MAX PLANCK INSTITUTE
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TECHNOLOGY FROM ERLANGEN EXPLORING THE ATMOSPHERE

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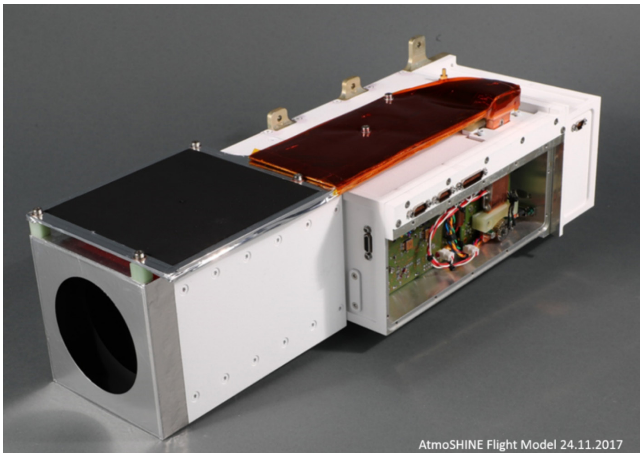
Normally, the optical systems studied in the TDSU 2 laboratory at the Max Planck Institute for the Science of Light (MPL) in Erlangen don't leave the vibration-isolated and vibration-damped optical tables. This time, however, everything is different. On December 22nd of 2018, shortly after midnight Central European Time, a "Long March 11" rocket was launched from China's Jiuquan spaceport to send a satellite into low Earth orbit in order to test a new communications system for global, seamless Internet connectivity. Also on board the satellite was a German remote sensing device, which was developed by researchers of the MPL in cooperation with atmospheric physicists of the University of Wuppertal and Research Center Jülich: AtmoSHINE.

"AtmoSHINE is a spectrometer used to measure high-resolution temperature distributions of the atmosphere in an altitude range of about 90 km", Klaus Mantel from the TDSU 2 of the MPL explains. The temperature distribution is an important indicator of the many dynamic processes taking place in the Earth's atmosphere. The satellite mission serves as "in-orbit verification", which is intended to test the functionality of the instrument under the extreme conditions in space. The global measurement of the temperature distribution from satellites is intended to better characterise so called gravity (or: buoyancy) waves in the atmosphere. These have received increasing attention because they significantly influence climate modelling. "A deeper understanding of gravity waves would allow improving and further developing climate models", says Martin Kaufmann of Research Center Juelich.

The spectrometer, a "spatial heterodyne interferometer", will measure the emission lines of the molecular O2 A-band at a wavelength of approx. 762 nm. The current temperature in the upper atmosphere can then be determined based on the intensity ratios of the individual spectral lines. "The fact that it was possible to create such a powerful device", Klaus Mantel explains, "is due to the excellent cooperation between the various institutes, which contributed their respective strengths". The focus at the MPL was on the technical-optical aspects of the project.



The AtmoSHINE device

The optics used must meet high standards; these must also be ensured from the metrological point of view. It was also necessary to develop adjustment and calibration strategies for the system.

The concept had already been tested under near space conditions within the framework of the REXUS programme in March 2017, whereby the flight of a sounding rocket only allowed for a measurement period of a few minutes. On the other hand, the Chinese technology satellite will be in operation for at least one year. It follows the day-night boundary in a sun-synchronous orbit at an altitude of 1100 km.

A successor device for a significantly extended altitude range of 60–120 km is also under development. According to Friedhelm Olschewski of University of Wuppertal, "a swarm of small satellites, so called CubeSats, equipped with spatial heterodyne interferometers, could be used to obtain tomographic, three-dimensionally resolved temperature fields of the upper atmosphere". These measurements would provide researchers with unique high-quality data. The optical systems from the Erlangen laboratories could thus be a decisive factor in advancing our understanding of nature.

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