

Seminar über Microwavephysics and Atmospheric Physics

Referent: Dr. Mikko Kotiranta, Institute of Applied Physics, University of Bern

Titel: Optical Design of the Submillimeter Wave Instrument on JUICE

The JUpiter ICy moons Explorer (JUICE) is a mission of the European Space Agency (ESA) to study Jupiter and its satellites Ganymede, Callisto and Europa. The launch is scheduled for 2022. The spacecraft will carry 10 instruments on board, one of them being the Submillimeter Wave Instrument (SWI). The SWI is a passive heterodyne radiometer that will observe the atmospheres and surface properties of the Jovian objects in the frequency bands 530–625 GHz and 1080–1275 GHz. This paper reports the design and detailed analysis of the optical system of the SWI instrument. The instrument receives the radiation with a paraboloidal off-axis Cassegrain antenna with an aperture diameter of 29 cm. The telescope is able to scan an angular range of $\pm 72^\circ$ in the spacecraft orbital plane and $\pm 4.3^\circ$ perpendicular to it to allow mapping of the entire surface area of Jupiter. The signal from the hyperbolic secondary mirror of the Cassegrain antenna is guided via planar and elliptical mirrors to a polarizing beam splitter (PBS) that divides the signal into two orthogonal polarizations. The signal transmitted through the PBS is reflected from an elliptical mirror and is then coupled to a smooth-walled spline-profiled feed horn of a double side band (DSB) receiver of the 1200-GHz channel. Similarly, the signal reflected from the PBS undergoes a further reflection at another elliptical mirror after which it is received by a linear-profiled corrugated feed horn of the 600-GHz DSB receiver. The instrument is calibrated by observing a conical blackbody calibration target and cold space that act as the hot and cold temperature references, respectively. In order to allow the receivers to view the hot load, the beam path is redirected by activating a planar flip mirror. A view to the cold load is enabled by rotating the telescope. The telescope is required to provide an antenna pattern with a full width at half maximum of less than 1.3 λ/D , a side lobe suppression of less than -30 dB, and a cross-polarization level of less than -20 dB. We have designed an optical network that is frequency independent in both frequency bands using Gaussian beam mode analysis and simulated the far-field radiation pattern of the telescope with the physical optics (PO) method. In addition to the ideal configuration, we have evaluated the optical performance by including measured surface profiles of prototype mirrors into the simulations. As the optical elements will be exposed to temperatures down to 110 K during the mission, the effect of shape deformation and misalignment provided by thermo-elastic finite element method simulations has been studied as well. Finally, the effect of manufacturing and assembly tolerances on the optical performance has been determined by running several thousand PO simulations: first, each component was misaligned one at a time, then random misalignments were assigned to all of the components in a Monte Carlo fashion.

Zeit: Freitag, 16.03.2018, 10:15 Uhr

Ort: Hörsaal A97, Gebäude exakte Wissenschaften, Sidlerstrasse 5, Bern, Schweiz