用伸长法测定金属丝的杨氏模量

姓名：张一萌 **学院：**网络空间安全学院**专业：**工科试验班（信息科学与技术）

学号：2313636 **组号：**L **座号：**3 **实验日期：**2024 年 6 月 11 日星期二上午

一、 数据处理：

次数	拉力示值 /kg	标尺读数/cm			逐差值/cm	
		加载p_i	减载p_i'	平均$\overline{p_i}$		
0	0.3	2.50	2.60	2.55	N_1	3.04
1	0.4	3.05	3.10	3.075	N_2	3.135
2	0.5	3.66	3.67	3.665	N_3	3.175
3	0.6	4.21	4.41	4.31	N_4	3.115
4	0.7	4.80	5.00	4.90	N_5	3.23
5	0.8	5.58	5.60	5.59	$\overline{N}$	3.139
6	0.9	6.26	6.16	6.21		
7	1.0	6.90	6.78	6.84		
8	1.1	7.40	7.45	7.425		
9	1.2	8.13	8.13	8.13		

L=41.10-4.00=37.10cm

B=93.00-5.00=88.00cm

游标卡尺零点读数 0.000cm 分度值 0.002cm

b=4.400cm

D

分度值：0.001mm 螺旋测微器零点读数：0.000mm

次数	1	2	3	4	5	6	平均
直径 /mm	0.810	0.800	0.805	0.802	0.806	0.802	0.804

$$E_1 = \frac{32BLmg}{\pi D^2 bN} = \frac{32 \times 0.8800 \times 0.3710 \times 5 \times 9.8}{\pi \times 0.000804^2 \times 0.04400 \times 0.0304} \approx 1.88458 \times 10^{11} pa$$

$$E_2 = \frac{32BLmg}{\pi D^2 bN} = \frac{32 \times 0.8800 \times 0.3710 \times 5 \times 9.8}{\pi \times 0.000804^2 \times 0.04400 \times 0.03135} \approx 1.82747 \times 10^{11} pa$$

$$E_3 = \frac{32BLmg}{\pi D^2 bN} = \frac{32 \times 0.8800 \times 0.3710 \times 5 \times 9.8}{\pi \times 0.000804^2 \times 0.04400 \times 0.03175} \approx 1.80444 \times 10^{11} pa$$

$$E_4 = \frac{32BLmg}{\pi D^2 bN} = \frac{32 \times 0.8800 \times 0.3710 \times 5 \times 9.8}{\pi \times 0.000804^2 \times 0.04400 \times 0.03115} \approx 1.83920 \times 10^{11} pa$$

$$E_5 = \frac{32BLmg}{\pi D^2 bN} = \frac{32 \times 0.8800 \times 0.3710 \times 5 \times 9.8}{\pi \times 0.000804^2 \times 0.04400 \times 0.0323} \approx 1.77372 \times 10^{11} pa$$

$$\overline{\boldsymbol{E}} = \frac{\sum_1^5 E_i}{5}$$

$$= \frac{1.88458 \times 10^{11} + 1.82747 \times 10^{11} + 1.80444 \times 10^{11} + 1.83920 \times 10^{11} + 1.77372 \times 10^{11}}{5}$$

$$= 1.825882 \times 10^{11} pa$$

不确定度的计算：

$$\boldsymbol{\mu_L} = \frac{0.5mm}{3} \approx 0.167mm \approx 0.17mm$$

$$\boldsymbol{\mu_B} = \frac{0.5mm}{3} \approx 0.167mm \approx 0.17mm$$

$$\boldsymbol{\mu_b} = \frac{0.02mm}{1} = 0.02mm$$

$$\overline{N} = \frac{\sum_1^5 N_i}{5} = \frac{3.04 + 3.135 + 3.175 + 3.115 + 3.23}{5} = 3.139cm$$

$$s_N = \sqrt{\frac{\sum_1^5 (N_i - \overline{N})^2}{(n-1)}}$$

$$= \sqrt{\frac{(3.04 - 3.139)^2 + (3.135 - 3.139)^2 + (3.175 - 3.139)^2 + (3.115 - 3.139)^2 + (3.23 - 3.139)^2}{4}}$$

$$\approx 0.0706576$$

$$s_{\overline{N}} = \frac{s_N}{\sqrt{n}} = 0.0315991$$

$$\boldsymbol{u_{AN}} = t_{(p,k)} s_{\overline{N}} = 1.14 \times 0.0315991 = 0.0360229$$

$$\boldsymbol{u_{BN}} = \frac{\varepsilon_x}{\sqrt{3}} = \frac{0.005cm}{\sqrt{3}} \approx 0.00288675$$

$$\boldsymbol{u_N} = \sqrt{{u_{AN}}^2 + {u_{BN}}^2} = \sqrt{0.0360229^2 + 0.00288675^2} \approx 0.0361384cm \approx 0.036cm$$

$$\overline{D} = \frac{\sum_1^6 D_i}{6} = \frac{0.810 + 0.800 + 0.805 + 0.802 + 0.806 + 0.802}{6} = 0.804mm$$

$$s_D = \sqrt{\frac{\sum_1^6 (D_i - \overline{D})^2}{(n-1)}}$$

$$= \sqrt{\frac{(0.810 - 0.804)^2 + (0.800 - 0.804)^2 + (0.805 - 0.804)^2 + (0.802 - 0.804)^2 + (0.806 - 0.804)^2 + (0.802 - 0.804)^2}{5}}$$

$$\approx 0.00360093$$

$$s_{\overline{D}} = \frac{s_D}{\sqrt{n}} = 0.00147007$$

$$\boldsymbol{u_{AD}} = t_{(p,k)} s_{\overline{D}} = 1.11 \times 0.00147007 = 0.00163178$$

$$\boldsymbol{u_{BD}} = \frac{\varepsilon_x}{\sqrt{3}} = \frac{0.001mm}{\sqrt{3}} \approx 0.00057735$$

$$\boldsymbol{u_D} = \sqrt{{u_{AD}}^2 + {u_{BD}}^2} = \sqrt{0.00163178^2 + 0.00057735^2} \approx 0.00173091mm \approx 0.0017mm$$

$$\boldsymbol{u_E} = \overline{E}\sqrt{\left(\frac{\mu_B}{B}\right)^2 + \left(\frac{\mu_L}{L}\right)^2 + \left(\frac{2\mu_D}{D}\right)^2 + \left(\frac{\mu_N}{N}\right)^2 + \left(\frac{\mu_b}{b}\right)^2}$$

$$= 1.825882 \times 10^{11} \times \sqrt{\left(\frac{0.000167}{0.8800}\right)^2 + \left(\frac{0.000167}{0.3710}\right)^2 + \left(\frac{2 \times 0.00000173091}{0.000804167}\right)^2 + \left(\frac{0.000361384}{0.03139}\right)^2 + \left(\frac{0.00002}{0.04400}\right)^2}$$

$$\approx 0.02247 \times 10^{11} \approx 0.022 \times 10^{11} pa$$

所以

$$\boldsymbol{E = \left(\overline{E} \pm u_E\right) pa = (1.826 \pm 0.022) \times 10^{11} pa}$$

二、 误差分析：

1. 金属丝弹性形变的滞后导致的系统误差

2. 金属丝并非均匀圆柱体，故测出的直径存在系统误差和随机误差。
3. 测量金属丝长度 L、两镜面间距 B、和光杠杆常数时存在随机误差，可能会影响实验结果。