Modelling the light-curve of KIC 12557548b : an extrasolar planet with a comet like tail

Jan Budaj

An object with a very peculiar light-curve was discovered recently using Kepler data. Authors argue that this object may be a transiting disintegrating planet with a comet like dusty tail. Light-curves of some eclipsing binaries may have features analogous to this light-curve and it is very interesting to see whether they are also caused by the same effects and put them in a more general context. The aim of the present paper is to verify the model suggested by the discoverers by the light-curve modelling and put constraints on the geometry of the dust region and various dust properties. We modify the code SHELLSPEC designed for modelling of the interacting binaries to calculate the light-curves of stars with such planets. We take into account the Mie absorption and scattering on spherical dust grains of various sizes assuming realistic dust opacities and phase functions and finite radius of the source of the scattered light. The planet light-curve is reanalysed using long and short cadence Kepler observations from the first 14 quarters. Orbital period of the planet was improved. We prove that the peculiar light-curve of this objects is in agreement with the idea of a planet with a comet like tail. Light-curve has a prominent pre-transit brightening and a less prominent post-transit brightening. Both are caused by the forward scattering and are a strong function of the particle size. This feature enabled us to estimate a typical particle size (radius) in the dust tail of about 0.1-1 micron. However, there is an indication that the particle size changes along the tail. Larger particles better reproduce the pre-transit brightening and transit core while smaller particles are more compatible with the egress and post-transit brightening. Dust density in the tail is a steep decreasing function of the distance from the planet which indicates a significant tail destruction caused by the star. We also argue that the ’planet’ does not show uniform behaviour but may have at least two constituents. This light-curve with pre-transit brightening is analogous to the light-curve of ϵ Aur with mid-eclipse brightening and forward scattering plays a significant role in such eclipsing systems.