



Anisoplanatic Atmospheric Measurements for Terrestrial Imaging

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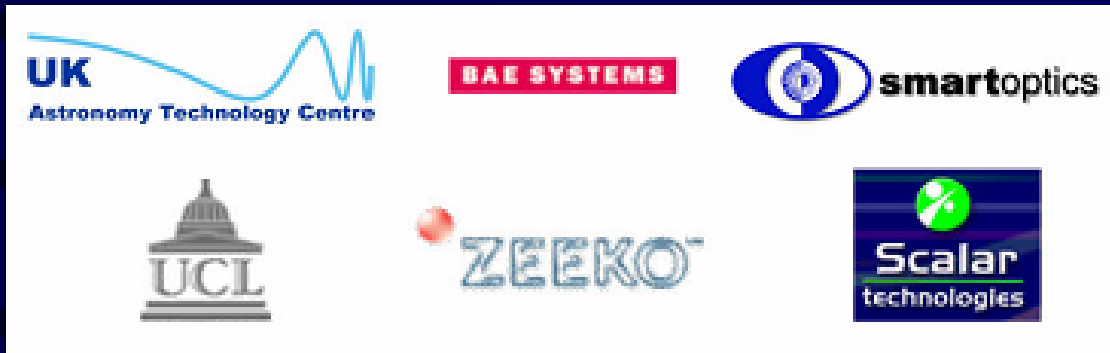
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Acknowledgements:

- OMAM Collaborators:



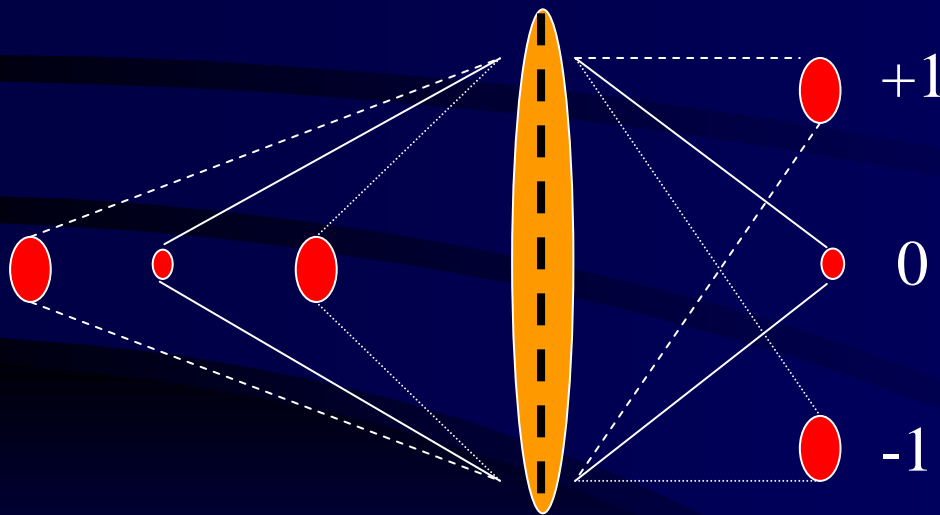
- OMAM Funding Institutions:



- Introduction to Phase Diversity Wavefront Sensing
- Modification to Allow Measurement of Scintillation Statistics
- Experimental Setup
- Simultaneous Measurement of Multiple Sources
- Advantages of this System
- Future Work

Phase Diversity Wavefront Sensing:

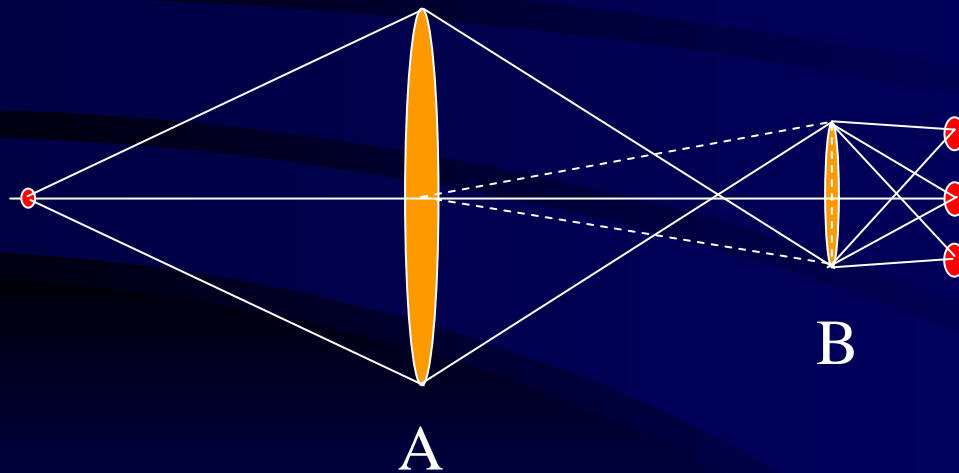
- Setup using a defocus grating:



- Zero-order is image of an object plane
- ± 1 orders are defocused images of the object

Pupil-Plane Imaging System:

- The system described previously can be modified to image the input pupil of a system:



- Grating located at lens B
- Zero-order is an image of the input pupil – lens A
- ± 1 orders are defocused images of that plane

Experimental Setup:



- Meade Schmidt-Cassegrain Telescope
- Basler CCD Camera

Experimental Setup:



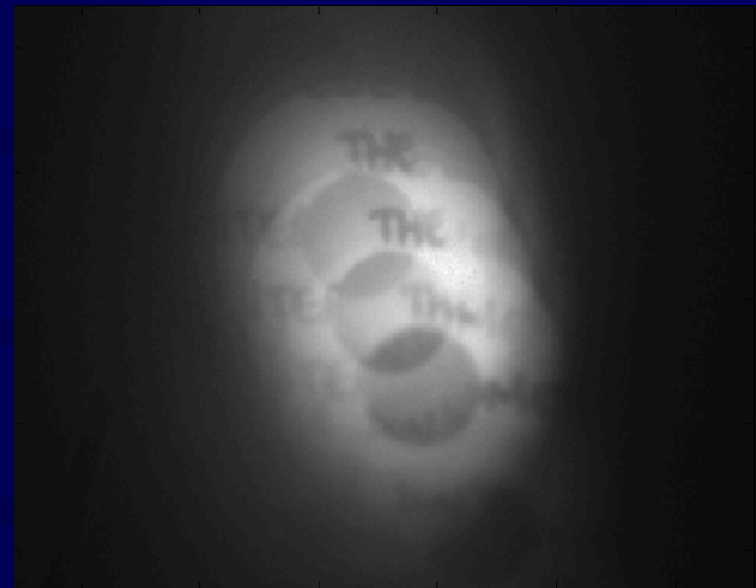
- Lens / Grating Assembly

Experimental Setup:



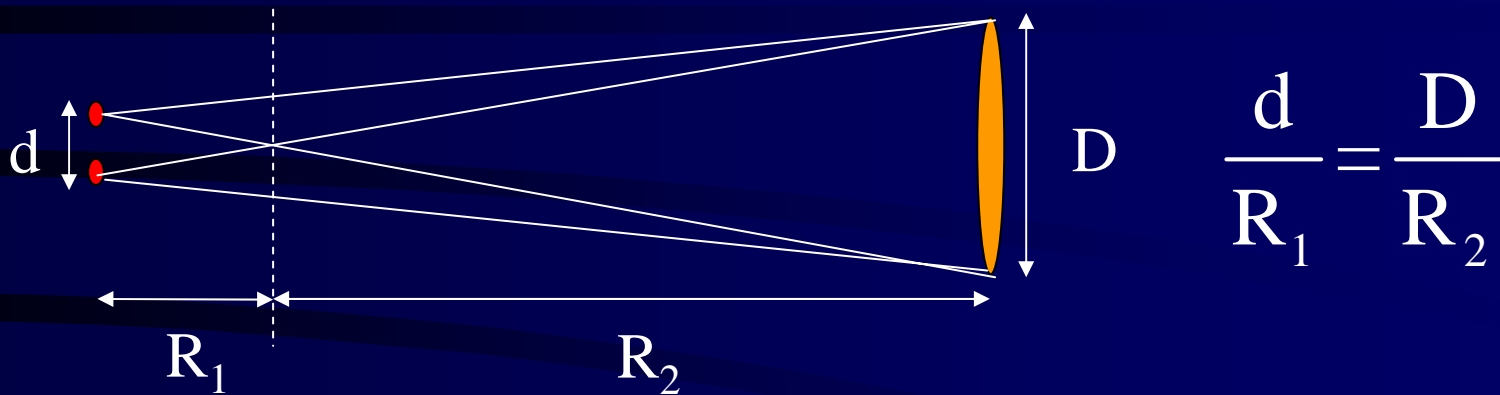
- Lens / Grating Assembly
- Variable Iris

Pupil Images:



- Zero-order image shows scintillation in pupil.
 - Can determine scintillation statistics
- ± 1 orders can be used to give phase information
 - Use phase diversity to reconstruct wavefront
- Can obtain both simultaneously

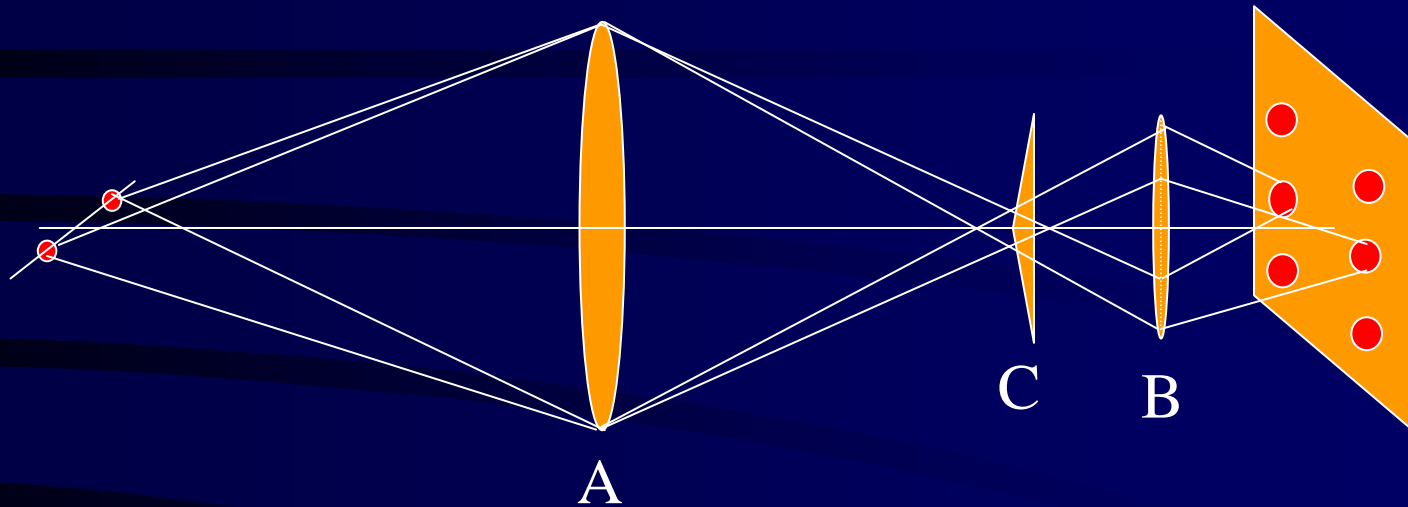
Anisoplanatism:



$$\frac{d}{R_1} = \frac{D}{R_2}$$

- Isoplanatic region, R_2 , decreases as source separation d is increased.
- In the anisoplanatic region, R_1 , there is no correlation between the sources.

Modification of System to Image Multiple Sources:



- The prism, C, separates images of the two sources
- Can obtain simultaneous measurements from multiple sources

Advantages of this System:

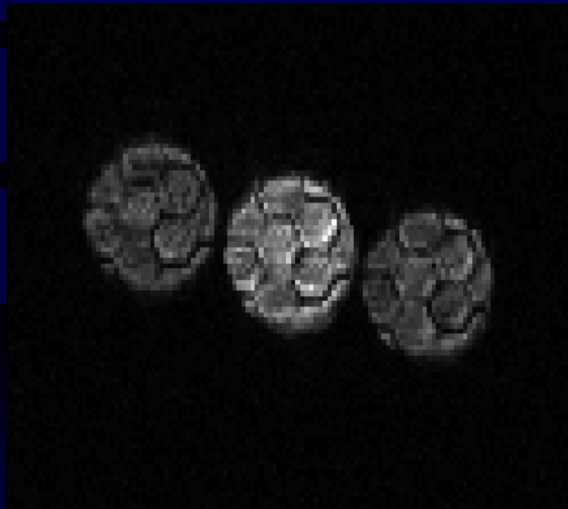
- Simultaneous imagery from multiple sources
 - Can extract scintillation and phase information simultaneously and without confusion from multiple spatially separated sources.
- Can hopefully relate scintillation and phase information
 - May be able to improve scintillation compensation in turbulence-degraded images.

Challenges in Implementation:

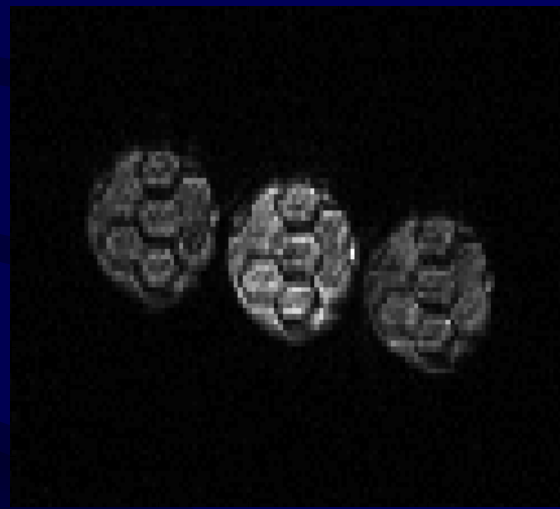
- It is difficult to ensure that the pupil plane is the one being imaged.
 - May be imaging some plane at an unknown position from the telescope
- Separation of pupil images on detector:
 - Have not yet incorporated the prism into the system.

Focusing on the Pupil Plane:

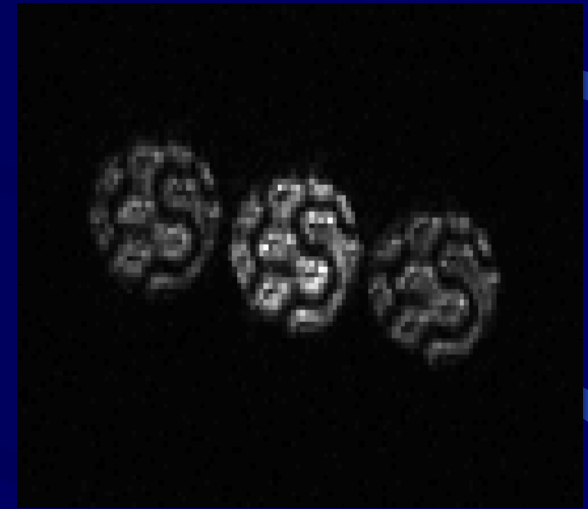
- Use a patterned glass plate placed in the pupil plane
 - When scatter from edges is minimised, plane is in focus



In Focus



7cm Separation



25cm Separation

Future Work:

- Insert prism and make measurements with multiple sources
- Change from CCD to CMOS camera
 - Can simulate aperture averaging
- Investigate relationship between scintillation and phase.
 - May be possible to use to improve imaging capability

Conclusions:

- Developing a new system to measure phase and scintillation information simultaneously.
- Can examine multiple sources, and measure anisoplanatism effects.
- System may allow us to develop a relationship between scintillation and phase.



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