CALIFORNIA SCIENCE & ENGINEERING FAIR
2019 PROJECT SUMMARY

Name(s)

Reuben Broudy

Project Number

J1703

Project Title

Modelling Minimum Voltage to Acoustically Levitate Non-spherical Objects at Near-wavelength Dimensions

Abstract

Objectives

The objective of this study is to understand the relation between the geometry of an object and the amount of voltage needed to acoustically levitate the object.

Methods

I built an acoustic levitator and put different shapes inside of it. The shapes tested included triangular, square, hexagonal and circular prisms. Using a Buck DC converter, I was able to decrease the voltage and record when the shape fell out of the acoustic levitator. I called this voltage, the drop voltage. I then analyzed the relationship between drop voltage and the size of a shape (small, medium and large), and also the geometry of a shape (triangle, square, hexagon, circle). For each set of shapes, I had three replicates and measured the drop voltage five times. I used this datat to calculate average drop voltages and standard deviations. I then drew an exponential curve through the data to create an equation that represents the relationship between drop voltage and geometry (i.e, number of sides) of an object for non-spherical near-wavelength objects.

Results

The results showed that all small and medium objects had similar drop voltages. However, in the large set of objects, the results showed a difference--the large circle shape had a drop voltage of 6.45V, compared to 7.62V for the triangle and 7.46V for square.

These results were not surprising because Gorkov s law says if an object is much smaller than the wavelength, size doesn t matter, only its density. But for the objects near the dimensions of the wavelength, Gorkov s law doesn t apply, and I hypothesized there could be a difference in drop voltage between shapes of different geometries.

Further testing of the large set of shapes was performed in a more controlled environment. In this testing, the circle shape once again had the lowest drop voltage (5.66V) compared to hexagon (6.28V), square (6.61V) and triangle (7.6V). Standard deviations were calculated, and the differences in the voltages had a high level of confidence.

Finally, I was able to fit a curve to the data, having the equation: y = 7.54(1.6)^(-x) + 5.6625 (y=drop voltage, and x=# of sides on an object). The curve fit the data well with an R^2 = 0.95.

Summary Statement

My project modelled the relationship between the geometry of an object and the amount of force needed to levitate the object in an acoustic levitator.

Help Received

I built and programmed the acoustic levitator myself after studying how to do it on the internet. I performed all testing and analysis. My science advisor, Matt Bessler, helped ensure I completed my study on time. I interviewed Dr. Arezo Marzo Perez of University of Sao Paolo, Brazil, who helped clarify