Physics EXP ⅡCD

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Measuring Laser wavelength and Index of Refraction of Air by Michelson Interferometer

University Physics Experiment Center

Content

1 Background

2 Aim

3 Principle

4 Equipment

5 Procedure

6 Questions

7 Expand training

8 Experimental data recording and processing

Significance

Invariance of the speed of light， promote the development of special relativity

Michelson's important contribution

- **Determination of the speed of light**

1924～1926Southern California mountains 22 miles long optical path， 299796±4 km/s

- **Determination of the reference length**

1893， Determination of the wavelength of the red cadmium line 643.84696 nm， for the standard length， recognized by the world， until 1960。

- **Michelson interferometer**

for： Michelson - Morley experiment 、 LIGO (LIGO) measuring gravitational 、 Detecting extrasolar planets

- **Echelle**

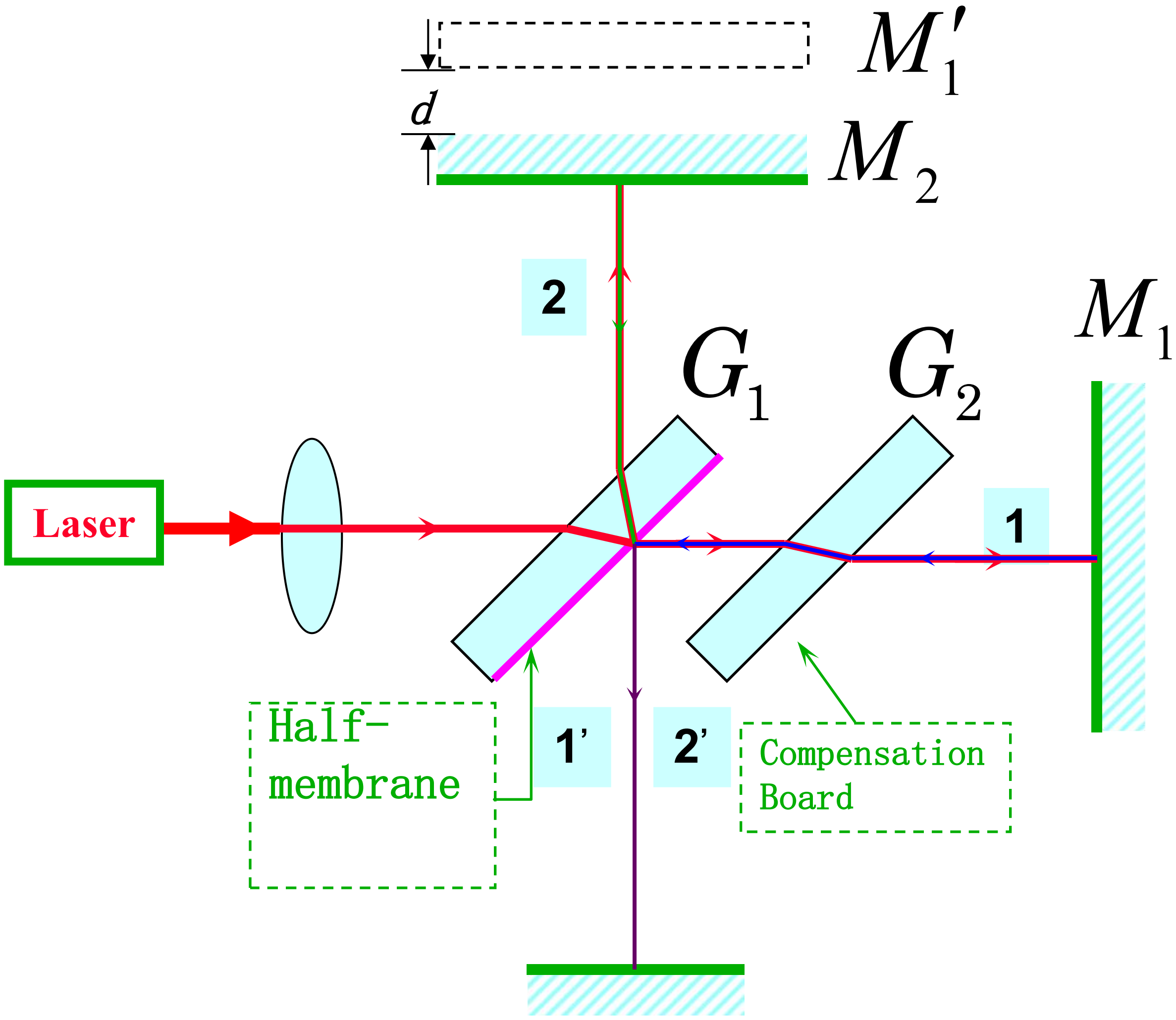
Especially for Broad-band, high dispersion, high resolution。

2. aim

- **Familiar Michelson interferometer configuration, grasp the adjustment methods and techniques.**
- **Understanding and equal inclination interference conditions and equal thickness interference fringes changes of formation.**
- **measuring the wavelength of the light source and measuring the refractive index of air.**
- **Enhance the fringe visibility and awareness of temporal coherence.**

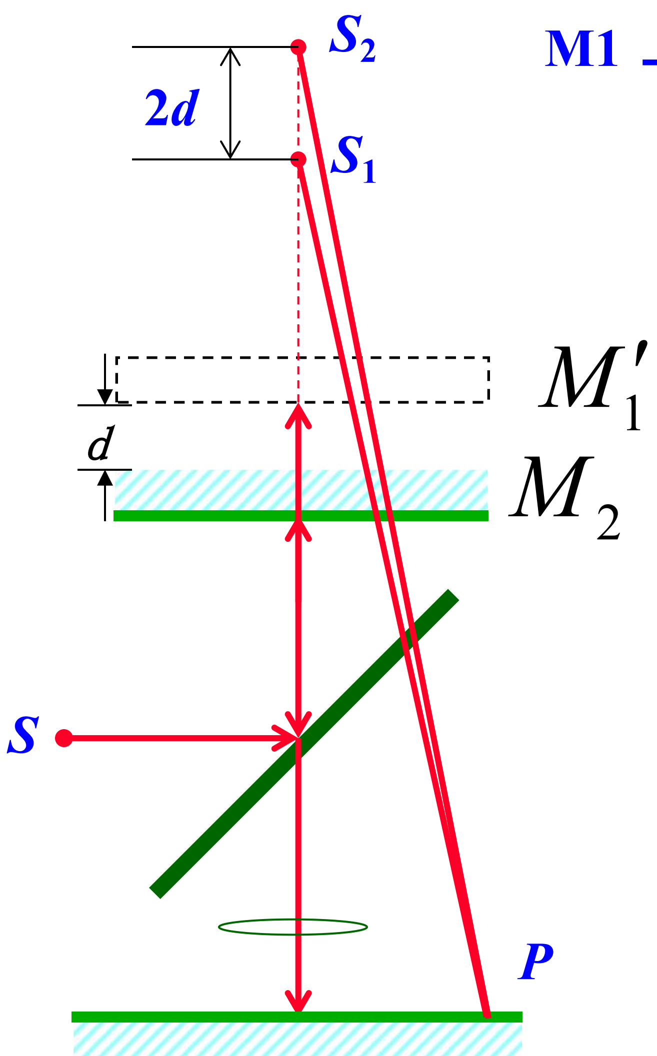
3. principle

3.1 Michelson interferometer

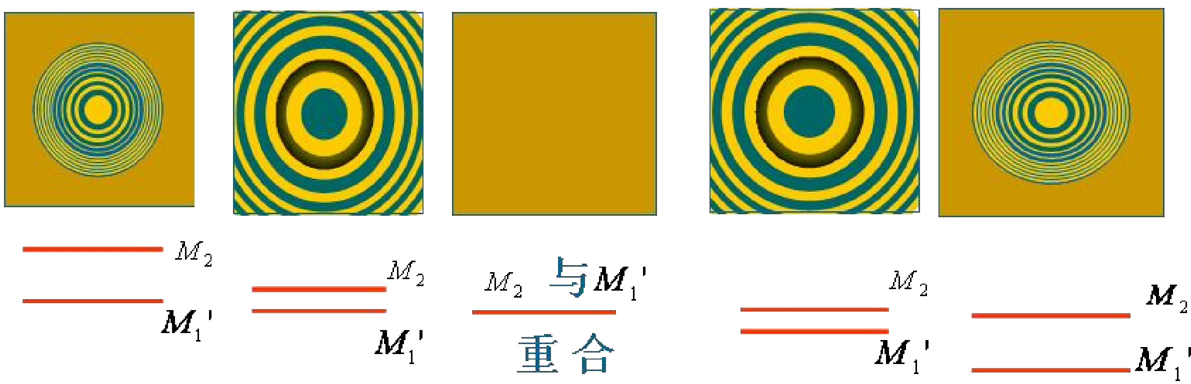


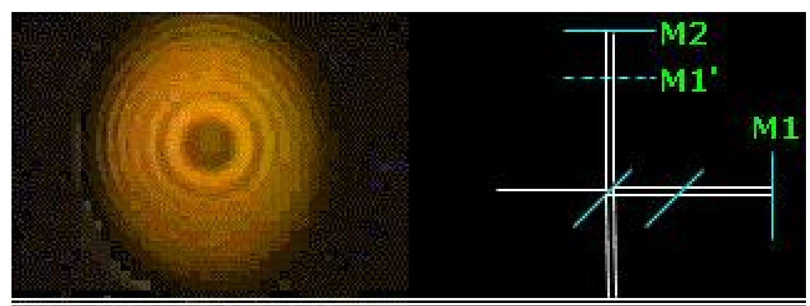
The same： M1, M2 air film between the interference generated。

3.2 Equal thickness interference and equal inclination interference



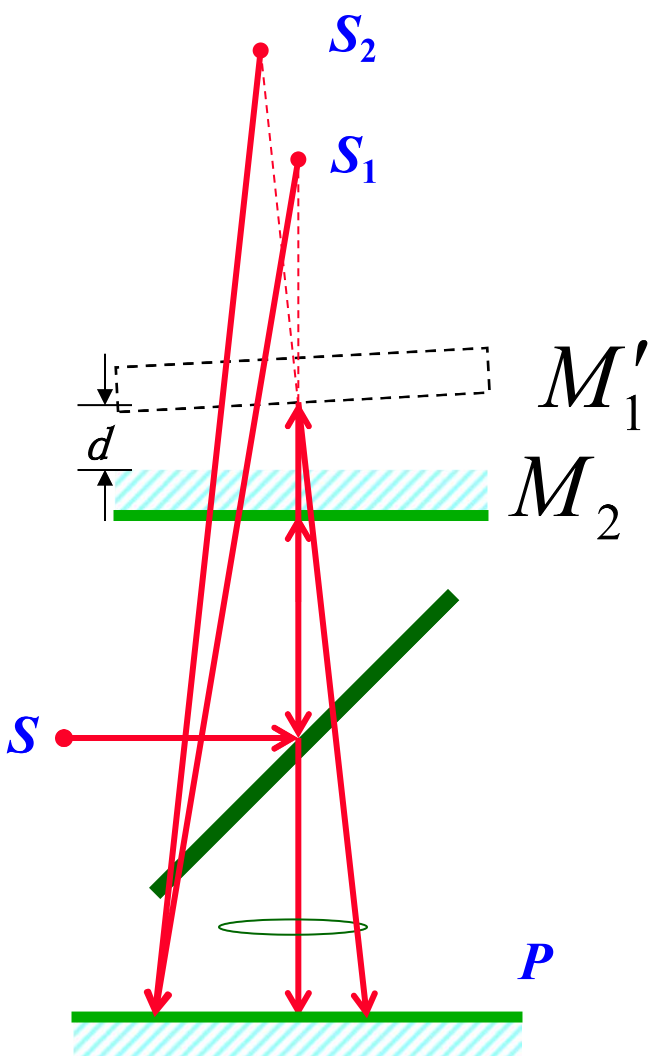
M1 ⊥ M2 perpendicular ➔ Equal inclination interference



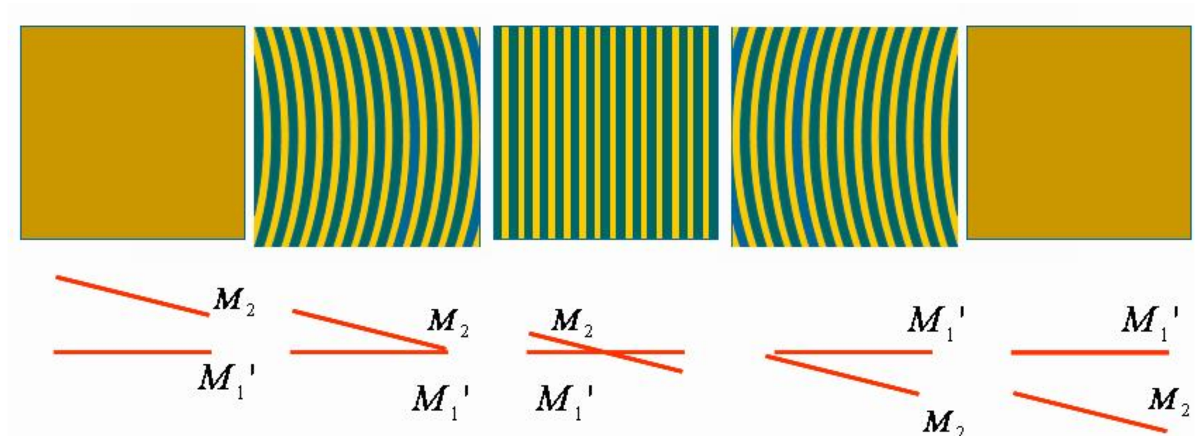


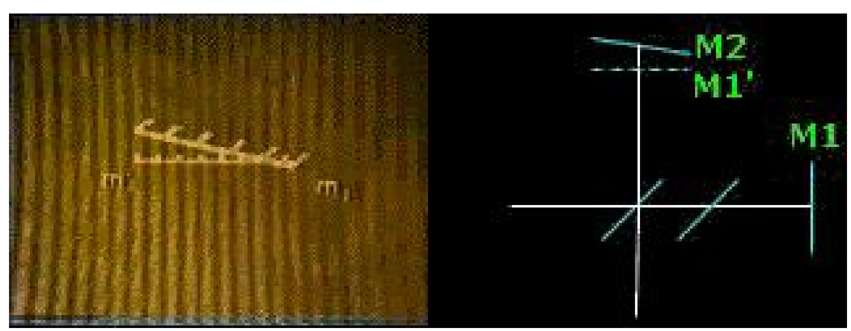
Bright fringes conditions： $2d\left(1-\dfrac{r^2}{2Z^2}\right)=K\lambda$

3.2 Equal thickness interference and equal inclination interference

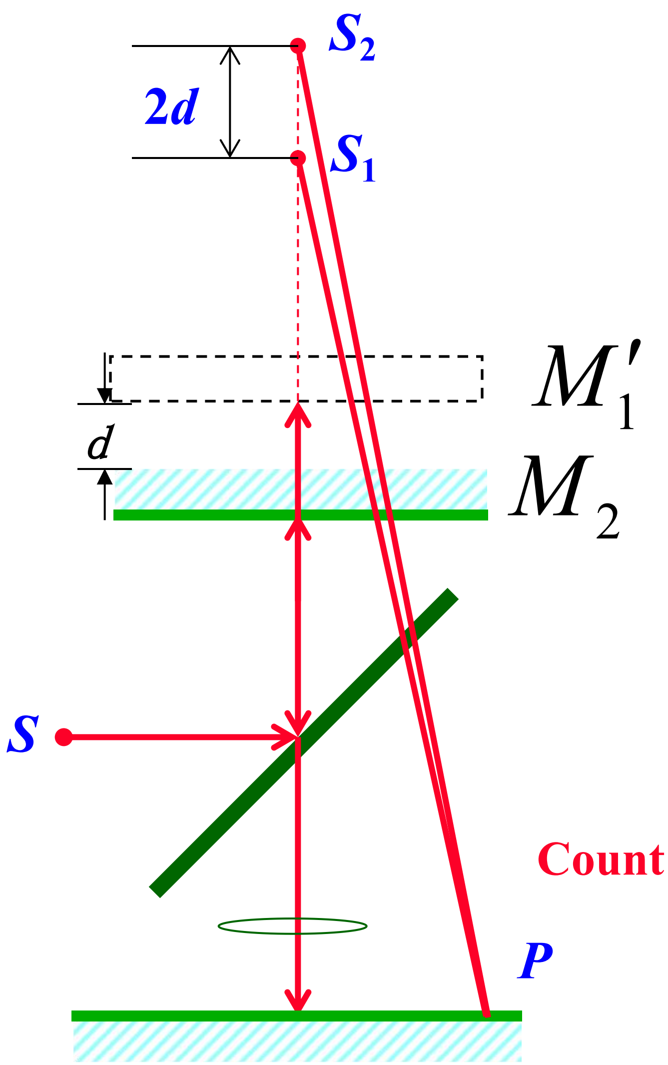


M_1 no $\perp$ M_2 ➔ Equal thickness interference





3.3 application



(1) for the wavelength of light

Bright fringe: $2d\left(1-\frac{r^2}{2Z^2}\right)=K\lambda$

center: $2d=K\lambda$

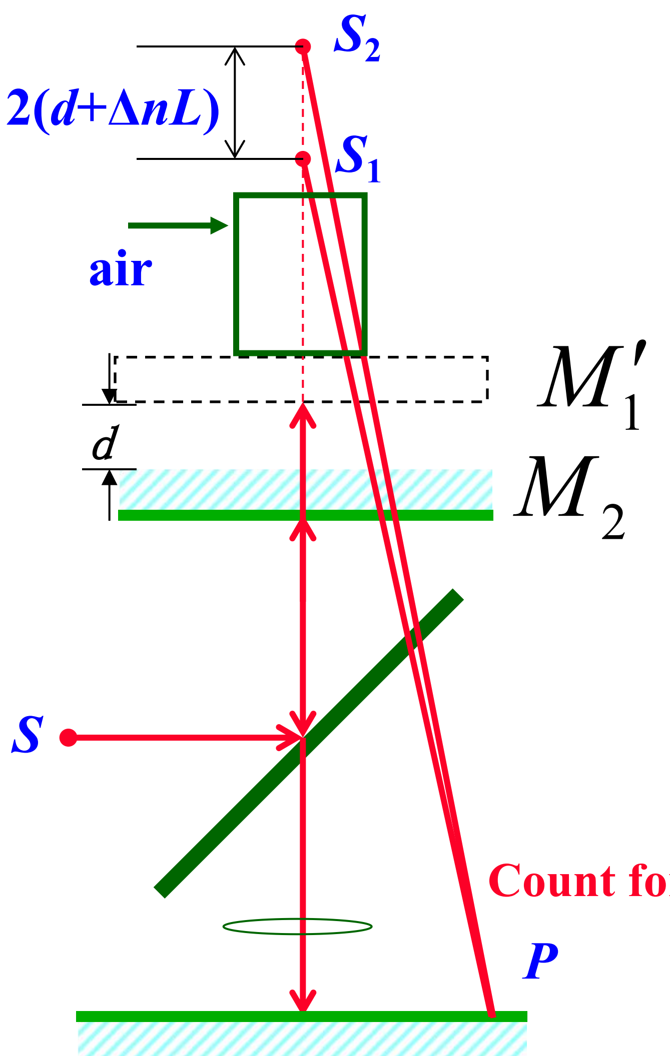
as: $2\Delta d=\Delta K\cdot\lambda$

In advance: $\lambda=\frac{2\Delta d}{\Delta K}$

In this experiment:

Count for 50 bright fringes, and record the length of lens moving

3.3 application



(2) measurement air Index of refraction

Bright fringe center: $2(d+\Delta nL)=K\lambda$

Refraction concerned with air pressure、:

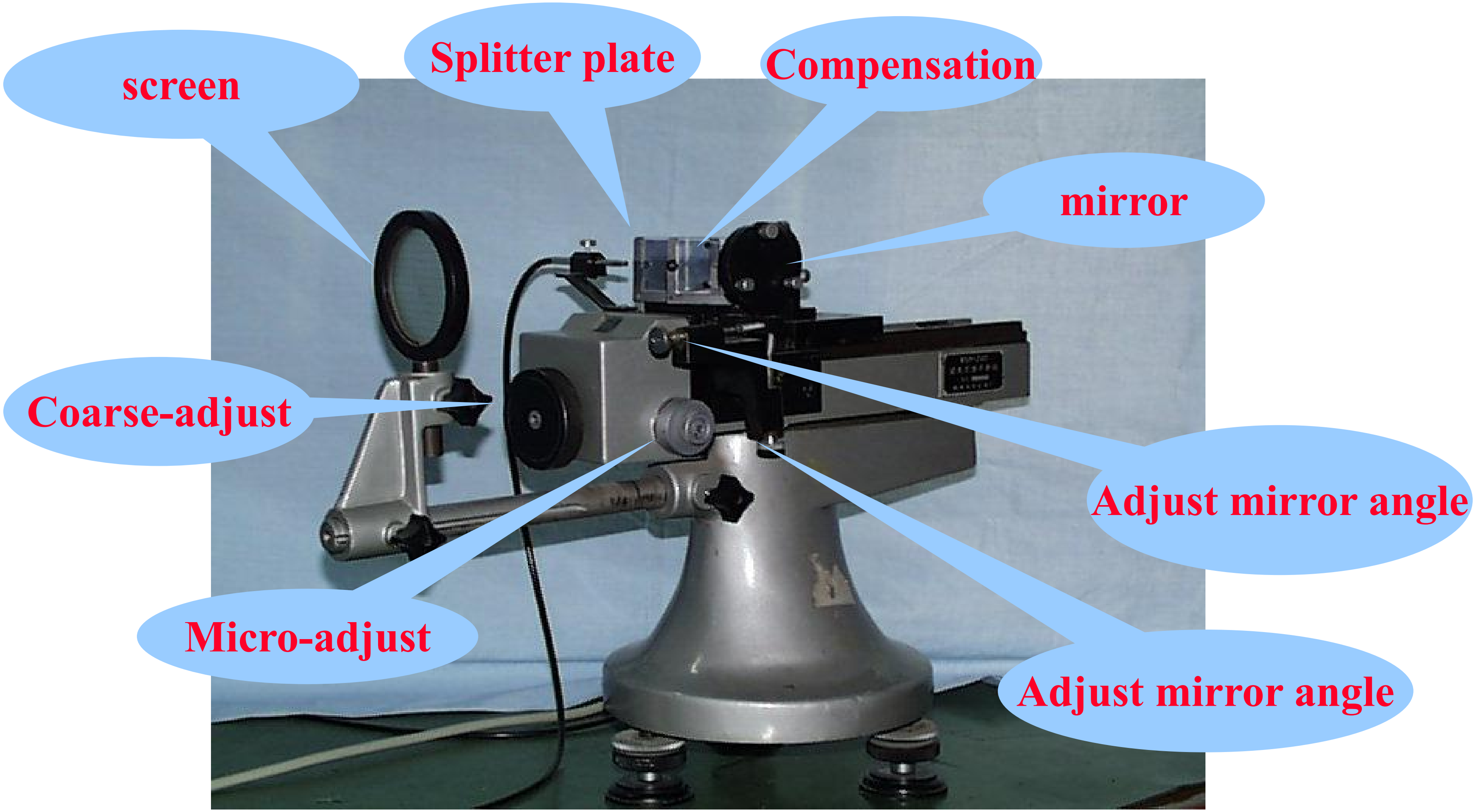
$$\Delta n=\frac{\lambda_0}{2L}\frac{60}{p_p}p_b$$

pressure: $p_b=1.01325\times10^5\,\text{Pa}$

In this experiment:

Count for 60 bright fringes, and record the pressure before and after.

4. Equipment


screen
Splitter plate
Compensation
mirror
Coarse-adjust
Adjust mirror angle
Micro-adjust
Adjust mirror angle

8. data

8.1 measurement He-Ne laser wavelength

table1 measurement He-Ne laser wavelength

N	0	50	100	150	200	250
d (mm)						
Δd (mm)	$\Delta d_1 = d_{150} - d_0 =$		$\Delta d_2 = d_{200} - d_{50} =$		$\Delta d_3 = d_{250} - d_{100} =$	
$\Delta\bar{d} = \frac{\Delta d_1 + \Delta d_2 + \Delta d_3}{3}$ (mm)						
$\bar{\lambda} = \frac{2\Delta\bar{d}}{\Delta m} = \frac{2\Delta\bar{d}}{3\times 50}$ (nm)						

8.2 measurement air index of refraction

Table 2 measure of air index of refraction

Trial	1	2	3
p_1 (MPa)			
p_2 (MPa)			
$\Delta p = p_2 - p_1$ (MPa)			
$\Delta\bar{p} = \frac{\Delta p_1 + \Delta p_2 + \Delta p_3}{3}$ (MPa)			
$n = 1 + \frac{\lambda_0}{2L}\frac{60}{\Delta\bar{p}}p$			