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Development of superconducting device for millimeter-wave atmospheric radiometer 2

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Minor atmospheric molecules radiate millimeter and sub-millimeter wave by rotation transition. Therefore, Division of Atmospheric Environment in Solar-Terrestrial Environment Laboratory, Nagoya University is operating the millimeter wave atmospheric radiometers, and monitoring long-term time variation and altitude distribution of minor atmospheric molecules in the middle atmosphere. Our monitoring molecules are O_3(208.7GHz, 235.7GHz), NO(250.9GHz), and ClO(204.3GHz). We have observation sites in Rikubetsu town in Hokkaido, Atacama highland in Chile, Rio gallegos in Argentina, and Syowa station in Antarctica. Moreover, we will set a new radiometer in Tromso, Norway in this year.

The capabilities of the millimeter wave radiometer are almost determined superconductivity device installed in radiometer. Therefore, we are developing a new superconductivity SIS (Superconductor-Insulator-Superconductor) device in millimeter and sub-millimeter wavelength for our radiometers under the collaboration with Advanced Technology Center, National Astronomical Observatory of Japan. Especially, we are developing new device in 200 GHz band (wavelength ˜1.5 mm) for the radiometers installed in Atacama and Tromso. Current devices can observe only limited molecules at one time, because the frequency range is very narrow. Therefore, we have started development of high sensitive device in wide bandwidth to observe a lot of molecules simultaneously. Specifically, we plan to make new device of which receiver noise temperature is less than 30 K from 190 to 260 GHz.

So far, we designed the transmission line for impedance matching between the feed point and SIS junction, which contains MSL (Micro-Strip Line) and CPW (Coplanar Wave Guide), based on the analysis of electromagnetic simulator and electrical circuit simulator. Specifically, we designed new device in 200 GHz band which was based on previously developed in 100 GHz band (Inoue 2011), and was fixed the structure between junction to junction which cannot be considered previously. As the result of simulation based on Tucker's quantum theory, we have successfully designed the new device of which receiver noise temperature is less than 30 K from 170 to 270 GHz. Now we have finished making the devices and we are measuring properties in laboratory. Therefore, we plan to measure other devices and the results feedback to next device design.

In this presentation, we describe the design, result of measurement properties in laboratory, and prospect for mounting millimeter wave atmospheric radiometer.

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