

## Magnetic Levitation Seismometer

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### 1. An astatic rotational pendulum seismometer

Development of new instruments with new ideas is important to open up a new window of earth science. The aim of this study is to realize a highly-sensitive/wideband seismometer for new seismological-observational network. We have developed an astatic rotational pendulum using magnetic levitation for removing the parasitic resonances of a spring to support a pendulum weight from a gravity force and the thermal dependence of the spring constant. The principle is as follows. A cylindrical plunger permanent magnet has a weight at one side of its end edge. The plunger magnet is inserted into a uniform magnetic field generated by a window-frame-type permanent magnet and attached to two crossed leaf spring hinges outside the magnet bore. Magnetic forces occurred by the magnetic field counterbalance a gravity force at the weight. A prototype seismometer using the rotational pendulum has a velocity feedback control system of a weight position, a magnetic spring, and, a capacitance position detector. To realize the stable operation of the rotational pendulum without the unnecessary movements of the plunger magnet, the magnetic field uniformity of the window-frame magnet reached  $10^{-4}$  by devising its pole shape. The thermal dependence of the magnetic field strength was compensated as much as  $9 \times 10^{-5}/^{\circ}\text{C}$  by Ni-Fe metal, having a negative coefficient of permeability. The natural period of the prototype was 10 s at the maximum and was able to be changed from 5 s to 8 s with the magnetic spring. These values of the period are consistent with theoretical calculations. Observations using this seismometer have been recently carried out. The results of the observations showed that the noise level of the seismometer was less than  $10^{-9}$  m/s in the frequency range over 1 Hz.

### 2. A horizontal component seismometer with magnetic levitation

In this study, we have developed a seismometer using a new principle to obtain further sensitivity than present one. This seismometer uses a horizontal pendulum having weak leaf-spring crossed hinges and using magnetic levitation for a pendulum weight. The levitation employs permanent magnets magnetized by N, S strip, alternatively. This pendulum has been built and evaluated by experiments. The results of the experiments are as follows. 1. The prototype of the pendulum achieved a natural period more than 11 s. 2. The natural period of the prototype was changed with a magnetic spring. These values of the period were consistent with theoretical calculations. 3. The prototype with a feedback control circuit, a feedback control coil and a capacitance displacement sensor worked as a servo-type seismometer. 4. The observations using the magnetic levitation seismometer have been carried out and showed capacity to measure microseisms.