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Frequency corrections of 10MHz atomic clocks in absolute gravimeters (A10 and FG5) at Syowa Station, Antarctica

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Absolute gravity values are estimated by precisely observing the drop distance and time of falling bodies in absolute gravimeters. Since the drop time is mostly observed with 10 MHz atomic clocks, the accurate clock frequency is needed in advance to estimate the absolute gravity values. However, the frequency of atomic clocks in absolute gravimeters often shifts slightly from 10 MHz, and some clocks have the time variation in the frequency. Therefore, in order to estimate the precise absolute gravity values, the correction for frequency values of the atomic clocks are needed, by comparing the clock frequencies with a reference clock.

We thus estimated the precise frequency values of 10 MHz atomic clocks in absolute gravimeters at Syowa Station in Antarctica during the 53rd Japan Antarctic Research Expedition (JARE53). We tested the following clocks: (1) Rubidium clock in the A10 absolute gravimeter (SN: #017), (2) Rubidium clock in the FG5 absolute gravimeter (SN: #210), and (3) the spare Rubidium clock for these absolute gravimeters. And we utilized the following clocks as references of 10 MHz signals: (4) Cesium clock and (5) Helium maser. First, we displayed the sine signals of a test clock and a reference clock in an oscilloscope, and recorded the movements of the sine waves with movie cameras. We then calculated the frequency difference between the test and reference clocks with the movie analyses. We conducted the above processes periodically for two months in January and February 2012, and finally we estimated the time variation in the absolute frequency values of the tested atomic clocks.

According to the results, the frequency of the Rubidium clock in the A10 gravimeter (No. 1) shifts by about +0.15 Hz from 10 MHz, and it changes in terms of time at a constant rate of -0.0018 Hz/day. These frequency shifts imply the artificial absolute gravity shifts by +30 micro-gal and -0.36 micro-gal/day respectively, which are larger than the gravity accuracy of the A10 gravimeter (˜10 micro-gal). On the other hand, the frequency shifts of the FG5 and spare Rubidium clocks (No. 2 and 3) are smaller than +/- 0.002 Hz (+/- 0.4 micro-gal for gravity), which are significantly smaller than the gravity accuracies of the A10 and FG5 gravimeters.

We will utilize these results for the correction of absolute gravity values observed in Antarctica. And in the coming poster presentation, we will show and discuss the final results of the observed absolute gravity values in Antarctica.

Keywords: Absolute gravimeter, 10MHz atomic clock, Rubidium clock, Cesium clock, Helium maser, Antarctica