# Mass Limits for Several Transiting Planets

D. R. Gadelshin[1], G. G. Valyavin[1] Byeong-Cheol Lee[2],
G. A. Galazutdinov[1,3,4], V. N. Aitov[1], and A. F. Valeev[1]

[1] Special Astrophysical Observatory, Russian Academy of Sciences, Nizhny Arkhyz, Russia,
gdamir-85@mail.ru
[2] Korea Astronomy and Space Science Institute, Daejeon, South Korea
[3] Instituto de Astronomia, Universidad Catolica del Norte, Antofagasta, Chile
[4] Central (Pulkovo) Astronomical Observatory, Russian Academy of Sciences, Saint Petersburg, Russia

**Abstract.** In this work we present the current results of a spectral study of two confirmed transiting exoplanets and one exoplanet candidate: a KOI-974 system candidate confirmed by us, a new TESS candidate in the TOI-1797 system, and also the known hot Jupiter MASCARA-3 b. KOI-974 b is a planet with a size slightly smaller than that of Neptune, orbiting an F-type subgiant with a period of 53.5 days. The candidate TOI-1797.01 also belongs to mini-Neptunes, but orbits arounds a solar-like star with a period of about 3.65 days.

New observations were carried out using the spectrograph of the 1.8-meter telescope of the Bohyeonsan observatory in the Republic of Korea (for KOI-974), and also the fiber-optic high spectral resolution spectrograph of the BTA SAO RAS.

For KOI-974 b a significant improvement in the radial velocity amplitude limit has been achieved in comparison with our first paper on the confirmation: the error bar now amounts to about 40 m/s on average.

For candidate TOI-1797.01 we obtained 4 measurements in total, each at a different orbital phase, but the error bar ranges from 4.7 to 20 m/s, which totally rules out a non-planetary nature of the transiting object.

In the case of MASCARA-3 b we fitted a radial velocity curve along half of the orbital phase. This result will allow us to derive the first estimate of the true mass of an exoplanet made using a SAO RAS instrument.

**Keywords:** techniques: spectroscopic; planets and satellites: individual: KOI-974, TOI-1797, MASCARA-3

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# 1 Introduction

As we were able to show in our previous paper Gadelshin et al. (2017) dedicated to the study of three stars with transiting exoplanet candidates discovered earlier by the Kepler space telescope, these candidates are indeed planets and not objects of stellar nature. To that end, we used high resolution BTA SAO RAS spectra to obtain several radial velocity estimates.

In this work we present the results of our new investigation of transiting exoplanets carried out with the spectrograph mounted on the 1.8-meter telescope of the Bohyeonsan observatory in Korea (Kim et al. 2007) and the fiber-optic high spectral resolution spectrograph at the BTA SAO RAS (Valyavin et al. 2020). In addition to our new study we also continue with the program of the confirmation of the Kepler candidates.

The process of observations and the radial velocity measuring method are described in detail in the poster of T.A. Burlakova et al. presented at the "Ground based astronomy in Russia. XXI century" conference (SAO RAS, September 2020).

# 2 Results

With the beginning of operation of the high resolution fiber-optic spectrograph at BTA SAO RAS in early 2020, we faced the task of testing the new instrument. For this purpose we selected a massive hot Jupiter, MASCARA-3 b, which causes its host star to exhibit radial velocity oscillations with a semi-amplitude greater than 400 m/s, and also several smaller transiting objects orbiting bright stars. The first tests demonstrated a satisfactory result.

## 2.1 MASCARA-3 (KELT-24, HD 93148)

The discovery of MASCARA-3 b was presented in June 2019 by two scientific teams independently of each other (Hjorth et al. 2019; Rodriguez et al. 2019). This hot Jupiter orbits around an F7-type star ($V = 8.3^m$) with a 5.55-day period. The ongoing results of our measurements are shown in Fig.1. Using these data together with the data of other authors will allow us to refine the physical and orbital parameters of the exoplanet.

## 2.2 KOI-974

The mini-Neptune KOI-974 b orbits around a subgiant ($V = 9.6^m$) (Bellinger et al. 2019) with a 53.51-day period. The results of our measurements are shown

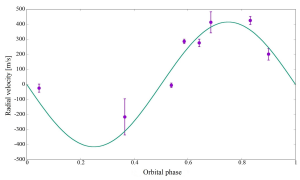


**Fig. 1.** Radial velocity of the star MASCARA-3, phase folded with the orbital period of planet b. The purple circles mark the measurements obtained with the high resolution fiber-optic BTA SAO RAS spectrograph. The model curve constructed in the assumption of a 415 m/s radial velocity semi-amplitude (from Hjorth et al. (2019)) is shown in green.

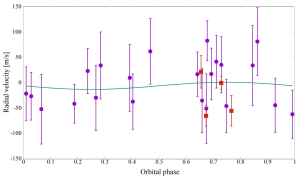


**Fig. 2.** Radial velocity of KOI-974 phase folded with the orbital period of planet b. The purple circles show the measurements carried out with the Bohyeonsan observatory 1.8-meter telescope; the red squares mark those from the fiber-optic high resolution spectrograph at BTA SAO RAS. The model curve plotted in the assumption of a 7 m/s radial velocity semi-amplitude, computed using the least squares method, is shown in green.

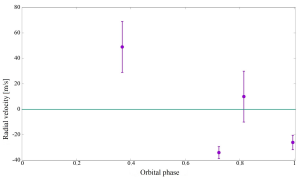


**Fig. 3.** Radial velocity of TOI-1797 phase folded with the orbital period of candidate 01. The purple circles show the measurements obtained with the high resolution fiber-optic spectrograph of the BTA SAO RAS.

in Fig. 2. These data proved to be sufficient for estimating the exoplanet mass upper limit: less than 0.16 of the mass of Jupiter.

### 2.3 TOI-1797 (HD 93963)

The planetary candidate TOI-1797.01 orbits a G-type star (V = $9.2^m$) with a period of 3.65 days and has the size of a mini-Neptune. Due to the small number of radial velocity measurements (Fig. 3) available to date, we are unable to restrict significantly the mass of the candidate. However, we believe that the 4 available measurements with error bars ranging from 4.7 to 20 m/s are sufficient to make a conclusion about the planetary nature of the candidate.

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