南京邮电大学
Nanjing University of Post & Telecom

物理实验教学中心

Physics Expeiment Center

Equal thickness interference

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Purposes：

1. Observation and measurement of the equal thickness interference image.
2. The basic regulation and measurement operation of the microscope.
3. Measure the curvature radius of lens using Newton ring.
4. Learn to use graphical method and differential method for data analysis.

Principles

Newton ring

o is the touch point, $e = 0$ at o point.

Optical path difference (OPD): δ

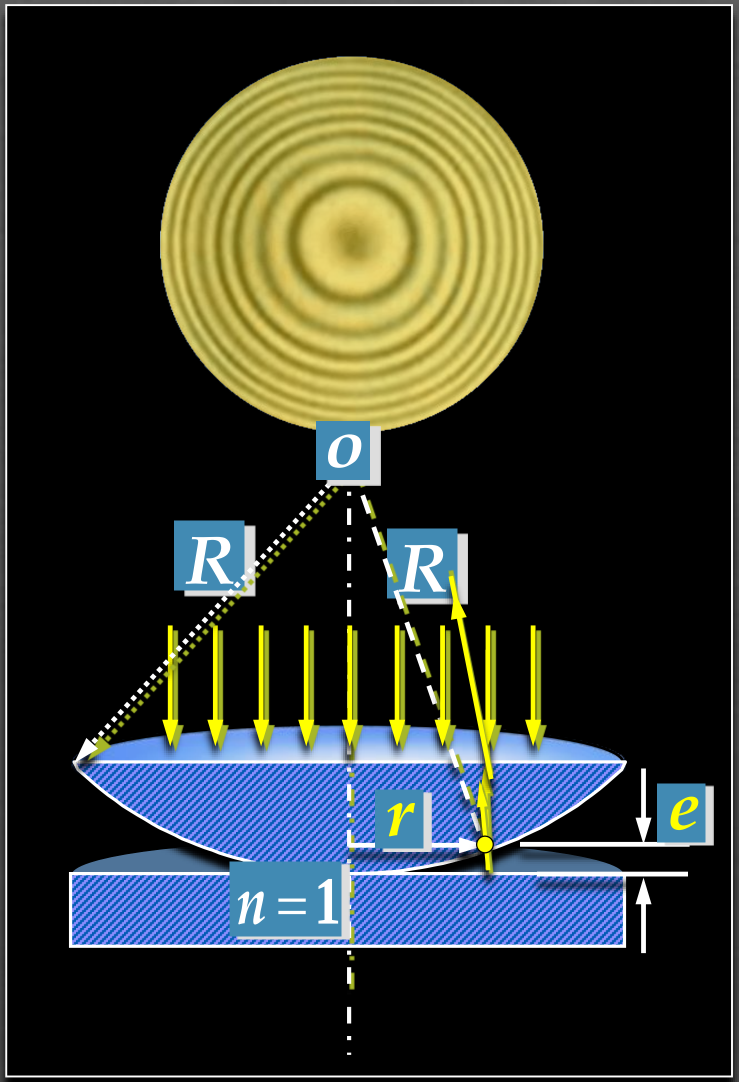
$$\delta = 2e + \frac{\lambda}{2} = 2\,\mathrm{R}e - e^2$$

$$r^2 = R^2 - (R-e)^2 \approx 2\,\mathrm{R}e$$, *because R>>e*

$$\delta = \frac{r^2}{R} + \frac{\lambda}{2} = \begin{cases} 2k\dfrac{\lambda}{2} \\ (2k+1)\dfrac{\lambda}{2} \end{cases}$$

Bright rings

Dark rings

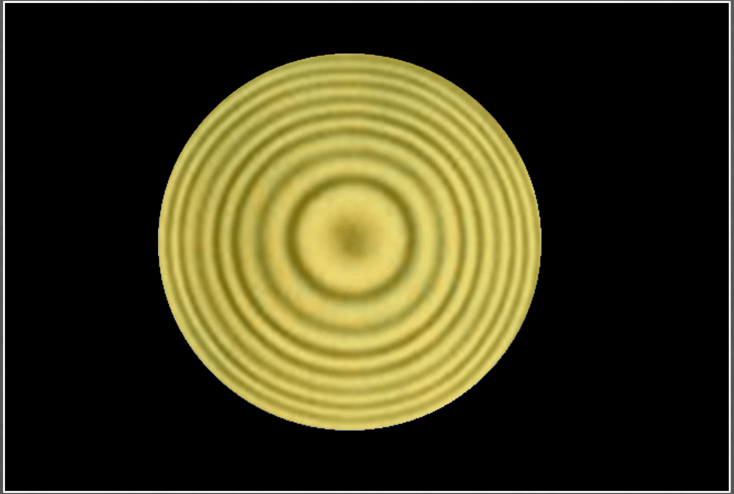


Convex lens

Measurement of the curvature radius (R) of convex lens using Newton ring

For Dark rings: $D_k^2 = (4R\lambda)k$

$$R = \frac{D_m^2 - D_n^2}{4(m-n)\lambda}$$

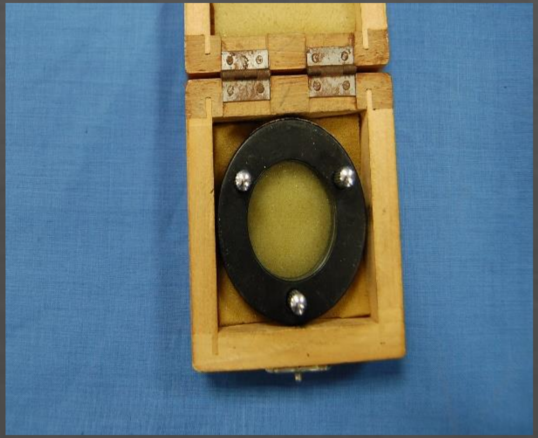


***m*, *n* is the order**

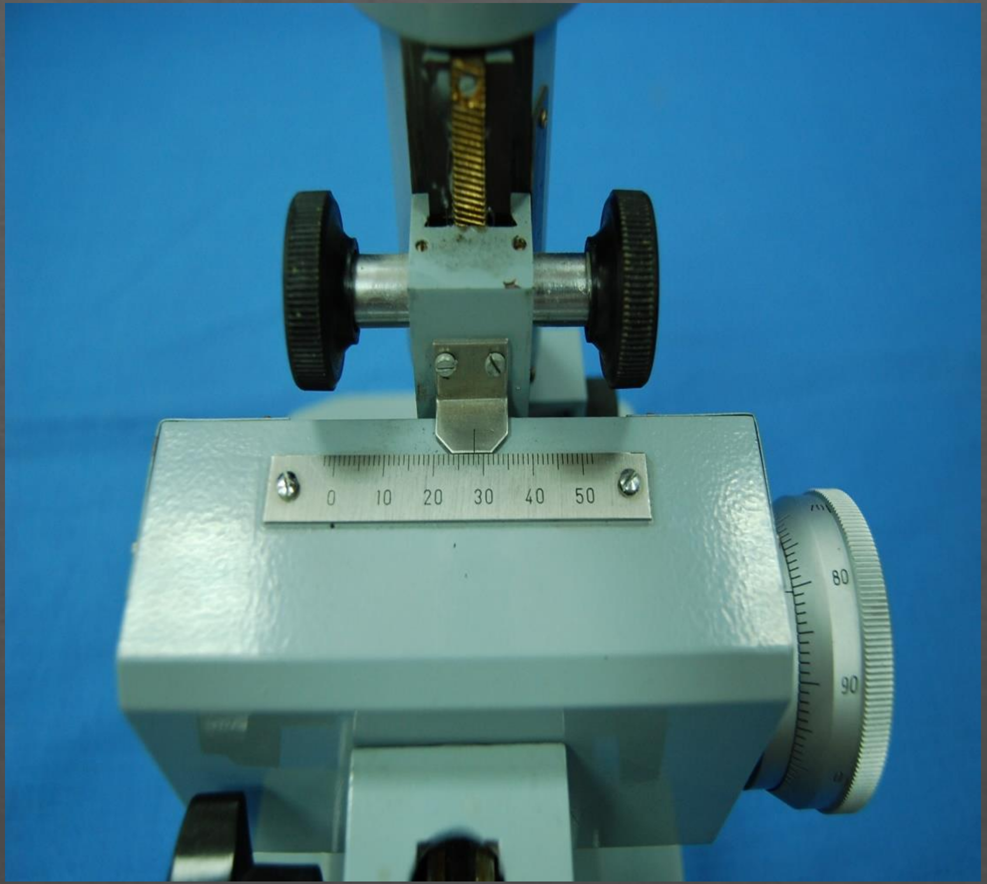
Features: **Bigger the level *k*, more dense the stripes. (*k* = 0 at center)**

Instruments

Microscope, Newton ring, Natrium lamp (λ = 589.3nm)



How to use microscope?

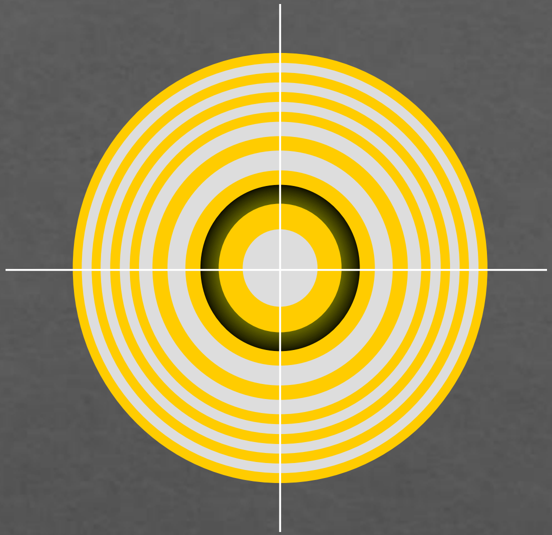


① **Corse adjustment**

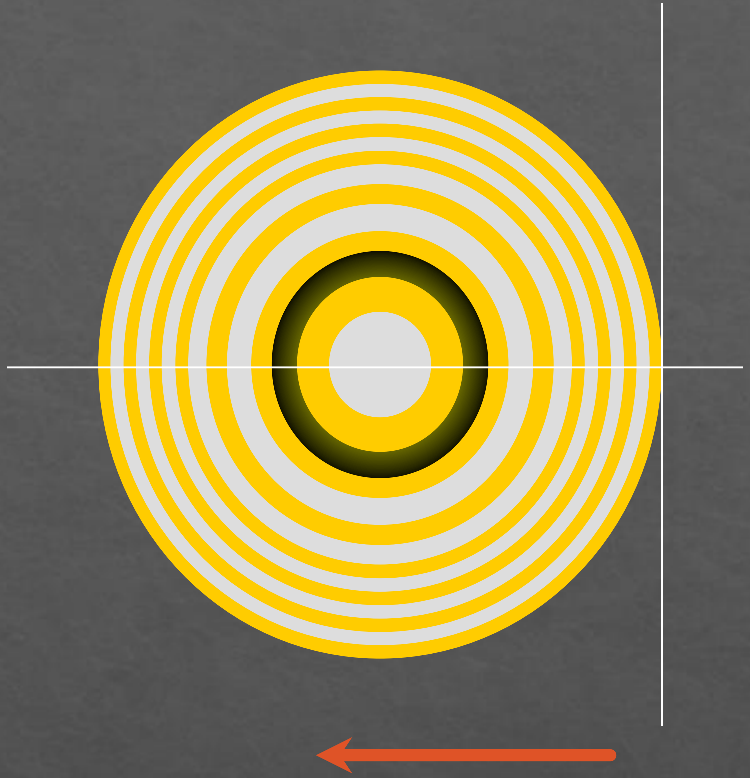
② **Fine adjustment**

***a*. Regulate eyepiece, make the cross wire clear**

***b.* Rotate transparent mirror, make the view of the microscope most bright.**



c. Rotating hand wheel from bottom to top slowly until the stripes clear.



To eliminate the return difference， we firstly move the cross wire to 35th dark ring on the right side, then turn back to the 30th dark ring, start to record the data as X_{30}， X_{25}， X_{20}， X_{15}， X_{10}， X_5 of both sides (Right to Left).

Table I

<table>
<tr><td colspan="2">Order</td><td>5</td><td>10</td><td>15</td><td>20</td><td>25</td><td>30</td></tr>
<tr><td rowspan="2">Data(cm)</td><td>Left X_K</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Right X_K'</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="2">Diameter of rings $D_K = \lvert X_K - X_K' \rvert$ cm</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="2">$D_K^2(\mathrm{cm}^2)$</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="2">$D_m^2 - D_n^2(\mathrm{cm}^2)$ $(m-n=15)$</td><td colspan="2"></td><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td colspan="2">$\overline{D_m^2 - D_n^2}$ ($\mathbf{cm^2}$)</td><td colspan="6"></td></tr>
<tr><td colspan="2">$\overline{R}$ ($\mathbf{cm}$)</td><td colspan="6"></td></tr>
</table>

$$R = \frac{D_m^2 - D_n^2}{4(m-n)\lambda}$$

λ = 589.3nm

Uncertainty (*Not required*)

$$u_{cR} = \overline{R}\sqrt{\left(\frac{u_{c\lambda}}{\lambda}\right)^2 + \left(\frac{u_{cmn}}{m-n}\right)^2 + \left(\frac{S_{\overline{D_m^2 - D_n^2}}}{\overline{D_m^2 - D_n^2}}\right)^2}$$

λ=589.3nm， u_λ=0.3nm， u_{mn}=0.2， $D_m^2 - D_n^2$ ： uncertainty of A class

Calculate the curvature radius (*R*) of lens using graphical method (not required)

$$D_k^2 = (4R\lambda)k$$

Use *k* as *x* axis, D_k^2 as *y* axis, plot $D_k^2 \sim k$ graph, calculate the slope of the line, then find out the value of *R*.

END