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DESHIMA on ASTE: Sky removal method for astronomical observations with an ultra-wideband submillimeter spectrometer

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We are developing an ultra-wideband spectroscopic instrument, DESHIMA, a spectrometer integrated on-chip filterbank and microwave kinetic inductance detector (MKID) technologies to investigate dusty starburst galaxies in the distant universe at millimeter and submillimeter wavelength. On-site experiment of prototype DESHIMA was promoted using the ASTE 10-m telescope in Oct. and Nov. 2017. In this session, we used 49 frequency pixels in 332-377 GHz band (frequency step of $\sim$1 GHz), and successfully detected some astronomical molecular lines such as the redshifted CO (J=3-2) line of VV 114, a luminous infrared galaxy at z=0.020.

In this poster, we present a method to remove a spectrum of sky emission from an observed time-series data of DESHIMA. Because of ultra-wideband ($\sim$45 GHz in prototype, $>$200 GHz in full operation), the time variation of atmospheric opacity, $\tau(t)$, is no longer constant over the waveband but has a frequency dependency, $\tau(\nu, t)$. This makes a spectral sky baseline strongly non-linear, which may fail the conventional sky removal using a constant or polynomial baseline estimates. With the ALMA atmospheric model, we calculate the frequency-dependent $\tau(\nu, t)$ as a function of frequency-independent precipitable water vapor, PWV(t). We then fit the sky baseline of each time-series spectrum by estimating PWV(t) and constant value, $C(t)$, instead of coefficients of a polynomial function. We demonstrate that the proposed method mitigates the non-flatness of an estimated astronomical spectrum compared to the conventional one in several DESHIMA data. We also find that the method enables us to keep continuum emission as $C(t)$, which may offer a new way of sky removal for continuum observations where we cannot adopt conventional method.

Less than 5 years of experience since completion of Ph.D

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