Aim for a magician of gravity ~ Microgravity generator and Gravity control apparatus ~

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In order to bring the space environment into the laboratory and the classroom, we developed a microgravity generator and a gravity control apparatus. Microgravity can be easily realized by free-falling. However, it is difficult to carry out precision experiments due to the residual G caused by air resistance. Therefore, the double capsule system used in the large drop tower was adopted for the indoor drop tower. The microgravity of 10^{-3}G level was created by the double capsule system. In addition, it was possible to smoothly switch from 1G to 0G by eliminating the vibration that occurs in the drop capsule immediately after falling. Therefore, we can conduct experiments using the law of conservation of energy. The falling distance of the drop capsule is about 2m and the microgravity duration time is about 0.5 seconds.

A new susceptibility measurement method has been proposed using the characteristics of this apparatus. The diamagnetic susceptibility of liquid water was measured without placing it in a container. We obtained similar values to the literature values. The mass independence of the measurement was confirmed, and the measurement principle was verified.

We also tried magnetic separation experiments on weak magnetic materials. The diamagnetic material was separated using the difference in diamagnetic susceptibility. By comparing the obtained values of the magnetic susceptibility with published values for individual particles, the material can be easily identified. It is expected to be applied to the development of solid-state chromatography technology that separates solid mixtures for each type of material prior to precise analysis.

The gravity control apparatus was constructed using using the Atwood pulley system. The wheels of the bicycle were mounted as pulleys at a height of 2.4 m, and a fall distance of about 2 m was secured. Therefore, low gravity was realized for 0.5 to 0.6 seconds. By adjusting the weight of the drop capsule and the counterweight, an arbitrary gravity from 0G to 1G could be created.

We conducted experiments on phenomena that have a correlation with gravity using this gravity control apparatus. First, we investigated the relationship between the height of water and the gravity of capillary action. According to theory, water height is inversely proportional to gravity. However, water did not follow the theoretical formula, and ethanol followed the theoretical formula. Next, an experiment on the crater was performed. Regarding the crater formation, it is known that the crater diameter D and the surface gravity g_{eff} is theoretically related by gravitational scaling law $D \propto g_{\mathrm{eff}}^{-0.25}$. Results of preceding experiments by NASA Ames Research Center (in 42 years ago) give $D \propto g_{\mathrm{eff}}^{-0.165 \pm 0.005}$, and results by MGLAB give $D \propto g_{\mathrm{eff}}^{0.004 \pm 0.003}$. Both of them are significantly different from the theoretical prediction. Then we placed a target glass beads, a high-speed camera, and an electric gun inside the drop capsule. As the fall of the capsule, the formation of a crater on the surface of glass beads by a bullet ejected from the electric gun was observed with the high-speed camera. As a result of the observation under various gravity, I figured out

that the crater diameter and the gravity inside the capsule is related by $D \propto g_{\mathrm{eff}}^{-0.246 \pm 0.009}$. The experimental result verified the gravitational scaling law.

By installing a vacuum device and a temperature control device in the drop capsule, the surface environment of the target object can be created. The drop capsule has a volume of about 15000cm^3. Also, since the falling time is about 0.5 seconds, large vacuum equipment and constant temperature equipment cannot be installed. For this reason, a mechanism to maintain the degree of vacuum and temperature for about 0.5 seconds was also devised.
The outline and results of these experimental devices are reported.

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