J Laser Opt Photonics 2018, Volume 5
DOI: 10.4172/2469-410X-C7-042

10th International Conference and Exhibition on
LASERS, OPTICS & PHOTONICS
November 26-28, 2018 | Los Angeles, USA

Geopotential determination using remote laser time transfer comparison

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Based on general relativity theory, a clock located at a position with higher gravity potential (geopotential) runs quicker than a clock located at a position with lower geopotential. Then one may determine the geopotential difference between the two stations by comparing the time elapse recorded by two atomic clocks located at these two stations. Here we propose an approach to determine the geopotential difference between two positions using a laser time transfer technique. After synchronization, two atomic clocks are set at arbitrary two stations. Using laser time transfer technique we may determine the time differences between the two clocks at any time. After a period, we may determine the time elapse caused by the geopotential difference between the two stations. Then, based on the time elapse between the two clocks, the geopotential difference between the two stations can be determined. The accuracy depends on not only the accuracy of the atomic clocks but also the influences of various error sources, which are carefully investigated. A clock with an accuracy level of 10E-18 may sense a geopotential variation of the 0.1geopotential unit (g.u.), which is equivalent to a height variation of 1 cm. Hence, to achieve an accuracy level of 0.1 g.u. measurement, we need clocks with an accuracy of 10E-18 level. With quick development, optic-atomic clocks with an accuracy of around 10E-18 level have been generated. Hence, the proposed approach here is perspective. This study is supported by NSFC (Grant Nos. 41631072, 41721003, 41574007 and 41429401), the Discipline Innovative Engineering Plan of Modern Geodesy and Geodynamics (Grant No. B17033) and DAAD Thematic Network Project (grant No. 57173947).

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