Redefining the Kilogram and Measuring Crustal Deformation using an Absolute Gravimeter

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The gravity force, which allows us to define the weight of an object, keeps us at the Earth's surface and is the origin of the free fall of a body. This force is proportional to the mass: $\vec{F} = m\vec{g}$, where $\vec{g}$ is the **gravity acceleration**. The magnitude of this acceleration is the **gravity** *g*, measured with a **gravimeter**. This is a physical quantity varying in time and space. Indeed, ***g*** depends, mainly, on the latitude, the mass distribution in the Earth's interior, the Earth's rotation (velocity and position of the rotation axis), and the relative positions of the Moon and the Sun, which cause the tides. The determination of *g* is essential in several areas of the scientific research. In **geophysics**, one measures the gravity variation to study tectonic deformations, the post-glacial rebound, the tides, the influence of the atmosphere and the hydrosphere, and the structure of the globe from the inner core to the Earth's crust. On the other hand, the analysis of the local variations of *g* presents numerous applications in **geology**. *g* is indispensable to **geodesy** for the determination of the geoid and therefore of the heights (the geoid represents the average level of the seas and their prolongation under the continents). Finally, in **metrology,** *g* enters in the determination of standards derived from the kilogram (ampere, pressure, force) and is to play an essential role in the new realisation of the kilogram. In the international system of units, the kilogram is the only remaining base unit that still relies on a material artefact. This is unsatisfactory, especially because the stability of the kilogram prototype is not well constrained. The most promising approach is the Watt balance experiment that allows expressing the kilogram in terms of the meter, the second and the Planck's constant *h*, by equating mechanical and electrical power. The electrical power is measured in terms of the Josephson and quantum Hall effects, and it will allow one to link the unit of mass to the Planck constant.

First we present the last generation of absolute gravimeter (AG), the FG5 from Micro-g Solutions, Erie, Colorado, USA. This is the most accurate and in fact, the only commercially available absolute gravimeter, which provides the value of *g* with an accuracy of 1 part in 10^9. Secondly, we describe the Watt balance experiment and briefly some other approaches aiming at redefining the kilogram. Then, we present the results of absolute gravity measurements performed across the Belgian Ardenne and the Roer Graben to better constrain the present-day deformation. This 140 km long profile includes 8 stations and has been conducted twice a year since September 1999. At this present time, there is no detectable gravity rate of change larger than 1.8 µGal/yr. This is equivalent to an uplift of 9 mm/yr. This long-term experiment shall be carried out at least until 2009; then we should be able to constrain any possible long-term trend with accuracy better than 0.5 µGal/yr. To ensure that the absolute gravimeter is giving accurate results it has been compared regularly with the superconducting gravimeter installed at the Membach reference station, which belongs to the profile. There, a low trend in gravity of -0.44+/-0.10 µGal/year is observed among 80 AG measurements since 1996. In particular, we show a good correlation between the gravity measurements and the continuous GPS measurements performed since 1997 at 3 km from the station.