

Observation of a stellar flare during a transit of HD 189733

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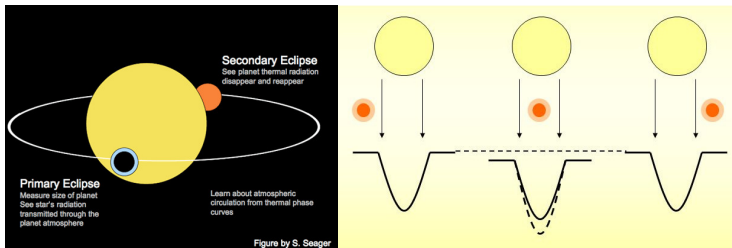
June 26, 2017
EWASS

Collaborators: S. Czesla, J. Schmitt, S. Khalafinejad, U. Wolter
Hamburg observatory, Germany

High-resolution transit spectroscopy

Method for detecting exoplanetary atmospheres

As proposed by Seager & Sasselov 2000



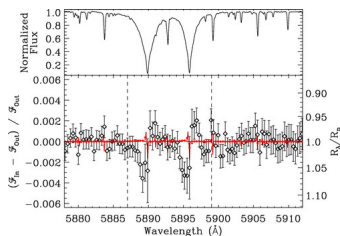
- ▶ Excess absorption in the cores of spectral lines during primary transit
- ▶ NaI and KI resonance doublets

Source: seagerexoplanets.mit.edu

High-resolution transit spectroscopy

HD 189733 - transiting exoplanetary system

- ▶ Ground based detection of sodium (5890, 5896 Å) in the exoplanetary atmosphere (Redfield 2008)



HD 189733

- ▶ Active K1V star + Hot Jupiter
- ▶ Spots (Pont et al. 2007), X-ray flares (Pillitteri et al. 2010)

Redfield et al. 2008, ApJ, 673, 87

Flare observation of HD 189733 with UVES/ESO

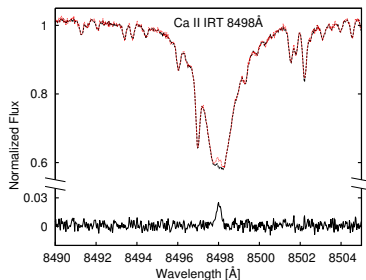
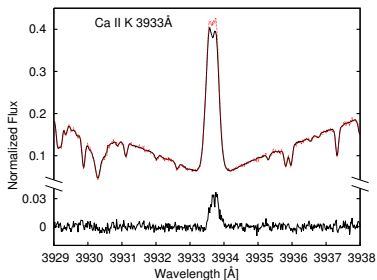
- ▶ UVES - high-resolution optical spectrograph, $R \sim 60,000$
- ▶ 4 hours of observation
- ▶ 244 spectra covering one exoplanetary transit
- ▶ temporal resolution of 1 min
- ▶ spectral coverage: 370-950 nm

HD 189733 during a flare

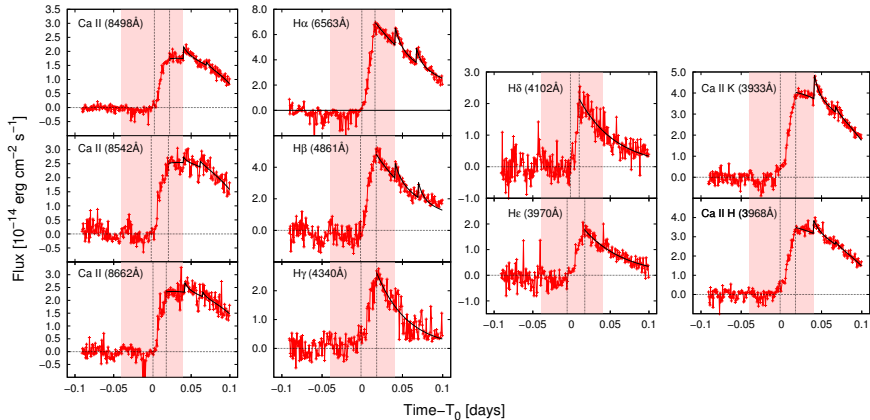
Studied lines

- ▶ Ca II K & H, IR triplet (3933.7, 3968.5, 8498, 8542 and 8662 Å); Balmer lines; Na I D1 and D2 lines (5896, 5890 Å)

Quiescent phase vs. Active phase



Evolution of a flare in cores of studied lines

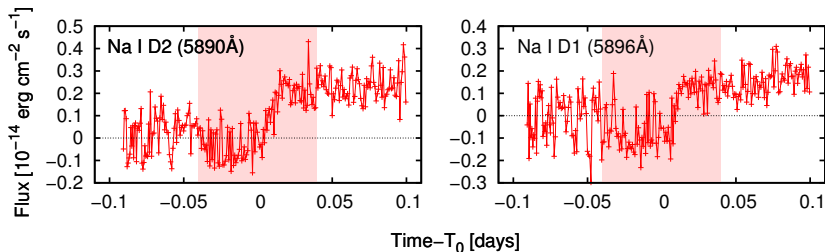


Characteristics of the flare

- ▶ Total energy released in all lines: 9×10^{31} erg
- ▶ Duration: 2 hours
- ▶ Solar flares energy: $10^{29} - 10^{32}$ erg
- ▶ Our flare is comparable to the most energetic flares on the Sun
- ▶ Flares on M type stars - up to 10^{34} erg

Flare in Na I D1 and D2 lines

Evolution of sodium cores during a flare on HD 189733



- ▶ D1 and D2 lines are used for transmission spectroscopy

Conclusion

- ▶ HD 189733 is an extremely active case of an exoplanet host star
- ▶ Active stars - variations in the cores of chromospheric lines
 - ▶ Activity can be confused with additional absorption caused by the exoplanet atmosphere
- ▶ Flares are unpredictable in nature