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Simulating exoplanetary atmospheres in the laboratory: comparing experimental data with output from an atmospheric model

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Since the discovery of the first exoplanet, several thousand have been found, including some Earth-like planets. A new generation of space telescopes (e.g., James Webb Space Telescope and Transiting Exoplanet Survey Satellite) are now taking the search for potential extra-terrestrial life one step further. With these new missions, direct imaging of exoplanets and spectral resolution of reflected or transmitted light through their atmospheres becomes scientifically feasible. The possibility of detecting biosignatures indicative for life on other habitable planets allows the search for extra-terrestrial life to go beyond our Solar System.
The correct interpretation of future exoplanetary spectra relies strongly on the understanding of atmospheric processes and possible chemical pathways. Given the large variety of exoplanets there is a pending need for theoretical and experimental atmospheric and astrochemistry studies.
With our new Planetary Simulation Chamber (PSC) at Freie Universitaet Berlin, we are capable of simulating a large set of atmospheric parameters, including pressure, temperature and various gas compositions characteristic for Earth-like planets. Triggering complex photochemical processes in the gas phase, the sample is exposed to solar radiation, including Lyman alpha, UV/VIS and particle radiation.
Most telescopes operate in the VIS/NIR range that corresponds to the fingerprint regions of interesting organic molecules. Our facility allows continuous spectroscopic monitoring of samples in the VUV, UV/VIS and NIR region and simultaneous mass spectroscopic analysis.
In collaboration with our partners at the DLR institute for planetary research, we compare experimental results from our chamber with output from their climate-chemistry model 1D-TERRA.
We expect to provide valuable insights in understanding complex chemical pathways in various, exotic atmospheres, which not only improve current atmospheric models but aid in the definition of a set of reliable and detectable biomarkers in exoplanet atmospheres.
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