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Height measures in relativistic geodesy

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The Newtonian gravity potential is one of the main notions for conventional geodesy and employed for basic concepts, such as the definition of heights. A modern height definition in terms of geopotential numbers can offer a variety of advantages. Moreover, from the theoretical point of view, such a definition is considered more fundamental.

We know, however, that relativistic gravity (here General Relativity) requires to reformulate basic geodetic notions and to develop a consistent theoretical framework, relativistic geodesy, to yield an undoubtedly correct interpretation of contemporary and future (high-precision) measurement results. The new framework of chronometric geodesy that builds on the comparison of clocks at different positions in the gravitational field offers fundamental insight into the spacetime geometry if a solid theoretical formulation of observables is underlying all observations. For chronometry, high-performance clock networks, i.e., optical clocks connected by dedicated frequency transfer techniques, are capable to observe the mutual redshift with incredible accuracy.

Here we approach a genuine relativistic definition of the concept of height. Based on the relativistic generalization of geopotential numbers, a definition of chronometric height is suggested, which reduces to the well-known notions in the weak-field limit. This height measure is conceptually based on the so-called time-independent redshift potential, which describes the gravitoelectric degree of freedom in General Relativity.

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