The spectral history of exoplanet atmospheres due to extreme escape

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The evolution of stars on grand time-scales affect their surroundings in many ways. Due to their intrinsic rotation, causing strong magnetic activity, they vary greatly in radiative activity in X-ray and ultraviolet (XUV) throughout their lifetime. Planets orbiting these stars close-in could, consequently, be affected by these drastic radiative changes. Close-in exoplanet atmospheres heat up due to XUV radiation from the host-star, resulting in bulk motion of light particles. This extreme flow of light particles escaping the atmosphere is also known as hydrodynamic escape. In this work we look at how extreme hydrodynamic escape affects the metallicity of planetary atmospheres in a large population study. By coupling thermal evolution codes to radiative and chemical kinetics codes, we show that CO2 and SO2 features can be found in the transmission spectrum of exoplanet atmospheres as consequence of millions to billions of years of extreme hydrodynamic escape. With the successful launch of the James Webb Space Telescope we are now able to look ever so closely at hydrodynamical escape processes and its effect on exoplanet atmospheres. Recent observations on WASP 39b have shown prominent CO2 features in the transmission spectra (Ahrer et al. 2022), hinting that the planet underwent metallicity enhancement at some point throughout its lifetime. Using our models we are now able to connect such features to escape models and describe the evolving history of exoplanets.