EPSC Abstracts
Vol. 13, EPSC-DPS2019-2058, 2019
EPSC-DPS Joint Meeting 2019

EPSC
EPSC-DPS Joint Meeting 2019
15–20 September 2019 | Geneva, Switzerland

The potassium absorption on HD189733b and HD209458b

Engin Keles, Matthias Mallonn, Carolina von Essen, Thorsten A. Carroll, Xanthippi Alexoudi, Lorenzo Pino, Ilya Ilyin, Katja Poppenhäger, Daniel Kitzmann, Valerio Nascimbeni, Jake D. Turner, Klaus G. Strassmeier

Leibniz-Institut für Astrophysik Potsdam (AIP), An der Sternwarte 16, 14482 Potsdam, Germany Stellar
Astrophysics Centre, Dep. of Physics and Astronomy, Aarhus University, Ny Munkegade 120, 8000 Aarhus C, Denmark
Leiden Observatory, Leiden University, Postbus 9513, 2300 RA Leiden, The Netherlands
University of Bern, Center for Space and Habitability, Gesellschaftsstrasse 6, CH-3012, Bern, Switzerland
Istituto Nazionale di Astrofisica, Osservatorio Astronomico di Padova, 35122 Padova, Italy
Dipartimento di Fisica e Astronomia - Universta di Padova, Vicolo dell Osservatorio 3, I-35122 Padova
Cornell University, Ithaca, New York, USA
University of Virginia, Charlottesville, Virginia, USA

Abstract

In this work, we investigate the potassium excess absorption around 7699A of the exoplanets HD189733b and HD209458b. For this purpose, we used high spectral resolution transit observations acquired with the 2 x 8.4m Large Binocular Telescope (LBT) and the Potsdam Echelle Polarimetric and Spectroscopic Instrument (PEPSI). For a bandwidth of 0.8A, we present a detection > 7-σ with an absorption level of 0.18% for HD189733b. Applying the same analysis to HD209458b, we can set 3-σ upper limit of 0.09%, even though we do not detect a K- excess absorption. The investigation suggests that the K- feature is less present in the atmosphere of HD209458b than in the one of HD189733b. This comparison confirms previous claims that the atmospheres of these two planets must have fundamentally different properties.

1. Introduction

For hot Jupiter atmospheres with T∼ 1500K, the strongest atomic absorber in the optical wavelengths are Na and K (Fortney et al. 2010). Different investigations on HD189733b and HD209458b have confirmed the presence of Na using low- and high resolution spectroscopy (see e.g. for HD209458b Charbonneau et al. (2002) and Snellen et al. (2008) or for HD189733b Redfield et al. (2008) and Wyttenbach et al. (2015)). However, the detection of K was not yet assured from high resolution investigations for any exoplanet, although attempts were made e.g. recently by Gibson et al. (2019) investigating K on the exoplanet Wasp-31b. Several investigations attempted to detect K on HD189733b and HD209458b. For instance, Jensen et al. (2011) used the Hobby-Eberly-Telescope and stated a non-detection of K for both exoplanets. A tentative 2.5-σ detection of K in the at- mosphere of HD189733b was claimed by Pont et al. (2013) using the ACS camera at the Hubble Space Telescope. To date, there is no significant detection of K for these two exoplanets, neither in low- nor in high- resolution observations. In this work, we show the first high resolution K- detection in an exoplanet atmosphere.

2. Observations

We observed one transit for HD189733b on October 11, 2017 at 01:47 – 06:39 UT (PI: J.D. Turner, UVA) and one transit for HD209458b on October 13, 2017 at 03:03 – 08:04 UT (PI: K.G. Strassmeier, AIP) using the PEPSI instrument (Strassmeier et al. 2015, 2018b) with a 3.2– pixel resolution of 130 000 at the LBT. The spectograph is a white–pupil fiber–fed spectograph located in a pressure-controlled chamber at a constant pressure, temperature and humidity to ensure constant refractive index of the air inside, providing radial velocity stability about 5 m/s on the long term and less than 0.5 m/s on the short term (Strassmeier et al. 2018).

3. Figures

K- excess absorption for HD189733b (left) & HD209458b (right). Shown are absorption curves at 0.8A bandwidth using reference bands (top) & no reference bands (middle). Bottom panel shows the excess level for other bandwidths. Green line shows the CLV-curve & the blue line the planet absorption.

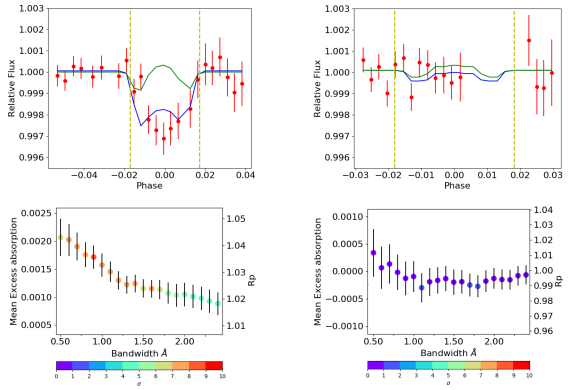

Figure 1: Potassium excess absorption for HD189733b (left) and HD209458b (right)

4. Summary and Conclusions

The excess absorption levels for HD189733b are 0.181 % ± 0.022 % (top) and 0.184 % ± 0.025 % (middle), thus similar within their error bars. This absorption value corresponds to ~13 scale heights, hinting that the absorption must originate at high altitudes in the atmosphere. The left bottom panel shows the mean absorption for different bandwidths (using no reference bands) and the significance level. By increasing the bandwidth more than 0.8A, the absorption level decreases, as expected, due to the integration of less atmospheric K absorption relative to the continuum flux. Also shown on the right y-scale is the apparent planetary radius i.e. the radius until which the atmosphere is opaque in units of the white light radius. The significance level of the K-detection for the 0.8A bandwidth is determined with > 7-σ with respect to the zero level. For the remaining other bandwidths, the determined excess absorption levels are also above 3-σ with respect to the zero level. In contrast to the HD189733b observation, there is no excess absorption evident in the atmosphere of HD209458b at the investigated bandwidths. Moreover, the result suggests an emission like behaviour at low bandwidths. Assuming zero excess absorption to not underestimate the error (as a negative excess level would suggest emission either than absorption), we determine a 3-σ upper limit of around 0.084% at a bandwidth of 0.8A.

Concluding, in comparison to HD189733b, HD209458b shows no significant absorption of potassium in its atmosphere

References

Charbonneau D., Brown T. M., Noyes R. W., Gilliland R. L., 2002, ApJ, 568, 377

Fortney J. J., Shabram M., Showman A. P., Lian Y., Freedman R. S., Marley M. S., Lewis N. K., 2010, ApJ, 709, 1396

Gibson N. P., de Mooij E. J. W., Evans T. M., Merritt S., Nikolov N., Sing D. K., Watson C., 2019, MNRAS, 482, 606

Jensen A. G., Redfield S., Endl M., Cochran W. D., Koesterke L., Barman T. S., 2011, ApJ, 743, 203

Pont F., Sing D. K., Gibson N. P., Aigrain S., Henry G., Husnoo N., 2013, MNRAS, 432, 2917

Redfield S., Endl M., Cochran W. D., Koesterke L., 2008, ApJ, 673, L87

Snellen I. A. G., Albrecht S., de Mooij E. J. W., Le Poole R. S., 2008, A&A, 487, 357

Strassmeier K. G., et al., 2015, Astronomische Nachrichten, 336, 324

Strassmeier K. G., Ilyin I., Steffen M., 2018, A&A, 612, A44

Wyttenbach A., Ehrenreich D., Lovis C., Udry S., Pepe F., 2015, A&A, 577, A62