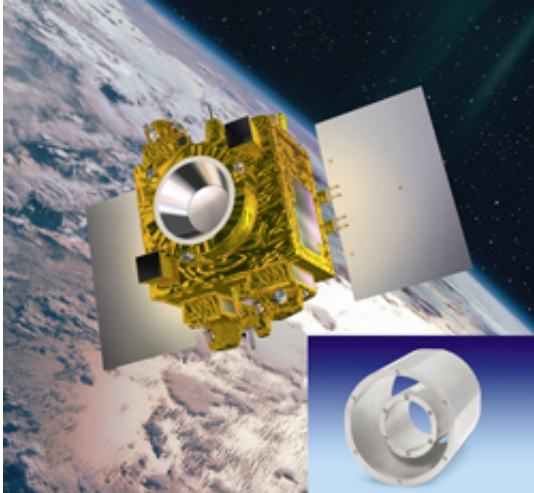


Equivalence principle in space test

May 11 2009



The "Microscope" space project will check the equivalence principle of inert and heavy mass with so far unequalled accuracy. The test masses for the acceleration experiments have (in the case of the external cylinders) a length of 80 mm and an inner diameter of 60 mm. The surface roughness is smaller than 0.2 μm .
(Image: CNES/PTB)

Since Galileo Galilei and Newton, the assumption is valid that inert and heavy mass are equivalent. This is, however, questioned by new physical theories such as the String theory. Now, the equivalence principle is put to test with so far unachieved accuracy within the scope of the "Microscope" space project -- a German-French cooperation. PTB (Physikalisch-Technische Bundesanstalt, Germany) has developed the manufacturing and measuring methods for the test masses.

The test masses are required for the acceleration experiments in a near-Earth orbit.

Space is the ideal place to check the equivalence of inert and heavy mass with an accuracy impossible under terrestrial conditions. This is why in 2013, the French Space Agency CNES (Centre National d'Etudes Spatiales) will bring a micro satellite in a near-Earth orbit and perform acceleration tests on different test masses. Main items of these tests are pairs of concentrically nested metal cylinders which flow in the satellite in equilibrium between the [gravitational force](#) of the Earth (which acts on the heavy mass of the cylinder) and the centrifugal force (which acts on the inert mass). If the satellite is, however, selectively accelerated, the equilibrium of forces is annulled.

The validity of these acceleration experiments decisively depends on the quality of the test masses used. Only if mass, form, density and thermal expansion of the cylinders are known with great accuracy, can the possibly very small differences between inert and heavy mass be observed anyway.

PTB's Scientific Instrumentation Department has now succeeded in optimizing the manufacturing process for the test masses (made of a standard titan alloy and a very special platinum rhodium alloy) in such a way that the deviations in form and dimensions lie in all three space dimensions of the metal cylinders in the range of 1 μm . This precision represents an enormous technical challenge in which the theoretical production limits of the usable manufacturing machines were almost reached. This is why a comprehensive measuring technique had to be integrated into the processing station.

The prototypes manufactured so far were checked by the respective technical laboratories of PTB. They meet the accuracy aimed at and will be used in the Centre of Applied Space Technology and

Microgravitation (ZARM) in Bremen - a coo-peration partner in the project - for measurements in the drop tower which are performed before the orbital experiment is carried out. After evaluation of these measurements, PTB will manufacture the actual test masses for the satellite experiments

Source: Physikalisch-Technische Bundesanstalt

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