Development of a wideband multi-channel receiver for simultaneous observations in 230 and 345 GHz bands with dual-polarization

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The 1.85–m mm–submm telescope of Osaka Metropolitan University has been operated at the Nobeyama Radio Observatory to observe molecular clouds in nearby star-forming regions and along the Galactic Plane in the molecular lines of ^{12}CO, ^{13}CO, and C^{18}O (J = 2–1) (e.g. [1]). Recently, we have been developing a wideband heterodyne receiver for simultaneous observations in CO lines of J = 2–1 and J = 3–2 transitions with dual-polarization using this telescope. To achieve these simultaneous observations, a wideband frequency separation system was required in the radio frequency (RF) circuit because the intermediate frequency (IF) range of the superconductor-insulator-superconductor (SIS) mixer is narrower than the frequency range of the CO lines from J = 2–1 to J = 3–2. As the frequency separation system, a waveguide multiplexer that connect three types of diplexers was applied and developed. The schematic diagram of the receiver system is shown in Figure 1 (a). In this system, the RF signal from 210 to 375 GHz is eventually distributed into four frequency bands by the waveguide multiplexer, each of which is fed to SIS mixers. The prototype multiplexer was already developed and installed in the Osaka 1.85-m radio telescope. Then, we succeeded in preliminary simultaneous observations in 230 and 345 GHz bands with single-polarization [2]. We are currently working on improving the multiplexer and developing a 90° differential phase shifter [3] and a wideband orthomode transducer (OMT). The 90° differential phase shifter and OMT can be combined to operate as a circular polarizer (CP) as shown in Figure 1 (b), which will contribute to observations of both circularly and linearly polarized waves by using the OMT and CP, respectively. In this conference, we will present the development of the prototype simultaneous receiver and the development status of a new design multiplexer, the OMT, and the CP.

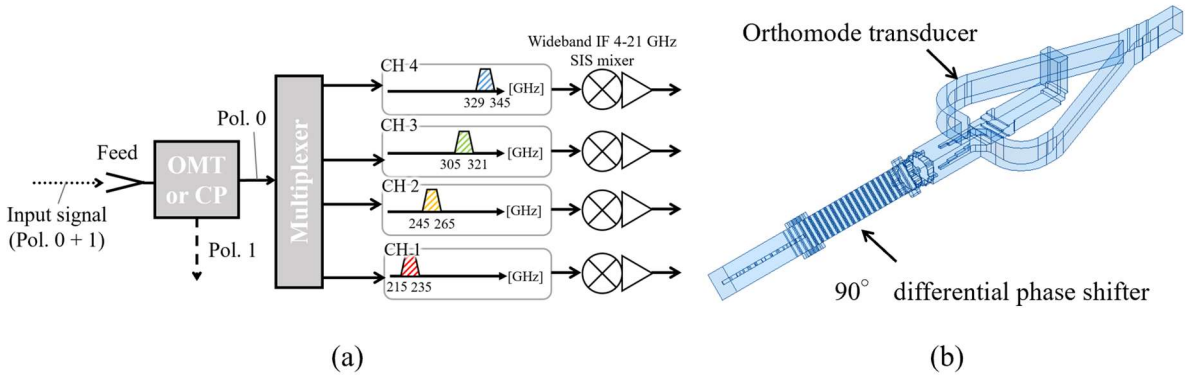

Figure 1. (a) Schematic diagram of the receiver system for simultaneous observations with dual-polarization. (b) Model of the wideband CP which consists of the wideband 90° differential phase shifter and OMT.

References

[1] Onishi, T. et al., "A 1.85-m mm-submm Telescope for Large-Scale Molecular Gas Surveys in ^{12}CO, ^{13}CO, and C^{18}O (J = 2–1)" *Publ. Astron. Soc. Japan*, 65, 4, 78, Aug. 2013, doi:10.1093/pasj/65.4.78.
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[3] S. Masui, et al., "210–365 GHz 90° Differential Phase Shifter for Wideband Circular Polarizer," *IEEE THz Sci. Technol.*, vol. 12, no. 5, pp. 527–534, Sept. 2022, doi: 10.1109/TTHZ.2022.3191851.