doric

doric lenses

APPLICATION NOTE

APLANATIC POINTS OF BALL (OR ROD) LENSES

Submitted to :

Prepared by :

Document version :

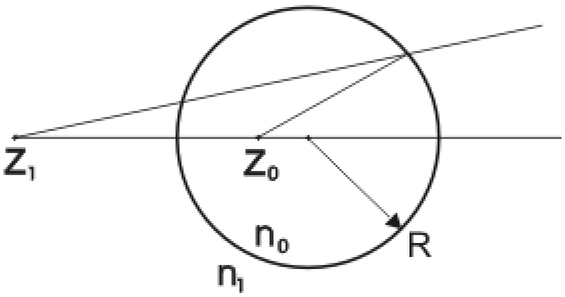
Date :

© DORIC LENSES INC
357 rue Franquet - Québec, (Québec) - G1P 4N7, CANADA
Tel. : (418) 877-5600 - Fax. : (418) 877-1008

Table of Contents

1. APLANATIC POINTS OF A SPHERE

Let us take a ball lens with radius R and index of refraction n0 immersed in the medium of refractive index n1. The center of the sphere is take at z=0. From the theory of aplanatic points of a sphere (see Luneburg's Mathematical theory of Optics) it follows that there exist two points z0 and z1 on the z-axis such that a spherical wave from z0 is transformed into a spherical wave diverging apparently from z1.



$$Z_0 = -\frac{n_1}{n_0} R$$

$$Z_1 = -\frac{n_0}{n_1} R$$

Figure 1. Aplanatic points of a sphere

It follows that aplanatic ball lens can change the beam divergence without introduction of aberrations. This principle has been used by many optical designers. We can apply the same reasoning to rods and transformation of cylindrical diverging wavefront using aplanatic points of the rods.

Aplanatic lens center thickness is given by :

$$CT_{Aplanatic} = \frac{n_1 + n_0}{n_0} R$$

Divergence reduction without any aberration is guided by aplanatic lens refractive index :

$$\frac{\tan\theta_1}{\tan\theta_0} = \frac{n_1}{n_0}$$

2. APPLICATIONS

Aplanatic ball lenses have been traditionally used to make high power microscope objectives and endoscope objectives. More recently aplanatic ball lenses have been used to reduce beam divergence from optical fibers. Similarly, aplanatic rod lenses could be used to reduce beam divergence from different planar light sources like LEDs, laser diodes or planar waveguides.

3. REFERENCES

1. R. Y. Luneberg, "Mathematical Theory of Optics", University of California Press, Berkeley, 1964.