GC2024-STP076

The structure of Hat-P-32b upper atmosphere and transit absorptions in metastable helium line

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The atmospheres of hot exoplanets undergo intense mass loss being exposed to extreme flux of ionizing radiation of the host stars. The processes of evaporation of primary atmospheres have been observed in Lyα line transit absorption for a number of exoplanets [1-3]. However, the information obtained by space telescopes from Lyα spectroscopy is limited due extinction in interstellar medium and geocoronal contamination. Thus, transit observations in other lines are needed to explore physical processes in exoplanetary atmospheres. The metastable helium HeI(2^3S) line at 10830 Å offers an alternative way to probe the evaporating exoplanetary atmospheres [4]. Since the first observation in 2018, for more than a dozen exoplanets positive detections have been made by ground telescopes [5].

One of the interesting targets related to HeI(2^3S) is the highly inflated atmosphere of Hat-P-32b. Hat-P-32b is an exoplanet transiting the moderately bright F/G star which is known to be very active [6]. The planet is quite fluffy with the mass of 0.73 Mj at radius of 1.79 Rj. Infrared observations in helium and Hα hydrogen lines [7] revealed intense escape of planetary material, possibly forming broad downstream and upstream outflows [8].

This work sheds light on the processes populating the HeI metastable level and spatial structure of absorption by upper atmosphere of Hat-P-32b. We use 3D global hydrodynamic multi-fluid model [9] which takes into account the plasma-photochemistry to reproduce the transit absorptions in 10830 A line and to obtain the best fit to the observational data available for Hat-P-32b. We found out that in spite of the absorption is located mainly at heights $0.1<r<1$ Rp it can reflects the streams of planetary outflow beyond the Roche lobe.

This work was supported by the RNF project № 23-12-00134.

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