EGU2020-10476
https://doi.org/10.5194/egusphere-egu2020-10476
EGU General Assembly 2020

Optical clocks for gravity field observation and further geodetic applications

Hu Wu, Jürgen Müller, and Annike Knabe
Leibniz Universität Hannover, Institut für Erdmessung, Civil Engineering, Hannover, Germany (wuhu@ife.uni-hannover.de)

In the past three decades, optical clocks and frequency transfer techniques have experienced a rapid development. They are approaching a fractional frequency uncertainty of 1.0×10^{-18}, corresponding to about 1.0 cm in height. This makes them promising to realize "relativistic geodesy", and it opens a new door to directly obtain gravity potential values by the comparison of clock frequencies. Clocks are thus considered as a novel candidate for determining the Earth's gravity field. We propose to use a spaceborne clock to obtain gravity potential values along a satellite orbit through its comparison with reference clocks on ground or with a co-orbital clock. The sensitivity of clock measurements is mapped to gravity field coefficients through closed-loop simulations.

In addition, clocks are investigated for other geodetic applications. Since they are powerful in providing the height difference between distant sites, clocks can be applied for the unification of local/regional height systems, by estimating the offsets between different height datums and the systematic errors within levelling networks. In some regions like Greenland, clocks might be a complementary tool to GRACE(-FO) for detecting temporal gravity signals. They can be operated at locations of interest and continuously track changes w.r.t. reference clock stations. The resulting time-series of gravity potential values reveal the temporal gravity signals at these points. Moreover, as the equipotential surface at a high satellite altitude is more regular than that on the Earth's surface, a couple of clocks in geostationary orbits can realize a space-based reference for the determination of physical heights at any point on the Earth through clock comparisons.

We gratefully acknowledge the financial support by the Deutsche Forschungsgemeinschaft (DFG) under Germany's Excellence Strategy EXC-2123/1 (Project-ID: 390837967).