

DIFFRACTION IMAGING BY OPTICAL SYSTEMS AFFLICTED
WITH OFF-AXIS ABERRATIONS AND IMAGE MOTION

by

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ABSTRACT

The influence of primary coma, astigmatism and image motion has been investigated on the diffraction imagery of various objects like disk, annulus, bar, edge and truncated periodic. These considerations are important in OTF measurements, image simulation programs for lens design and image evaluation in aerial photography and microscopy.

The intensity distribution in the diffraction images of incoherent extended circular, annulus and truncated periodic sine and square wave targets has been calculated using optical transfer approach. The results are presented graphically along various azimuths to show the marked asymmetry and distortion in the images for different amounts of aberration. Results for encircled energy distribution were also obtained.

The study dealing with the effect of coma is then extended to obtain the intensity distribution, encircled energy and angular resolution in the far field diffraction patterns under the partially coherent light due to atmospheric turbulence. The diffraction images of partially coherent truncated bar patterns were also evaluated. in presence of coma. That it is impossible to reduce the aberrations of an optical system precisely to zero is well known, therefore, the influence of optimum balanced coma is studied on the diffraction

images of disk, annulus, edge and bar objects. Strehl intensity criterion is used to obtain the optimum balance among various coma terms. The validity of the Strehl criterion was examined on the imaging of these types of extended objects.

The effect of primary astigmatism has been investigated on the intensity distributions, encircled energy and Strehl ratio in the far-field diffraction patterns under partial coherent illumination. Further the effect of a quadratic phase factor in the mutual coherence function has also been taken into account to evaluate intensity distributions. Intensity distribution in diffraction images of incoherent annulus object has also been studied for different object sizes and contrast between the object and their surround in the presence of astigmatism.

Next, investigations have been made on the diffraction images of single bar, truncated periodic and annulus objects in the presence of parabolic image motion occurring in transverse scanning panoramic and tilted frame cameras. The deleterious effects of motion in various cases have been described in detail.

In the end we have reviewed briefly some of the recent work related to Schell's theorem.

The work reported in the present thesis has resulted in the following publications:-

1. Diffraction images of extended circular targets in presence of coma, Can.J.Phys., 55, 1025 (1977).
2. Diffraction theory of image formation in the presence of linear coma; Annulus object, Optica Applicata, 7, 47 (1977).
3. Diffraction images of truncated incoherent periodic objects in presence of primary coma (submitted for publication).
4. The joint influence of atmospheric turbulence and primary coma on the far-field diffraction of a circular aperture (Submitted for publication).
5. Influence of primary coma on partially coherent imagery; truncated periodic bar patterns (submitted for publication).
6. Influence of optimum balanced coma on disk spread functions, Can. J.Phys. 56, 12 (1978).
7. Diffraction theory of image formation in the presence of optimum balanced coma; Annulus object, Jemna Mechanika A Optika, 2, 41 (1978).
8. Influence of optimum balanced coma on diffraction images of bar and edge objects, Microscopica Acta, 80, 313 (1978).
9. Partially coherent far-field diffraction in the presence of primary astigmatism, Can.J.Phys., 56 (1978) in Press.
10. Effect of a quadratic phase factor on the partially coherent far-field diffraction in the presence of primary astigmatism (Submitted for publication).

11. Diffraction images of incoherent annulus object in presence of primary astigmatism. *Microscopica Acta*, 80, 359 (1978).
12. Motion degraded bar images in panoramic cameras. *Ind. J. Pure Appl. Phys.*, 13, 767 (1975).
13. Bar spread functions for parabolic image motion. *Photogramm. Engr. Remote Sensing*, 43, 529 (1976).
14. Diffraction images of truncated periodic targets in the presence of parabolic image motion. *Current Science*, 45, 41 (1976).
15. Diffraction images of incoherent annulus object in the presence of parabolic image motion. *Atti. Fond G. Ronchi*, 31, 609 (1976).
16. Intensity point spread function of slit in presence of linear image motion, *J. Optics (India)* 4, 68 (1975).

CONTENTS

CHAPTER		Page
	ABSTRACT	i-iv
I	INTRODUCTION	
	1.1 Image Formation in the Presence of Aberration and Motion	1
	1.2 Geometrical Optics Treatment of Aberrations	5
	1.2.1 Wave and Ray Aberration; the Aberration Function	6
	1.3 Classification of Aberrations	7
	1.3.1 Nijboer Treatment of Aberration Function and Zernike Circle Polynomials	9
	1.4 Diffraction Theory of Aberrations	10
	1.4.1 Diffraction Integral in Presence of Aberrations	12
	1.4.2 Imaging of Extended Objects	15
	1.4.2.1 Imaging of Incoherent Extended Objects and Optical Transfer Function	16
	1.4.2.2 Diffraction Images: Isolated Extended Objects	20
	1.4.2.3 Effect of Atmospheric Turbulence	23
	1.4.2.4 Partially Coherent Objects	24
	1.4.2.5 Effect of Image Motion in Aerial Photography	25

II	DIFFRACTION IMAGES IN PRESENCE OF PRIMARY COMA; INCOHERENT EXTENDED CIRCULAR, ANNULUS AND TRUNCATED PERIODIC TARGETS	
2.1	Introduction	29
2.2	Diffraction Images of Extended Circular and Annulus Objects	31
2.2.1	Theory	34
2.2.2	Results and Discussions	38
2.2.2.1	Extended Circular Targets	38
2.2.2.2	Annulus Object	43
2.3	Diffraction Images of Truncated Periodic Objects	46
2.3.1	Theoretical Formulation	48
2.3.2	Discussion of the Results	50
2.3.2.1	Additional Remarks	56
III	EFFECT OF COMA ON FAR-FIELD DIFFRACTION PATTERNS IN PRESENCE OF TURBULENCE AND IMAGING OF PARTIALLY COHERENT OBJECTS	
3.1	Introduction	58
	<u>Section-I</u>	
3.2	Partially Space Coherent Diffraction	59
3.2.1	Introductory Considerations	59
3.2.2	Fourier Transform Theorem for Plane Quasimonochromatic Partially Space Coherent Sources	61
3.2.3	Far-Field Diffraction Patterns under the joint Influence of Atmospheric Turbulence and Primary Coma	63
3.2.4	Theoretical Formulation	64
3.2.5	Results and Discussions	66

Section-II

3.3	Influence of Primary Coma on Partially Coherent Truncated Bar Patterns	69
3.3.1	Introduction	69
3.3.2	Mathematical Formulation	72
3.3.2.1	Truncated Periodic Square wave Targets	75
3.3.2.2	Sine Wave Objects	76
3.3.3	Results and Discussions	77
IV	DIFFRACTION IMAGES IN THE PRESENCE OF OPTIMUM BALANCED COMA: INCOHERENT DISK, ANNULUS, BAR AND EDGE OBJECTS	
4.1	Introduction	81
4.2	Coma Aberration Balancing	85
4.3	Disk and Annulus Objects	87
4.3.1	Theoretical Formulation	87
4.3.2	Results and Discussions	89
4.3.2.1	Disk Object	89
4.3.2.2	Annulus Object	91
4.4	Bar and Edge Objects	94
4.4.1	Introduction	94
4.4.2	Theoretical Formulation	96
4.4.3	Results and Discussions	97
V	PARTIALLY SPACE COHERENT DIFFRACTION AND IMAGING OF INCOHERENT ANNULUS OBJECT IN THE PRESENCE OF PRIMARY ASTIGMATISM	
5.1	Partially Space Coherent Far-Field Diffraction; Effect of Quadratic Phase Factor	101

5.1.1	Introduction	101
5.1.2	Theory	103
5.1.3	Results and Discussions	109
5.2	Incoherent Annulus Object	115
5.2.1	Theoretical Formulation	115
5.2.2	Discussion of Results	116
VI	EFFECT OF PARABOLIC IMAGE MOTION ON THE IMAGE QUALITY; SINGLE BAR, TRUNCATED PERIODIC AND ANNULUS OBJECTS	
6.1	Introduction	120
6.2	Parabolic Image Motion	122
6.2.1	OTF for Parabolic Image Motion	124
6.3	Bar Objects	127
6.3.1	Bar Spread Function for Circular Aperture System	129
6.3.1.1	Theoretical Formulation	129
6.3.1.2	Results and Discussions	132
6.3.2	Bar Spread Function for Annular Aperture Systems	135
6.3.2.1	Theoretical Formulation	137
6.3.2.2	Results and Discussions	138
6.4	Truncated Periodic Objects	141
6.4.1	Results and Discussions	142
6.5	Annulus Objects	144
6.5.1	Theory	144
6.5.2	Discussion of the Results	146
6.6	Intensity Point Spread Function of a Slit in Presence of Linear Image Motion	148

APPENDIX	AN OVERVIEW OF SOME RECENT WORK ON SCHELL THEOREM	151
A.1	Spatial Coherence, Radiometry and the Inverse Scattering Problem of Planar Sources.	152
A.2	Radiant Intensity and Spatial Coherence for Finite Planar Sources	156
A.3	Walther and Schell Model Sources	159
A.4	Additional Remarks	163
	REFERENCES	165
	BIODATA	180