Ground-based transmission spectroscopy of the terrestrial exoplanets GJ 1132b and LHS 1140b

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Abstract

GJ 1132b and LHS 1140b are rocky worlds transiting nearby mid-M dwarf stars. These planets offer an early opportunity for comparative terrestrial planetology, and the investigation begins on the ground. Future telescopes like JWST will deliver high precision, high resolution data, but for now, current instrumentation can test the cases of cloud-free, low mean molecular weight atmospheres on these worlds. We disfavor such an atmosphere on GJ 1132b at >3σ confidence, in agreement with theoretical models. We present preliminary results for LHS 1140b, which, due to its higher surface gravity and cooler temperature, may retain a low mean molecular weight atmosphere.

Data & Analysis

The data sets:
- 5 transits of GJ 1132b with Magellan Clay/LDSS3C
- 1 transit of LHS 1140b with Magellan Clay/LDSS3C and Magellan Baade/IMACS, simultaneously

The analysis: We extract 1D spectra of the target and comparison stars from the raw images. We divide the target spectra by the comparison spectra to achieve a white light curve. We bin the white light curve into 0.02 μm wavelength bands to make a transmission spectrum. In each band we decorrelate the light curve by fitting a linear combination of systematic parameters and a transit model simultaneously.

We run a dynamic nested sampling routine to estimate the transit depths and uncertainties.

GJ 1132b

- 1x solar, μ = 2.36, conf. = 3.09σ
- 1x solar, μ = 5.16, conf. = 3.73σ
- 100x solar, μ = 4.00, conf. = 2.19σ
- linear fit, conf. = 0.79σ
- flat fit, conf. = 0.64σ
- joint fit data (5 nights)

LHS 1140b

- 1x solar, μ = 2.36, conf. = 3.94σ, 2.77σ
- 10x solar, μ = 5.72σ, 1.26σ
- flat fit, conf. = 6.45σ, 2.68σ
- 1 transit (1 night)

Note. In this preliminary transmission spectrum of LHS 1140b we present data from the LDSS3C instrument. In the legend we give the confidence at which we rule out a given model with all of the data points, and also if we exclude the outlier point at 0.73μm.

The LHS 1140b transmission spectrum is preliminary and includes data from only the LDSS3C instrument.

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