MILLIARCSECOND IMAGING WITH A LARGE OPTICAL ARRAY

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Abstract. Considerable progress has been made over the last few years in ground based optical interferometery. The Mark III optical interferometer at Mount Wilson which at this time is operating with a 12 meter north south baseline is capable of measuring amplitude and phase. Experience gained from this facility will allow for the development of a large optical array. Preliminary plans are described for a facility that will be capable of milliarcsecond imaging of celestial objects at wavelengths from 0.4 to 10 microns. If funded this array will be in operation by 1993.

1. Introduction

There is the need for high resolution measurements at optical wavelengths to measure precisely the position and diameters of stars in our galaxy as well as compact collapsed objects in external galaxies. Interferometeric techniques offer an increase in resolution of an order of magnitude over other techniques using a single large aperture.

Optical interferometry is advancing rapidly as is evidenced by the development of independent aperture interferometers for amplitude interferometry by Labeyrie in France and Davis in Australia as well as interferometers that measure both amplitude and phase (Shao and Staelin) in the visible and Townes in the IR.

2. Mark II/Mark III Optical Interferometers

A series of stellar interferometers have been built on Mt Wilson over a period of years to develop the technology for aperture synthesis at optical wavelength. After an initial demonstration of phase tracking on Polaris, the Mark II was built on the principle that as much of the complexity of a stellar interferometer be placed in software. The Mark II

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demonstrated the technology to reliably and quickly find stellar fringes from stars all over the sky.

The Mark III is presently operating with a 12 m N-S baseline and 9 m E-S baseline. From measurements obtained in 1986 with just the N-S baseline, it has measured the position of stars to a formal accuracy of 0.02 arc sec (Mozurkewich et al), determined the diameter of several stars (Shao, et. al. 1987b) and made measurements characterizing the turbulence of the atmosphere (Colavita et al). Plans are underway in 1987 to operate with the two baselines and a laser metrology system consisting of 15 laser interferometers. Additional information on IR operation will be obtained from a two element 10 micron interferometer, to become operational in late 1987.

3. The Large Optical Array

The Mark III will be upgraded over the next two years in several ways to test aperture synthesis techniques. One planned modification is to increase the size of the collecting optics to approximately 1 meter. Another is to extend the baseline to 40-50 meters so that a much larger number of stellar disks are resolved. Another is to add the capability for simultaneous operation of three interferometers for closure phase/ triple correlation measurements. The development of these additions to the Mark III will give us the experience needed to build the large optical array. The preliminary design of this array which will image objects at wavelengths between 0.4 and 10 microns consists of approximately thirteen elements with apertures between 1.0 and 1.6 meters with baselines up to 200 meters at visible wavelengths to almost a kilometer at IR wavelengths. Table 1 gives the preliminary parameters for the array.

Table 1: Large Optical Array Instrument Parameters

# elements	7 (medium sized telescopes) 0.75 meter 6 1.65 meter telescopes one delay line per telescope.
baselines	5 meter to >200 meters (site dependent)
wavelength	0.4 to 10 microns
resolution	0.0002 arc sec at 0.4 micron 0.005 arc sec at 10. micron

4. Status

We are in the process of seeking funding for this program. If we are successful we hope to initiate this program in fiscal year 1989 and have initial operation of the array in 1993.