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Characterization of continuous vacuum ultraviolet lamps - Implication on the study of methane photolysis at Lyman alpha (121.6 nm)

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Low-temperature hydrogen plasmas are widely used as continuous vacuum ultraviolet irradiation sources in photochemical studies and, in particular, in laboratory simulations of planetary atmospheres. One of the most challenging objectives of such experiments is to retrieve accurate quantitative laboratory data allowing a reliable comparison with theoretical and/or observational ones. This task can only be achieved when the irradiation source delivers a well characterised radiation in terms of flux and wavelength dependency.
As an example, we will present a study, developed in the frame of a program dedicated to simulations of Titan's atmosphere, on methane photolysis at Lyman alpha (121.6 nm). CH4 irradiations have been performed by a microwave discharge lamp using a He/H2 mixture (98/2). The determination of the chemical mechanism involved requires the comparison with a dedicated 0D kinetic model in which photolysis rates are fundamental parameters. Their values depend on the emission spectrum of the source. In our experiments, we used CO2 as an actinometer to determine the absolute value of the photon flux. Unfortunately, the measurement of the VUV emission spectrum of our lamp has shown that it was not monochromatic at 121.6 nn, and that molecular H2 emissions around 160 nm widely influence the result. We will emphasize on the implications of this fact for our study of the methane photolysis at Lyman alpha.
We are now aware that trustworthy experimental studies using Lyman alpha radiation require the use of optimized source, in terms of energy flux and monochromaticity. According to our recent study, this objective is reached when Ar is added to the He/H2 microwave plasma source. These new results will also be presented.