ATMOSPHERIC PHASE NOISE AND APERTURE SYNTHESIS IMAGING AT MILLIMETER WAVELENGTHS

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ABSTRACT

We analyse data obtained with the Hat Creek interferometer at 86 GHz to estimate the atmospheric phase noise on spatial scales of 6m to 846m, and time scales of 1 second to 10 hours. We find a phase structure function with a power law index, β between 0.6 and 1.7. A slope close to the Kolmogorov 2D value 0.67 is obtained for longer baselines and stable weather conditions; the slope approaches the Kolmogorov 3D value 1.67 only on short baselines and in turbulent weather. The rms phase at a 1 km baseline is 1 mm, with a variation by a factor 4 over a few days even during good weather conditions. The mean elevation dependence is sin(elevation) $^{-0.7+/-0.2}$. The variation of β and the elevation dependence with baseline length are consistent with turbulent regions 100 - 300 m thick.

The resolution and dynamic range of millimeter wavelength aperture synthesis images is limited by atmospheric turbulence. Observing techniques and data analysis procedures to correct for atmospheric seeing are discussed in some detail.