GR 5: Classical Relativity

Time: Tuesday 17:00–18:00 Location: ZEU/0255

GR 5.1 Tue 17:00 ZEU/0255

Spinning light source orbiting a compact Schwarzschild object — •Jan-Menno Memmen and Volker Perlick — Zentrum für angewandte Raumfahrttechnik und Mikrogravitation, Bremen, Deutschland

In this talk, we determine the radiation of an extended, *spinning* light source in circular orbit in the symmetry plane of an stationary, axially symmetric spacetime. The light source is assumed to be a test particle, as to not interfere with the background spacetime. We derive the necessary transformations for a reference frame that is at rest on the surface of the rotating emitter, and link the emission angle on the surface of the emitter to the constants of motion of the light ray. Two emitter geometries are considered; a sphere and a Maclaurin spheroid that is flattened as a result of its spin. In particular, we investigate the influence of the emitter spin on the radiation in a Schwarzschild background. Specifically, the influnece of the spin on the redshift distribution and flux at an arbitrarily positioned observer is studied in detail.

GR 5.2 Tue 17:20 ZEU/0255

Gravitational field recovery via inter-satellite redshift measurements — •Jan P. Hackstein, Eva Hackmann, Dennis Philipp, and Claus Lämmerzahl — Center of Applied Space Technology and Microgravity, Bremen, Germany

Satellite gravimetry is a common technique to monitor global changes in the Earth system. High-precision atomic clocks are currently used in first experiments in terrestrial gravimetry to measure physical heights. In relativistic gravity, a clock comparison is sensitive to their positions in the gravity field and relative velocity. This makes clocks ideal tools to investigate the Earth's gravity field. Equipping Earth-orbiting satellites with clocks and comparing them to terrestrial ground stations allows for global and continuous measurements. However, one important obstacle for Earth-satellite chronometry is the low measurement accuracy of satellite velocity, which enters 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. Considering an idealised satellite setup in the Schwarzschild spacetime, pairwise redshift measurements between satellites equipped with clocks are used to recover the gravitational field's monopole moment. We investigate whether or not only relative observables between satellites suffice to recover the complete information about the gravitational field. This method promises higher accuracy for gravity field recovery by improving control of the Doppler effect. We compare the results and error estimates of this setup with conventional Earth-satellite measurements and conclude with future steps to generalise this approach.

GR 5.3 Tue 17:40 ZEU/0255

On the redshift and relativistic gravity potential determination in GR — •Dennis Philipp[1,2], Eva Hackmann[1,2], and Claus Laemmerzahl[1,2] — [1]ZARM, University of Bremen, 28359 Bremen, Germany — [2]Gauss-Olbers Center, c/o ZARM, University of Bremen, 28359 Bremen, Germany

We derive exact, formal expressions for the relativistic redshift and timing between observers in various configurations on stationary spacetimes for the purpose of chronometry, i.e., relativistic gravimetry based on clocks. These observers are assumed to transport standard clocks along their respective worldlines and may move in an arbitrary way - on geodesics, accelerated, or are simply stationary. It is shown how redshift observations can be used to infer the (mass) multipole moments of the underlying spacetime, i.e., a decomposition of the gravito-electric potential. In particular, an Earth-bound observer is considered that is meant to model a standard clock on the Earth's surface (or on the geoid). Its clock is continuously compared to a satellite's clock to determine a relativistic gravity potential from redshift measurements. Results shown here are in agreement with the Newtonian potential determination from the so-called energy approach. The framework is intended for applications within relativistic geodesy and is applied in different exact vacuum spacetimes for illustration.