Shape-dependent rotation of acoustically levitated object

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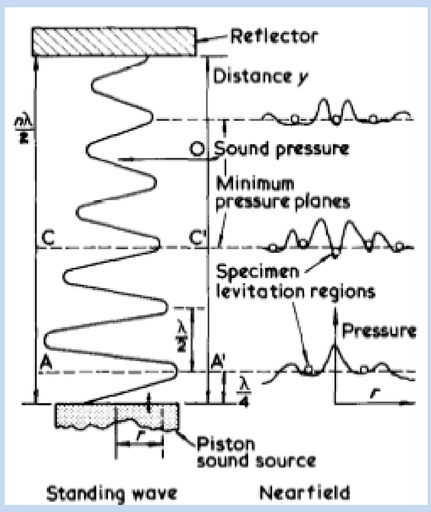
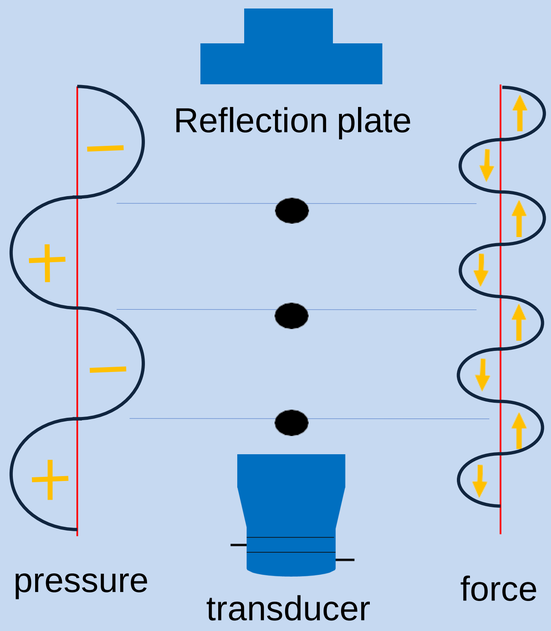
Introduction

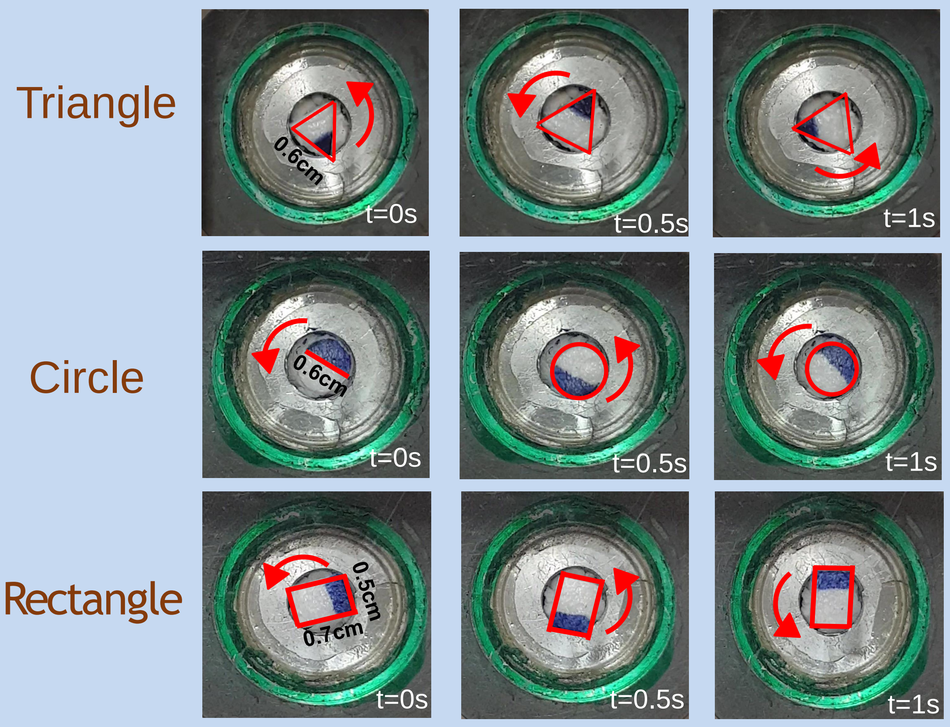
Ultrasonic levitation is different from other levitated methods because its levitated object doesn't need to be charged or magnetic substance. Ultrasonic levitation has been applied to pharmaceutical and high purity chemical reactions that do not require contact. Ultrasonic levitation uses standing wave property to make energy stay in the wave, the object will levitate at the minimum pressure point. Because the pressure has a distribution, different part of the objects are involved in the different pressure distribution, for this reason the object will experience a torque and rotate. We want to observe the effect of its shape to the rotation.



The acoustically levitated field is point symmetry [1]

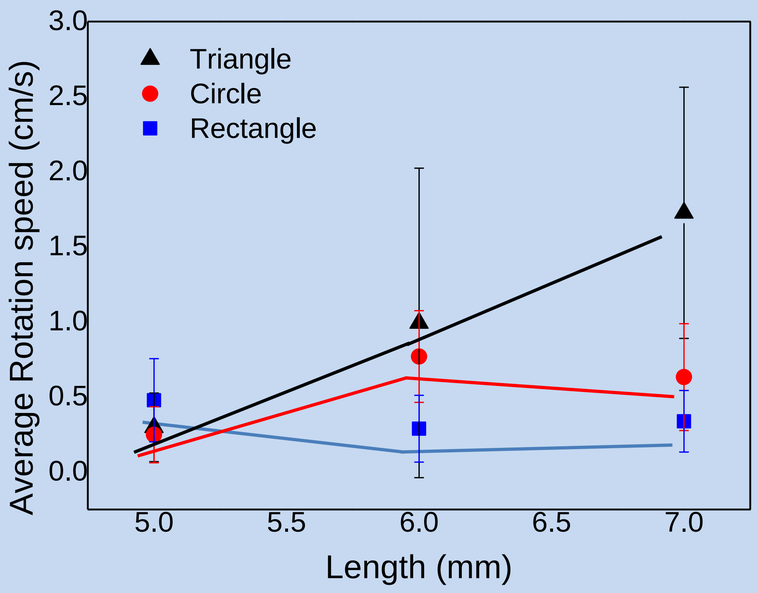


Rotation phenomenon



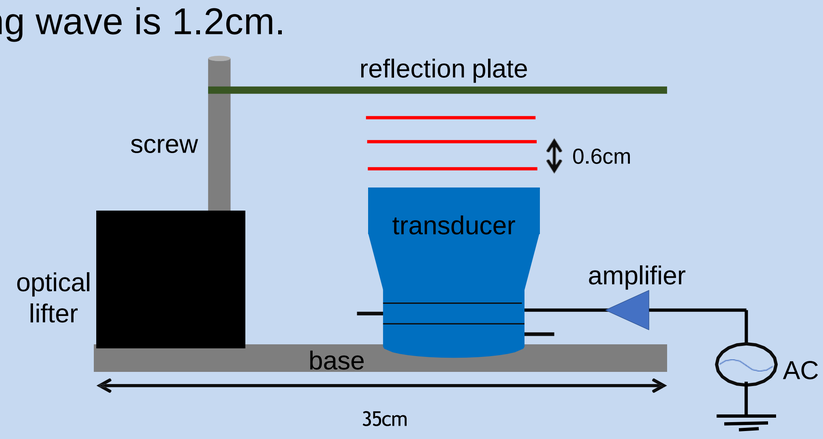
Shape and Length affected rotation speed

We suspends three different shapes of objects with different size, and measure the average rotation speed of the object when it is rotating steady. The rotation speed of the triangle object is higher and higher when the length is increasing. However, the rotation speed of the rectangle object is oppositive to the triangle object. The result might concern to the symmetry of the geometry of suspending objects.



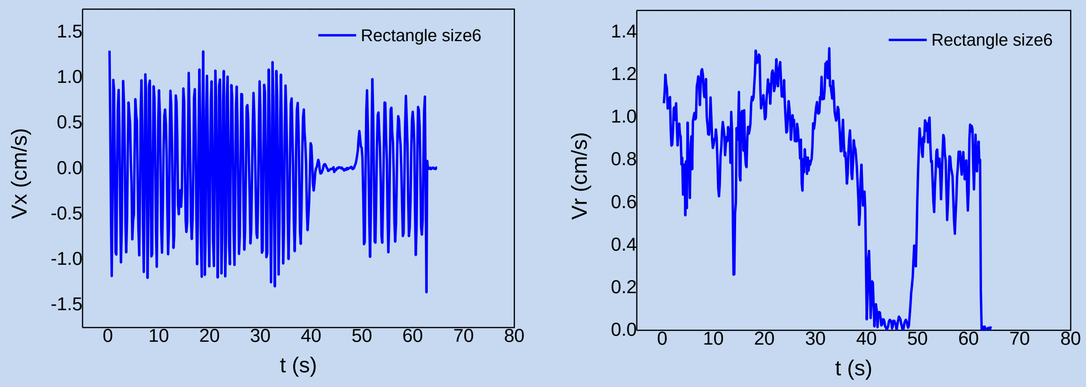
Setup

The output voltage is amplified by a push pull circuit. The input voltage is 110V, 60HZ, through raising voltage and increasing frequency, the output voltage is 880V, 28000Hz. Transducer and lifting platform is fixed on a aluminum plate, through rotating the nut to adjust the reflection plate height. The wavelength of standing wave is 1.2cm.



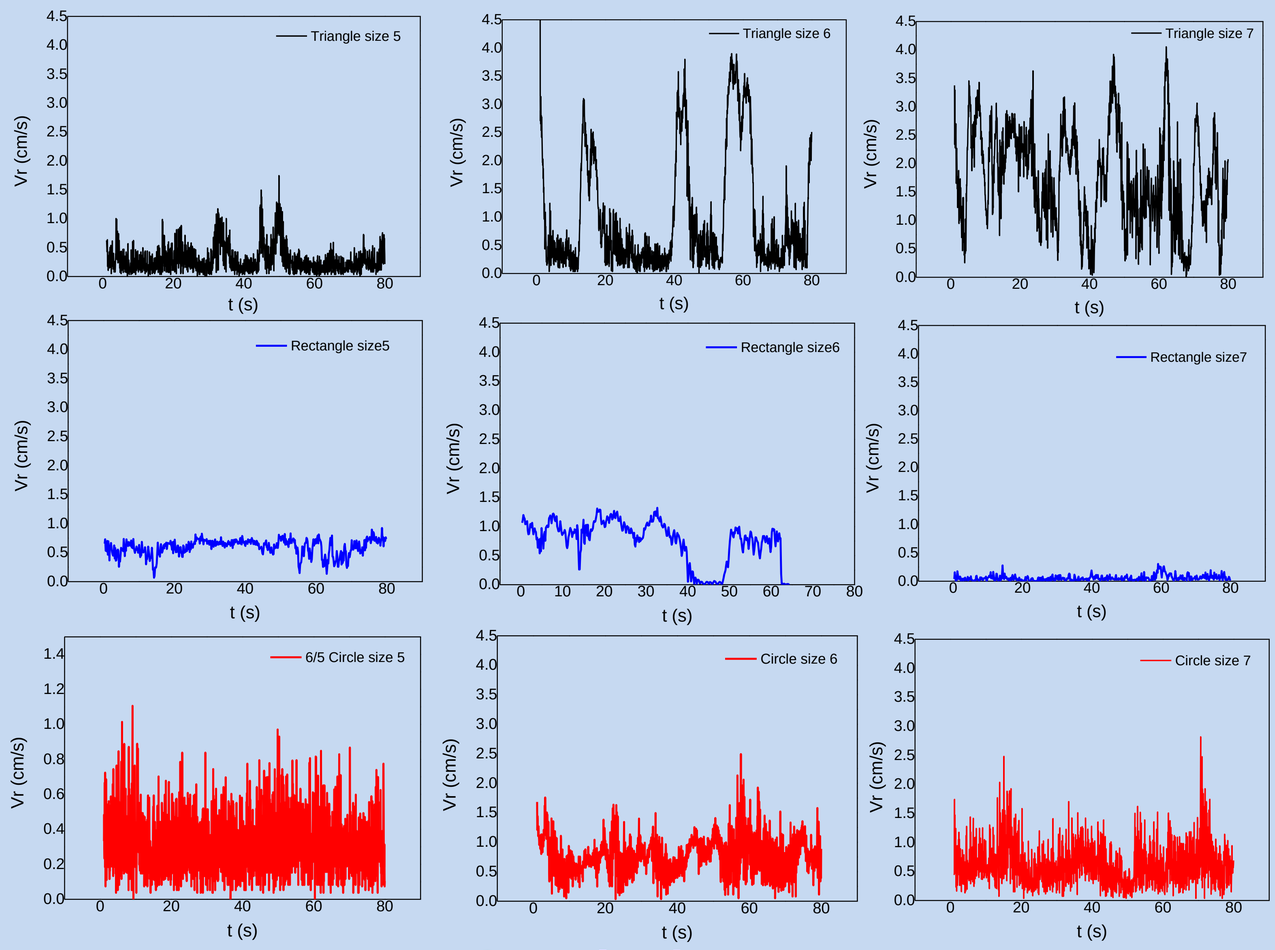
Self-oscillation

From the Vx-t figure, we find that the object might have self-oscillating and have its oscillating period when it is rotating. Furthermore, by comparing the Vr-t and Vx-t figures, we find that the rotation motion of the object is also affected by the self-oscillating motion of the object.



Stable rotation time

From a series V-t figure of triangle objects with different length, we find the triangle object with larger length will give a longer steady time when it is rotating. However, the steady rotation state of rectangle object become shorter and shorter when the length of object increases. Although the circle object does not rotate faster as the length becomes longer, the steady rotation state of circle object is not shorter.



Conclusion

1. Object in the acoustically levitated field suffers the torque of the point symmetry field causing it oscillate and rotate.

2. The degree and duration time of oscillation and rotation are affected by the symmetry of shape and the size. The more asymmetry shape, the longer unstable oscillation time.

Reference

[1] Acoustic field positioning for containerless processing - R. R. WHYMARK