Optic-fiber gravity frequency transfer network

Anh The Hoang\textsuperscript{1,2} and WenBin Shen\textsuperscript{1,3}
\textsuperscript{1}Time and Frequency Geodesy Center, Department of Geophysics, School of Geodesy and Geomatics, Wuhan University, Wuhan 430079, China (anhthe.dhv@gmail.com)
\textsuperscript{2}School of Agriculture and Natural Resource, Vinh University, Vinh City- 460000, Vietnam
\textsuperscript{3}State Key Laboratory of Information Engineering in Surveying, Mapping and Remote Sensing, Wuhan University, Wuhan 430079, China

According to Einstein’s general relativity theory (GRT), a clock at a position with higher potential runs faster than a clock at a position with lower potential. Hence, inversely, one can determine the gravity potential (geopotential) and orthometric height based on precise clocks. If a clock with an accuracy of $10^{-18}$ is used, the geopotential difference between two points can be determined with an accuracy of centimeters level. With the rapid development of science and technology, optical clocks achieve $10^{-18}$ stability, which opens up opportunity for scientists to practically determine geopotential as well as orthometric height using optical clocks. One of the challenges of classical geodesic in the long time has been the unification of local height systems. To complete this task is very difficult because each country has a regional high system. This problem can be solved if using a clock network, which overcomes the weaknesses of the spirit leveling method. Here we provide a formulation to establish a model of a network using optical clocks linked together by optical fibers for the purpose of determining the geopotential and establishing a unified world height system at centimeter accuracy level. This study is supported by National Natural Science Foundation of China (NSFC) (grant Nos. 41721003, 42030105, 41631072, 41874023, 41804012), and Space Station Project (2020)228.

Key words: GRT, optical clocks network, frequency transfer, geopotential, orthometric height