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Light-curve analysis of KIC 12557548b: an extrasolar planet with a comet-like tail

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Abstract. We will demonstrate how amateur observations with small telescopes of ϵ Aur (a bright eclipsing binary with the longest known orbital period) help to understand the nature of this object and how the understanding of physical processes in this object helps to understand superb Kepler observations of KIC 12557548b (an extremely short-period transiting exoplanet with a comet-like tail).

We modified the code SHELLSPEC, which is designed for modelling interacting binary stars to calculate the light curves of such planets. Mie absorption and scattering on spherical dust grains with realistic dust opacities, phase functions, and a finite radius of the source of the scattered light are taken into account.

We prove that the peculiar light curve of this exoplanet agrees with the idea of a planet with a comet-like tail. The 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 μm. However, there is an indication that the particle size changes (decreases) along the tail. The 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-planet interaction. Several possible combinations of other dust properties are tabulated. We reveal interesting periodic long-term evolution of the tail on a time scale of about 1.3 years and also argue that the 'planet' does not show a uniform behaviour, but may have at least two constituents. This exoplanet's tail evolution may find an analogy in the comet tail disconnection events caused by the magnetic/coronal activity of the Sun while the light curve with pre-transit brightening is analogous to the light curve of ϵ Aur and AZ Cas with mid-eclipse brightening and forward scattering playing a significant role in such eclipsing systems.