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Development of superconducting device for millimeter-wave atmospheric radiometer 1

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Division of Atmospheric Environment in Solar-Terrestrial Environment Laboratory, Nagoya University is operating the millimeter-wave atmospheric radiometers for long-term monitoring observation of ozone and related molecules of ozone depletion in the middle atmosphere. These monitoring systems are installed in Rikubetsu town in Hokkaido, Atacama highland in Chile, Rio-gallegos in Argentina, and Syowa station in Antarctica. In order to detect the emission from atmospheric molecules with high sensitivity, we use STJ (Superconducting Tunnel Junction) device which is constructed from SIS (Superconductor-Insulator-Superconductor) structure for receiver in the radiometers. From the last year, we have started the collaborative development of new STJ device for atmospheric radiometers with Advanced Technology Center, National Astronomical Observatory of Japan, because the research and development of the STJ device is extremely active in the area of radio astronomy. In this presentation, we describe the design, test production, and result of measurement properties in the laboratory of 100 GHz (wavelength ~3 mm) band new device for observation of ozone molecular spectrum at 110 GHz.

The STJ device in 100 GHz band has been used in our radiometers as well as NANTEN2 radio telescope in Chile, 45-m millimeter wave telescope in Nobeyama, and so on. However, these receivers are used old design STJ devices and these performances are a little worse. For example, the receiver noise temperature and gain compression at ambient temperature are approximately 80 K and more than 10 %, respectively. It is necessary more high sensitivity and better linearity to detect and determine the brightness temperature of weak emission from minor molecules. Therefore, we designed the device with new structure based on previous work (Inoue, 2011), which performances to be about 20 K of noise temperature and about 1 % of gain compression, and also we have fabricated and tested five SIS junction array devices. As a result, we successfully developed low noise temperature (18-25 K) devices in 100 GHz band. We will measure the gain compression, performance of intermediate frequency, and stability of the output signal in the future, and we plan to practical use for the radiometers in Rikubetsu and Riogallegos.

Keywords: middle atmosphere, minor molecules, millimeter wave, radiometer, superconducting device, SIS mixer