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Development of 230GHz SIS receiver for the monitoring of minor constituents in the planetary atmospheres

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We are promoting the monitoring observations of some atmospheric minor constituents of the terrestrial planets with grand-based sub-millimeter telescopes NANTEN2, NRO and ASTE. These single-dish telescopes are complementary tools with in situ instruments, or interferometers for the studies of dynamics and photochemistry of planetary atmospheres. Single-dish telescopes have significant beam size comparable to, or larger than the angular diameters of planets, and we can get the sum of spectra emitted by the almost all points of visible hemisphere. So we may more easily pick up the local events and long time scale oscillations.
However, grand-based observations are sometimes disturbed by beam dilutions, wind disturbances in pointing, and large optical depths under bad weather conditions. The intensities of observed spectra weaken by these effects. This is reason one needs to prepare a stable, sensitive receiver system to get sufficiently accurate data to derive the distributions of target species in the atmospheres.
So, we are co-developing the 230 GHz Superconductor-Insulator-Superconductor (SIS) devises for NANTEN2 with National Astronomical Observatory of Japan. SIS has a so thin insulator layer between two superconductor layers that it can have the normal ohmic resistance at the room temperature. SIS shows the intrinsic non-linear current-voltage characteristic because of a forbidden band, and operates as a high efficiency down-convert mixer at temperatures lower than the superconductor transition temperature.
We allocated two 1.5 square-micrometer junctions in parallel. This is a L-C resonant circuit made up of inductance and capacitance comes from the distance and area of the junctions. The structure is called the Parallel-Connected-Twin-Junctions.
At this time, we performed the experimental production of the SIS with the facilities of NAOJ Mitaka. We have not been able to optimize the parameter of the production line. And so, our first SIS has 15-40 % gap from the respective value 7 kA/cm2 of the critical current density. After this, we will measure the noise temperature of SIS, and make the serious productions with iteration method reflecting the old one data toward better SIS noise temperature enough to load NANTEN 2.
Collaterally, we are loading a digital spectrometer (AC240, Acqiris) onto NANTEN2. AC240 has fourfold wider frequency band width than the existing Acousto-Optic Spectrometer. So, we can pick up the broadened atmospheric spectrum more certainly. Moreover, there is a possibility of attenuation of the standing-waves originate in high power planetary continuum when we use a digital spectrometer.
By these developments, we will be conducting the high sensitive, periodic and long term observations of planetary atmospheres with NANTEN2 in the near future. I will talk about the progress in this presentation.

Keywords: sub-millimeter, heterodyne, SIS receiver, planetary atmosphere, grand-based telescope, high sensitivity development