用拉伸法测量钢丝的杨氏模量

【Latex 代码在下面,请向下翻阅】

标尺到平面镜的距离 D 的平均值

$$\overline{D} = \frac{1}{n} \sum_{i=1}^{n} D_i = \frac{99.78 + 99.9 + 99.86}{3} \text{ cm} = 99.847 \text{ cm}$$

标尺到平面镜的距离 D 的标准差

$$\sigma_D = \sqrt{\frac{1}{n-1} \sum_{i=1}^{n} (D_i - \overline{D})^2}$$

$$= \sqrt{\frac{(99.78 - 99.847)^2 + (99.9 - 99.847)^2 + (99.86 - 99.847)^2}{3-1}} \text{ cm}$$

$$= 0.061101 \text{ cm}$$

标尺到平面镜的距离 D 的 B 类不确定度

$$\Delta_{B,D} = \sqrt{\Delta_{(\dot{\chi})}^2 + \Delta_{(\dot{t})}^2} = \sqrt{0.12^2 + 0.05^2} \text{ cm} = 0.13 \text{ cm}$$

标尺到平面镜的距离 D 的展伸不确定度

$$U_{D,P} = \sqrt{(t_P \frac{\sigma_D}{\sqrt{n}})^2 + (k_P \frac{\Delta_{B,D}}{C})^2} = \sqrt{(4.3 \times \frac{0.061101}{\sqrt{3}})^2 + (1.96 \times \frac{0.13}{3})^2} \text{ cm}$$
$$= 0.17385 \text{ cm}, P = 0.95$$

光杠杆的臂长 | 的平均值

$$\bar{l} = \frac{1}{n} \sum_{i=1}^{n} l_i = \frac{7.15 + 7.17 + 7.16}{3}$$
 cm = 7.16 cm

光杠杆的臂长!的标准差

$$\sigma_l = \sqrt{\frac{1}{n-1} \sum_{i=1}^{n} (l_i - \bar{l})^2} = \sqrt{\frac{(7.15 - 7.16)^2 + (7.17 - 7.16)^2 + (7.16 - 7.16)^2}{3-1}} \text{ cm}$$

$$= 0.01 \text{ cm}$$

光杠杆的臂长 I 的 B 类不确定度

$$\Delta_{B,l} = \sqrt{\Delta_{(\chi)}^2 + \Delta_{(t)}^2} = \sqrt{0.12^2 + 0.05^2} \text{ cm} = 0.13 \text{ cm}$$

光杠杆的臂长 | 的展伸不确定度

$$U_{l,P} = \sqrt{(t_P \frac{\sigma_l}{\sqrt{n}})^2 + (k_P \frac{\Delta_{B,l}}{C})^2} = \sqrt{(4.3 \times \frac{0.01}{\sqrt{3}})^2 + (1.96 \times \frac{0.13}{3})^2} \text{ cm} = 0.088487 \text{ cm}, P$$

$$= 0.95$$

钢丝原长L的平均值

$$\overline{L} = \frac{1}{n} \sum_{i=1}^{n} L_i = \frac{138.33 + 138.56 + 138.6}{3}$$
 cm = 138.5 cm

钢丝原长 L 的标准差

$$\sigma_L = \sqrt{\frac{1}{n-1} \sum_{i=1}^{n} (L_i - \overline{L})^2}$$

$$= \sqrt{\frac{(138.33 - 138.5)^2 + (138.56 - 138.5)^2 + (138.6 - 138.5)^2}{3-1}} \text{ cm}$$

$$= 0.14572 \text{ cm}$$

钢丝原长 L 的 B 类不确定度

$$\Delta_{B,L} = \sqrt{\Delta_{(!)}^2 + \Delta_{(!)}^2} = \sqrt{0.12^2 + 0.05^2} \text{ cm} = 0.13 \text{ cm}$$

钢丝原长L的展伸不确定度

$$U_{L,P} = \sqrt{(t_P \frac{\sigma_L}{\sqrt{n}})^2 + (k_P \frac{\Delta_{B,L}}{C})^2} = \sqrt{(4.3 \times \frac{0.14572}{\sqrt{3}})^2 + (1.96 \times \frac{0.13}{3})^2} \text{ cm} = 0.37159 \text{ cm}, P$$

$$= 0.95$$

钢丝直径 d 的平均值

$$\overline{d} = \frac{1}{n} \sum_{i=1}^{n} d_i = \frac{0.295 + 0.298 + 0.296 + 0.296 + 0.299 + 0.298}{6} \text{ mm} = 0.297 \text{ mm}$$

钢丝直径 d 的标准差

$$\sigma_d = \sqrt{\frac{1}{n-1} \sum_{i=1}^{n} (d_i - \overline{d})^2}$$

$$= \sqrt{\frac{(0.295 - 0.297)^2 + (0.298 - 0.297)^2 + (0.296 - 0.297)^2 + (0.296 - 0.297)^2 + (0.299 - 0.297)^2 + (0.298 - 0$$

钢丝直径 d 的 B 类不确定度

$$\Delta_{B,d} = \sqrt{\Delta_{(!)}^2 + \Delta_{(!)}^2} = \sqrt{0.004^2 + 0.005^2} \text{ mm} = 0.0064031 \text{ mm}$$

钢丝直径 d 的展伸不确定度

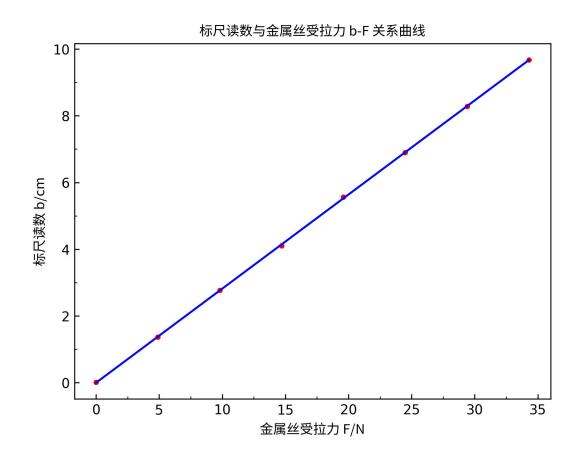
$$U_{d,P} = \sqrt{(t_P \frac{\sigma_d}{\sqrt{n}})^2 + (k_P \frac{\Delta_{B,d}}{C})^2} = \sqrt{(2.57 \times \frac{0.0015492}{\sqrt{6}})^2 + (1.96 \times \frac{0.0064031}{3})^2} \text{ mm}$$
$$= 4.4881 \times 10^{-3} \text{ mm, } P = 0.95$$

金属丝受拉力 F 与标尺读数 b 的关系:

砝码总质量 m/g	金属丝受拉力 F/N	标尺读数平均值 b/cm
0	0	0.01
500	4.9	1.365
1000	9.8	2.765

1500	14.7	4.1
2000	19.6	5.565
2500	24.5	6.895
3000	29.4	8.285
3500	34.3	9.68

最小二乘法拟合:



斜率

$$m = 0.28218 \text{ cm/N}$$

截距

$$b = -0.00625$$
 cm

线性拟合的相关系数

$$r = \frac{\overline{Fb} - \overline{F} \cdot \overline{b}}{\sqrt{(\overline{F^2} - \overline{F}^2)(\overline{b^2} - \overline{b}^2)}} = 0.99997481$$

斜率的延伸不确定度

$$u_m = t_P \cdot |m| \cdot \sqrt{(\frac{1}{r^2} - 1)/(n - 2)} = 0.0020034 \text{ cm/N}, P = 0.95$$

截距的延伸不确定度

$$u_b = u_m \cdot \sqrt{\overline{F^2}} = 0.041065 \text{ cm}, P = 0.95$$

这里我们只考虑了 A 类不确定度;至于由 x 物理量和 y 物理量的 B 类不确定度如何推出斜率的 B 类不确定度, 这个问题非常复杂,且物理实验教学中心并未对其作出解释。

杨氏模量

$$E = \frac{8DL}{\pi d^2 lm} = 1.9759 \times 10^7 \text{ N/cm}^2$$

杨氏模量 E 的延伸不确定度

$$\begin{split} &U_{E,P} = \sqrt{(\frac{\partial E}{\partial D}U_{D,P})^2 + (\frac{\partial E}{\partial L}U_{L,P})^2 + (\frac{\partial E}{\partial d}U_{d,P})^2 + (\frac{\partial E}{\partial l}U_{l,P})^2 + (\frac{\partial E}{\partial m}U_{m,P})^2} \\ &= \sqrt{(\frac{8L}{\pi d^2 lm}U_{D,P})^2 + (\frac{8D}{\pi d^2 lm}U_{L,P})^2 + (-\frac{16DL}{\pi d^3 lm}U_{d,P})^2 + (-\frac{8DL}{\pi d^2 l^2 m}U_{l,P})^2 + (-\frac{8DL}{\pi d^2 lm^2}U_{m,P})^2} \\ &= 6.6325 \times 10^5 \text{ N/cm}^2, P = 0.95 \end{split}$$

杨氏模量最终结果

$$E = (1.98 + 0.07) \times 10^7 \text{ N/cm}^2$$

【Latex 代码】

标尺到平面镜的距离 D 的平均值

 $\label{lem:coverline} $$\operatorname{D}=\frac{1}{n}\sum_{i=1}^{n}D_i=\frac{99.78+99.9+99.86}{3}\,\mathrm{c} $$m$=99.847\,\mathrm{cm}$$

\$\$

标尺到平面镜的距离 D 的标准差

\$\$

\begin{aligned}

1}}\,\mathrm{cm}\\

 $\&=0.061101\$ \mathrm{cm}

\end{aligned}

\$\$

标尺到平面镜的距离 D 的 B 类不确定度

\$\$

\Delta_{B,D}=\sqrt{\Delta_\text{仪}^2+\Delta_\text{估}^2}=\sqrt{0.12^2+0.05^2}\,\mathrm{cm}=0.13\,\mathrm{cm}

\$\$

标尺到平面镜的距离 D 的展伸不确定度

\$\$

\begin{aligned}

 $\label{left} $$U_{D,P}&=\sqrt{\left(\frac{D}}{\sqrt{n}}\right)^2+\left(\frac{D}{c}\right)^2} $$ B_D}_{C}\right)^2 \$

 $$$ = \left(\frac{0.061101}{\sqrt{3}}\right)^2 + \left(1.96\times \frac{0.1}{3}\right)^2 \right)^2 \mathbb{C}^3$

 $\&=0.17385\,\mathrm{cm},P=0.95$

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$$
  光杠杆的臂长 | 的平均值
  $$
  \operatorname{l}=\frac{1}{n}\sum_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_{i=1}^{n}_
  7.16\,\mathrm{cm}
  $$
  光杠杆的臂长 | 的标准差
  $$
  \begin{aligned}
 \sigma_{l}&=\sqrt{\frac{1}{n-1}\sum_{i=1}^n\left(|_i-\cos\{l\}\right)^2}\
    \&=\sqrt{(7.15-7.16)^2+(7.17-7.16)^2+(7.16-7.16)^2}_{3-1}}\
  \&=0.01\,\mathrm{cm}
  \end{aligned}
  $$
  光杠杆的臂长 I 的 B 类不确定度
  $$
 \Delta_{B,l}=\sqrt{\Delta_\text{仪}^2+\Delta_\text{估}^2}=\sqrt{0.12^2+0.05^2}\,\
    mathrm{cm}=0.13\\mathrm{cm}
  $$
  光杠杆的臂长 | 的展伸不确定度
  $$
 \begin{aligned}
 U_{l,P}\&=\left(\frac{L_P\frac{l}}{\sqrt{n}}\right)^2+\left(\frac{L_P\frac{l
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\end{aligned}

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}}{C}\right)^2}\\
\&=\sqrt{(4.3)times\frac{0.01}{\sqrt{3}}\right)^2+\left(1.96\times\frac{0.13}{3}\right)}
right)^2 \, mathrm{cm} \
\&=0.088487\,\mathrm{cm},P=0.95
\end{aligned}
$$
钢丝原长 L 的平均值
$$
\operatorname{L}=\frac{1}{n}\sum_{i=1}^{n}L_i=\frac{138.33+138.56+138.6}{3}\
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钢丝原长 L 的标准差
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\begin{aligned}
\sigma_{L}&=\sqrt{\frac{1}{n-1}\sum_{i=1}^n\left(L_i-\operatorname{C}_i\right)^2}\
\&=\sqrt{(138.33-138.5)^2+(138.56-138.5)^2+(138.6-138.5)^2}
1}}\,\mathrm{cm}\\
\&=0.14572\ \mathrm{cm}
\end{aligned}
$$
钢丝原长 L 的 B 类不确定度
$$
\Delta_{B,L}=\sqrt{\Delta_\text{仪}^2+\Delta_\text{估}^2}=\sqrt{0.12^2+0.05^2}\\
mathrm{cm}=0.13\,\mathrm{cm}
$$
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钢丝原长 L 的展伸不确定度

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$$
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\begin{aligned}

 $\&= \frac{0.14572}{\sqrt{3}}\right)^2 + \left(1.96\times \frac{0.13}{2}\right)^2 + \left(1.96\times \frac{0.1$

 ${3}\right)^2,\mathrm{mathrm}_{cm}\$

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\end{aligned}

\$\$

钢丝直径 d 的平均值

\$\$

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\$\$

钢丝直径 d 的标准差

\$\$

\begin{aligned}

 $\&=\sqrt{(0.295-0.297)^2+(0.298-0.297)^2+(0.296-0$

 $0.297)^2+(0.299-0.297)^2+(0.298-0.297)^2$ {6-1}}\\mathrm{mm}\\

 $\&=0.0015492\,\mathrm{mm}$

\end{aligned}

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钢丝直径 d 的 B 类不确定度

\$\$

钢丝直径 d 的展伸不确定度

\$\$

\begin{aligned}

 $\label{left} $$U_{d,P}&=\sqrt{t_P\frac{\delta}{\sqrt{n}}\right^2+\left(k_P\frac{\delta}{C}\right)^2}\$

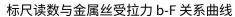
&=4.4881 \times $10^{-3}\$ \end{aligned}

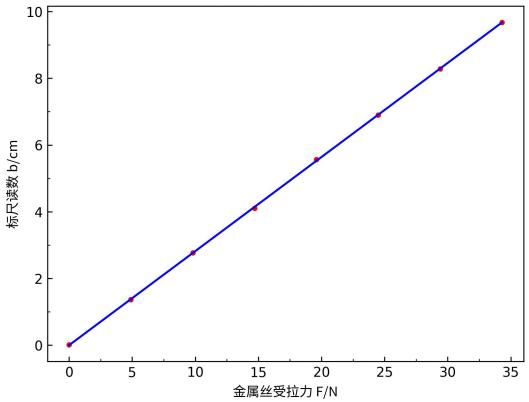
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最小二乘法拟合:





斜率

\$\$

 $m=0.28218\$ \\mathrm{cm/N}

\$\$

截距

\$\$

 $b=-0.00625\$ \mathrm{cm}

\$\$

线性拟合的相关系数

\$\$

 $r = \frac{F}-\operatorname{FF}--\operatorname{FF}--\operatorname{FF}-\operatorname{FF}--\operatorname{FF}-\operatorname{FF}--\operatorname{FF}--\operatorname{FF}--\operatorname{FF}--\operatorname{FF}--\operatorname{FF}$

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\operatorname{F}^2\right(\operatorname{b}^2-\operatorname{b}^2\right)=0.99997481
$$
斜率的延伸不确定度
$$
u_m=t_P\cdot\vert m\rvert\cdot\sqrt{\left(\frac{1}{r^2}-1\right)/(n-1)}
2)}=0.0020034\,\mathrm{cm/N},P=0.95
$$
截距的延伸不确定度
$$
u_b = u_m \cdot (F^2) = 0.041065 \cdot (mathrm{cm}, P = 0.95)
$$
这里我们只考虑了 A 类不确定度;至于由 x 物理量和 y 物理量的 B 类不确定度如何推出斜率的 B 类不确定度,
这个问题非常复杂,且物理实验教学中心并未对其作出解释。
杨氏模量
$$
E=\frac{8 D L}{pi d^{2} l m}=1.9759 \times 10^{7}\
$$
杨氏模量 E 的延伸不确定度
$$
\begin{aligned}
U_{E,P}&=\sqrt{\left(\frac{partial E}{partial D}U_{D,P}\right)^2+\left(\frac{partial E}{partial D}U_{D,P}\right)^2}
E_{\rho tial L}U_{L,P}\right)^2+\left(\frac{partial E}{partial E}\right)
d}U_{d,P}\right)^2+\left(\frac{\partial E}{\partial
I_{I,P}\right^2+\left(\frac{E_{partial E}(partial E)}{partial m}U_{m,P}\right)^2}
```

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杨氏模量最终结果

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 $E=\left(1.98 \right) \times 10^{7}\$ \times $10^{7}\$ \mathrm{N/cm^2}

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