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PRIMARY SPHERICAL ABERRATION WITH TWO-ZONE APERTURES

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ABSTRACT
Apodisation improves some selected properties of an imaging system at the cost of some others. Apodisation can be accomplished either by aperture shading or aperture shaping. The former alters the shape of the aperture and the later alters the aperture transmission characteristics. Aperture shaping can be accomplished by altering the shape of the aperture from circular to non-circular. Aperture shading can be achieved by modifying the pupil transmission function. In the case of aperture shaping, the entrance pupil covers by the spatial filter resultantly; the transmission characteristics of the aperture are altered. Thus aperture shading results in a non-uniform amplitude transmission of the pupil from point to point (MONDAL and VENKAT REDDY, 1987). In addition to these two methods of apodisation, there is one more method of apodisation in which narrowing the central part below the classical Rayleigh limit of 3.832 units
KEY WORDS: *Aberration, Aperture, Hanning pupil and annular zones etc;*

1.1 INTRODUCTION
Apodisation may be defined as the deliberate modification of the pupil function so as to improve some measure of the image quality (WETHERELL, 1980). Straubel may be considered as the founder of apodisation theory (BARAKAT, 1962). A complete or partial suppression of the side-lobes at the cost of enlarging the central part of the diffraction pattern by modification of the entrance pupil of an optical device is known as apodisation. The resolving power of the system for point objects of equal brightness is diminished by apodisation (JACQUINOT and ROIZENDOSSIER, 1964). A rotationally symmetric optical system is that system, which has the same properties on the circumference of any circle and whose center lies on the symmetry axis of the system. Further it is also assumed that the optical system is isoplanatic (space invariant) where, if the object point changes in its location, the image point changes only in its location but not in functional form. The diffracted field characteristics have been studied for both circular apertures and annular apertures in the presence of defocus under the influence of aberrations like primary spherical aberration. A comprehensive analytical study has been made on the performance of the optical system by considering PSF

1.2 MATHEMATICAL FORMULATION:
When the aperture is divided into five concentric zones with different amplitude filter in each zone, which in turn results in variable apodisation, the expression will be of the form:

$$G_F(\phi_d, \varphi_s, \ Z) = 2\int_0^{0.2} f(r)\exp\left[-i\left(\phi_d \frac{r^2}{2} + \frac{1}{4}\varphi_s r^4\right)\right] J_0(Zr) r dr \ +$$

$$2\int_{0.2}^{0.4} f(r)\exp\left[-i\left(\phi_d \frac{r^2}{2} + \frac{1}{4}\varphi_s r^4\right)\right] J_0(Zr) r dr \ +$$

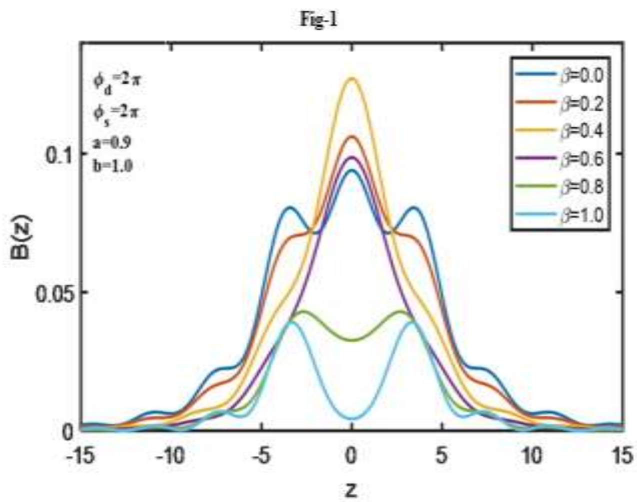
$$2\int_{0.4}^{0.6} f(r)\exp\left[-i\left(\phi_d \frac{r^2}{2} + \frac{1}{4}\varphi_s r^4\right)\right] J_0(Zr) r dr \ +$$

$$2\int_{0.6}^{0.8} f(r)\exp\left[-i\left(\phi_d \frac{r^2}{2}+\frac{1}{4}\varphi_s r^4\right)\right] J_0(Zr)rdr \quad + \quad 2\int_{0.8}^{1} f(r)\exp\left[-i\left(\phi_d \frac{r^2}{2}+\frac{1}{4}\varphi_s r^4\right)\right] J_0(Zr)rdr$$

Where f(r) is the amplitude filter chosen. The intensity or irradiance PSF $B_F(\phi_d, \varphi_s, Z)$ is given by the squared modulus of the amplitude PSF.

1.3 RESULTS AND DISCUSSION

The intensity distribution profiles in the case of three-zone aperture with Shaded amplitude filter in the first zone and Hanning amplitude filter in the second-zone while the Happ-Ganzel amplitude filter is employed in the third-zone of the circular aperture when the optical system is subjected to primary spherical aberration for various defocused planes are presented in Fig.1 depicts the case when the optical system is free from either primary spherical aberration with the first-zone of the three-zone aperture being at a value of 'a' = 0.6 and the second-zone parameter 'b' is fixed at a value of 0.8. From the analysis of the intensity distribution. When the optical system is subjected to primary spherical aberration for various defocused planes with apodisation parameter varying from β = 0, 0.2, 0.4, 0.6, 0.8 and 1. Here the zone varying parameters 'a' and 'b' are chosen as 'a' varying from 0.6 and 0.7 while parameter 'b' is varied from 0.8 and 0.9. In all of these cases the intensity in the central irradiance is maximum for extreme apodisation when the optical system is under the severe conditions.



1.4 CONCLUSIONS

Even in most well corrected systems, there are some residual aberrations present. Aberrations results in phase errors in the wave front as it traverses the optical system. The phenomenon of diffraction and aberrations are the primary contributors in the degradation of image quality and affecting the performance of the optical system. The general feature of all the optical systems is the presence of optical aberrations. The presence of aberrations introduces undesirable results and unnecessary degradation in the performance of the optical systems. The study of imaging properties of optical systems suffering from aberrations from the knowledge of the point spread function has become an important method in the design and testing of such systems. These reasons have incited to explore the possibilities in enhancing the performance of the optical systems which forms the principal aim of the present work. In the present work, the main focus was on the effects of defocus, primary spherical aberration and two-zone apertures.

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