Constraining Atmospheric Evaporation Rate From Gas Giants by Simultaneous Modelling of Lyman-α, Hα and Helium Transit Spectra

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Evaporation of atmospheres from giant planets is well observed in various spectral lines, for example in Ly-alpha, H-alpha and helium lines. This atmospheric evaporation is driven by X-ray and Ultraviolet (XUV) radiation from the host star but total evaporation rate does not solely depend on XUV radiation. The complex photochemistry of the atmosphere also play a significant role on the evaporation rate. We model the atmospheric evaporation by considering a hydrogen-helium atmosphere using a self-consistent radiation-driven atmospheric escape model. We include the self-consistent hydrogen-helium photochemistry in the atmosphere. After successfully modelling the evaporating atmosphere, we compute synthetic Ly-alpha, H-alpha and helium spectra. We compare our synthetic transit spectra with the observed Ly-alpha, H-alpha and helium spectra simultaneously for gas giants (e.g., HD189733b) to constrain some uncertain parameters and put a stringent constraint on the evaporation rate. As the initial fractional composition of hydrogen and helium in the atmosphere and the incident stellar XUV radiation remain sources of uncertainty, we first estimate those values by comparing our synthetic transit spectra with observed ones and then compute the evaporation rate. Our findings will be discussed in detail.