

五、实验数据处理

实验2.钠光劳埃镜干涉

(1)原始数据记录

| | | | | | | | | | | |
|----------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| i | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| x_i/mm | 1.154 | 1.442 | 1.652 | 1.924 | 2.123 | 2.391 | 2.652 | 2.9 | 3.162 | 3.442 |
| i | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| x_i/mm | 3.691 | 3.95 | 4.191 | 4.451 | 4.712 | 4.933 | 5.231 | 5.551 | 5.821 | 6.125 |

| | | | |
|------|--------|--------|-------|
| | 狭缝 | 透镜成小像 | 透镜成大像 |
| X/cm | 144.51 | 115.43 | 70.23 |

| | | | | |
|---|----------|-------|-----------|-------|
| | b/mm(小像) | | b'/mm(大像) | |
| 左 | 4.991 | 4.112 | 7.281 | 7.001 |
| 右 | 4.091 | 3.231 | 1.231 | 0.943 |

(2)数据处理

用逐差法计算条纹间距 Δx :

$$\overline{\Delta x} = \frac{\sum_{i=1}^{10} |x_{i+10} - x_i|}{10 \times 10} = 0.2581mm$$

计算波长 λ :

$$\bar{b} = \frac{b_{\text{正}} + b_{\text{反}}}{2} = \frac{(4.991 - 4.091) + (4.112 - 3.231)}{2} = 0.8905mm$$

$$\bar{b}' = \frac{b'_{\text{正}} + b'_{\text{反}}}{2} = \frac{(7.281 - 1.231) + (7.001 - 0.943)}{2} = 6.054mm$$

$$S = |144.51 - 115.43| = 29.08cm$$

$$S' = |144.51 - 70.23| = 74.28cm$$

$$\lambda = \frac{\Delta x \sqrt{\bar{b}\bar{b}'}}{S + S'} = 579.9nm$$

(3) 不确定度计算

Δx 的不确定度:

$10\Delta x$ 的A类不确定度:

$$u_a(10\Delta x) = \sqrt{\frac{\sum_{i=1}^{10} (10\Delta x_i - 10\overline{\Delta x})^2}{10 \times (10 - 1)}} = 0.0197mm$$

$10\Delta x$ 的B类不确定度:

$$u_b(10\Delta x) = \frac{\Delta_{\text{仪}}}{\sqrt{3}} = \frac{0.01}{2 \times \sqrt{3}} = 0.00289mm$$

$10\Delta x$ 的不确定度:

$$u(10\Delta x) = \sqrt{u_a(10\Delta x)^2 + u_b(10\Delta x)^2} = 0.01991mm$$

Δx 的不确定度:

$$u(\Delta x) = \frac{u(10\Delta x)}{10} = 0.001991mm$$

$$\frac{\Delta b}{b} = \frac{\Delta b'}{b'} = 0.025$$

b' 的不确定度:

$$u(b') = \frac{0.8905 \times 0.025}{\sqrt{3}} = 0.01285mm$$

b 的不确定度:

$$u(b) = \frac{6.054 \times 0.025}{\sqrt{3}} = 0.08738mm$$

S 的不确定度:

$$\Delta S = \Delta S' = 0.5cm$$

$$u(S + S') = \sqrt{2} \times 0.289 = 0.409cm$$

不确定度的合成:

$$\ln \lambda = \ln \Delta x + \frac{1}{2}(\ln b + \ln b') - \ln(S + S')$$

$$\frac{\ln \lambda}{\lambda} = \frac{\ln \Delta x}{\Delta x} + \frac{1}{2}\left(\frac{\ln b}{b} + \frac{\ln b'}{b'}\right) - \frac{\ln(S + S')}{S + S'}$$

$$\frac{u(\lambda)}{\lambda} = \sqrt{\left[\frac{u(\Delta x)}{\Delta x}\right]^2 + \frac{1}{4}\left[\frac{u(b)}{b}\right]^2 + \frac{1}{4}\left[\frac{u(b')}{b'}\right]^2 + \left[\frac{u(S + S')}{S + S'}\right]^2} = 0.008665$$

$$u(\lambda) = 5.025nm$$

最终结果为:

$$\lambda \pm u(\lambda) = 580 \pm 6nm$$