Abstract

Sulphur chemistry in exoplanetary atmosphere: a concrete example of the impact of SO_2

Sulphur and more precisely sulfur dioxide (SO_2) is a compound currently observed in the atmospheres of the solar system (e.g Venus and Io (Ballester at al 1994)) but also beyond. This molecule has indeed been detected thanks to the JWST first observations in very diverse type of exoplanets: in the hot Jupiter WASP-39b (Tsai et al 2023), and potentially in two temperate sub-Neptunes TOI-270d (Benneke et al 2024) and WASP-107b (Dyrek et al 2023). Moreover, future JWST atmospheric characterization will probably reveal more sulfur species in other exoplanets to extend this non-exhaustive list. However, despite the recurrence of sulfur species in the atmospheres of planetary systems, the atmospheric chemistry of such mixture has never been really explored experimentally (He al 2020). In this work, we try to investigate the influence of SO_2 on a N_2-CH_4 mixture which is known to generate easily a big diversity of organic molecules up to C-4. Thus, how the presence of sulfur will affect this complex N_2-CH_4 organic chemistry?

To address this question plasma experiments, which are used to simulate the photochemistry in high atmosphere of exoplanets, were performed on different $N_2/CH_4/SO_2$ mixtures with various SO_2 amount from 10% to 0.1%. The resulting gaseous species were analyzed by mass spectrometry. Moreover, the solid matter formed was studied first by elementary analysis to estimate its chemical composition and then by Infrared spectroscopy to reveal the main vibration modes of its constitutive bonds.