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Terahertz Intensity Interferometry for High Angular Resolution Astronomy

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Intensity Interferometry was demonstrated in 1950's by Hanbury-Brown and Twiss [1], showing high angular resolution measurements of astronomical sources. However, their applications were mostly limited to obtain diameter of stars. The limitation is due to low correlation efficiencies in optical and high dynamic range requirements in radio waves. Due to missing visibility phase, aperture synthesis imaging was not possible. In this paper, we present our activities to demonstrate aperture synthesis imaging using intensity interferometry in terahertz frequencies, and discuss future possibilities of space terahertz interferometers.

Our concept of aperture synthesis imaging is based on fast delay time measurements using terahertz photon detectors to measure photon bunching. We use 500 GHz SIS photon detectors to obtain complex visibilities by intensity correlations. SIS photon detectors are cooled by compact He4 sorption coolers down to 0.8 K. Figure 1 shows the cryostat and optical setups for intensity interferometry. Using a high temperature blackbody source and a ϕ600-mm spherical (R=4800 mm) collimating mirror, aperture synthesis imaging experiment was set up. With baseline length between 100 and 500 mm, intensity correlation will be measured using two SIS photon detectors, which is readout by cryogenic readout electronics based on GaAs FETs and SiGe amplifiers.

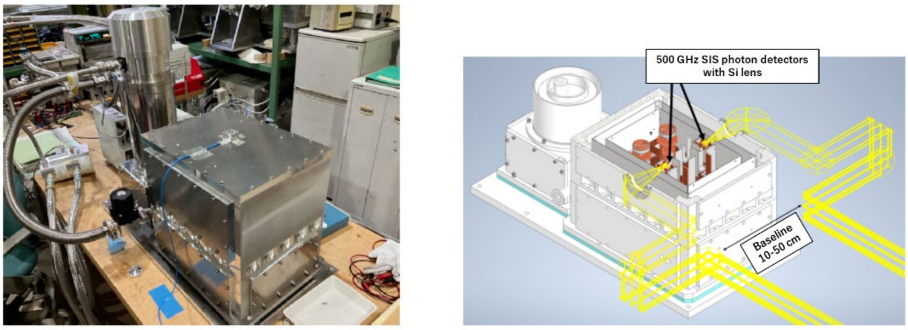

Figure 1. (left) A cryostat cooled by a pulse-tube cooler for intensity interferometer experiments. (right) cut away view of the cryostat accompanied with incoming beam from a ϕ600-mm collimating mirror. Baseline can be changed from 100 to 500 mm. Baseline rotation can be simulated by rotating a shaped aperture in front of the blackbody at the focus of the collimating mirror.

Owing to the concept of intensity interferometry, we can design very long baseline terahertz interferometry. From ground, we plan to make interferometry in Dome-Fuji, Antarctica, up to a baseline of 5 km. Even under atmospheric phase fluctuation we will obtain intensity correlation stably. From space, cryogenic space telescopes can be used with fast photon counting detectors to achieve background limited sensitivity which surpass the sensitivities of heterodyne receivers. High dynamic range measurements of intensity correlation will be obtained toward proto-planetary disks and active galactic nuclei.

References

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