Gas dynamic simulation of the star-planet interaction using a binary star model

Ionov D. E., Bisikalo D.V., Kaygorodov P. V., Shematovich V. I.

Institute of Astronomy of the Russian Academy of Sciences

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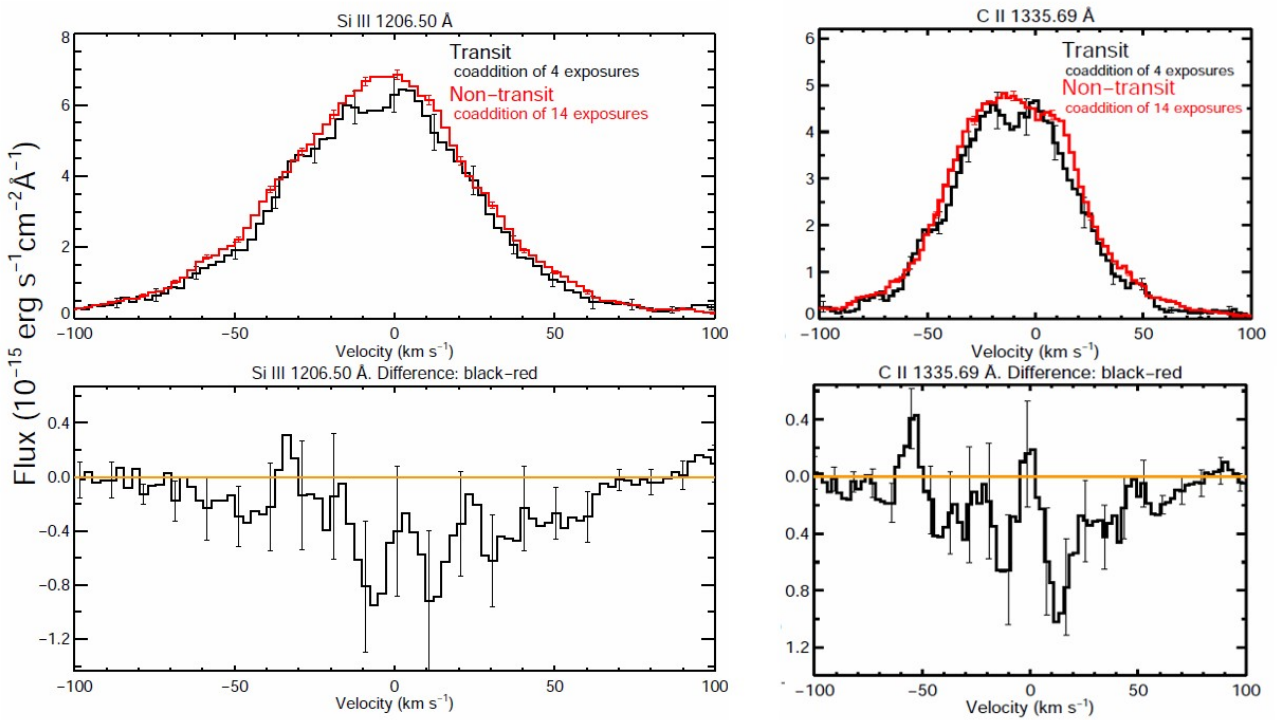
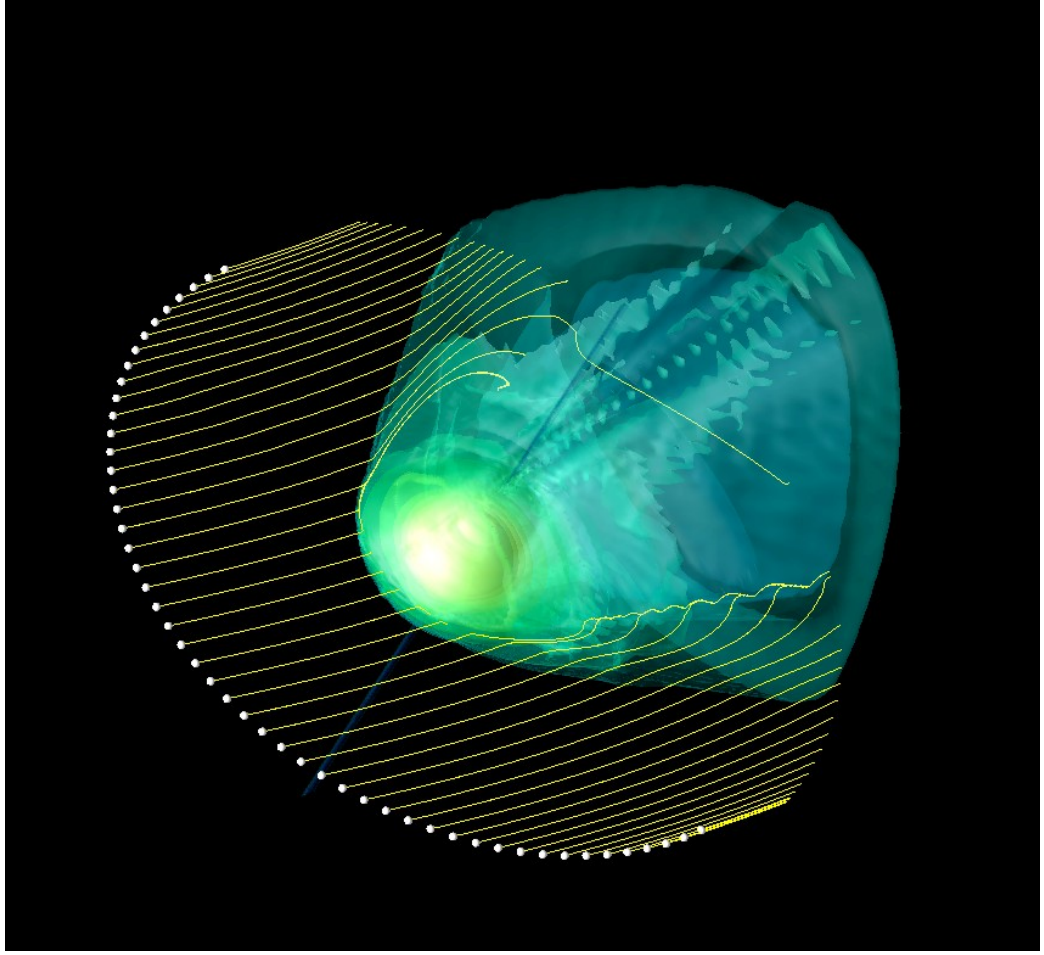
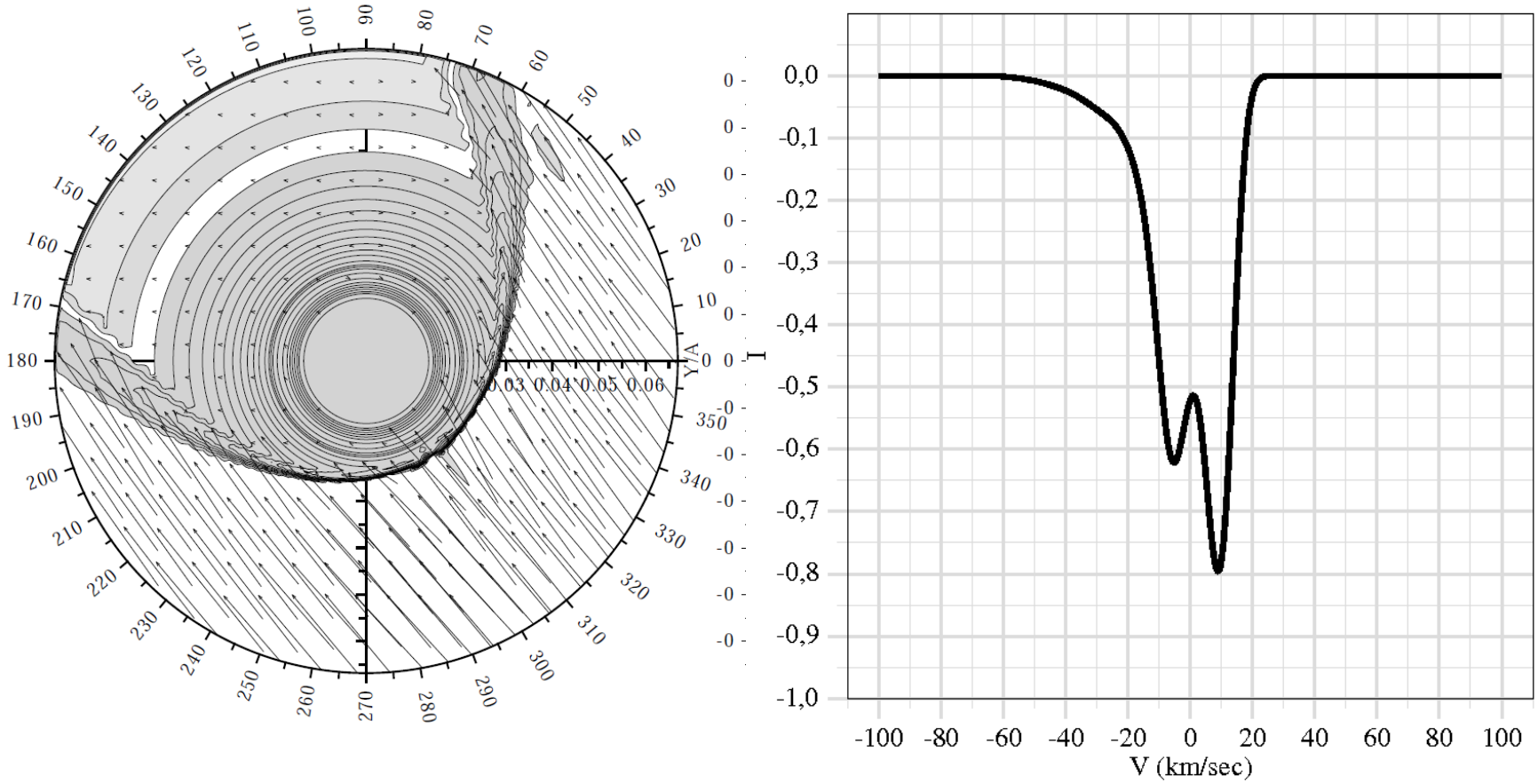
Transit planet HD 209458b



The observation of a "hot Jupiter" planet HD 209458b were carried out using the COS spectrograph mounted aboard HST (Linsky et al.,2010). The results showed that the investigated spectral absorption lines (of CII, Si III) obtained as the difference of the stellar spectra in the transition and out of it have a non-trivial double-peaked shape. The distance between the peaks is about 20 km/s and for the carbon line it is clearly seen that the peaks are asymmetric.



If a gravitating body or a body with an atmosphere moves with a supersonic velocity a bow-shock must occur. The matter of the stellar wind mixes with the matter of the atmosphere and forms two streams moving in different directions from the head-on collision point. This motion can lead to occurrence of two peaks in observed spectral lines. A shape of the spectral line is determined by projections of the velocities of matter behind the bow shock wave onto the line of sight.



The density distribution and velocity vectors in equatorial plane (left panel) and synthetic absorption line profile (right panel) are shown. It is seen that the line has two distinguishable clearly asymmetric peaks. The synthetic line profile has the same features as the observed one.

The presented model allows us to conclude that when analyzing observational properties of the atmosphere of a planet one must take into account gas dynamical processes caused by the interaction of the atmosphere and stellar wind.