Melde's Experiment

1 Objective

- Generating standing, circularly polarised thread waves for various tension forces F, thread lengths s and thread densities m^*.
- Determining the phase velocity c of thread waves as a function of the tension force F, the thread length s and thread density m^*.

2 Prelab Questions

1. What are standing waves?
2. How do standing waves form and what are the conditions for their formation?

3 Principles

An elastically tensioned thread is attached to a mechanical vibrator and weighted from the other end is allowed to vibrate. Standing waves form and are analysed.

4 Apparatus

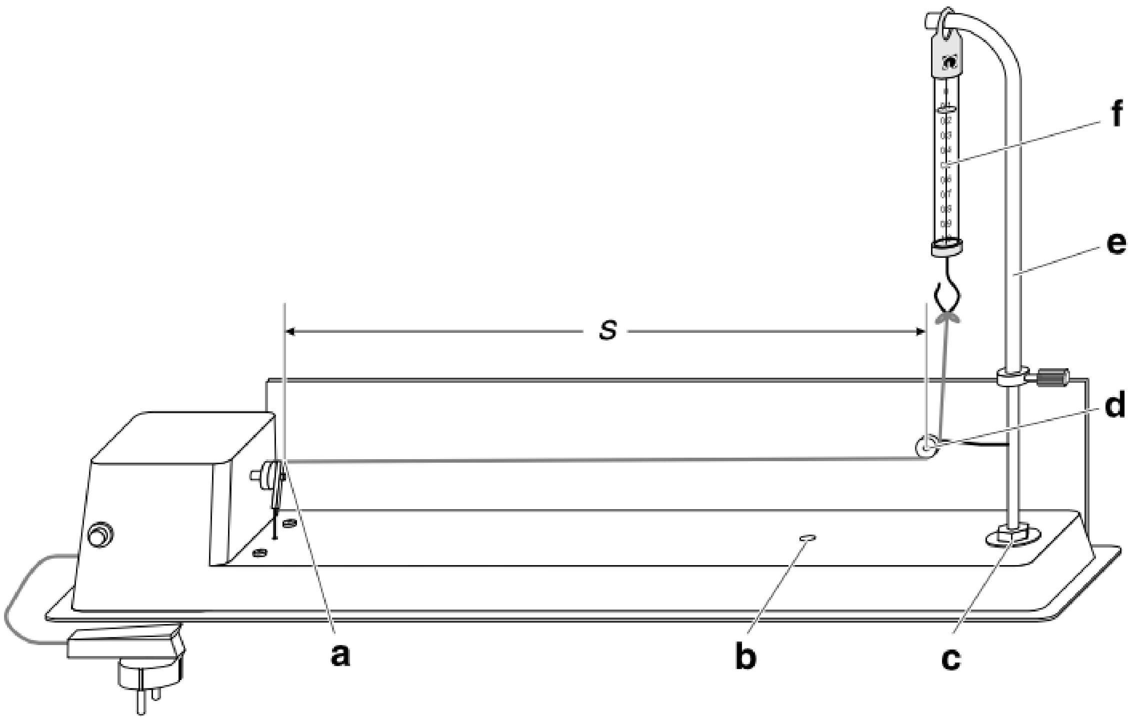

Fig. 1: Schematic representation of Melde's setup:
a: Cam.
b: Mounting point for thread length s = 0.35 m.
c: Mounting point for thread length s = 0.48 m.
d: Deflection pulley.
e: Holding arm.
f: Dynamometer.

5 Precautions

1. When measuring the length of the thread s, note that the actual length (effective) of the string is measured between cam **a** and the centre of the deflection pulley **d**.

2. Be careful not to overload the string and cause it to snap violently.

6 Experimental Steps

1. Measure the distance s between cam **a** and the centre of the deflection pulley **d**. This is your effective thread length.

2. Switch on the motor of the apparatus.

3. On the holding arm **e**, loosen the adjusting screw and vary the force F by changing the height of the holding arm until a standing wave of maximum amplitude with the wavelength $\lambda = 2s$ is formed. You should be able to see one oscillation antinode, in this case $n = 1$.

4. Read off the corresponding force F_1 and write this value in the experiment log.

5. Use the stroboscope to determine the excitation frequency f. Set the dial to the maximum frequency and slowly reduce the frequency until a simple standing sinusoidal wave becomes visible. You should be able to see a perfect sine wave, standing still clearly.

6. Repeat Steps [3-5] for different values of F_n, f and n, until $n = 6$.

7. Switch off the motor.

8. Measure the mass m_0 of the thread.

9. Measure the entire length of the thread s_0.

7 Evaluation

1. Calculate the linear mass density m^* of the thread.

$$m^* = \frac{m}{s} \tag{1}$$

2. Calculate the phase velocity (propagation speed) c_F of the thread for each F.

$$c_F = \sqrt{\frac{F}{m*}} \tag{2}$$

3. Calculate the wavelength λ for each mode.

$$\lambda_n = \frac{2s}{n} \tag{3}$$

4. Using the results from Eq (3), calculate the phase velocity (propagation speed) c.

$$c = \lambda f \tag{4}$$

5. Plot c vs. c_F and calculate the slope. It should be ≈ 1.

6. Explain why the slope should be ≈ 1, and calculate the error percentage in your experiment.

8 Postlab Questions

1. What is the difference between standing waves on a string and standing waves in air columns?

2. What are the natrual frequencies for a one dimensional string, with one free end and one fixed end, of length s and linear mass density $m*$ under tension F?