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Relativistic Geodesy Using Optical Clocks

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Optical atomic clocks have demonstrated unprecedented stability and estimated systematic uncertainty, far surpassing the current generation of caesium primary frequency standards. Large-scale efforts are underway to verify their uncertainty budgets by means of international comparisons using optical fibre networks or satellite-based frequency comparison techniques. Such comparisons, together with the incorporation of optical clocks into International Atomic Time (TAI), are an essential prerequisite for an anticipated future redefinition of the SI second in terms of an optical transition frequency.

General relativity predicts that time, and hence clocks, are affected by gravity. When the frequencies of clocks are compared, or when they contribute data to international time scales, it is therefore necessary to account for the gravitational redshift of their frequencies. But state-of-the-art laboratory optical clocks have now reached the point where their estimated systematic uncertainties are below the uncertainty with which we are able to correct for gravitational effects at the Earth's surface. This offers the exciting prospect of using optical clocks as sensors for measuring gravity potential differences, an approach termed chronometric levelling or relativistic geodesy.

In this talk I will describe a proof-of-principle demonstration of chronometric levelling using a transportable optical clock and discuss the future prospects of this new approach.

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