Origins: From the Protosun to the First Steps of Life
Proceedings IAU Symposium No. 345, 2018
B. G. Elmegreen, L. Viktor Tóth & M. Güdel, eds.

doi:10.1017/S1743921318008293

Analysis of KOI 2700b, the second exoplanet with a comet-like dusty tail – selected results

Zoltán Garai[1] **and Peter Dolinský**[2]

[1]Astronomical Institute, Slovak Academy of Sciences,
05960 Tatranská Lomnica, Slovak Republic
email: zgarai@ta3.sk

[2]Slovak Central Observatory,
Komárňanská 134, 94701 Hurbanovo, Slovak Republic
email: peter.dolinsky@suh.sk

Abstract. The *Kepler* object KOI 2700b was discovered recently as the second exoplanet with a comet-like dusty tail. We aimed at verifying the disintegrating-planet scenario of KOI 2700b by modeling its light curve and to put constraints on various tail and planet properties, as was done in the case of KIC 12557548b. Here, we describe some selected results of our analysis.

Keywords. planets and satellites: general, techniques: photometric, scattering

---

1. Introduction and Data analysis

The *Kepler* object KOI 2700b (KIC 8639908b) was discovered by Rappaport *et al.* (2014) as the second exoplanet with a comet-like dusty tail. It exhibits a distinctly asymmetric transit profile, likely indicative of the emission of dusty effluents and reminiscent of KIC 12557548b (Kepler 1520b), the first exoplanet with a comet-like dusty tail, discovered by Rappaport *et al.* (2012). We aimed at verifying the disintegrating-planet scenario of KOI 2700b by modeling its light curve and to put constraints on various tail and planet properties, as was done in the case of KIC 12557548b by Budaj (2013).

We used the publicly available *Kepler* data from the quarters 1 – 17 in the form of SAP-fluxes. Only the long cadence data were used to construct the light curve. These are 64 842 observations with an exposure time of about 30 min. *Kepler* observations were reduced in a similar manner to in Budaj (2013). We obtained the phase-folded and binned transit light curve of KOI 2700b, which we iteratively modeled using the radiative-transfer code SHELLSPEC, described in Budaj & Richards (2004). During the modeling we applied selected species (γ-alumina, enstatite, forsterite, olivine with 50% magnesium and 50% iron and pyroxene with 40% magnesium and 60% iron) and dust particle sizes (0.01, 0.1 and 1 micron in radii). Mie absorption and scattering on spherical dust grains with realistic dust opacities, phase functions, and finite radius of the source of the scattered light were taken into account.

2. Selected results and Conclusions

We modeled the comet-like tail as part of a ring around the parent star. The geometrical cross-section of the ring is monotonically enlarging from the planet to the end of the ring. In our calculations we assumed a dust tail with a cross-section of 0.05×0.05 $R_\odot$ at the beginning and 0.09×0.09 $R_\odot$ at its end. Since there is still ample room for a contribution to the light curve from the solid body of the planet, we also included it in the model, defined as a dark, non-transparent sphere and located at the beginning of the ring. Our

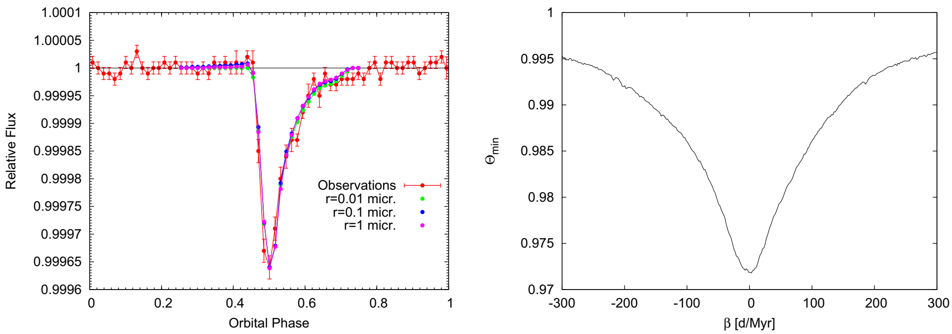

Figure 1. Model light curves calculated for 0.01-micron, 0.1-micron, and 1-micron grains of γ-alumina (left), and search for a long-term orbital period change of KOI 2700b (right).

average fitted value for the dimension of the planet is $R_{\mathrm{p}}/R_{\mathrm{s}} = 0.008$ ($R_{\mathrm{p}} = 0.497\ \mathrm{R}_{\oplus}$, or 3172 km). Since the modified ring model of the tail satisfies the observations well, we confirm the disintegrating-planet scenario of KOI 2700b (Fig. 1).

Furthermore, we derived some interesting features of KOI 2700b and its comet-like tail. As an example, we describe search for a long-term orbital period change of KOI 2700b. Perez-Becker & Chiang (2013) suggest that disintegrating planets undergo negligible orbital period variations due to the evaporation process. During this step we examined this prediction via searching for possible long-term changes of the orbital period of KOI 2700b. For this purpose we used the method of phase dispersion minimization, as per Stellingwerf (1978), application PDM2, version 4.13†, which uses bin structure 50/2. The detrended data were used for this purpose, see Budaj (2013). We assumed that the period changes linearly:

$$P = P_0 + \beta t, \tag{2.1}$$

where β is a dimensionless value, but is often expressed in days/million years (d/Myr). The output from the analysis is a curve (Fig. 1), which shows the dependence of Θ_{min} as a function of β. The term Θ_{min} is a dimensionless statistical parameter, see Stellingwerf (1978). The minimum value of Θ_{min} indicates the speed of the period change – β. We fitted a parabola to this curve and obtained $\beta = 1.3 \pm 3.2$ d/Myr, which means that there is no significant evidence for the long-term orbital period change during the time span of the *Kepler* observations. This result is in agreement with the prediction, presented by Perez-Becker & Chiang (2013). The error was estimated by means of Monte Carlo simulations. We generated and analyzed 100 artificial datasets with the same standard deviation as the original data. For more details and results see Garai (2018).

References

Budaj, J. 2013, *A&A*, 557, 72
Budaj, J., & Richards, M. T. 2004, *Contributions Astron. Obs. Skalnate Pleso*, 34, 167
Garai, Z. 2018, *A&A*, 611, 63
Perez-Becker, D., & Chiang, E. 2013, *MNRAS*, 433, 2294
Rappaport, S., Levine, A., Chiang E., *et al.* 2012, *ApJ*, 752, 1
Rappaport, S., Barclay, T., DeVore, J., *et al.* 2014, *ApJ*, 784, 40
Stellingwerf, R. F. 1978, *ApJ*, 224, 953

† Actual version of the software package is available at `http://www.stellingwerf.com`.

https://doi.org/10.1017/S1743921318008293 Published online by Cambridge University Press