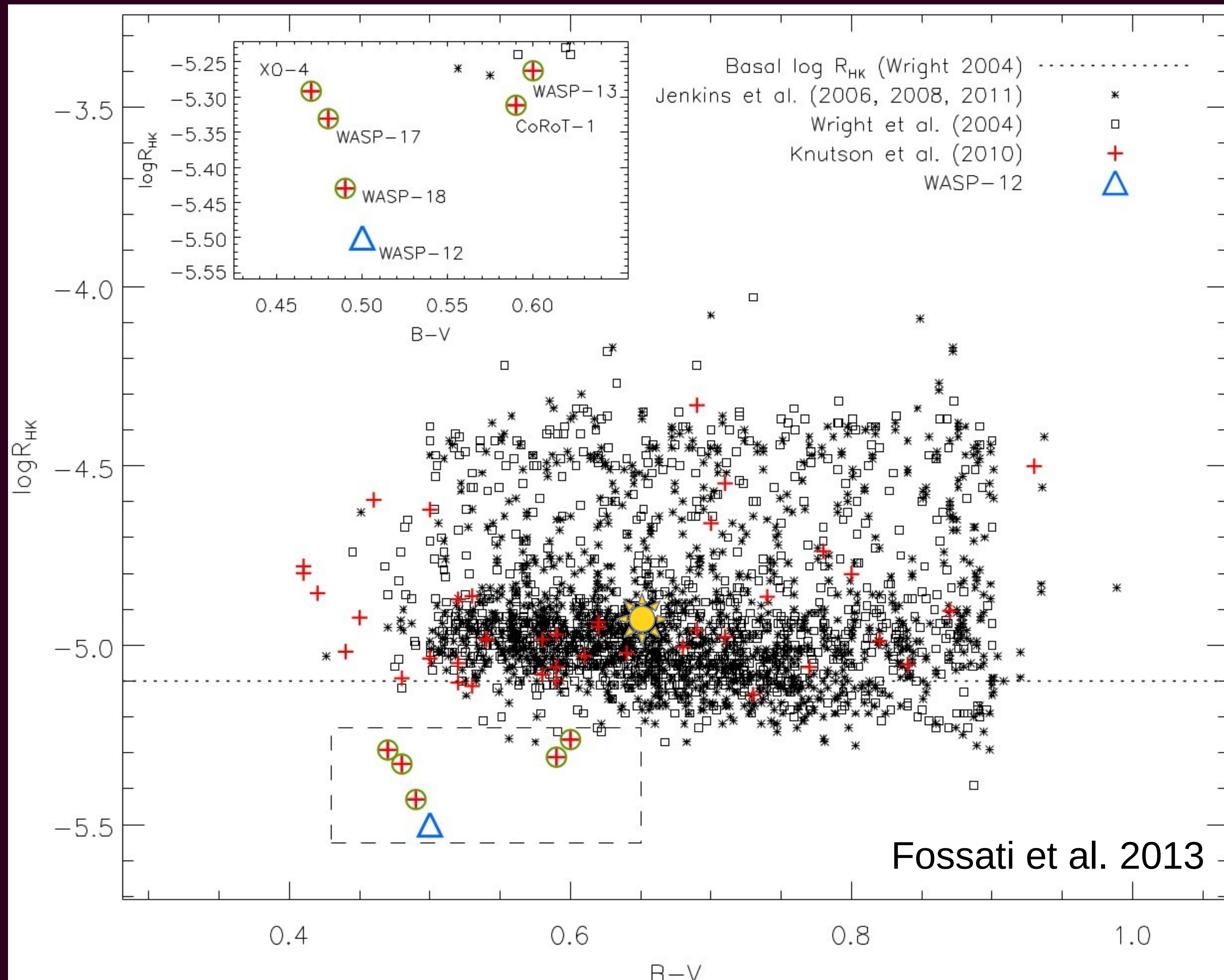


The estimated mass loss ($3x10^7$ kg/s; Eherenreich & Desert 2011) is consistent with this picture (Haswell et al. 2012)!

Anomalous stellar activity

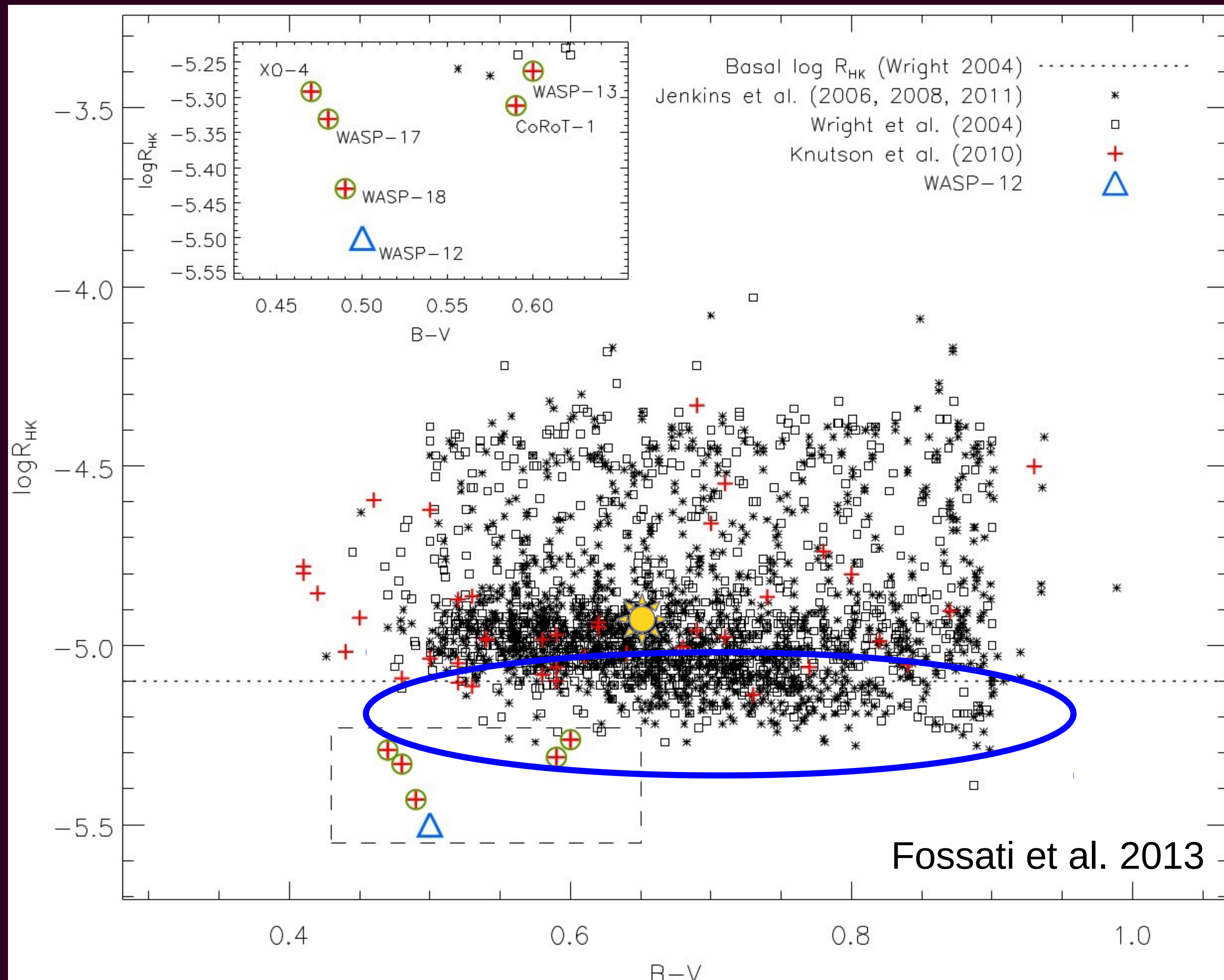
– Other planet-hosts show an anomalous stellar activity, possibly indicative of the presence of an optically thick circumstellar torus.

Are all these transiting planets evaporating?
We need to observe their primary transit in the UV to know this for sure.



Anomalous stellar activity

– Several RV planet-hosts. Some would be subgiants, but some might host an optically thick torus.

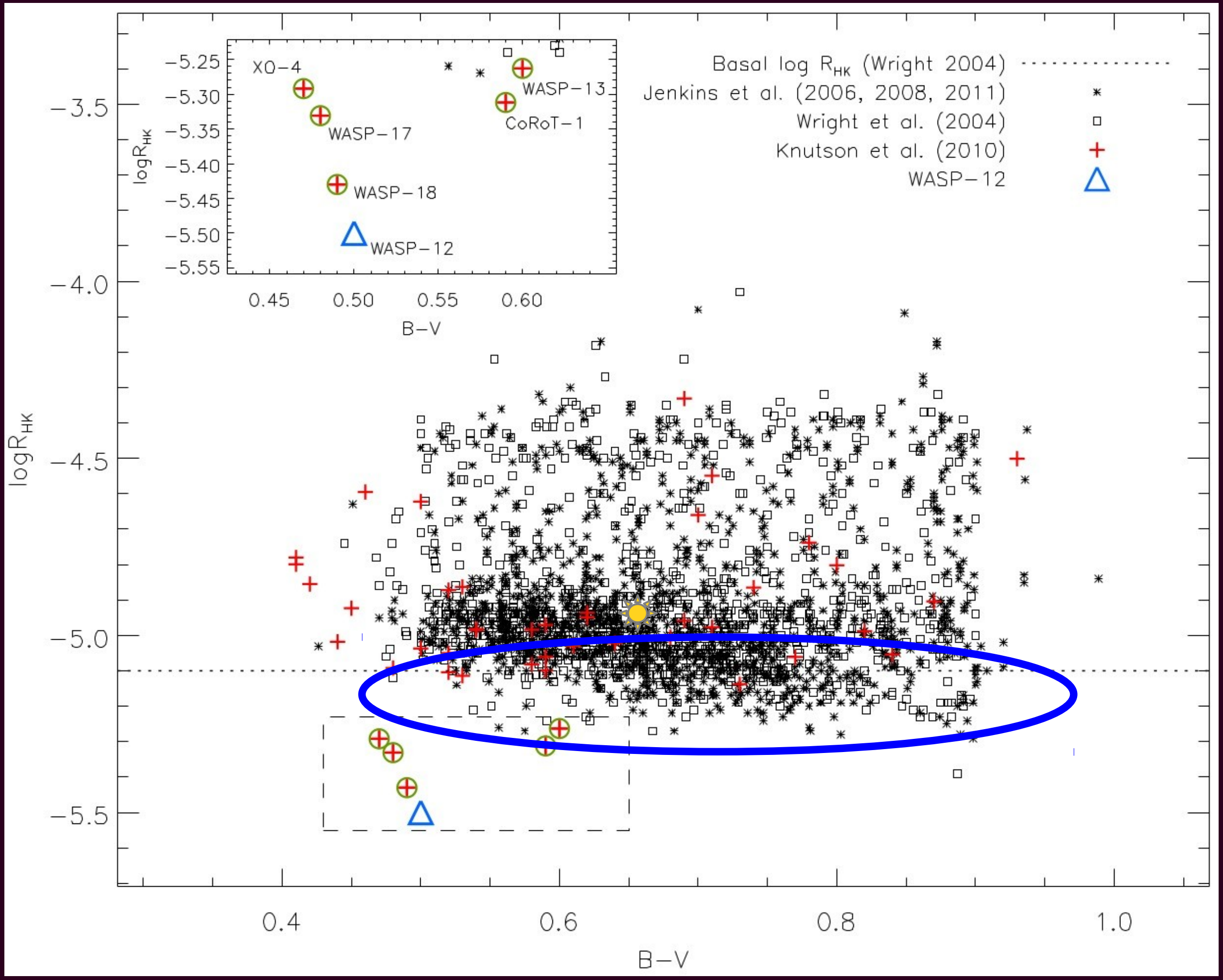


To conclude …

To conclude …

To conclude …

– Near-UV spectra of the Mg2 h&K lines for the planet-hosts showing a low activity

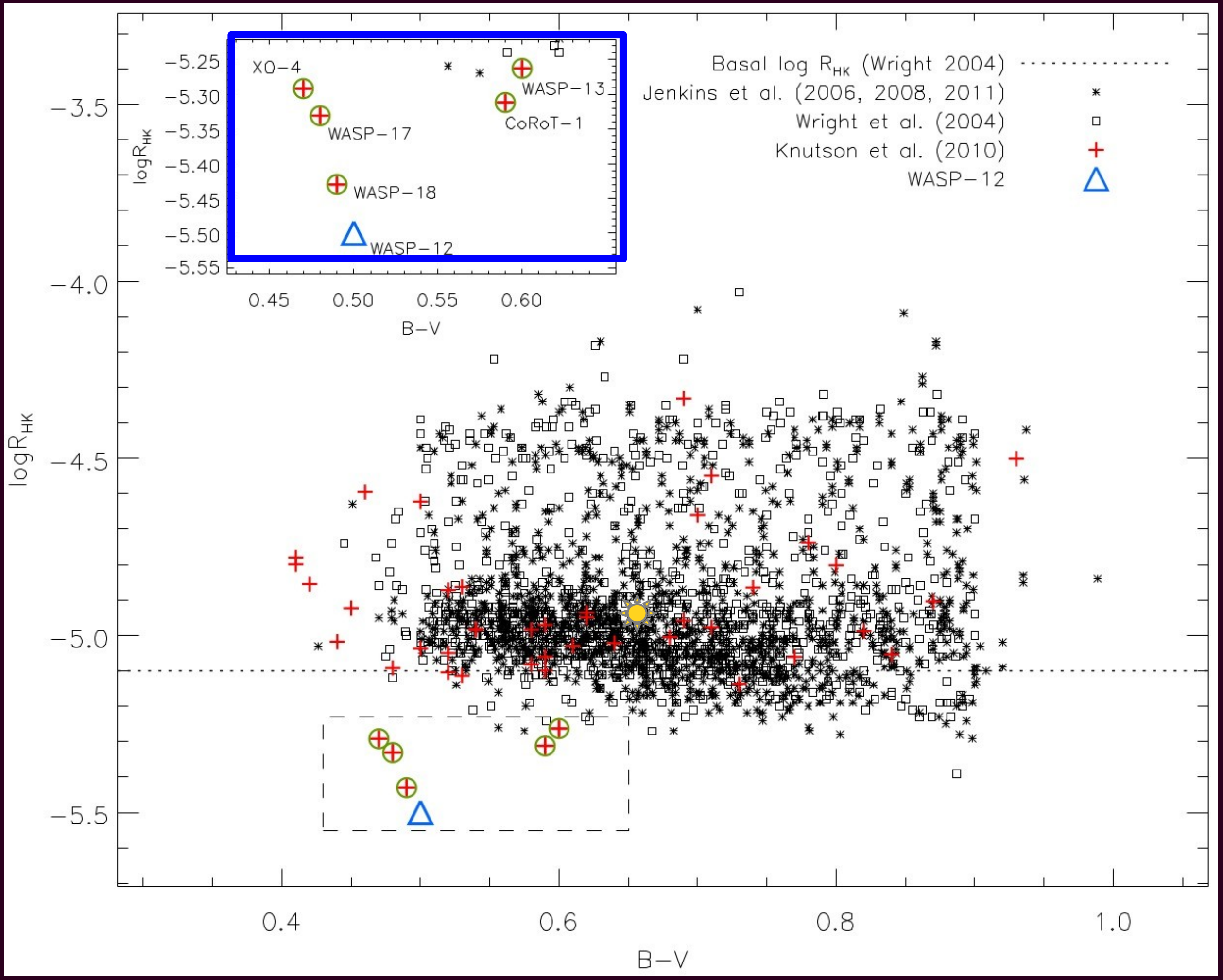


To conclude …

– Near-UV spectra of the Mg2 h&K lines for the planet-hosts showing a low activity

– Far-UV spectra of a few planet-hosts which are more likely to be surrounded by an optically thick torus, in order to improve the estimates of mass-loss

– Near-UV transit spectra

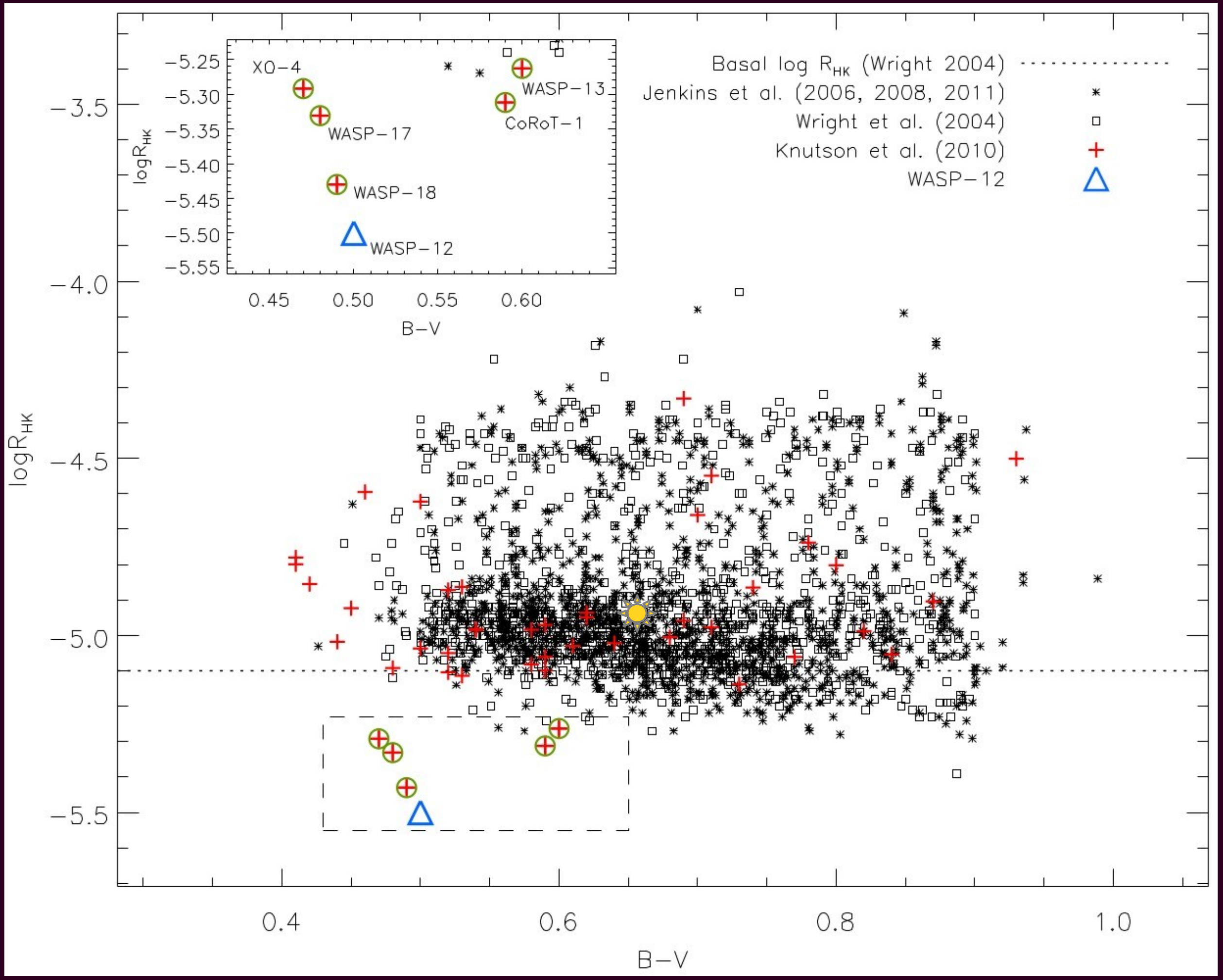


To conclude …

– Near-UV spectra of the Mg2 h&K lines for the planet-hosts showing a low activity

– Far-UV spectra of a few planet-hosts which are more likely to be surrounded by an optically thick torus, in order to improve the estimates of mass-loss

– Near-UV transit spectra



I'll be a good boy, I promise!

Luca