Predicting the effects of Anomalous Refraction on the telescope Point Spread Function: a possible compensating technique

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Radio seeing effects on cm and mm wavelength interferometers are now reasonably well known. These are a consequence of the inhomogeneously distributed atmospheric water vapor which can cause spatial and temporal variations in the optical path length of radio waves. Therefore, phase fluctuations on a two-element interferometer occurr whenever the columns of water vapor above them are different.

On the other hand, radio seeing shows up on filled-aperture telescopes as an "Anomalous Refraction" (AR), i.e. an apparent displacement of a radio source from its true position, with varying pointing shifts (a few arcsec to $> 10'' - 30''$) and time scales (a few sec to $\sim$ 30 sec). However, little is known, from both an experimental and theoretical standpoint, about how the pathlength differences across the aperture plane of a *radio* telescope distort the incoming wavefront, thus affecting the angular resolution and sensitivity of astronomical observations.

In fact, if for small- to medium-size ($D < 20$ m) mm-wave antennas the main AR effect is a pointing shift, this may no longer be entirely true for large telescopes ($D > 30$ m), where the diameter to Fried parameter ratio, $D/r_\circ(\lambda)$, may become close to or larger than 1. This is the case, e.g., of the *"Large Millimeter Telescope"* (LMT), a 50 m diameter Cassegrain telescope that will be working in the $1-3$ mm wavelength range. Because the LMT will be using focal-plane arrays, it is of interest to study the atmospherically distorted shape of the telescopic Point Spread Function (PSF) and the resulting "cross-talk" among adjacent pixels.

The atmospherically aberrated PSF can be studied by assuming that the effects of the irregular medium above the telescope are equivalent and can be modeled by a two-dimensional phase screen located in the aperture plane of the antenna. Simulations of the corrupted wavefront can be made in several ways but, following a technique in use at optical wavelengths, the polynomials of Zernike can be used to represent the wavefront within a circular aperture. Phase screens can be generated that contain the correct statistical (Kolmogorov) distribution and can then be moved past the aperture plane at a given velocity, namely the wind speed component parallel to the aperture plane. Several examples of phase screens and aberrated PSFs are shown and a possible compensating scheme making use of an *aperture-plane* array is proposed.

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