GR 15: Classical Theory of General Relativity

Time: Thursday 14:00–14:40 Location: HBR 14: HS 2

GR 15.1 Thu 14:00 HBR 14: HS 2

Gravitational field recovery via inter-satellite redshift measurements — •Jan Patrick Hackstein, Dennis Philipp, and Eva Hackmann — ZARM, University of Bremen, Germany

Satellite gravimetry is a common tool to monitor global changes in the Earth system, generally utilising accelerometers aboard satellites to measure acting forces along the orbits. In contrast, high-precision atomic clocks are used in first experiments in terrestrial gravimetry to measure physical heights. In relativistic gravity, a comparison of two clocks is sensitive to their relative positions and velocity, making clocks ideal tools to investigate Earth's gravity field. However, one important obstacle for Earth-satellite chronometry is the low measurement accuracy of satellite velocities, which enter into the redshift via the Doppler effect.

We present an alternative approach based on the framework of general relativity without velocity measurements from ground stations, instead measuring redshift between satellite pairs equipped with clocks via laser ranging. This method promises higher accuracy for gravity field recovery by improving control of the Doppler effect. We investigate this problem in analytically given spacetimes as well as in the general first post-Newtonian approximation of Earth's gravity field, and discuss the prospects for gravity field recovery.

GR 15.2 Thu 14:20 HBR 14: HS 2

General Relativistic Chronometry from Ground and in Space — •Dennis Philipp[1,2], Eva Hackmann[1], Jan Hackstein[1], and Claus Lämmerzahl[1,2] — [1]ZARM, University of Bremen, Germany — [2]Gauss-Olbers Center, University of Bremen, Germany

One of the main tasks of geodesy is to determine the gravity field of the Earth from measurements based on ground and in space.

General relativistic geodesy allows for an entirely new perspective and high-precision clock comparison has the potential to provide a new tool in the global determination of the Earth's gravito-electric potential based on the gravitational redshift. Toward this clock-based gravimetry, i.e., chronometry in stationary spacetimes, exact expressions for the relativistic redshift and the timing between observers in various configurations are discussed. These observers are assumed to be equipped with standard clocks and move along arbitrary worldlines. It is shown how redshift measurements, involving clocks on ground and/or in space, can be used to determine the (mass) multipole moments of the underlying spacetime geometry. Our results are in agreement with the Newtonian potential determination from, e.g., the energy approach in conventional geodesy. The framework of chronometric geodesy is presented and exemplified in different exact vacuum spacetimes for illustration. Gravity degrees of freedom, also involving gravito-magnetic contributions, are studied and potential experiments for their determination are investigated. Future gravity field recovery missions may use clock comparisons as an additional source for advanced data fusion.