Studies of atmospheric structure in new very-hot Jupiter with high-resolution transmission spectroscopy

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In the last decade, the understanding of exoplanetary atmospheres has advanced considerably through spectroscopic observations during planetary transit events, known as transmission spectroscopy.

Transmission spectroscopy done by Charbonneau et al. (2002) using Hubble Space Telescope first detected Na in the atmosphere of the hot Jupiter HD209458b. Currently, alkali metals have been detected in some hot Jupiter atmospheres. (e.g. Sing et al. 2012) Alkali metal lines are one of the most important key opacity sources because the Na I and K I resonance doublets are thought to be the cause of the generally low albedos, as the alkali metal's wide line wings absorb almost all of the incoming stellar irradiation.

Especially, high-resolution transmission spectroscopy of Na absorption lines can investigate temperature of a thermosphere where temperature is increased by stellar X-ray and EUV irradiation and the atmospheric escape is caused because the depth of Na absorption lines is deep and comparable to that of Hα absorption line which is formed in upper atmosphere (Huang et al. 2017).

We performed high-resolution transmission spectroscopy for WASP-76 with Subaru HDS. For WASP-76b, we detected strong Na D absorption lines and measured an average absorption depth of 0.427 ±0.018% for a 3.0 Åpassband. We derived the temperatures of the upper atmosphere as about 3700 K (Na D1) and 4000 K (Na D2) on the assumption of an atomic layer where an atomic hydrogen is dominated. As the equilibrium temperature is about 2160K, these results suggest the existence of a thermosphere.

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