

Contents

List of participants	6
Preface	11
I Diffraction-dominated observational astronomy	16
1 Introduction	17
2 Images in astronomy	18
3 Coherence properties of light	19
4 Diffraction-dominated imaging	25
5 High-contrast imaging	29
5.1 Pupil apodization	30
5.2 Coronagraphy	32
5.3 Coronagraphic formalism	33
6 Atmospheric turbulence and Adaptive Optics	34
7 Extreme adaptive optics	40
8 Calibration of biases	42
9 Focal-plane based wavefront control?	44
10 Conclusion	50
II Introduction to optical/IR interferometry: history and basic principles	55
1 Introduction	56
2 Some reminders	58
2.1 Complex representation of an electromagnetic wave	60
2.2 Principle of Huygens-Fresnel	62
3 Brief history about the measurements of stellar diameters	64
3.1 Galileo	64
3.2 Newton	64
3.3 Fizeau-type interferometry	64
3.4 Home experiments: visualization of the Airy disk and the Young interference fringes	68

4 Light coherence	70
4.1 Quasi-monochromatic light	70
4.2 Visibility of the interference fringes	71
4.3 Spatial coherence	73
4.4 Zernicke-van Cittert theorem	74
4.5 Some remarkable properties of the Fourier transform and applications	75
4.5.1 Linearity:	76
4.5.2 Symmetry and parity:	76
4.5.3 Similarity:	76
4.5.4 Translation:	77
4.5.5 Door function:	77
4.5.6 Distribution of Dirac:	77
4.5.7 Applications:	78
5 Some examples of interferometers	80
6 Three important theorems and some applications	83
6.1 The fundamental theorem: relation between the pupil and focal planes	84
6.1.1 Applications of the fundamental theorem: the case of a single square aperture	87
6.1.2 Applications of the fundamental theorem: the case of a circular aperture	89
6.1.3 Applications of the fundamental theorem: the two telescope interferometer	90
6.1.4 Other types of beam recombination	91
6.2 The convolution theorem	96
6.2.1 Application to the case of the two telescope interferometer	97
6.2.2 Interferometric observations of a circular symmetric source	98
6.3 The Wiener-Khinchin theorem	99
6.4 Appendix	100
III Optical Long Baseline Interferometry	104
1 Introduction	105
2 Angular diameter and coherence of the wavefront	106
3 Angular diameter and Object-Image relationship	108
4 A direct imaging technique	111
5 The reality of the coherence	114
6 Practical considerations for the implementation of an interferometer	117
7 A modern panorama of optical long baseline interferometry	120
7.1 NPOI	120
7.2 MROI	121
7.3 The VLTI array	121
7.4 The CHARA array	122

8 The study of stellar surface and their close environment using interferometry	123
8.1 Imaging at very high angular resolution	123
8.1.1 Giant and red supergiants stars	124
8.1.2 The star/planet interaction	126
8.1.3 The rotating stars	127
8.2 Cepheids and eclipsing binaries as distance indicators in the universe	129
8.3 Young stellar objects	130
8.4 The prototypic star β Lyrae	132
8.5 Interferometry, asteroseismology and fundamental stellar and planetary pa- rameters	133
8.6 Doppler Imaging and Hot Jupiter Detection	136
8.7 Detection of the gravitational redshift in the orbit of the star S2 near the Galactic center massive black hole	138
9 Steps to the future	138