FIRST TESTS OF 183 GHZ WATER VAPOR MONITORS

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At millimeter and submillimeter wavelengths the transmission and refraction of the atmosphere are mainly determined by water vapor and oxygen. In contrast to most other atmospheric gases the amount of water vapor can change by up to an order of magnitude within a few hours. In order to determine the changing atmospheric properties we built two radiometers which monitor the strong emission line of water vapor at 183 GHz. The main purpose of the radiometers is to allow phase correction of interferometric observations with the James Clark Maxwell Telescope (JCMT) and the Caltech Submillimeter Observatory (CSO). However, the radiometers are also important for single dish observations: From the instrument's measurements the atmospheric transmission can be calculated. First, knowing the transmission allows the astronomer to find the appropriate observing frequency, since successful observations above 450 GHz require a dry atmosphere with less than 2 mm of precipitable water vapor, whereas lower frequency observations are possible in moister weather. Second, the flux of the astronomical source can be determined knowing the atmospheric transmission. Since the amount of water vapor and therefore the transmission varies with space and time, it is necessary to monitor the atmosphere along the line of sight of the astronomical beam and to update the measurement every few minutes. Third, the amplitude and frequency in the variation of water vapor give an indication of the submillimeter seeing.

Our radiometers measure the intensity 1.2, 4.2 and 7.8 GHz away from the line center at 183.3 GHz. The three measurements give an indication of the line shape, which contains information on the temperature, pressure and height of the atmospheric water vapor. In order for the water vapor monitors to probe the same atmosphere as the astronomical beam the instruments are mounted on the JCMT and CSO respectively. A system of four mirrors directs the beam from the secondary mirror of the telescope to the radiometers. An double sideband subharmonic mixer downconverts the incoming radiation to an intermediate frequency (IF) of 0 to 8 GHz. The IF signal is split into three, the appropriate frequency channels are filtered out and the intensity in each channel is measured. To keep maintenance simple the instruments are uncooled resulting in system temperature of 2000 to 3000 K depending on the channel. However, a one second integration over 1 GHz bandwidth has thermal noise of only 0.1 K, which results in an error in opacity of less than 0.002. The water vapor monitors contain a hot calibration load at 370 K and a warm load at 300 K. A small flat mirror switches between the sky position and the two calibration loads in a one second cycle. Due to the frequent calibrations any gain variations of the instrument are removed. With the radiometers we have so far successfully corrected the phase of interferometric observations of test objects. In the near future we hope to also use the instruments during single dish observations.

References: M. C. Wiedner, PhD thesis, University of Cambridge, 1998.

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3. (a) Atmospheric transmission at mm/submm wavelengths

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5. I have submitted no other abstracts for this meeting.

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