3. HIGH ANGULAR RESOLUTION IMAGING FROM THE GROUND

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INTRODUCTION TO THE JOINT COMMISSION MEETING ON HIGH RESOLUTION IMAGING FROM THE GROUND

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1. INTRODUCTION

As a result of advances in instrumentation and techniques, from radio through to optical wavelengths, we have before us the prospect of producing very high resolution images of a wide range of objects across this entire spectral range. This prospect, and the new knowledge and discoveries that may be anticipated from it, lie behind an upsurge in interest in high resolution imaging from the ground. Several new high angular resolution instruments for radio, infrared, and optical wavelengths are expected to come into operation before the 1991 IAU General Assembly.

Although several meetings and workshops have been held in recent times in the general area of high resolution imaging they have catered primarily for those already active in the field. The majority of astronomers are probably unaware of the status of imaging techniques - what can and what cannot be done. With this in mind, the aim of this Joint Commission Meeting is to inform the astronomical community of the status of high angular resolution imaging from the ground and of the capabilities which will soon be available for astrophysical studies. To meet this aim, the program consists of a number of invited reviews covering the techniques, the instruments, and the astrophysical potential of high resolution imaging for the different regions of the spectrum. Imaging from space is not included since the emphasis of the meeting is on opportunities in the near future.

2. SOME BACKGROUND MATERIAL

Radio astronomers are producing remarkable maps of the sky which have revealed details of a wide range of objects such as supernova remnants, radio galaxies with complex structures including jets and tails, and apparent superluminal motion infrared from images obtained at different epochs. Infrared and optical astronomers have lagged behind their radio colleagues in high resolution imaging but work is under way at a number of centres to adapt radio techniques to the shorter wavelengths.

Objects for which images are already being obtained, or soon will be, include asteroids, planets and satellites, protostars and envelopes, stellar surfaces and circumstellar shells, binary and multiple systems, pulsating stars (Cepheids, Miras etc.), planetary nebulae, supernova remnants, central regions of globular clusters, galactic nuclei and quasars. The list is not intended to be exhaustive but simply to indicate the wide range of objects which can be studied with the aid of high resolution imaging.

Unfortunately, while the imaging capabilities of optical telescopes are being improved

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by speckle interferometry and adaptive optics, the angular resolution required to achieve images of the objects listed above is generally well beyond the capability of existing and, in many cases, of any conceivable single aperture instrument at any wavelength. It is necessary to use an array which may range from a simple two aperture interferometer to multi-element arrays like the Very Large Array (VLA).

The task of producing images from interferometric arrays is non-trivial and later speakers will address some aspects of the problems posed by the atmosphere, by instrumental factors, by the dilute nature of the aperture and the limited u,v plane cover. Nevertheless, there has been a revolution in imaging capabilities and some of the major advances in instrumentation and techniques that have brought this about include the development of aperture synthesis, large radio telescope arrays (e.g. Westerbork, VLA, Merlin), very long baseline interferometry (VLBI), electronics and computers, image processing algorithms such as CLEAN and MEM, self-calibration using closure phases and amplitudes, speckle interferometry, measurement of accurate optical and infrared visibilities, optical fringe tracking and the demonstration of phase closure at optical wavelengths.

Some of the major instruments currently under development (with expected completion dates where known) which make this meeting timely include:

- The Australia Telescope (AT) (radio) (1989)
- The Berkeley Infrared Spatial Interferometer (ISI) (USA) (1989)
- The Sydney University Stellar Interferometer (SUSI) (optical) (Australia) (1990)
- The Very Long Baseline Array (VLBA) (radio) (USA) (1992)
- The Giant Meterwave Radio Telescope (GMRT) (India) (1992)
- The Cambridge Optical Aperture Synthesis Telescope (COAST) (ir) (UK)
- The Institut de Radio Astronomie Millimétrique Interferometer (France & W. Germany)
- Development of the CERGA I2T into an INT with N telescopes (ir and optical) (France)
- The United States Naval Observatory Astrometric Optical Interferometer (USA)
- The Very Large Telescope (VLT) (ir and optical) (ESO) (1994-9)

In addition there are several optical and infrared projects in the early planning or prototype stage.

In summary, techniques which have been developed and used successfully at radio wavelengths are now being tried in the infrared and optical spectral regions. Several major high resolution instruments covering the spectrum from radio to optical wavelengths are under construction. The field is at an exciting stage and it is hoped that this meeting will stimulate further interest in the use of high resolution imaging in astrophysical studies.