LABORATORY INFRARED SPECTROSCOPY OF SMALL ASTROPHYSICALLY RELEVANT MOLECULES

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A large number of astrophysically relevant molecules can be clearly identified by characteristic spectra in the mid-infrared range. Among them are important species such as CO_2 or C_3, which cannot be detected in the microwave range due to the lack of a permanent dipole moment. The broad spectral coverage of the MIRI spectrometer aboard JWST allows detection of a large number of molecules in the envelopes of aging stars. Together with observations in the microwave and optical spectral regions, the infrared region provides valuable information about the physical and chemical processes in the gas surrounding these stars. While infrared observations with Earth-based telescopes such as the IRTF on Mauna Kea / Hawaii are limited due to infrared absorption in the Earth's atmosphere, JWST will provide an unrestricted view over the entire spectral range from 5 - 28 μm. The spectral resolution of JWST (R = 2000 - 3000) is sufficient to detect rotational vibrational transitions of small diatomic to triatomic molecules as well as characteristic vibrational bands of larger molecules. A large number of new molecules are expected to be discovered in the infrared spectra of late-type stars, provided their spectral signatures are known from precise laboratory studies.

The laboratory astrophysics group in Kassel is conducting experiments in the 3-12 μm range with quantum cascade lasers and OPO lasers. In combination with electric discharge sources and laser ablation, a variety of molecules such as Si_2C [1], C_3, TiO [2], Al_2O and VO can be produced in cold supersonic jets, which are studied with high resolution infrared spectroscopy. The talk will give a brief insight into the ongoing work.

[1] D. Witsch, V. Lutter, A.A. Breier, K.M.T. Yamada, G.W. Fuchs, J. Gauss, T.F. Giesen, JPC A, 123, 4168 (2019).
[2] D. Witsch, A.A. Breier, E. Döring, K.M.T. Yamada, T.F. Giesen, G.W. Fuchs JMS, 377, 111439 (2021).