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GENERAL RELATIVISTIC GEODESY - THE NEW SHAPE OF THE EARTH

Abstract

Owing to new highly sensitive devices like clocks, freely falling corner cubes, spinning tops, and laser and atom interferometers on ground and in space the relativistic gravitational field of the Earth can now be measured with unprecedented accuracy. This accuracy requires a relativistic formulation of the gravitational field and, thus, of geodesy. In our presentation a fully general relativistic formalism for geodesy is presented. Starting from stationarity of the Earth, two potentials can be defined for the Earth - one is related to the norm of the underlying Killing vector, the other related to its twist. The first potential can be measured with clocks (on ground and in space where for the measurements in space a modified approach is needed taking into account the motion of the clocks), falling bodies, or atom interferometry. The second potential can be measured with spinning tops or by measuring a Sagnac effect with laser or atom interferometry. While the first potential can be used to introduce a height system, the second potential defines a latitudinal system. So, it is the gravitational field of the gravitating body itself which defines the reference system of the gravitating body. Finally, based on analyses by Hansen, Simon, and Beig a scheme is presented for measuring the full general relativistic gravitational field of the Earth using laser interferometry employed by constellations like GRACE Follow On using laser interferometry or again clocks.