ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com

International Journal of Advanced Research Trends in Engineering and Technology (IJARTET) Vol. 10, Issue 11, November 2023

Intensity Distribution Curves With Maxima and Minima for Apodised Two Zone Apertures

Dr. S. Radhika[1], Dr. T. Kiran Kumar[2]
Principal, Government Degree College, Badangpet, R.R District –500058, Telangana , INDIA.
Email.ID radhikasekhar74@gmail.com[1]
Assistant Professor, Department of Physics, Brilliant Institute of Engineering and Technology Hyderabad – 501505. Telangana, INDIA.
Corresponding author email ID: t.kirankumar@yahoo.co.in[2]

Abstract: It has been observed in the previous investigations that apodised optical systems result in an enhanced limit of resolution. In further pursuit of determining the two line resolution of pupil functions which have been framed as perfect apodisers rotationally symmetric $\cos^2$-type of amplitude apodisation filters have been considered as the prime subject of this research. The amplitude transmission of this filter is higher than that of the associated filters considered. choosing the transmission function of the pupil of the system, the intensity in the outer parts of the diffraction pattern can be totally suppressed or at least considerably reduced without increasing the dimensions of the pupil. Many apodisation filters have been proposed in instrumental optics for various purposes. In the present investigation, the diffracted field characteristics of rotationally symmetric optical systems shaded with the variable apodisation with two zones have been considered to analyze the intensity distribution in terms of the width of the central maximum and reduction in the secondary maxima by shaping the circular aperture

Keywords: Resolution, apodisation, Sparrow, Rayleigh and Conrady etc.

I. INTRODUCTION

In this investigation decreases for higher values of the apodisation parameter with a larger central area of transmission which results in a better image fidelity and lesser obstruction in the visual sense and practically negligible secondary maxima with a decrease in the shifting of the first zero's away from the origin, for higher values of apodisation parameter. The $\cos^2$- types of filters were studied by many researchers in different imaging situation. TSUJIUCHI[1958] has studied the property which a co-sinusoidal filter possesses to focus the light, though he restricted himself to the calculation of irradiance along the axis only, he was able to show its utility as a spatial filter for the improvement of optical images. WALDMANN [1966] had studied the effect on the image of a variable contrast pupil of cos filter, In this section, the limit of resolution of two lines separated by u_o diffraction units about the origin is calculated by applying the Sparrow, Rayleigh and Conrady's criteria. The resolution limits for lines of different intensity ratios β = 1.0, 0.75, 0.50, 0.25 have been obtained using the Central contrast method for each value of the apodisation parameter C = 0.25, 0.5, 0.75, 1.0. The resolution limits for lines of equal intensity have been obtained using the Five-Point Finite difference approximation method for each value of the apodisation parameter C.

II. CENTRAL CONTRAST METHOD

The central contrast in the intensity distributions has been calculated using the formula,

$$\text{Central Contrast (C.C)} = (I_{max} - I_{centre})/ I_{max}$$

The central contrast for each object separation beyond Sparrow limit for each value of β has been obtained and plotted against the object separation for each value of the intensity ratio. The value of the separation at which the contrast in the image drops to zero gives the Sparrow limit of resolution. The Rayleigh limit is the separation at which the contrast in the image drops to 26.5% and the Conrady limit is the separation at which the contrast in the image of the two line objects drops to is 2%. The estimated limits of resolution and is evident that there is an increase in an increase in the resolution limit for increasing values of β and C. A minimum increase of 0.18 diffraction units in the resolution limit as the value of C increases from 0 to 1 has been found for β = 1.0 and a maximum increase 0.35 diffraction units has been found for β = 0.25 in the case of Sparrow and Conrady's criteria and in the case of Rayleigh criteria the minimum increase in the resolution limit has been found to be 0.225 diffraction units for β = 1.0 and a maximum increase of 0.35 diffraction units for β = 0.25.

Five – Point Finite Difference Approximation; Taking the cue from the Sparrow criterion the central curvature has been estimated on the basis of

ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com

International Journal of Advanced Research Trends in Engineering and Technology (IJARTET) Vol. 10, Issue 11, November 2023

"Five- point finite difference approximation" [PRABHAKAR RAO, 1979] using the formula discussed in chapter V section 5.4.2.(ii) when the curves are symmetrical about the origin for lines of equal intensity.

When the central curvature is zero the lines are said to be resolved in the Sparrow sense. When the central curvature is 0.265 the two lines are resolved in the Rayleigh sense and in the Conrady's sense when the central curvature is 0.02.

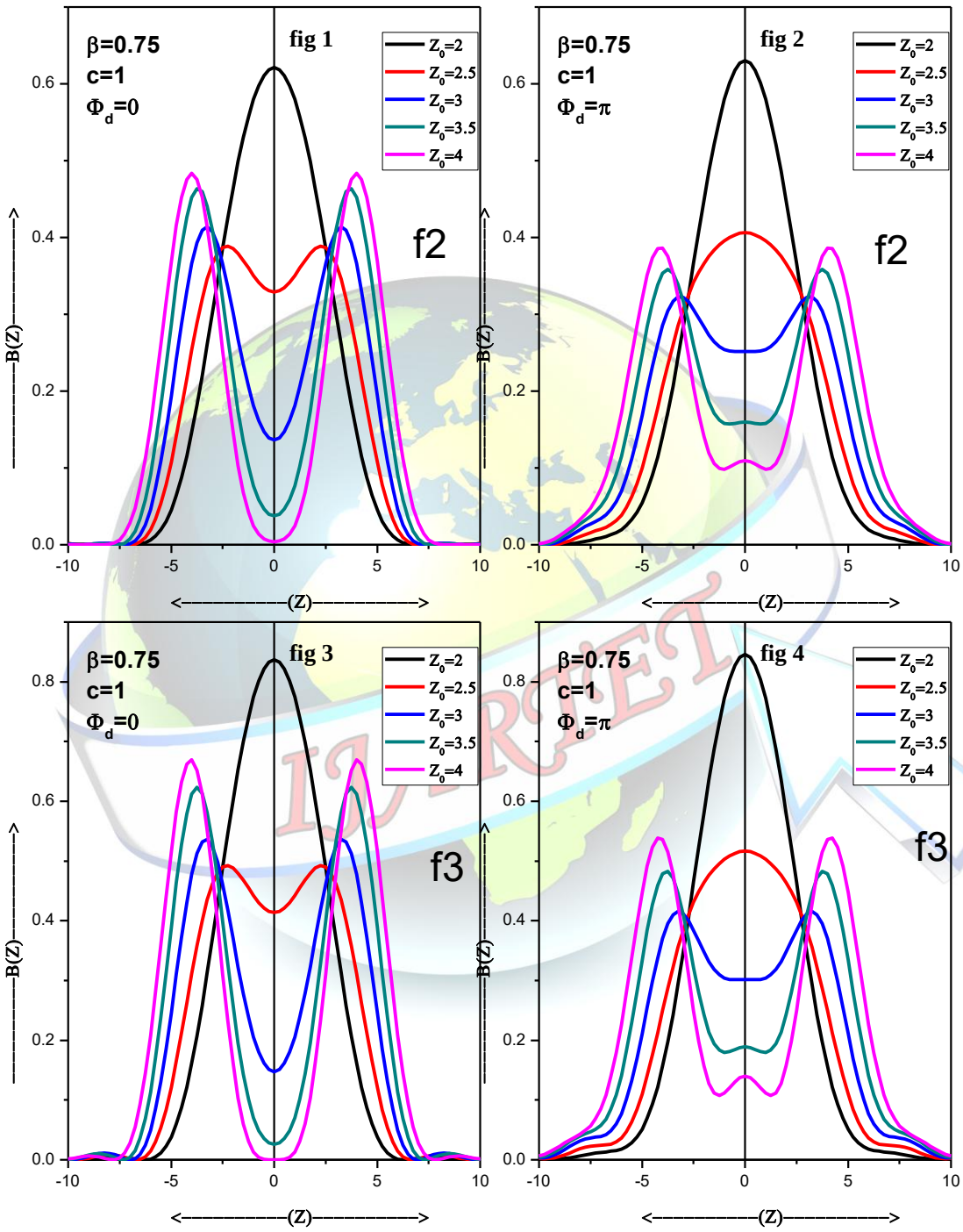
III. RESULTS

From an inspection of the image intensity distribution curves and the limits of resolution the following conclusions are drawn

i. It is clearly seen from the curves that the secondary maxima are absent for values of C>0
ii. In each of the figures there look to be two points through which all the curves pass for lower values of the apodisation parameter and particularly at lower separation. The reason being the lower the separation the greater is the slope of the intensity curve.
iii. The contrast in the image increases for decreasing values of β beyond resolution limit.

ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com

International Journal of Advanced Research Trends in Engineering and Technology
(IJARTET) Vol. 10, Issue 11, November 2023



INTENSITY DISTRIBUTION CURVES

ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com

International Journal of Advanced Research Trends in Engineering and Technology (IJARTET) Vol. 10, Issue 11, November 2023

		c. max		c. min		c.max		c.min	
a = 0.2 b = 0.8 $Ø_d$ = π	0	0	0.1021	5.2404	0.002	7.3034	0.0309	9.5498	0.0025
	0.2	0	0.1156	5.2573	0.0024	7.3201	0.0314	9.571	0.003
	0.4	0	0.1567	5.267	0.003	7.3273	0.031	9.5702	0.0034
	0.6	0	0.2001	5.2725	0.0036	7.328	0.03	9.555	0.0037
	0.8	0	0.2455	5.275	0.0043	7.324	0.0285	9.5298	0.0039
	1	0	0.2934	5.2749	0.0051	7.3157	0.0268	9.4972	0.0039

The decrease in the Gaussian intensity peak is less than that of the associated triangular pupils for equal intensity lines.

The limit of resolution increases with increase in the apodisation parameter C

The increase in the Rayleigh limit is more when compared to the increase in Sparrow and Conrady limits of resolution for a given ratio of intensity of the lines with increasing values of C.

The value of the resolution limit increases as the intensity of one of the lines decreases. The reason being, for a less intense line to be resolvable it should be at a separation where its image peak superposes with the more intense line at a point where the contrast at the point of inflection is at least zero in the least possible case (Sparrow limit).

One has to bear with the increase in the resolution limit seen for increasing values of the apodisation parameter, and reach at a compromise between apodisation and resolution. In the case of $\cos^2$-type of apodisation filters the best compromise between apodisation and resolution can be struck for the value of C = 0.25 where the pupil function behaves as a perfect apodisers and the deviation of the resolution limit from that of the Airy systems is only 0.07 diffraction units.

REFERENCES

1. Karuna Sagar D, Sayanna R and Goud SL. Effects of defocusing on the sparrow limits for apodized optical systems. Opt. Commun., 2003. – Vol.217. – P. 59-67.
2. Naresh Kumar Reddy A, Karuna Sagar D. Point spread function of optical systems apodised by a semicircular array of 2D Aperture functions with asymmetric apodization. Journal of Information and Communication Convergence Engineering, 2012. – Vol.12 (2). – P. 83-88.
3. Keshavulu Goud M, Komala R, Naresh Kumar Reddy and Goud SL. Point spread function of asymmetrically apodised optical systems with complex Pupil filters. Acta Physica Polonica A, 2012. – Vol.122(1). – P. 90-95.
4. Kowalczyk, M. Zapata-Rodriguez, CJ. Martinez-Corral, M. Asymmetric apodization in confocal scanning systems. Applied Optics, 1998. – Vol.37(35). – P. 8206-8214.
5. Siu, GG. Cheng, L. Chiu, DS. Improved side-lobe suppression in asymmetric apodization. J. Phys. D: Applied Physics, 1994. – Vol.27(3). – P. 459-463.
6. Cheng, L. Siu, GG. Asymmetric apodization. Measurement and Technology, 1991. – Vol.2(3). – P. 198-202.

Dr. S. Radhika working as Principal, Government Degree College, Badangpet, Ranga Reddy 500058 Ph.D in the field of Optics- ' Studies on the performance of Optical Systems with the Super resolving filters. Masters in Physics with Distinction Awarded State Best Teacher Award in the year 5th September 2020.Awarded 'Academic Excellence Award' (Physics) by the Telangana State Government on 23-02-2019.

Dr.T.Kiran Kumar received his Ph.D in Physics from Osmania University 2017. He received his M.Sc. from Osmania University in 2005 and B.Sc. from Kakatiya University in 2003. He has served in academics for more than 14 years. He as published 32 research papers in National and International journals. He has got Young Scientist Award by IARDO on 10th February 2019.