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Systematic error evaluation of the compact absolute gravimeter TAG-1

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In recent years, absolute gravimeters are used not only for determining static or secular-changing gravity field but for observing dynamic gravity change associated with movement of underground fluid, such as groundwater and magma. For the latter purpose, we have developed a compact absolute gravimeter, TAG-1, to use it for continuous monitoring volcanic activities at a site close to the volcanic vent. As compared to relative gravimeters, absolute gravimeters enable continuous stand-alone measurements without any round-trip comparison to the gravity reference point.

In July of 2013, we carried out a short-term observation at Kirishima volcano observatory (Miyazaki, Japan) using TAG-1 [1]. The statistical error was 0.8 uGal for one-day observation. Measured absolute gravity, however, showed reduction of 20-25 uGal from preceding observation in March of 2012. The regional crustal deformation inferred from GPS data suggested the reduction probably originated from instrumental error of TAG-1. We consider two error sources: recoil vibration and photo-detector response. The recoil force is generated at the time of releasing a free-fall mass and actuates the floor, resulting in vibration of the reference mirror. Slight phase delay determined by the photo detector causes systematic error in the gravity calculated from the quadrature fringe data [2].

In this presentation, both errors are evaluated, and performance of TAG-1 including its accuracy after the error correction is discussed.

References

[1] A. Araya, H. Sakai, Y. Tamura, T. Tsubokawa, and S. Svitlov, ”Development of a compact absolute gravimeter with a built-in accelerometer and a silent drop mechanism”, in Proc. of the International Association of Geodesy (IAG) Symposium on Terrestrial Gravimetry: Static and Mobile Measurements (TGSMM-2013), 17-20 September 2013, Saint Petersburg, Russia, 98-104 (2014).

[2] S. Svitlov and A. Araya, ”Homodyne interferometry with quadrature fringe detection for absolute gravimeter,” Appl. Opt. 53, 3548-3555 (2014) .

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