THz Atmospheric Transmission Measured at Antarctic Dome A

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***Abstract*—China is planing to construct a 5-m THz telescope (DATE5) at Dome A, Antarctic, which is the best site on the earth for astronomical observations in the THz regime. To evaluate the atmospheric transmission at Dome A, we have developed a broadband Fourier transformer spectrometer for 0.75~15 THz (Dome A FTS). The details of the instrument and measurement results will be presented.**

I. Introduction

IT has long been known that the THz frequency regime is scientifically rich in astronomy. One example is that there are plenty of rotational molecular spectral lines and fine structure atomic lines observed in giant molecular clouds or in planetary atmospheres, which are mostly located in the THz regime. They are very important tracers for studying the dynamics of astronomical objects such as stars and planetary systems. These spectral lines are usually observed by air-borne or space-borne telescopes, as the earth's atmosphere absorbs these weak THz emission lines significantly, in particularly at frequencies beyond 1 THz. Dome A in Antarctic, with an altitude of 4093 m and temperature below -80 Celsius degree in winter, is a very promising site for terahertz and optical/infrared astronomy [1]. China is proposing to build a 5-m THz telescope (DATE5) there. Before the construction of the telescope, we firstly developed a Fourier transform spectrometer (Dome A FTS) to measure the atmospheric transmission for 0.75~15 THz at Dome A.

II. DATE5 THz Telescope

The proposed DATE5 THz telescope has a diameter of 5m and surface rms accuracy of less than 10 μm. The first generation instrument for DATE5 will be two superconducting heterodyne receivers operating at 0.9 THz and 1.4 THz, respectively, just corresponding to two major atmospheric windows at Dome A. The 1.4 THz heterodyne receiver, which adopts a twin-slot antenna coupled superconducting hot-electron bolometer, has demonstrated a receiver noise temperature of approximately 800 K and an instantaneous bandwidth up to 4 GHz. In addition, the DATE5 telescope is designed to have a relatively large field of view (FOV) measuring 5'×5' to accommodate its second generation instrument, which is a large-scale imaging array at 0.9 THz.

III. Dome A FTS and Measurement Results

A Fourier transform spectrometer (Dome A FTS) has been developed to evaluate the atmospheric transmission at Dome A, Antarctica, from 0.75~15 THz. This broad spectral coverage is particularly important at Dome A, where the extremely cold temperatures lie well outside the tested range of water vapor continuum models. The Dome A FTS is a polarizing Martin-Puplett interferometer operated in rapid-scan mode. The two output ports of the interferometer are equipped with different detector/filter combinations. Resolution for both bands is 10 GHz. Note that the adopted detectors are an ambient-temperature DLATGS pyroelectric detector, as cryogenically-cooled detectors and calibration loads are not feasible at Dome A. The Dome A FTS was installed at Dome A in January 2010. Measurements since then have shown exceptionally good atmospheric transmission beyond 1 THz. Fig. 1 is a typical result of the measured atmospheric radiation intensity at zenith relative to the reference load.

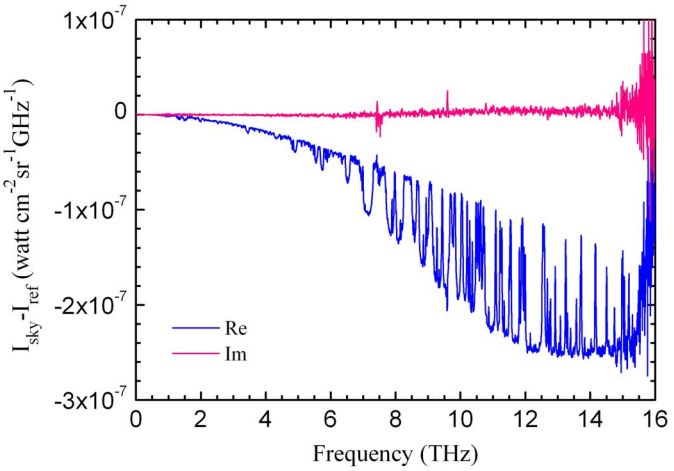

Fig. 1 Atmospheric radiation intensity at zenith relative to the reference load, measured by Dome A FTS.

IV. Conclusion

China is planning to build a 5-m THz telescope at Dome A, Antarctic. A broadband THz FTS has been developed firstly to evaluate the atmospheric transmission for 0.75~15THz at Dome A. Measurement results have demonstrated that Dome A

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is the best site on the earth for astronomical observations in the THz regime.

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