SCI-FI SOUND

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ABSTRACT

When we tap a slinky spring we hear an amplified laser sound. Also after we tapped it we can see the slinky moving up and down. We use different slinky springs with different lengths, diameter and we show that there is a delay between higher frequencies and lower frequencies and it's the reason for this laser shot sound. By decreasing the length this delay will decrease.

(This is just a short explanation)

1 Introduction

By angular velocity (ω) which shows frequency and wave number (k), we obtain velocity (v) .In this phenomenon important concepts such as Euler-Bernoulli beam theory, dynamic stiffness, mechanical waves, wave concepts and sound waves are considered . Wire diameter, spring diameter, pitch of spring, and the free height of spring are effective parameters.

Higher frequencies have more velocity than lower frequencies. This difference in velocity causes delay in sound because we hear sounds with higher frequencies sooner. Due to this delay, we hear a laser shot sound.

2 Theory and Experiment

As figure (1), we use a slinky spring in a horizontal way which has a cup at the end as an amplification. It is tapped with a hard object to hear its sound in a certain point . We use a phone as a recorder. We repeat our experiment with slinky springs different in radius, length, thickness, stiffness and other parameters.

Fig. 1: Sci-Fi Experiment setup

In spring the longitudinal wave (Fig. 2) equations are as follows (Eq. 1-3):

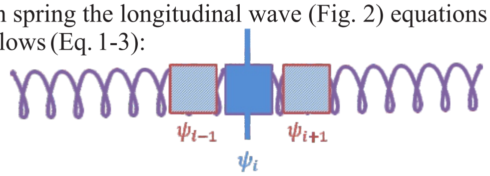

Fig. 2: Longitudinal wave in spring

$$v_g = \frac{d\omega}{dk} = c \qquad (1)$$

$$\psi = A\sin(\omega t - kx) \qquad (2)$$

$$F_T = 2ka^2\frac{d^2\psi}{dx^2} = 2m\frac{d^2\psi}{dt^2} \qquad (3)$$

In our experiment transverse wave is considered in the spring too (Fig. 3) (Eq. 4-9).

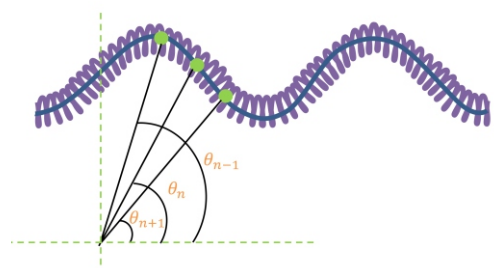

Fig. 3: Transverse wave in spring in our experiment

$$F = ma \xrightarrow{F = s} a\frac{ds}{dx} = \mathrm{m}\frac{d^2\psi}{dt^2} \qquad (4)$$

$$F_T = \frac{a\left(s\left(\frac{a}{2}\right) - s\left(-\frac{a}{2}\right)\right)}{a} = a\frac{ds}{dx} \qquad (5)$$

$$S = -k\Delta x \qquad (6)$$

$$s = -kla\frac{d\theta}{dx} \qquad (7)$$

$$s_T = -kla\frac{d\theta}{dx}\left(\frac{a}{2}\right) - \left(-kla\frac{d\theta}{dx}\left(-\frac{a}{2}\right)\right) = -kla^2\left(\frac{d^2\theta}{dx^2}\right) \qquad (8)$$

$$F_T = -kla^3\frac{d^3\theta}{dx^3} \qquad (9)$$

Frequency of the sound is recorded and the plot is compared with theory (Fig. 4) (Eq. 10 - 12).

$$v_g = \frac{d\omega}{dk} = 2ck \qquad (10)$$

$$\left.\begin{aligned} v_g &= c'' f^{\frac{1}{2}} \\ t &= \frac{L}{c'' f^{\frac{1}{2}}} \end{aligned}\right\} \boxed{f = \frac{L^2}{c''^2}\frac{1}{t^2}} \tag{11}$$

$$\boldsymbol{\omega = ck^2} \tag{12}$$

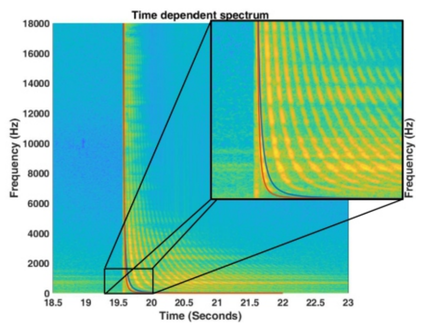

Fig. 4: Frequency versus time in sound recorded

We have a sound-recorder and a cup to hear the sound easier. We have a camera to record the slinky spring movement. We record the sound and analyze our data in different lengths.

In different lengths and diameters of the spring (table 1 and 2) , frequencies are compared (Fig. 5 and 6).

Table 1: Different lengths of the spring

N=1	2.78318
N=2	19.132
N=3	80.132
N=4	150.132

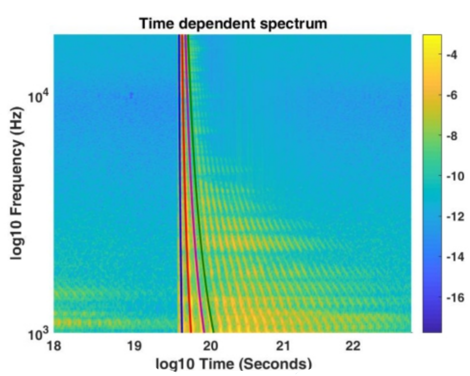

Fig. 5: Frequency versus time in different length of the spring

Table 2: Different length of the sprin

S_1	1.71090909 D=0.075 m
S_2	5.56636364 D=0.05 m
S_3	11.132727272 D=0.025 m

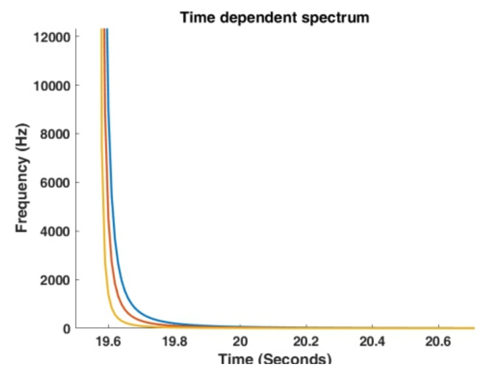

Fig. 6: Frequency versus time in different diameters of the spring

4 Results and Discussion

If we tap the same slinky spring with different intensities, we hear similar sound. The slinky spring with longer length has more delay in compare with the shorter one.

According to the graph , by tapping the slinky spring in several times, we saw the sound seems the same on special condition so the way we tap the slinky is not important. By time passing the frequencies will decrease and when the length decreases the delay will decrease either.

The main acoustic observation is that the helical spring is highly dispersive and the most important parameters in this research are force that is added to the system, spring material, spring diameter, length of the spring , pitch of the spring, and the free height of spring.

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