

The Relation Between LSF of lens and Temperature

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DEFENTION

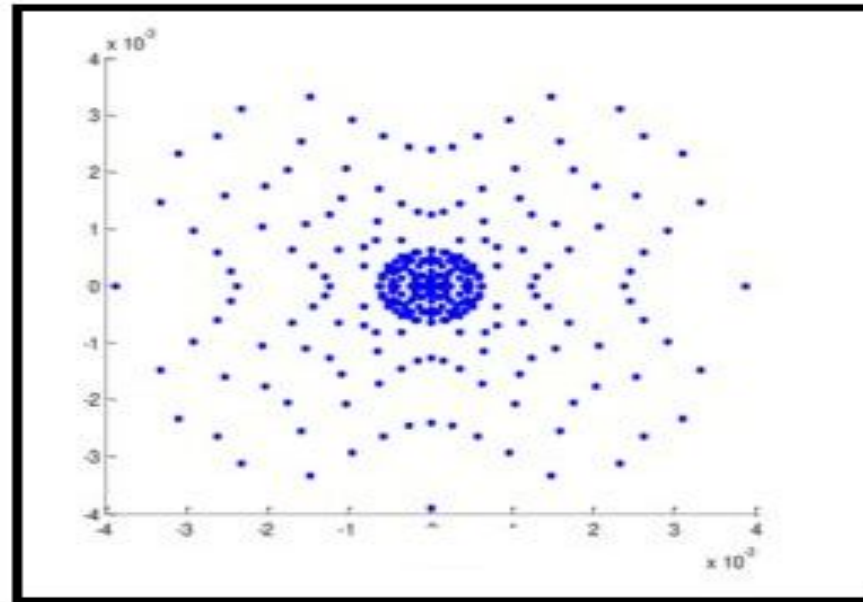
It is well known that the variable of temperature degree will effect on the characteristics of any optical component especial lenses and mirrors, because this thermal variable will effect on thermal expansion of the optical component material,(such as CV,TH,)

Sequences of The effective :

- Thermal variable effect --on Thermal Expansion of the optical mater – Optical Components (The lens)– Effect on radiuses of Curvature for the lens)– Effect on the Focus Point (focal point)—At image plane-Which contains the spots (the spot is the point of intersect the rays with image plane)—It effect on the Spot Distribution at image plane which called (Spot Diagram)

SPOT DIAGRAM

It is a plane of intersect between the light rays with image plane



Figure(1) Spot diagram

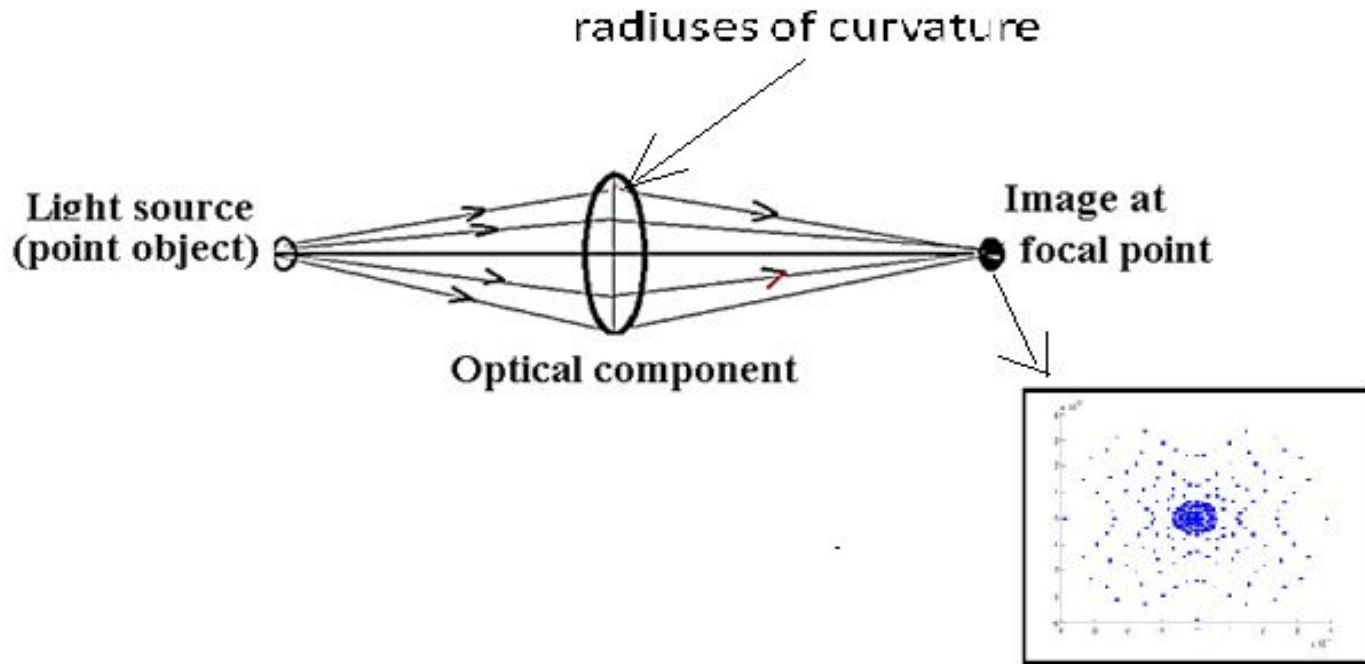
From Spot diagram we can
calculate following spread
functions:-

1-Point Spread Function **PSF**

2-Line Spread Function **LSF**

3-Edge Spread Function **ESF**

SPOT DIAGRAM



Fig(2) Best image at focal point, at room temperature ($T_n K^\circ$)
(without thermal effect)

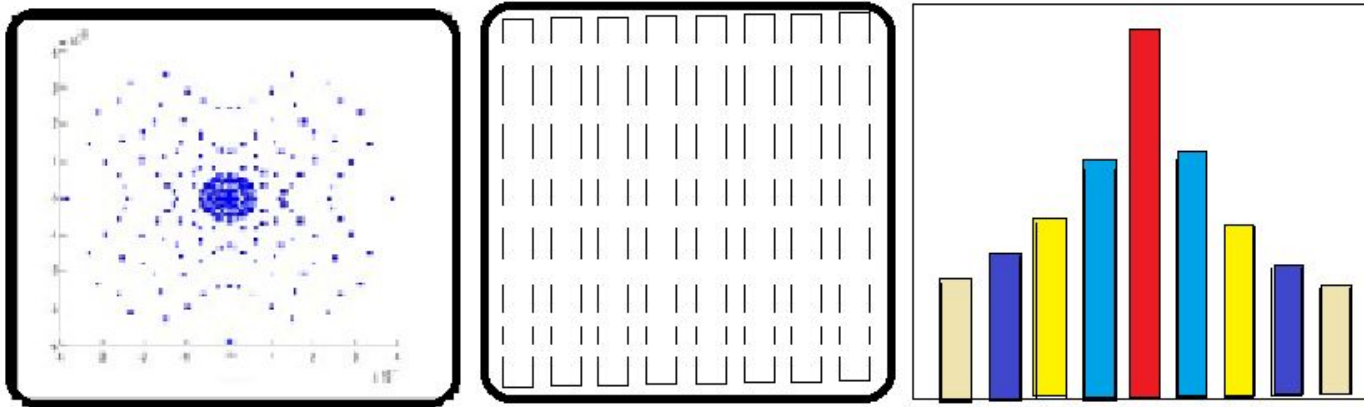
Let (y,z) is point object coordinate and (Y,Z) is spot image coordinate. There for the different between two points is:

$$\delta(y, z, Y, Z) = \delta(Y - y, Z - z)$$

To get the intensity distribution for spot diagram

$$I(Y, Z) = \int_{-\infty}^{+\infty} \int_{-\infty}^{+\infty} F_o(y, z) \delta(Y - y, Z - z) dy dz$$

Evaluation Spot Distribution at Image Plane by using LSF



Figure(3) Shows method of LSF evaluation

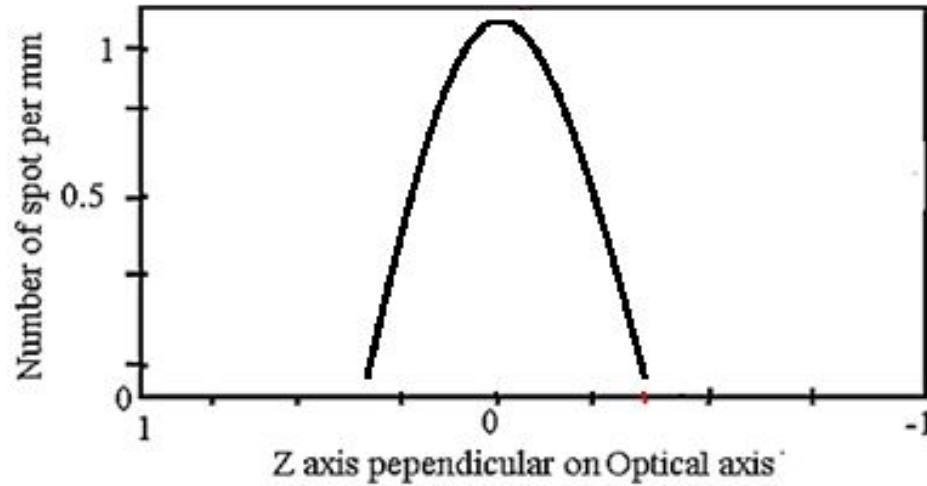


Figure (4) shows Line Spread Function at focus position (without thermal effect) (At room temperature $T_n K^\circ$)

When the temperature increase it will affect directly on the refractive index of the material (depend on thermal expansions) the amount of variable will transfer to the radius of curvature of the optical component (which means shape of it) that makes bending the rays transmitting because the refracted angle will change according to shape variable depending on the snail's law:

(Δf),

Which effect on the position of the focus

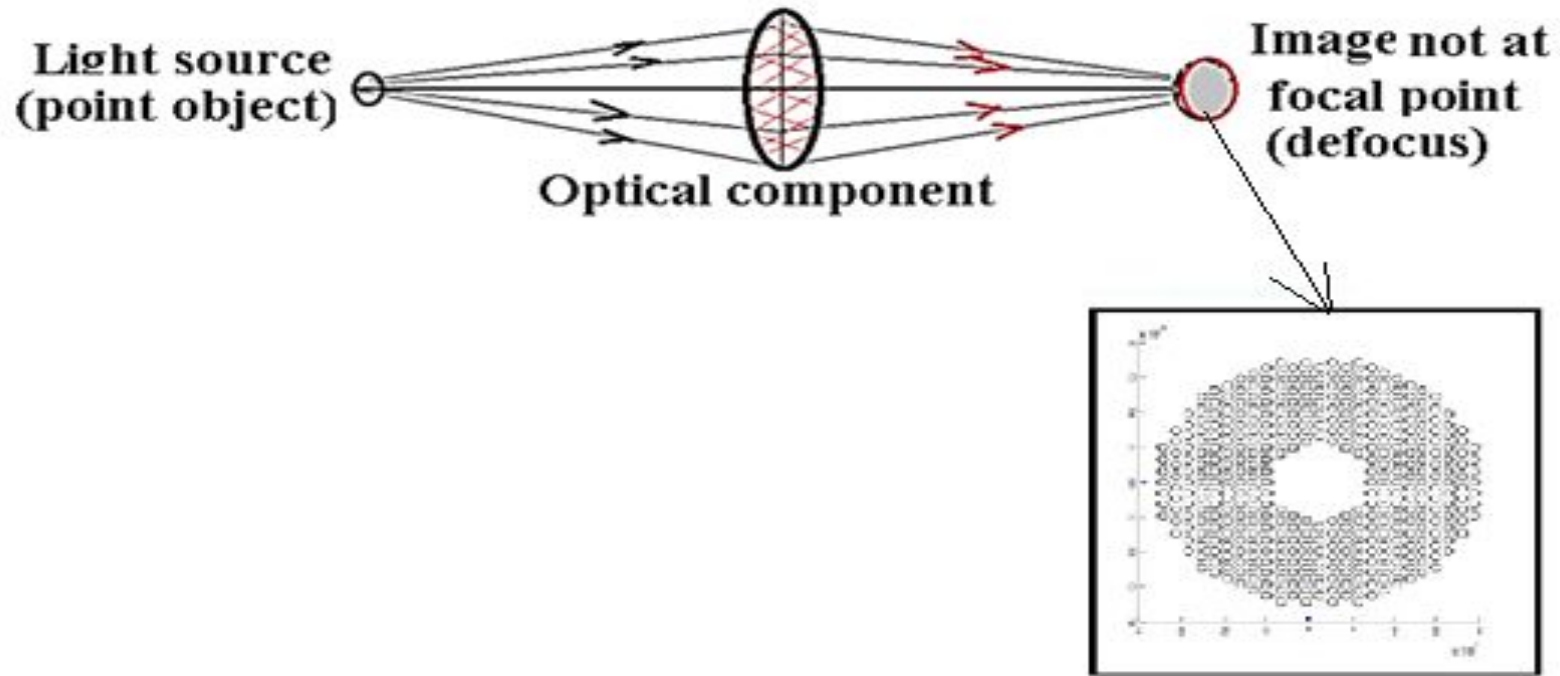
$$n_1 \sin \theta_1 = n_2 \sin \theta_2$$

Where K is geometrical constant

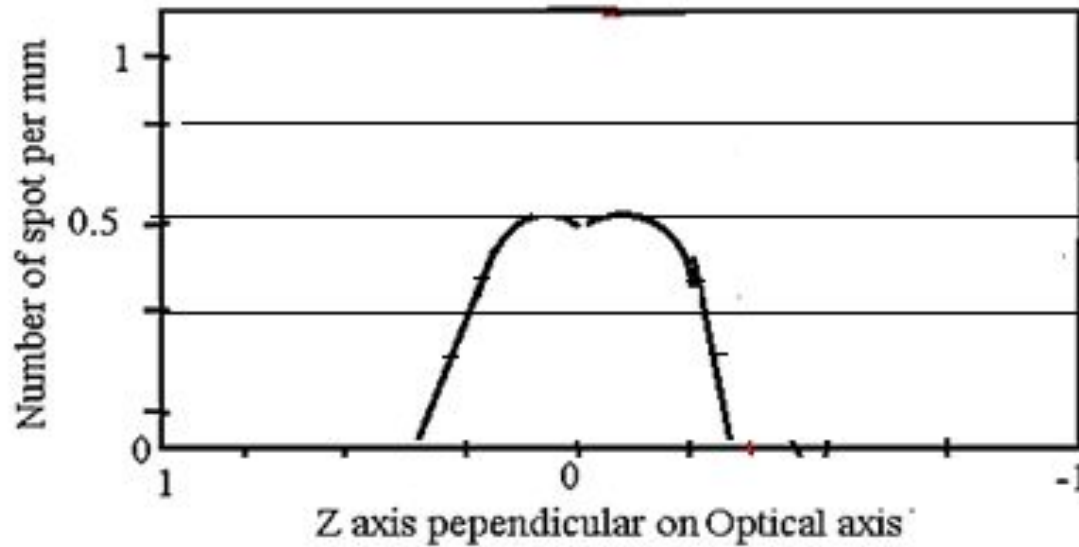
Where (Δf), as follow

$$\Delta f = \frac{\partial n}{\partial T} \cdot \frac{K}{(n-1)^2} \cdot = - \frac{f}{n-1} \cdot \frac{\partial n}{\partial T} \Delta T$$

Where K is geometrical constant



Fig(5)Spot diagram at defocus image. With thermal effect,(At temperature $T_n \times 40K^\circ$)



Fig(6) Line Spread Function at defocus position
(With thermal effect At temperature $T_n \times 40K^\circ$)

**Thank you for
Attendance and Attention**