

On the origin of hydrogen around HD 209458b

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Lecavelier des Etangs et al.¹ object to the conclusion by Holmström et al.² that radiation pressure alone cannot explain the Lyman- α absorption observed³ during transits of HD 209458b. We agree that hydrogen atoms can be accelerated to large velocities by radiation pressure. However, with our model we cannot reproduce the observed spectrum, as shown in the Supplementary Information², Fig. 3.

To support the hypothesis that radiation pressure alone can explain the observation, Lecavelier des Etangs et al. show a modeled spectrum that fit well with the observed spectrum¹. Thus, there is a difference between the two models, and we encourage Lecavelier des Etangs et al. to publish a full description of their model so that this discrepancy can be resolved.

Also, Lecavelier des Etangs et al.¹ state that the energetic neutral atom (ENA) model needs a significant escape from the planet's atmosphere. This is incorrect, since the only requirement for ENA production is that a sufficient number of hydrogen atoms are available for charge exchange with the stellar wind. This does not put any strong constraints on the escape of the planet's atmosphere. ENA production will occur independent of a large or small thermal escape rate, but the focus of Holmström et al.² was not to study the escape rate in detail.

Finally, Lecavelier des Etangs et al.¹ thinks that the stellar wind conditions derived from the model of Holmström et al.² are extraordinary. We agree that a stellar wind velocity of 50 km/s is low compared to the solar wind. This might be an effect of

the simplified stellar wind flow model that we used (constant stellar wind outside an obstacle). A more detailed model that includes the stellar wind flow around the obstacle might change the estimation of the stellar wind velocity. This is a topic of future investigations.

1. Lecavelier des Etangs, A., Vidal-Madjar, A., & Desert, J.-M., The origin of hydrogen around HD209458b. *Nature*, this issue.
2. Holmström, M., Ekenbäck, A., Selsis, F., Penz, T., Lammer, H., & Wurz, P., Energetic neutral atoms as the explanation for the high velocity hydrogen around HD 209458b. *Nature* **451**, 970–972 (2008).
3. Vidal-Madjar, A. *et al.* An extended upper atmosphere around the extrasolar planet HD209458b. *Nature* **422**, 143–146 (2003)