Na I and Hα absorption features in the transmission spectrum of MASCARA-2b/KELT-20b

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Summary: We used high resolution spectroscopy techniques (R~115 000) with the HARPS-N@TNG observations to analyse the atmosphere of the highly irradiated exoplanet MASCARA-2b/KELT-20b, observing extra-absorptions centered on the Na I doublet and the Hα lines.

During the last 15 years, atmospheric studies using photometry and low-resolution spectroscopy (LRS) observations have lead to a better understanding of exoplanet atmospheres. Recently, high resolution spectroscopy (HRS) has become an additional and potentially very powerful tool to characterize exoplanet atmospheres.

One of the most common methods to study exoplanetary atmospheres is transmission spectroscopy. When a planet transits its host star, the stellar light goes through its atmosphere and part of this incident stellar light is absorbed in the exoplanet atmosphere producing an extra absorption in the stellar spectrum depending on the atmospheric composition.

The Target: MASCARA-2b/KELT-20b

MASCARA-2b/KELT-20b (Talens et al. 2018, Lund et al. 2017) is a highly irradiated hot Jupiter orbiting a fast-rotating (v sin i = 115 km/s) A2-type star (m_V = 7.6, T_eq = 2260 K). The mass and gravity of the planet have not been determined yet, and only upper limits are known: M_p <3.5 M_J and g <3.46 cgs

We clearly observe the RM effect in the stellar lines, with consistent absorption depth in the TLC. Since KELT-20b is a highly irradiated planet, we expect Hα absorption in its atmosphere.

We adjust isothermic temperature profiles to the features, as presented in Lecavelier des Etangs et al. (2008).

Transmission spectra (TS)

Transmission light curves (TLC)

Emission features corrected with fiber B

Differential spectroscopy

Transmission spectra corrected for CLV

Absorption features corrected using telluric standard

TS around Na I (top) and Hα (bottom). The red line shows the best fit Gaussian profile. The black dots are bins of 10 pixels (for Na I) and 30 pixels (for Hα).

RESULTS

Transmission spectra (TS)

Transmission light curves (TLC)

When the planet is not transiting

During the transit

Absorption depth [%]

Passband Specie TS TLC

0.75 Å Na I 0.100 ± 0.005 0.145 ± 0.007

0.5 Å Hα 0.150 ± 0.005 0.145 ± 0.007

Consistent TS and TLC measurements

CONCLUSIONS

We observe Na I and Hα absorption features in the TS, with consistent absorption depth in the TLC.

Since KELT-20b is a highly irradiated planet, we expect Hα absorption in its atmosphere.

We clearly observe the RM effect in the stellar lines, reflected in the TLC.

The cores need higher temperatures than equilibrium to explain the lines contrast.

REFERENCES

References

Lecavelier des Etangs et al. (2008).

Maurice, E. et al. (2015).


Lund et al., 2017, AJ, 154, 194


References

During the transit, different regions of the stellar disk, which present different rotation radial velocities, are occulted by the planet.

Effects on the stellar lines profile

CLV: variation of the stellar lines profile from the center to the edge of the stellar disk.

RM: during the transit, different regions of the stellar disk, which present different rotation radial velocities, are occulted by the planet.

Temperature profiles

We adjust isothermic temperature profiles to the features, as presented in Lecavelier des Etangs et al. (2008).