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

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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

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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

<table>
<thead>
<tr>
<th>The star:</th>
<th>The orbit:</th>
<th>The planet:</th>
</tr>
</thead>
<tbody>
<tr>
<td>V\text{mag}: 11.7</td>
<td>Period: 1.09 days</td>
<td>Mass: 1.41\pm0.10 \text{ M}_J</td>
</tr>
<tr>
<td>T\text{eff}: 6250\pm100 \text{ K}</td>
<td>SM Axis: 0.02 \text{ AU} \sim 1 \text{ stellar diameter}</td>
<td>Radius: 1.79\pm0.09 \text{ R}_J</td>
</tr>
<tr>
<td>[Fe/H]: 0.32\pm0.15</td>
<td>Teq: 2516\pm36 \text{ K}</td>
<td></td>
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<tr>
<td>Fossati et al. 2010b</td>
<td></td>
<td>Hebb et al. 2009</td>
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</tbody>
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The COS/HST observations

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

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

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Anomalous stellar activity

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Anomalous stellar activity

Comparison with Alpha Cen
Column density required to absorb the whole emission:
\[ N_{\text{Mg}^+} = 2 \times 10^{17} \]
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

~ 2000 measurements
~ 1200 late-type stars

Fossati et al. 2013

Basal log $R_{HK}$ (Wright 2004)
Wright et al. (2004)
Anomalous stellar activity: intrinsic low activity

Wright et al. 2004 +
~ 2000 measurements
~ 1200 late-type stars

Fossati et al. 2013
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 ($3 \times 10^7$ 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 …
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– Near-UV spectra of the Mg2 h&K lines for the planet-hosts showing a low activity
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– 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!

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