Answer on Question #60467-Physics-Optics

Show that the radius of a dark Newton's ring is directly proportional to the square root of the radius of curvature of the lens used.

Solution

Plano-convex lens of large radius of curvature R is placed on a plane glass plate with its curved surface downwards and is illuminated from above with a parallel beam of monochromatic light. Some of the light is reflected from the upper surface of the glass plate and some from the lower surface of the lens; interference thus occurs by division of amplitude, the fringes being localized in the air gap between the lens and plate.

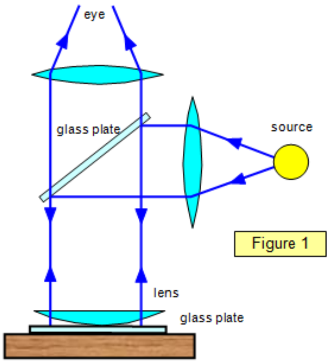

Figure 1

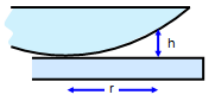

Figure 2

At any point a distance r from the axis of the lens the path difference will be 2h, where h is the distance between the lens and the plate at that point (See Figure 2). The interference fringes are circular because the system is symmetrical about the center of the lens. The radius of any ring is given by:

$$(2R - h)h = r^2 \; so \; r^2 = 2Rh - h^2$$

But h^2 is small compared with $2Rh$ and so: $r^2 = 2Rh$

The path difference $(2h)$ is therefore $\frac{r^2}{R}$.

A phase change of π occurs when the light reflects from the top surface of the plate but not at the lower surface of the lens, and therefore:

For a dark ring viewed by reflection:

$$m\lambda = \frac{r_m^2}{R}$$

$$r_m^2 = m\lambda R$$

$$r_m = \sqrt{m\lambda R} \sim \sqrt{R}$$

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