Development of a new portable gravity gradiometer for field measurements

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Laser interferometric gravity gradiometers have been expected to be a useful tool for geophysical observation and the basic concepts have been discussed and patented since 1970s. However, they have not been practically applicated to field measurements yet. This is mainly because of the technical difficulty in carrying out repeated measurements with precision sufficient for laser interferometry. To overcome the technical difficulty, a new interferometric gravitygradiometer has been developed [1]. In this gravity gradiometer, a pair of test masses located at different heights (the separation is about 70 cm) is thrown up at the same time in a vacuum tank. The differential acceleration between the test masses in free fall is measured by a Mickelson interferometer. This gravity gradiometer is designed to release the test masses quickly and precisely by applying a mounting method developed for an earth orbiting free-fall experiment (Satellite Test of the Equivalence Principle) [2]. This release mechanism was found to be effective for the realisation of precise repeated measurements [1].

The first prototype of the gravity gradiometer was tentatively operated at the Sakurajima Volcanological Observatory of Kyoto University, located on the active volcanic island of Sakurajima, Kyusyu Japan. From this tentative operation, it was found that the instrument was robust against seismic vibration; the resolution was $\pm 0.3\,\mu$Gal/m, which is the same level as that operated at a quiet observation station. This result indicates that this gravity gradiometer could detect local underground activities, which are buried in seismic noise and have not been detected by previous gravimeters. However, the first prototype is heavy (weighs about 200 kg) and it was difficult to install it at the local observatory without crane equipment. We are developing a new laser-interferometric gravity-gradiometer that is designed to be portable and more practical for field measurements. In this presentation, I will report the status and prospects of the development.

References

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