FIRST EXPERIMENTAL RESULTS FROM PUPIL MASKING ON A SOLAR TELESCOPE

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We present the results of a pupil masking experiment using the Sun as a source. The goal of the experiment was a first proof of concept validation for Fizeau interferometric beam combination using a source that fills the field of view of the telescope. Phase diversity techniques are employed to record the phasing errors in the mask required to construct the optical transfer function (OTF) and are used to deconvolve the *dirty* images.

1. Introduction

The need for high angular resolution is well recognized in astronomy and motivates the search of sites with good *seeing* and the development of large aperture imaging systems.

Nowadays, it is well known that technological and financial limits do not allow fabrication of monolithic optical systems with apertures much larger than 10 meters. In order to overcome this limitation the only practical solution is to use interferometric arrays of telescopes.

The situation is a little more complicated when the object of the observations is an extended source that completely fills the field of view because, in such a case, it is not sufficient to use *normal* interferometric techniques (i.e. measuring fringe visibilties in the common pupil plane). For this problem the use of an imaging interferometric array (i.e. an array which combines the image planes of the different elements)is more appropriate.

In this poster we present some first results of a pupil masking experiment that simulates an imaging type of array (without the additional complication of phasing the various elements of the array).

2. The Experimental Set-up

The experiment was carried out on the Vacuum Tower Telescope (VTT) of the National Solar Observatory at Sacramento Peak.

The lay-out of the optical set-up is shown in Fig. 1.

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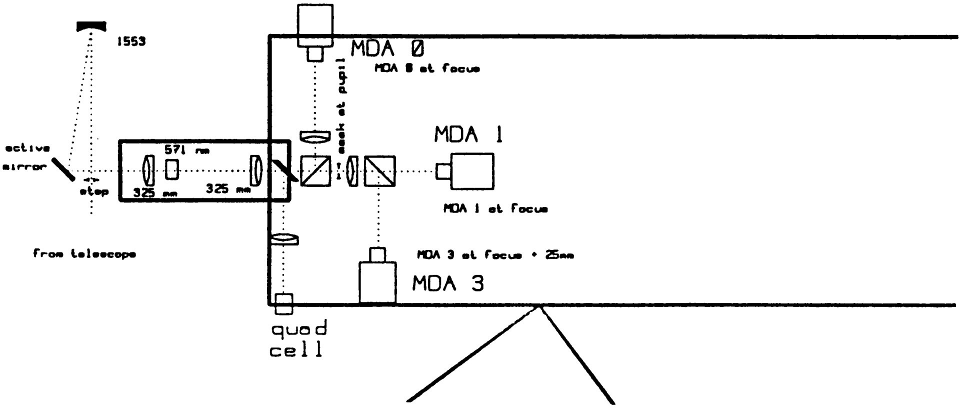

Fig. 1. Schematic lay-out of the optical set-up. M is the mask located in the pupil plane of the telescope. FM is an agile mirror that removes the global tilt in the wavefront.

We exposed simultaneously three CCD cameras, one recording the image coming from the full aperture, a second recording the image coming from the masked pupil, and the third one recording an out-of-focus image from the masked pupil.

Several sets of observations of a small sunspot (NOAA AR # 7348 12N, 37W) were acquired during December 1st 1992.

The mask was composed of a ring of 11 holes equidistantly arrayed on a 57.5 cm diameter circle. The diameter of each hole is 5 cm projected onto the entrance pupil of the VTT (76 cm), with the center of each hole 7.5 cm from the edge of the pupil. We stopped the the entrance pupil down to 60 cm in diameter.

3. Data and Data Reduction

Each frame of data consists of 3 CCD images recorded using RCA 504 chips with 403X256 pixels. Each pixel is rectangular with dimensions of 16X20 μm^2.

Standard calibration frames, i.e. dark current and gain, were acquired following each set of observations ($\approx$ 17 minutes in length).

From the phase diversity information we retrieved the phase information (Restaino, 1992) that allowed us to construct the OTF of the system. From the OTF we were able to deconvolve the images coming from the masked pupil. The deconvolution algorithm used was a modified Wiener filter (Kalestynski, 1990). The results of some frames deconvolved are shown in Fig. 2.

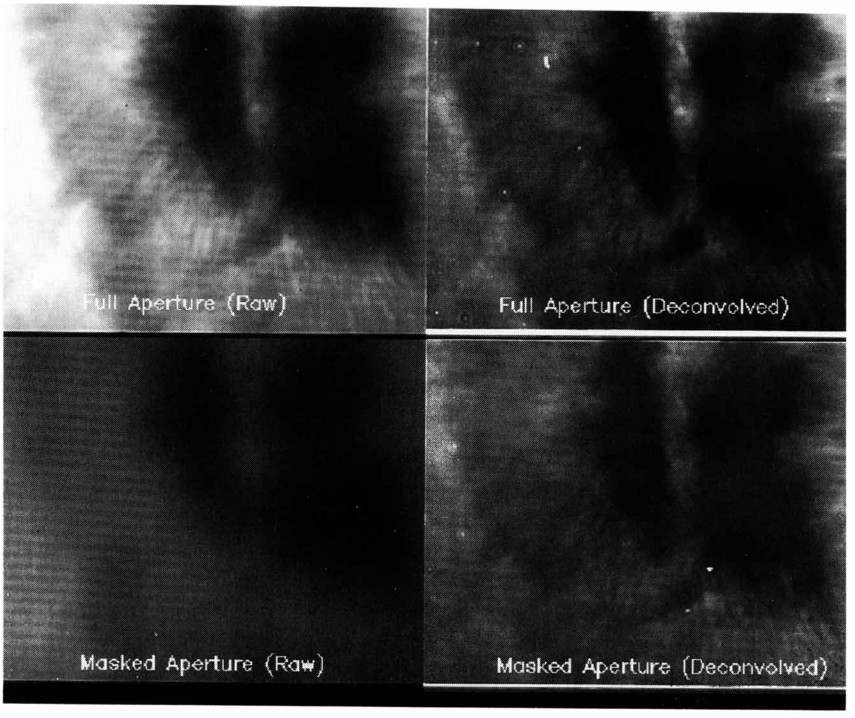

Fig. 2. An example of a full pupil frame (top left), deconvolved full pupil frame (top right), masked pupil (bottom left), and deconvolved masked pupil frame (bottom right).

4. Conclusions

We have presented results of a pupil masking experiment. The results show that it is possible to retrieve the phase information required to phase an interferometric array from phase diversity data. Further investigation of the engineering issues related to implementing a solar interferometric arrays are needed. We are, in fact, undertaking further steps in this direction.

Acknowledgements

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5. References

1. Restaino, S.R.: 1992, Applied Optics **31** (35),7442

2. Kalestynski, A.: 1990, Optik **85**, 53

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