Measurement the apex angle of a prism and the wavelengths of lines in the spectra of mercury by Spectrometer

University Physics Experiment Center

Content

1. Background

1.1 spectrometer

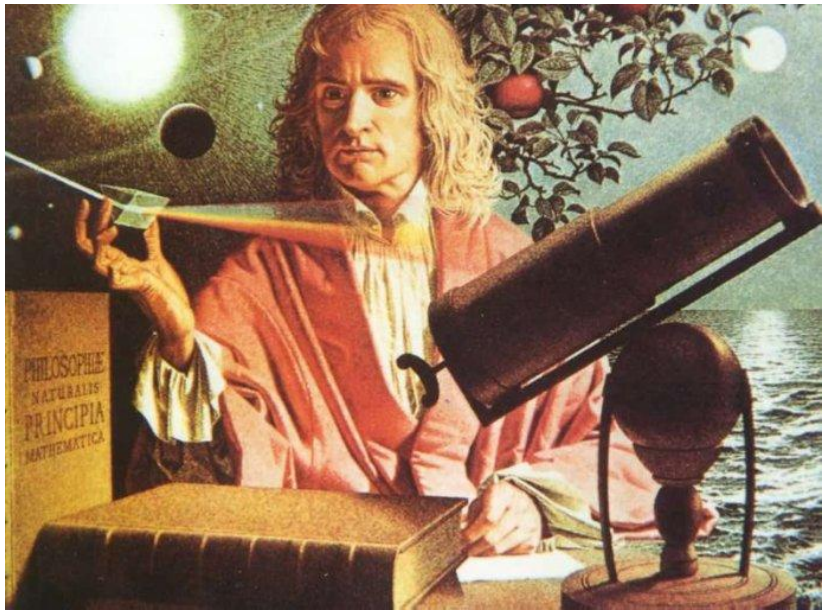
Spectrometer is an equipment for measuring micro angle 1′

（Isaac Newton，1642~1726）

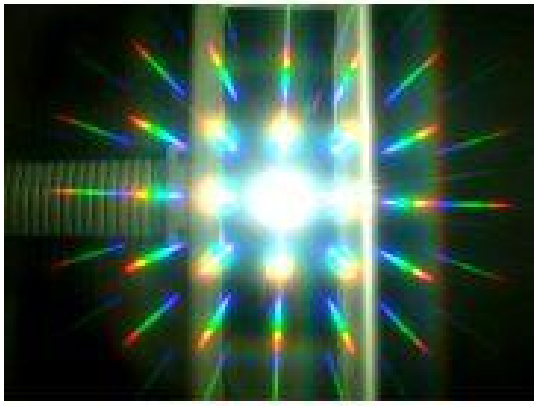
inventor for the spectrometer

(Joseph Fraunhofer, 1787～1826)

Belts prism spectrometer carefully studied the solar spectrum.



1.2 Diffraction grating



Former gratin

(David Rittenhouse, 1732～1796)

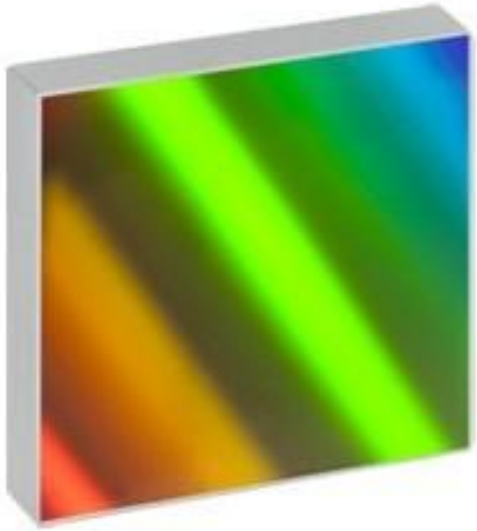
•1786, between the two made by a watchmaker fine screw, parallel to the filament winding to form a diffraction grating.

•parameter：4.3line/mm

Divided to

(1) Reflection gratings and transmission gratings

(2) Amplitude grating and the phase grating

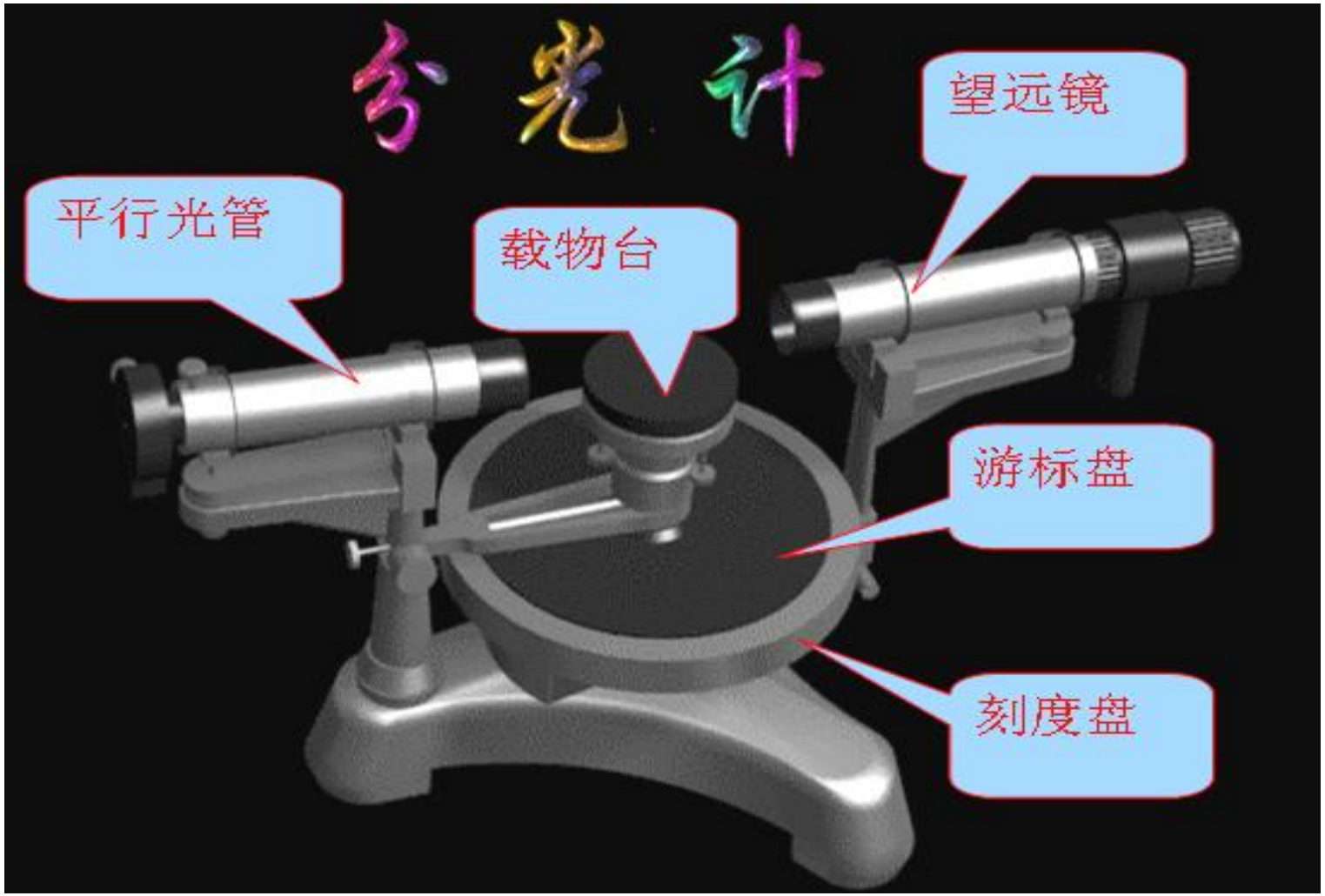


2. aim

- Understanding of the structure and the basic principles of the spectrometer
- Learn to adjust and use spectrometer
- Observed diffraction grating, to understand the basic laws of diffraction gratings
- Learn to use spectroscopy and wavelength grating constant

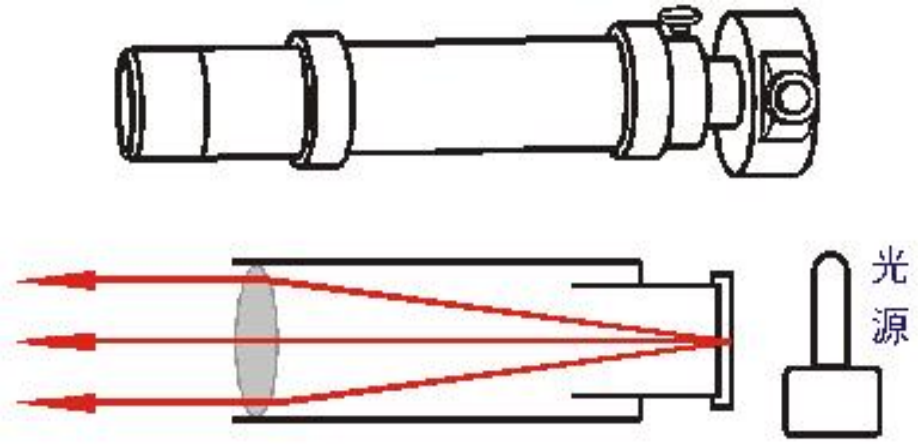
3. principle

3.1 structure



3.1 structure

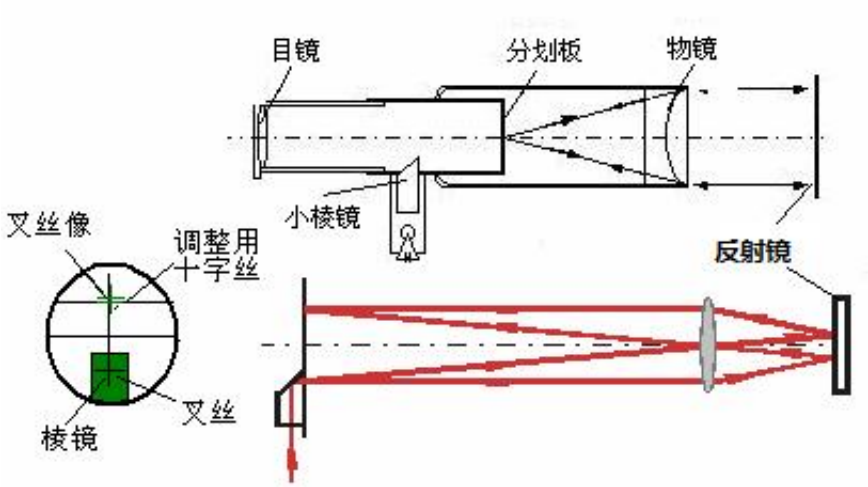
Collimator



- **Collimator role is to produce a parallel light.**
- **One end of the tube is equipped with a tube move back and forth along the sleeve, the sleeve end with a slit width adjustable;**
- **The other end of the tube is equipped with a converging lens.**
- **Moving back and forth along the tube slot means when the slit is located just on the focal plane of the lens, the light impinging on the slit after the lens becomes parallel light.**

3.1 structure

telescope



- **Auto collimation methods:**

1.from the eyepiece, reticle between the objective lens and can be adjusted,

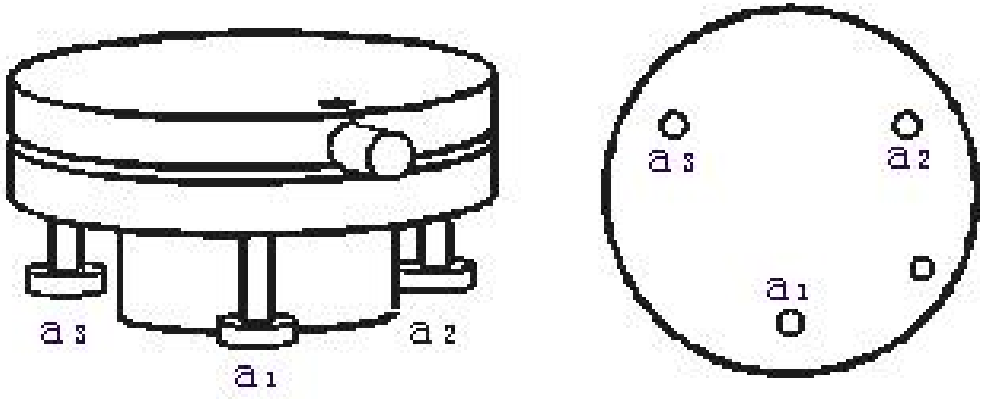
2.when adjusting the reticle is located in the focal plane of the objective lens,

3.the light emitted through the objective lens crosshairs after becoming parallel light.

4.The parallel light after the double-sided mirror reflection, and then by the objective lens focused on the reticle plane, formed like crosshairs (green).

3.1 structure

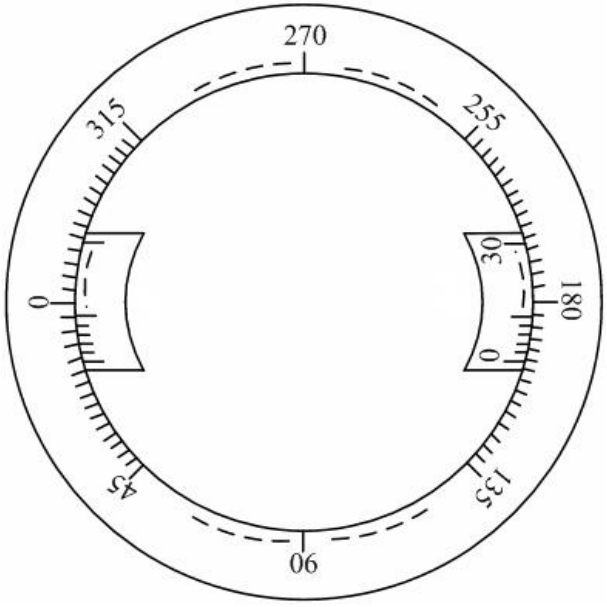
stage



- **Stage for placing the object to be measured.**
- **There are three screws for adjusting the audience platform level.**

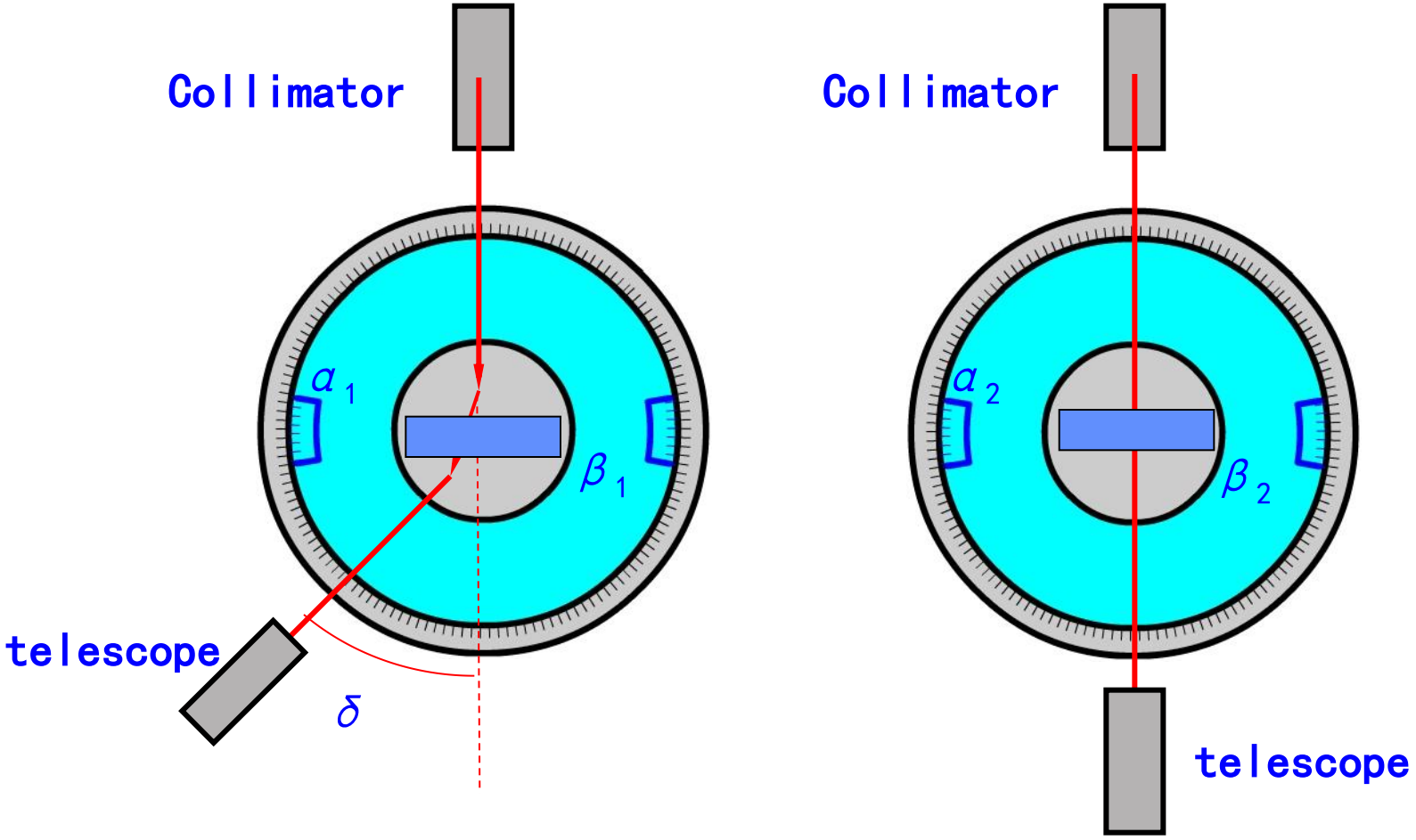
3.1 structure

Reading data



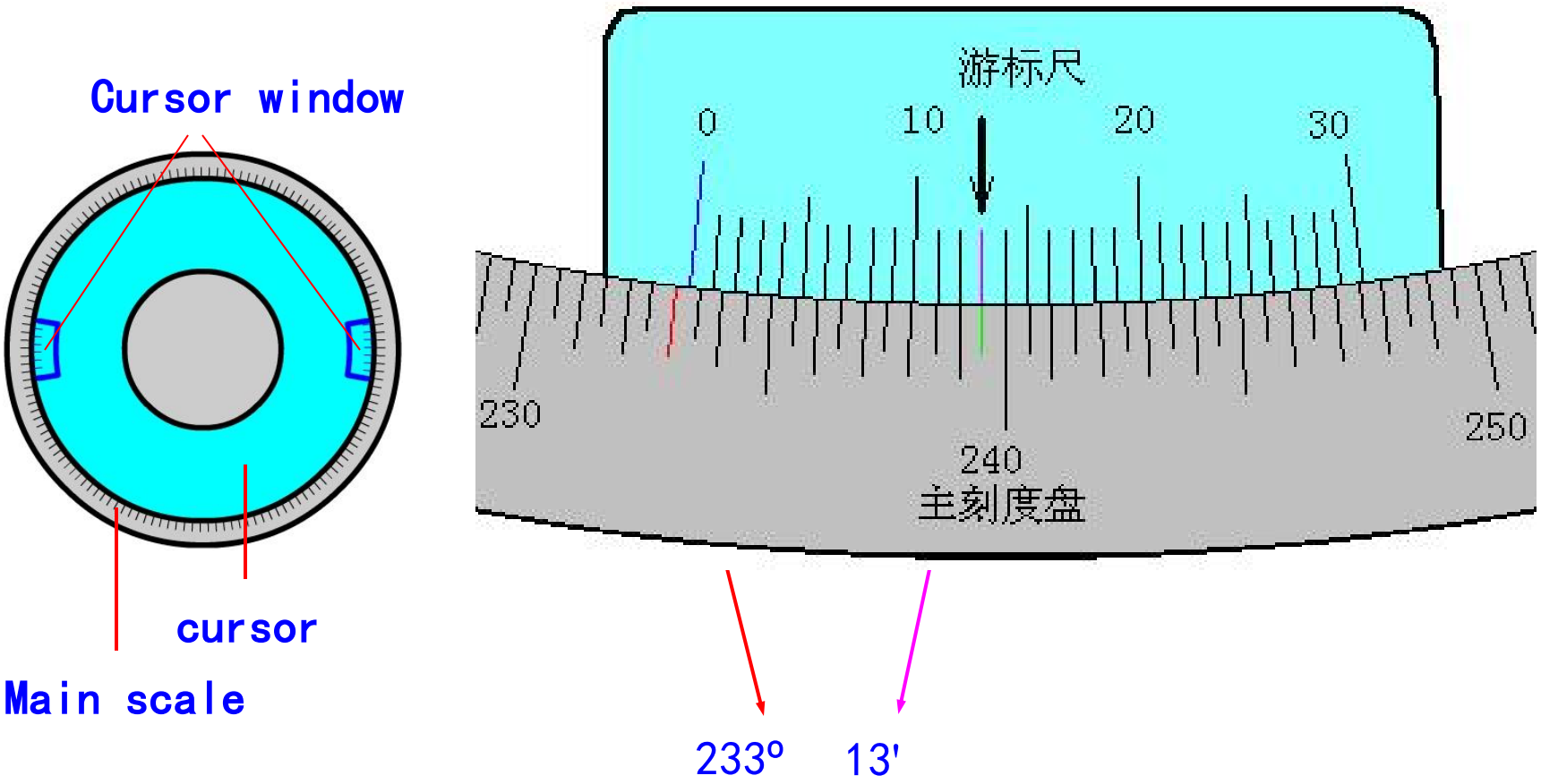
- **Scale disc is divided into 360 °,**
- **minimum scale of 0.5 degrees (30 '),**
- **the use of less than 0.5 degrees cursor readout.**
- **30 grid reading unit 1 'cursor.**

3.2 measurement principle



3.2 measurement principle

reading

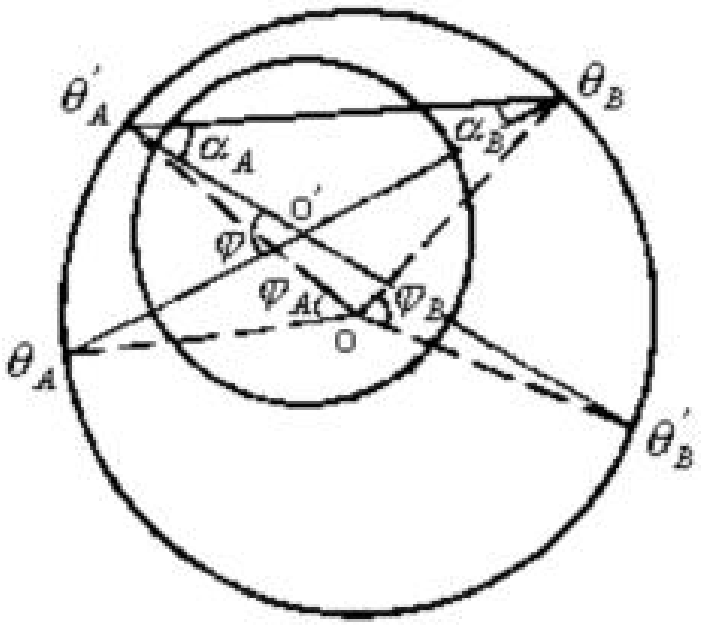


3.3 Principle of double cursor m to eliminate eccentricity errors

Two cursors respectively measured angle is φA and φB,

the spectrometer with respect to the center axis O 'is for the angle φ.

Since the axis O with O 'does not necessarily coincide, under normal circumstances



$$\varphi \neq \varphi_A \neq \varphi_B$$

From geometric principles

$$\alpha_A = \frac{1}{2}\varphi_A, \quad \alpha_B = \frac{1}{2}\varphi_B$$

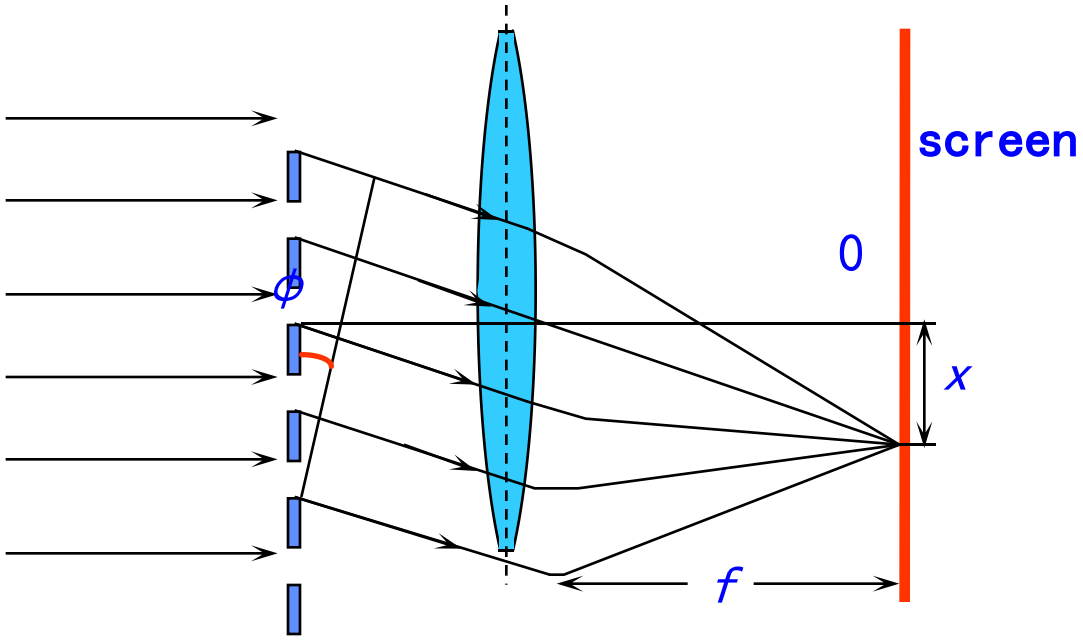
as $\varphi = \alpha_A + \alpha_B$

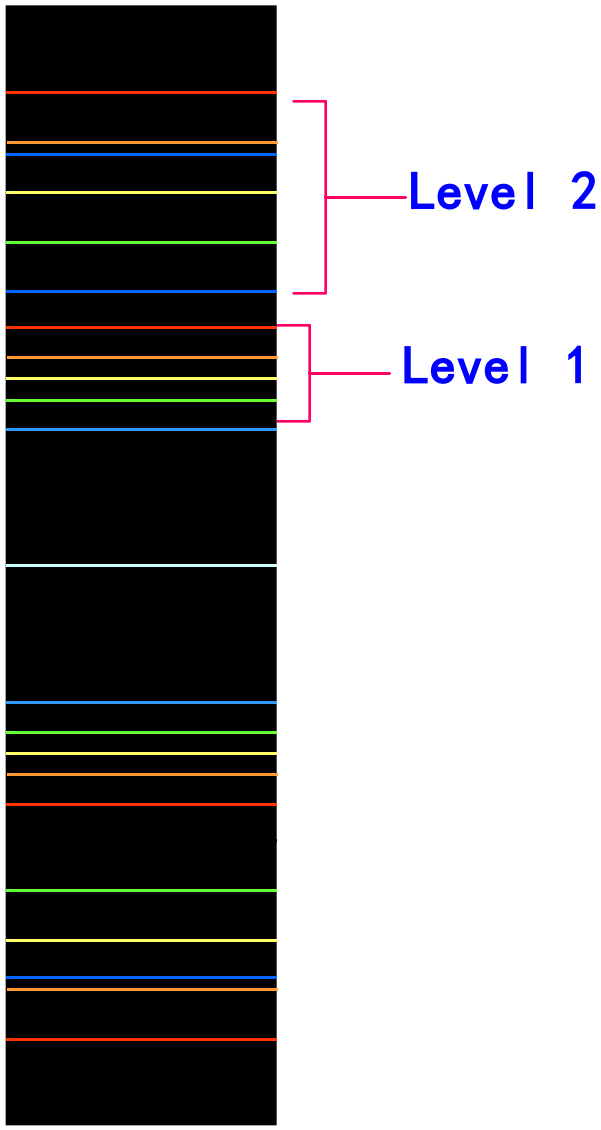
for

$$\varphi = \frac{1}{2}(\varphi_A + \varphi_B) = \frac{1}{2}\left(\left|\theta'_A - \theta_A\right| + \left|\theta'_B - \theta_B\right|\right)$$

Average of the two cursors measured angle is the actual angle turned.

3.5 Diffraction grating spectrometer and measuring wavelength of principle





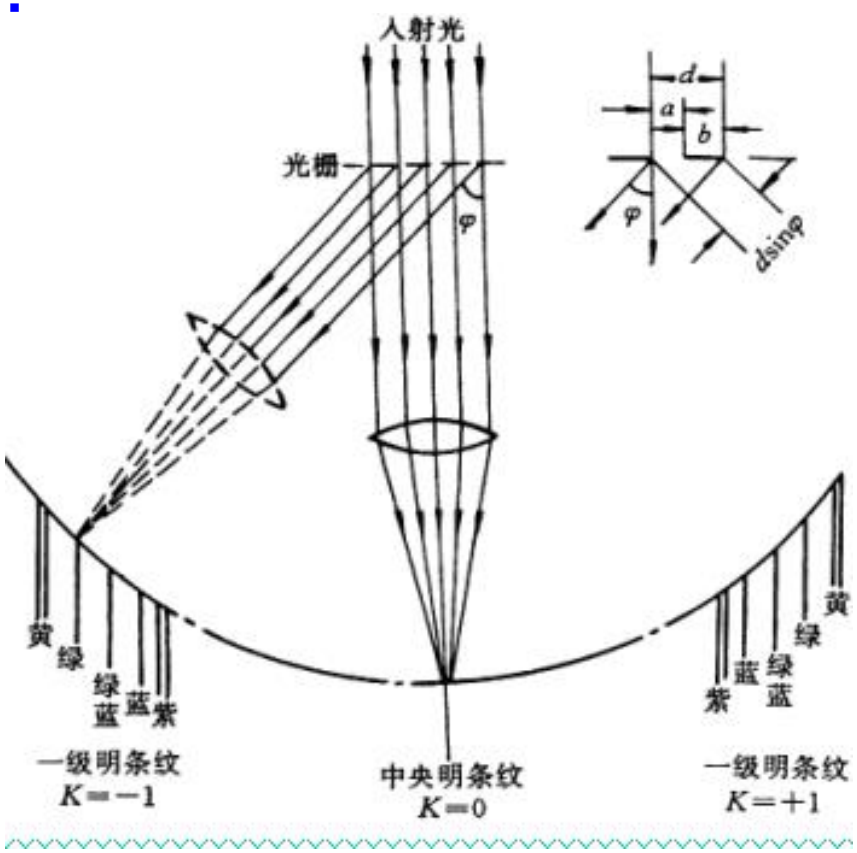
3.5 Diffraction grating spectrometer and measuring wavelength

Ming diffraction grating fringes conditions:
$\sin\varphi = k\lambda$ $k=0,\pm1,\pm2,\ldots$

λ wavelength, k bright level

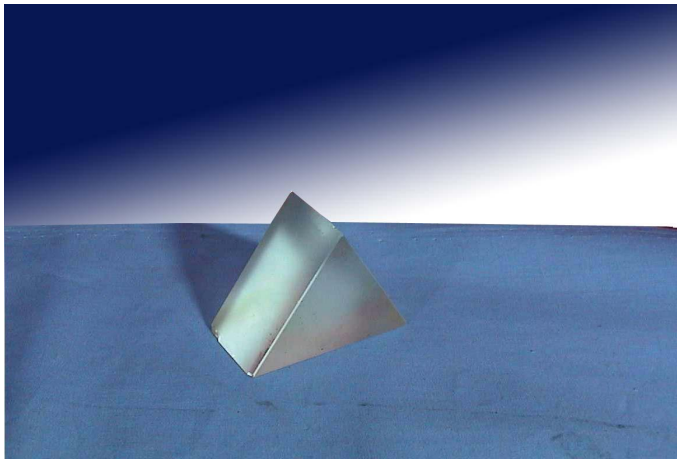
If the grating constant d is known, with all levels of the spectrometer measured spectral diffraction angle φ,

you can find the spectral lines corresponding to the wavelength of light.

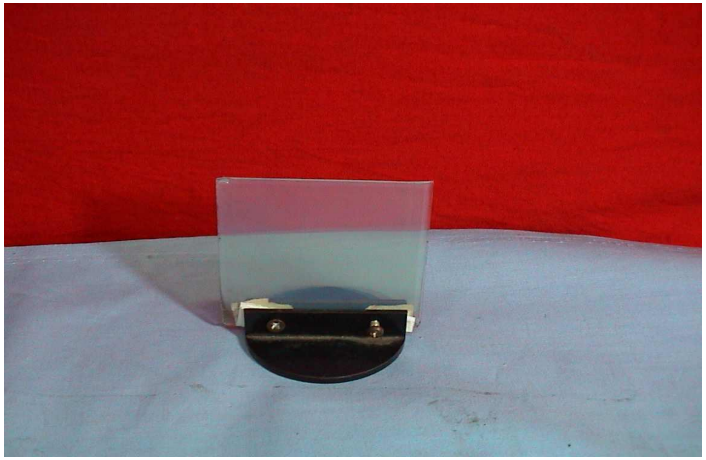


4. equipment

spectrometer



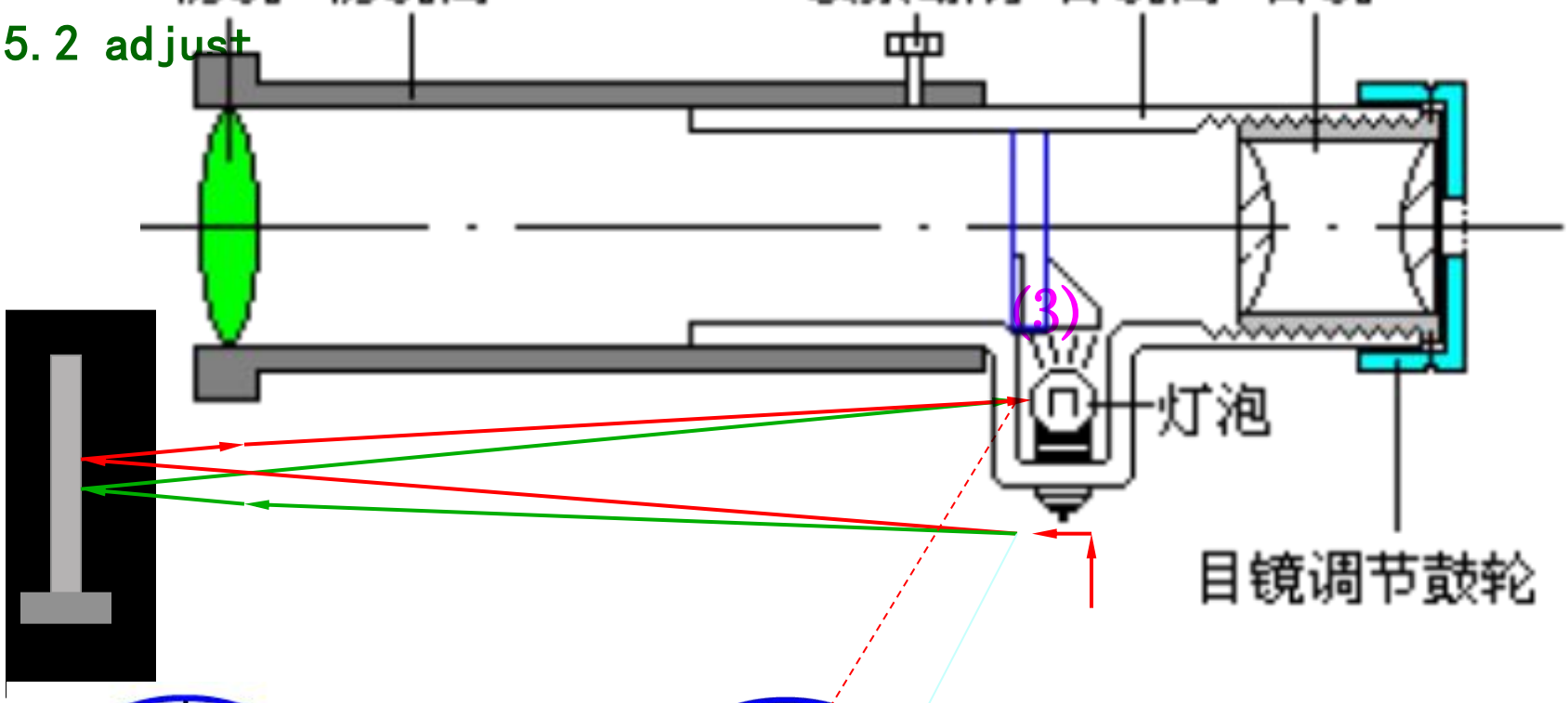
Triangular prism

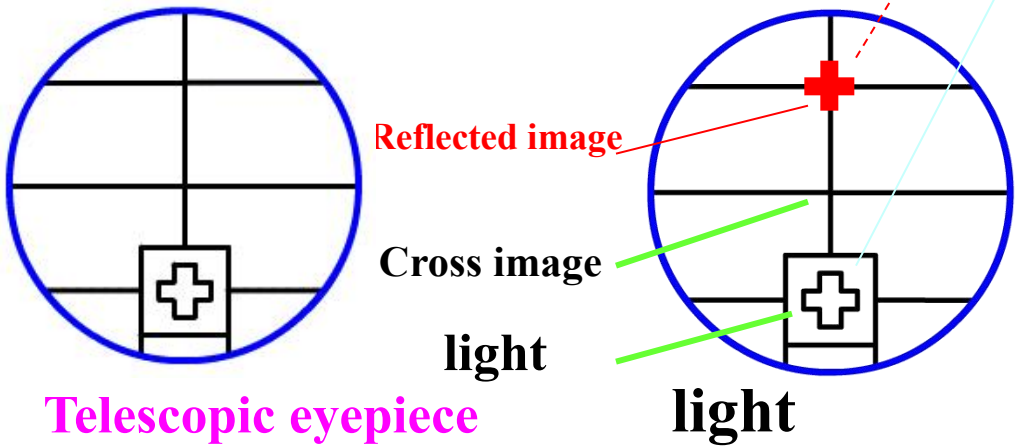


Diffraction grating

Mercury light

5.2 adjust





Telescopic eyepiece

5. Data Tables

DATA TABLE 2-1 (*purpose*: to measure the apex angle of a prism)

Instrument error:_____

Position of telescope	Left side (position 1)		Right side (position 2)	
Trial	Vernier 1	Vernier 2	Vernier 1	Vernier 2
	θ_1 (°, ')	θ_1'(°, ')	θ_2(°, ')	θ_2'(°, ')
1				
2				
3				
Averaged				

DATA TABLE 2-2 (*purpose*: to measure the wavelengths of lines in the spectra of mercury)

Diffraction order	k=-1(left side)						k=+1(right side)					
Lines	Yellow 2		Yellow 1		Green		Green		Yellow 1		Yellow 2	
Trial	$\varphi_{Y\text{-}L21}$	$\varphi_{Y\text{-}L22}$	$\varphi_{Y\text{-}L11}$	$\varphi_{Y\text{-}L12}$	$\varphi_{G\text{-}L1}$	$\varphi_{G\text{-}L2}$	$\varphi_{G\text{-}R1}$	$\varphi_{G\text{-}R2}$	$\varphi_{Y\text{-}R11}$	$\varphi_{Y\text{-}R12}$	$\varphi_{Y\text{-}R21}$	$\varphi_{Y\text{-}R22}$
1												
2												
Averaged												