Performance of Contactless Micro Vibration Isolator Using Flux Pinning Effect

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Exploring planets and Galaxies gives us much information about space. Space telescopes have been used for acquiring data of planets and galaxies which are far from the Earth. NASA has been developing the James Webb Space Telescope with a requiring pointing accuracy higher than that of conventional satellites to get high resolution data of a target. To achieve this pointing objective, we must take care of the influence of vibration. Active components such as the reaction wheel and cryocooler generate and transmit vibrations throughout the spacecraft. The influence decreases the pointing accuracy and introduces blur and deviation into the observed data. A Stewart Platform and a Tip Tilt Mirror were used for suppressing the vibration. However, understanding the frequency characteristics correctly is difficult because those conventional vibration isolators consist of structures and the characteristics that are sensitive to the space temperature. In addition, a space telescope with high pointing accuracy requires us to consider thermal problems. Heat is generated as instruments are activated in the bus part as with vibration. It can then be transmitted to the observation instruments through a conventional micro vibration isolator and thermal strain occurs on the mirror in telescope.

We propose a micro vibration isolator utilizing the flux pinning effect (Fig.1) to resolve those challenging problems for next generation space telescopes [1]. A mission part and a bus part are connected using the flux pinning effect. The effect is yielded between a type-II superconductor and a material generating magnetic flux. An initial relative distance and attitude between those materials are maintained without control due to retentive forces called pinning force affect. The initial values are decided when the type-II superconductor is cooled below a critical temperature. Pinning force can be approximated by linear spring-damping force, therefore we adapt those properties to the micro vibration isolator.

The proposed mechanism is mainly composed of type-II superconductors, permanent magnets, metal plates and magnetic coils (Fig.2). Metal plates are used to add damping force between each part because the damping force yielded by flux pinning force is small. The proposed mechanism can change the observation direction with an infinitesimal angle by controlling magnetic flux from magnetic coils. The Meissner effect affects between the external magnetic field and the type-II superconductor cooled below the critical temperature and works as a repulsive force. To control magnetic field enable to change the observing direction. The proposed mechanism consists of a few permanent magnets and type-II superconductors. The mechanism must be designed to fulfill an objective frequency response. Performance of the proposed mechanism is evaluated and discussed. To understand the performance, the frozen image model [2] supported by an experiment is used.

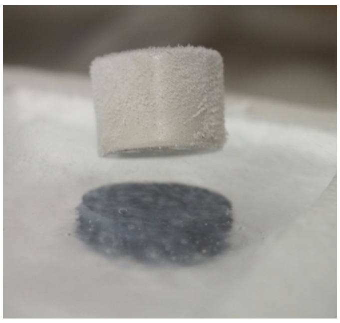

Fig. 1 Flux pinning effect

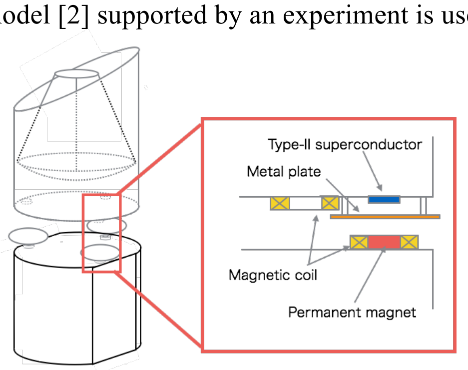

Fig. 2 Proposed mechanism

References

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