Measurements of Atmospheric Vapor Above Mauna Kea Using an Infrared Radiometer

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The performance of astronomical interferometer arrays operating at (sub)millimeter wavelengths is seriously compromised by rapid variations of atmospheric water vapour content that distort the phase coherence of incoming celestial signals. Unless corrected, these phase distortions, which vary rapidly with time and from antenna to antenna, seriously compromise the sensitivity and image quality of these arrays. Building on the success of a prototype Infrared Radiometer for Millimeter Astronomy (IRMA I), which was used to measure atmospheric water vapour column abundance, this paper presents results from a second generation radiometer (IRMA II) operating at the James Clerk Maxwell Telescope (JCMT) on Mauna Kea, Hawaii from December, 2000 to March, 2001. These results include comparisons with other measures of water vapour abundance available on the summit of Mauna Kea, including measurements from the Submillimeter Common User Bolometer Array (SCUBA) and from the Caltech Submillimeter Observatory (CSO) opacity meters.

This paper will also discuss the development of a new radiative transfer model, the University of Lethbridge Transmittance and Radiance Atmospheric Model (ULTRAM), in the Interactive Data Language (IDL®). Also included is a comparison of the experimental data from IRMA II with a theoretical curve-of-growth calculated from ULTRAM, which was developed specifically for the purpose of investigating spectra for the atmosphere above Mauna Kea.

ULTRAM has been extended to produce spectra for the atmosphere above the Atacama desert in Chile, future site of the Atacama Large Millimeter Array (ALMA). This paper will discuss the expected performance of a third-generation radiometer (IRMA III), which will be deployed to Chile for site testing as a possible phase correction device for ALMA.