Improvements and developments in chemical modelling of exoplanet atmospheres

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The future JWST (2020) and ARIEL (2028) will highly improve our current knowledge on exoplanets. To interpret their observations, atmospheric models are necessary. On one hand, 1D models are able to describe the detailed atmospheric chemical composition of exoplanets, thanks to complex chemical schemes involving hundreds of compounds linked by thousands of reactions (i.e. Venot+ 2012; Moses+ 2011; Rimmer+ 2016). However, one limitation of these models concerns the description of the gas circulation, represented by the vertical Eddy diffusion. On the other hand, 3D models describe the global circulation of the gas with a very good precision, but the chemical composition can not be calculated by these models. The reason for that is the too important computational time that would required a such complete 3D model. However, developing such innovative 3D models is the key to fully understand the chemical composition of exoplanet atmospheres, which is the indispensable step to improve our knowledge of planetary formation. For this purpose, we are currently developing a reduced chemical scheme in order to couple a 3D circulation model with an accurate chemical kinetics.

Another improvement necessary for the modelling of warm exoplanet atmospheres concerns the molecular data used, in particular the VUV absorption cross sections, that describe the amount of light absorbs by species and permit to calculate their photodissociation rates. However, very few molecules have been studied at high temperature relevant for exoplanet atmospheres. To address this lack, we built an innovative project that aims at measuring the VUV absorption cross sections of the most important absorbing species of exoplanet atmospheres. We already measured the VUV absorption cross section of CO2 up to 800K (Venot+ 2013, 2018).

We will present these two improvements that are important for exoplanetary modelling.

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