Plasma Vortex Theory

Investigation of the Effects of Sound on Noble Gases used in Electronic Propulsion Devices.

Undergraduate Research 294
Winter 2018 Quarter Research Proposal
Team Name: "Cyberdyne Gundam Shinra Capsule Corp" (CGSCC)
Members: Cory Andrew Hofstad

Authored By: Cory Andrew Hofstad

10002 Aurora Ave N Ste 36,
Seattle, WA 98133
cory.hofstad@seattlecolleges.edu
(206) 701-9378

I. Introduction

"Revival of Scientific Approach at the Ground Level of Engineering."

The Big Picture in Space Flight Evolution

In the last century space travel humans of gone through three stages of spaceflight research and development… (Robertson, 2011, p. 319-330)

A. Scientific Period

In the early 1900s scientists began research and rocketry and spaceflight with a scientific approach that discovered unknown "methods of reaching extreme altitudes" (Goddard, 1920, p.809-811). Scientists starting with Konstantin Tsiolkovsky, Robert Esnault-Pelerie, Robert Goddard, Hermann Oberth and Wernher von Braun created new viable methods of spaceflight from scientific experimentation, scientific methods and results based engineering (Emme, 1962 ,p. 81). From 50 years of scientific discovery and scientific engineering in an attempt to reach orbit we developed proof of concept via the Russian Sputnik one in October 4th 1957.

B. Engineering Period

In the excitement of obtaining proof of concept, and through the competition that the orbit of the sputnik created, humans grabbed a hold of what scientific research had already been done and compiled all knowns to begin engineering competitive rockets and spaceflight vehicles with a focus in engineering devices which were designed better than the competition.

On July 29, 1958, the United States of America founded the national Aeronautics and space administration known as NASA. As a primary goal of NASA and the American space program was to outcompete other countries specifically Russia in becoming the first achieve new frontiers in space travel manned and unmanned, discoveries in science and research took a backseat to competitive engineering and manufacturing processes.

Thus, in the hands of a majority of aerospace engineers, human space programs have dedicated the last 50 years to developing rockets with the focus that they are better than last generation's designs. In the competition between rival aerospace programs we have lost the motivation to develop new scientific theories, experimentations and methods which add to the unified body of knowledge related to spaceflight. Instead, much of achieving thrust relies on using the same principles we already know while adding more fuel or larger burners in an effort to increase thrust within rockets and spaceflight devices.

C. Commercial Period (Current Period)

On May 20, 2003 SpaceShipOne made the first civilian spaceflight in our recorded history. This time period marked the beginning of many private space companies, and brought about the third period of spaceflight which will be referred to as the Commercial period of space flight.

10002 Aurora Ave N Ste 36, Seattle, WA 98133 | cory.hofstad@seattlecolleges.edu | (206) 701-9378

Through several successful resupply missions by space exploration technologies to the international space station a mixed commercial and governmental space exploration program has attained proof of concept. Although we have taken a major step in allowing the general public access to human spaceflight through commercial space programs, these new commercial

Space programs are still using the technology that our original space flight scientists developed at the beginning of last century. The latest major concept spaceflight program revealed by SpaceX entitled the BFR or literally the “Big Fucking Rocket” (SpaceX, 2016), uses the engineering method of building bigger for building better. While the BFR platform is designed as a multistage reusable platform, the idea of a multistage reusable rocket was proposed over 100 years ago in 1912 by Dr. Robert Goddard in his early journals. The first methods of separation of rocket stages were patented and used in 1958 (Allenson, 1958) by Ray E. Allenson.

D. Revival of Scientific Approach at the Ground Level of Engineering.

This proposal is not just about a single scientific experiment. This proposal is an effort to promote the combination of Science, Engineering, Commercialism and Education at the very ground level. Spaceflight is expensive (Martin, A. 2015). In order to run space flight missions, governments, have to have motivation, commercial organizations have to have profit return, and educational institutions have to have publishable results in order to get funding. The cost of engineering and the lack of science is the number one hindrance in spaceflight in this generation.

In the last century, human spaceflight has taken a dangerous turn away from the scientific research and discovery methods of the pioneers in spaceflight. Budgets are not designed to pay for experiment that may or may not work they are designed to build rockets that can sell based on power. The scientists within NASA are tasked with observing external systems such as new planets, biology and observing radio waves. Most NASA scientists are not tasked with finding new ways to create propulsion using unknown methods and scientific discovery.

E. The Scientific Method & Electronic Propulsion Engineering

The goal of this proposal is to re-introduce a scientific approach to the way we handle space propulsion sciences, specifically electronic propulsion. The function of this proposal is to introduce an experiment that combines physics, chemistry, engineering, sound, electricity, and magnetism.

The Field of Electronic Propulsion was created with Ideas by Konstantin Eduardovitch Tsiolkovsky in 1911, in an article titled “The investigation of universal space by means of reactive devices.” He published “It is possible that in time we may use electricity to produce a large velocity for the particles ejected from a rocket device (Tsiolkovsky, 1911, p. 8).”, which first gave us the idea that particles could be accelerated through the use of an electromagnetic field. The equations, formulas and methods of attaining velocity in relation to expelled fuel mass are still used today and all electronic propulsion and liquid chemical spaceflight devices.

The first electronic propulsion device used in space was on November 30th, 1964 when the Soviet Zond-2 spacecraft used plasma thrusters for rotations needed for solar panel alignment, which offered another concept in efficiency in energy usage. In the missions since, the goal of developing new electronic propulsion systems has been to maximize the use of electrical energy. While we have developed numerous forms of powering satellites in space flight vehicles our troubles still lie in the fact that we have not achieved our full potential in our abilities to transfer energy into an energy which we can use for acceleration and velocity in relation to the mass of gas which we expel during spaceflight.

While engineers have made huge achievements in manufacturing more robust yet infinitely smaller electronic equipment for spaceflight vehicles, we are still using the same technology and methods to achieve thrust. While building better hardware is the end result for any mission, the use of science must be the first step in creating any space flight objective, plan or strategy.

F. Benefits of The Scientific Method & Electronic Propulsion Engineering

The processes of engineering better hardware can be done in the laboratory instead of building more and more rockets. Building new rocket systems cost organizations within the aerospace industry billions of dollars. Scientific experimentation on new methods of achieving thrusts through the use of alternative methods are beneficial both to the scientist and the organization alike. Scientists learn more about conservation and transfer of energy in space propulsion systems through their research, while organizations are able to do the engineering via the scientific method in the lab before investing in the repetitive costs of building newer versions of last generations technology, every generation.

G. Using Scientific Research to Solve Problems in Electronic Propulsion

The field of electronic propulsion is critical to human spaceflight and our ability to conduct further space explorations which enhance our scientific knowledge of the future. When dealing with an issue in the scientific community that has the potential to rescue and save the human species from problems such as planet overpopulation and extinction level events we must be willing to research any new hypothesis which has the possibility of teaching us something which could help us learn about achieving propulsion through transfer of energy.

To support the theory of promoting a scientific method within the aerospace engineering community, new research topics and experimentation must be investigated. In the field of electronic propulsion, we are faced with two major obstacles, manufacturing robust hardware for deep space missions and increasing the ratio of thrust generated from electricity vs relying on chemical fuel for thrust.

This type of scientific investigation of the unknown through experimentation will be provided as a proof of concept for future space exploration planning. In this experiment, a new hypothesis which is original in his idea and its experimentation will be presented and tested. A scientific approach will be used to determine how sound waves effect gas contained in a vacuum. Data will be taken and new methods of research, development and engineering will be learned.

II. Research Question

“The Experimental Question”

A. Can a plasma vortex be created in a noble gas (under pressures common in electronic propulsion), by using sound?

The purpose of this experimentation for winter quarter 2018's undergraduate research 294 class is to obtain proof of concept that “sound can be used to increase the density of a plasma propellant via the formation of a vortex.

The basic idea behind this Electronic Propulsion experiment is to find new ways to increase the energy of a noble gas propellant in the pre-exhaust phase of electronic thrust. In this experiment, we will use the scientific method to form a hypothesis based on previous research in Physics and chemistry as to how we can increase the energy of the propellant gas using sound waves. The data used to form the hypothesis used in this experiment was inspired by the experimentation of Hans Jenny, and the field of Physics related to sound and wave movement. (Jenny. 2001)

1. About the Experiment & Background

In nature we see many vortexes, contained within solids liquids and gas. In the observation of these vortex we notice many things in common. In many common vortex formations in nature we observe harmonic motion in the three dimensions. We observe sinusoidal motion, with an axis which is in a spherical formation that carries motion in three dimensions which we can measured and investigated. Within the three-dimensional rotational forms created by substances which carry the qualities of a vortex, we find large conservations of energy within their structures. We can observe this energy as kinetic energy through measuring the movement of particles within a vortex in three dimensions.

In this study, we will examine various mediums under different conditions using sound and harmonic motion to investigate which tones or frequencies create a form which most resembles a vortex, or spinning 3-dimensional cloud structure. Physics and mathematics including such as trigonometry will be used to measure the geometry of our gas cloud such as, radius, angular velocity, angular acceleration, period and height. This data will be used to make an attempt at finding the sinusoidal axis of our vortex and in order to make calculations regarding the energy change of the medium.

2. Educational Application of The Scientific Method and Aerospace Engineering

North Seattle College – Undergraduate Research Winter 2018

This proposal covers the first stage of a timeline that constitutes a three-quarter program to build a fully functioning electronic propulsion device which operates using trust enhanced by sound. We will be using a safety-first approach in testing all frequencies at low amplitudes scaling up with the area and volume of active soundwave in mind for calculations used for the container volume of our vacuum container. We are not igniting liquid fuel and no ignition chemical reactions are planned in this experimentation. We are attempting to create a contained cortex using sound which we can use to create plasma that can be accelerated out and exhaust appendage to create volumes of thrust which would be unattainable without the assistance of sound. Proof of concept at each stage of development will be a checkpoint before proceeding to the next event. Calibrations measurements and investigation of events within the laboratory will be discussed before next stage of experimentation will begin.

B. Research Goals

Goals for this first quarter of the experimentation in undergraduate research include:

- acquiring hardware, software, tools, elements, mixtures, measurement devices and recording devices needed for physical and chemical experimentation.
- setting up harmonic motion experimentation equipment including recording and measurement devices.
- calibration of sound waves to determine which frequencies excite solid and gas particles into a vortex formation
- using calibrated frequencies on known noble gases in an effort to achieve similar vortex formations
- creating a gas chamber environment which can withstand pressures within the range of current electronic propulsion devices
- creating this chamber so that it can properly sound from a wave driver into the gas within the pressurized environment
- creating this chamber so that and external electrode can be placed near the device to excite the gas into a plasma
- applying an arc to noble gases in a vortex formation and observing results

This experimentation is designed to show how even at the community college level scientific investigation of new applications can create research and discussion that brings an opportunity for new science. The application of sound waves to a gas which will be introduced to electricity brings together scientists, physicists, chemists, mathematicians, engineers, students, educators for the common goal which in the 60s under James Kennedy motivated a nation to attain spaceflight and land on the moon.

This project reaches outside of the undergraduate research department into other departments within our school such as the rocket club physics department in chemistry department which allows the undergraduate research program to encourage research and gain attendance through networking and science which was promoted early in the fall quarter.

If successful, all experimentation and results in findings will be published under the authorship of all involved in the project under an open-source license which will be shared with others in the scientific and public community. Any new technology acquired through this project will be shared with others in chemistry physics Aerospace mathematics and education. all funding required for this project will be specifically used to build systems which are affordable, modular and reusable. Equipment attained for this project can be used in future investigations within the physics department, chemistry department and engineering departments within our college.

III. Methods

Step1: Calibration and determination of frequencies which create patterns suitable for electronic propulsion.

Calibration of select frequencies Which show stable increased energy environments will be done with a function generator connected to a mechanical wave driver which will oscillate Chladni Plates and sound diaphragms of made of stretched paper. Hans Jenny's video documentation "Experimentations in Animation with sound and Vibration." And data from "Cymatics A Study of Wave Phenomena and Vibration" are going to be used as reproducible scientific proof of concept which we will use to reproduce a vortex cloud in lycopodium, a substance used in physics experimentation for its similarity to gas.

Specific frequencies will be determined during initial experimentation through the following method. Frequencies used on gas will be calculated using the scientific method of testing multiple frequencies on a dial under different conditions in order to attain a vortex similar to the plume shown in the Hans Jenny's Cymatic Soundscapes 4:39. This test and observe method of attaining vortex stimulating frequencies is similar to the method found in chemistry for observing and recording reaction rates by testing reactions at different concentrations.

The calibration will be done using the following systems
- Chladni Plates and a Mechanical wave driver
- Circular Diaphragm of stretched paper of about 30cm which is excited by vibration.
- A ripple pool using with wave driver for CO2 gas and lycopodium.
- A rubber diaphragm similar to the design used by "Laser + Light + Sound", a Steve Mould presentation.

Step 2: Experimentation of calibrated frequencies on noble gases to produce a vortex

The calibration mediums, and test gasses (noble gas propellants used an electronic propulsion devices) will be tested against calibrated frequencies, in a vacuum with an initial pressure within the common range of an electronic thruster. This experiment will allow us to measure temperature changes of our gas cloud along with change in pressure, at constant volume and molecular amount. This experiment attempts to bring a propellant gas into an excited state through vibrational waves, so it can be used as a high-energy plasma which would increase the gas's efficiency as a high-energy propellant for future spaceflight applications.

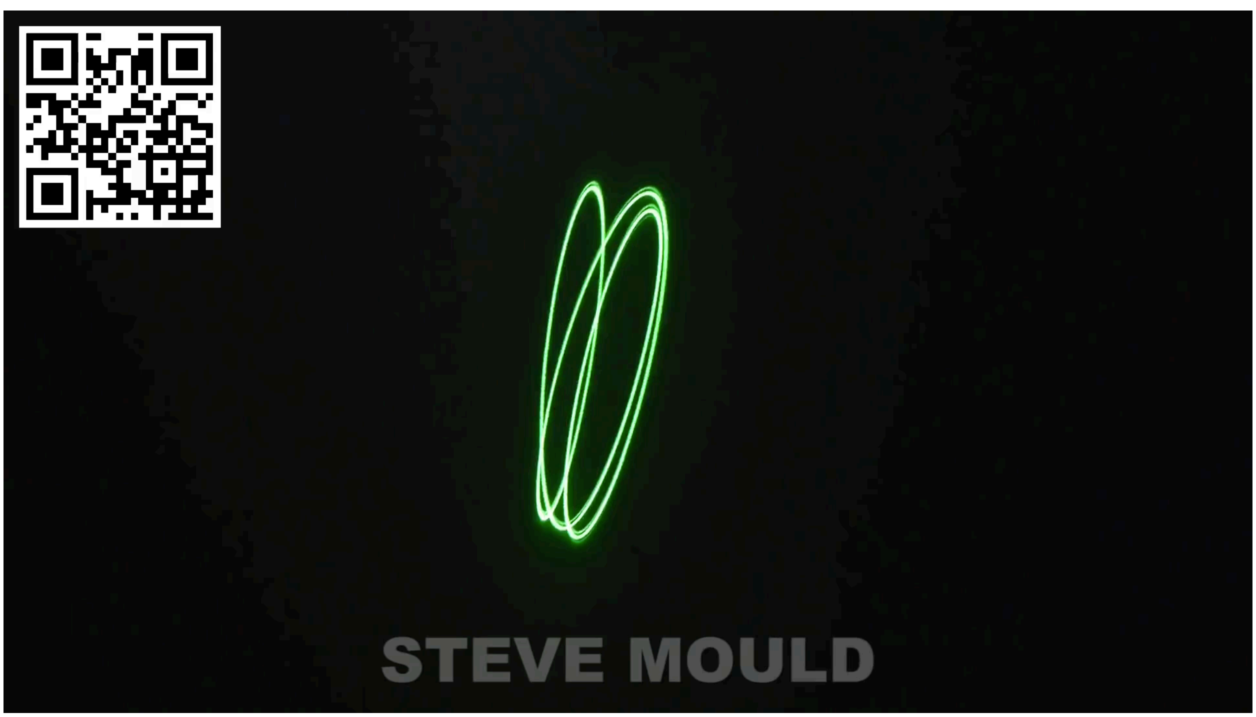
As part of the experiment and enclosure must be designed to contain the gas in a vortex configuration. This enclosure must maintain stability in pressures over what would normally be found in most electronic propulsion devices because of the increased energy found within vortex formations. The base or initial pressure which we will begin testing noble gases will be in line with modern electronic propulsion devices.

As we use sound to excite gas particles and began to form a vortex we will monitor changes in energy via infrared thermometer devices and changes in pressure within our container. Once we observe the form of a vortex within our experimental chamber we will then continue the experiment with increased amplitudes while constantly observing temperature and pressure changes.

We will experiment with different ranges and frequency container arrangements noble gases in amplitude in order to form the most measurably and observably stable vortex possible within our physical limitations.

Step 3: Observation and recording of laser path to determine shape and period of sound wave during vortex formation.

A laser beam directed at a reflective mirror located on a rubber diaphragm on top of our gas containment vessel will be used to report the path of our active sound waves during vortex formation (Figure 1). Observation of the laser path (Figure 2), will be used to determine physical geometries of our soundwave and data related to period Length of the sound wave within our test chamber (Video 1).



Video 1 "Laser + Light + Sound", Presented by Steve Mould

10002 Aurora Ave N Ste 36, Seattle, WA 98133 cory.hofstad@seattlecolleges.edu (206) 701-9378

Our method of experimentation comes from experimentation by BBC broadcasting physics journalist Steve Mould (Mould Effect - Biggins JS,Warner M. 2014), Finding Curiousity). His presentation of experimentation and documentation done by Brian Mackenwells will be used to observe real-time soundwave data of our vortex formations.

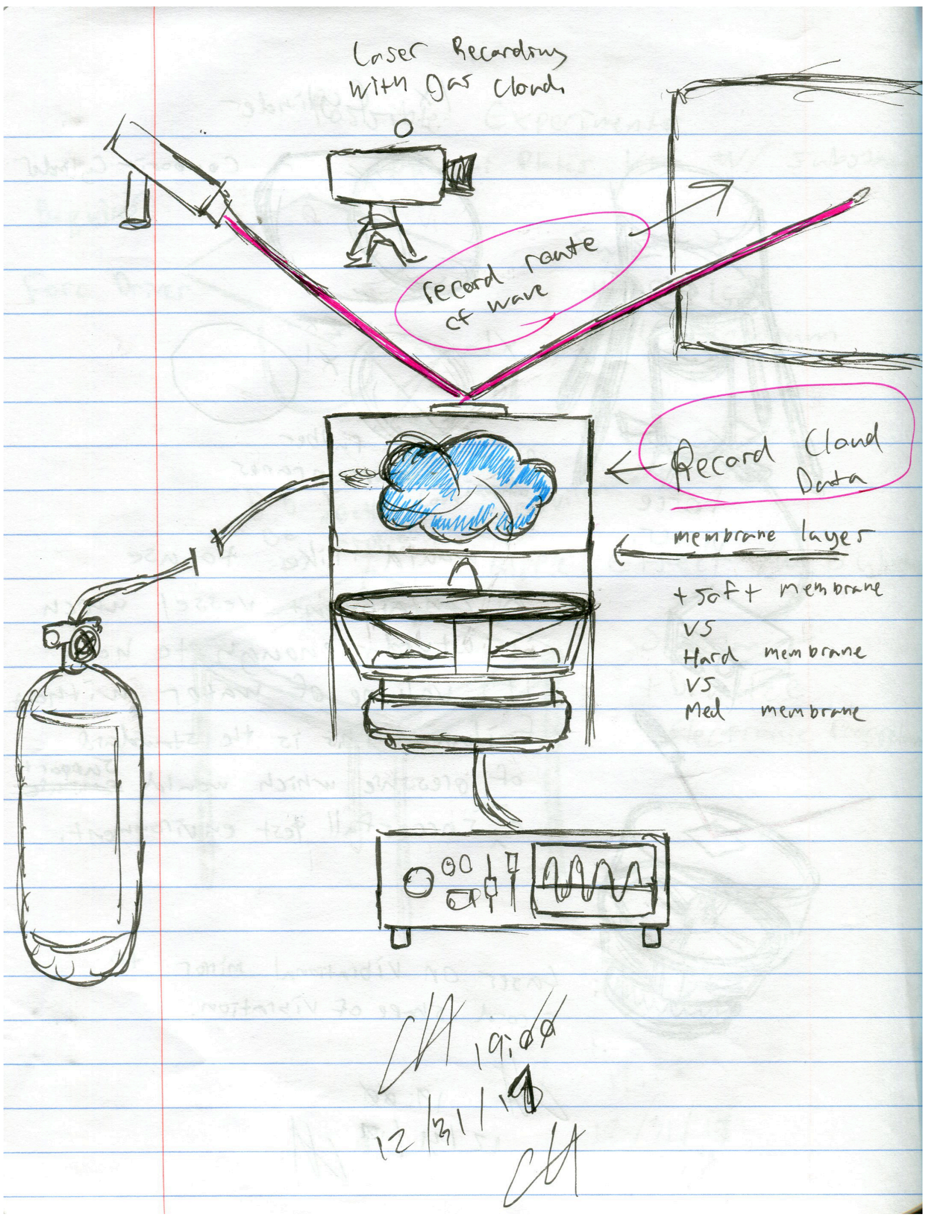


Figure 1: Gas/Plasma testing chamber with laser tracking.

The work of the late scientist Hans Jenny, specifically the video series “Cymatic soundscapes” and the book titled “Cymatics a study of wave phenomena and vibration” (Jenny, 2001) will be used as a form of roadmap in experimentation with using sound as a means of changing the form of a gas.

BBC and TedX physics presenter Steve mold has published video demonstrations which show us how to analyze the actual path in which a sound wave travels using lasers, diaphragms and sound waves. (Mould, 2017)

10002 Aurora Ave N Ste 36, Seattle, WA 98133
cory.hofstad@seattlecolleges.edu
(206) 701-9378

HOFSTAD, CORY ANDREW
1/11/18

PLASMA VORTEX THEORY

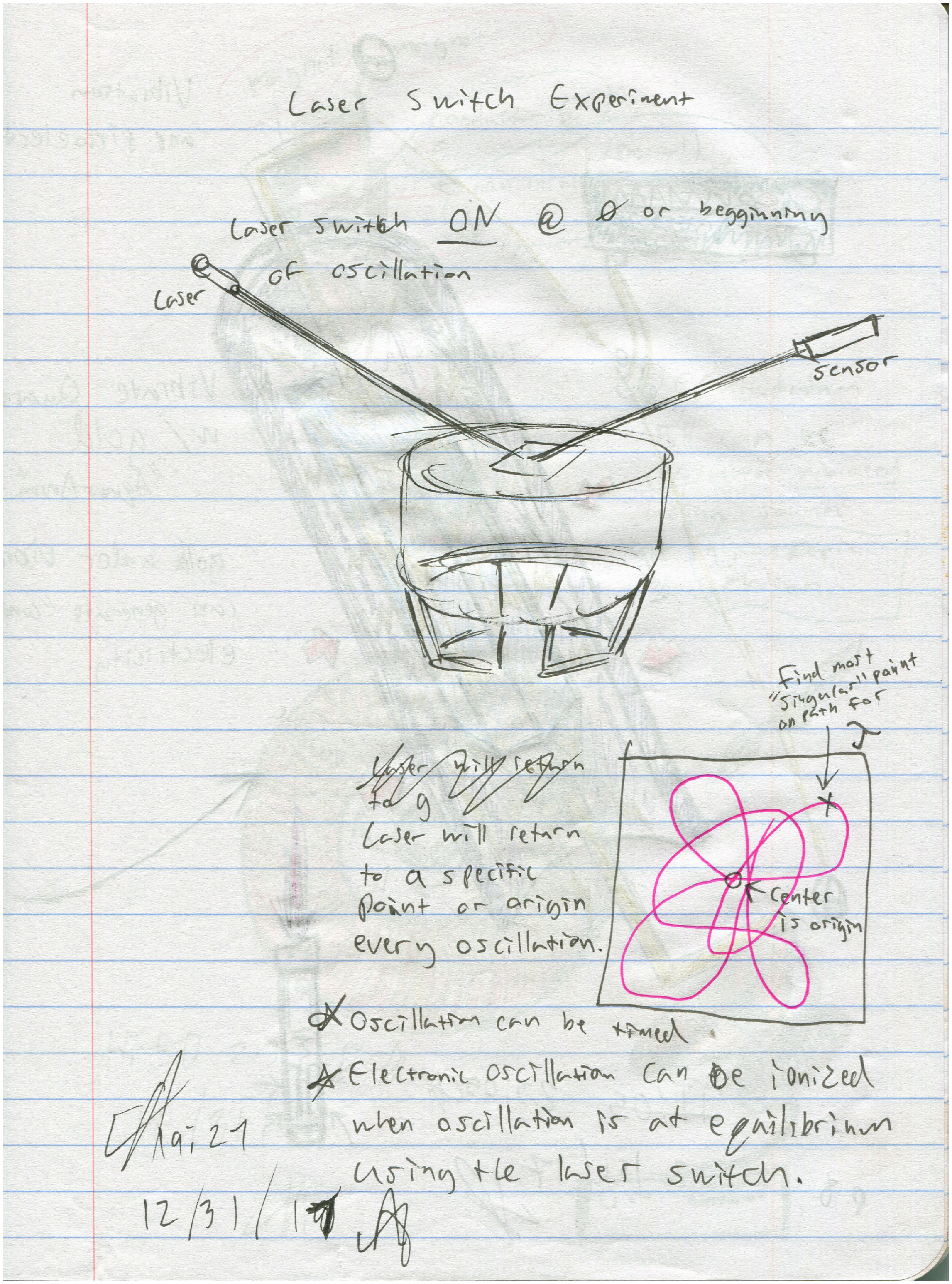


Figure 2: visual tracking of Laser to find path of sound wave.

10002 Aurora Ave N Ste 36,
Seattle, WA 98133
cory.hofstad@seattlecolleges.edu
(206) 701-9378

Step 4: Experimentation with gas vortex and inducing a plasma state

Once we have obtained and recorded the needed conditions for a stable and reproducible vortex using our calibrated sound frequencies, gas container, and noble gas combination, we will then begin to experiment with inducing a plasma state.

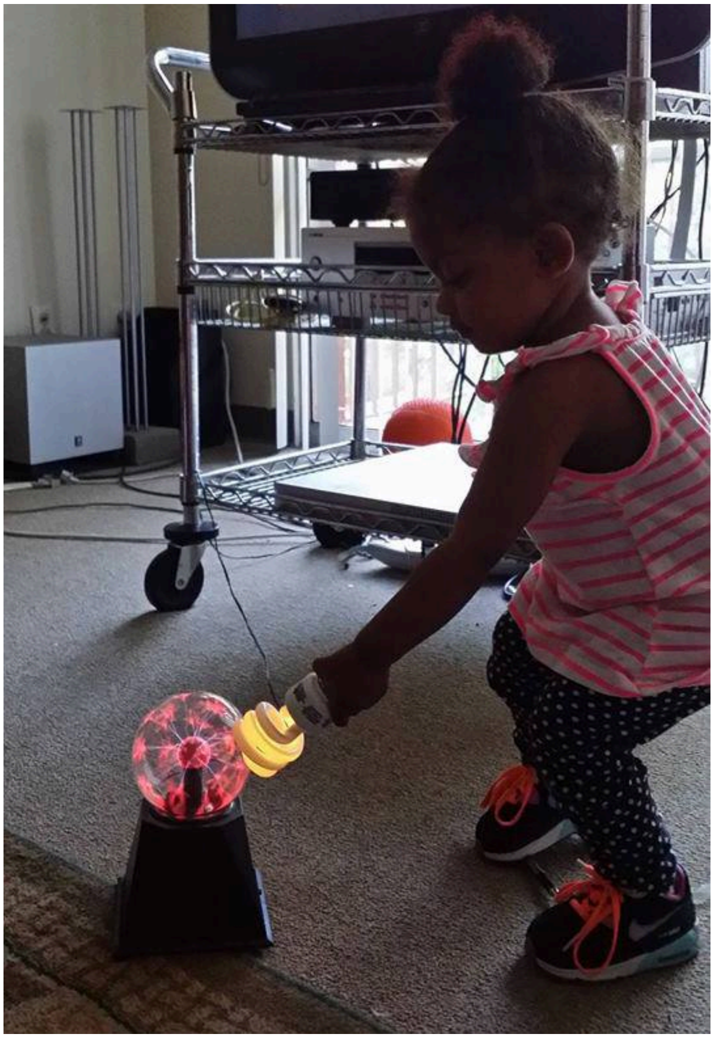


Figure 3: "Olivia safely ionizing a contained gas with an external electrode". Image by Cory Andrew Hofstad

In a similar fashion to the figure (Figure 3), we will introduce the contained gas to an external electrode and inherent magnetic field. The gas will remain contained within the vessel and will not come in contact with the electromagnetic device, but will come in direct contact with the field it produces.

Experimentation will start with the electrode at an extreme distance from the gas container. The electrode will then be incrementally moved toward the gas chamber while constantly monitoring temperature and pressure within the gaseous container.

Tuning of an electrode power, distance, sound amperage and frequency will be made in order to attain the most stable plasma vortex. Stability of the vortex cloud will also be monitored throughout the process of introduction to electronic field by looking for abnormalities in the shape and configuration of the vortex.

Adjustments may need to be made to the amplitude and or frequency to ensure vortex stability (avoiding spikes and jagged areas in vortex) throughout the introduction of the electrode.

At this stage data will be recorded, calculations of measurable observations will be made and a scientific journal will be written with our findings. We will move beyond the stage of creation of a plasma vortex once we have observed and recorded data and video footage for scientific review to verify our findings.

Plans for Spring 2018 and Fall 2018 will be published including designing and producing a fully functioning plasma vortex thruster which will measure thrust density changes vs frequency and amplitude calibration data.

IV. Equipment, Reagents, Supplies and Other Needs.

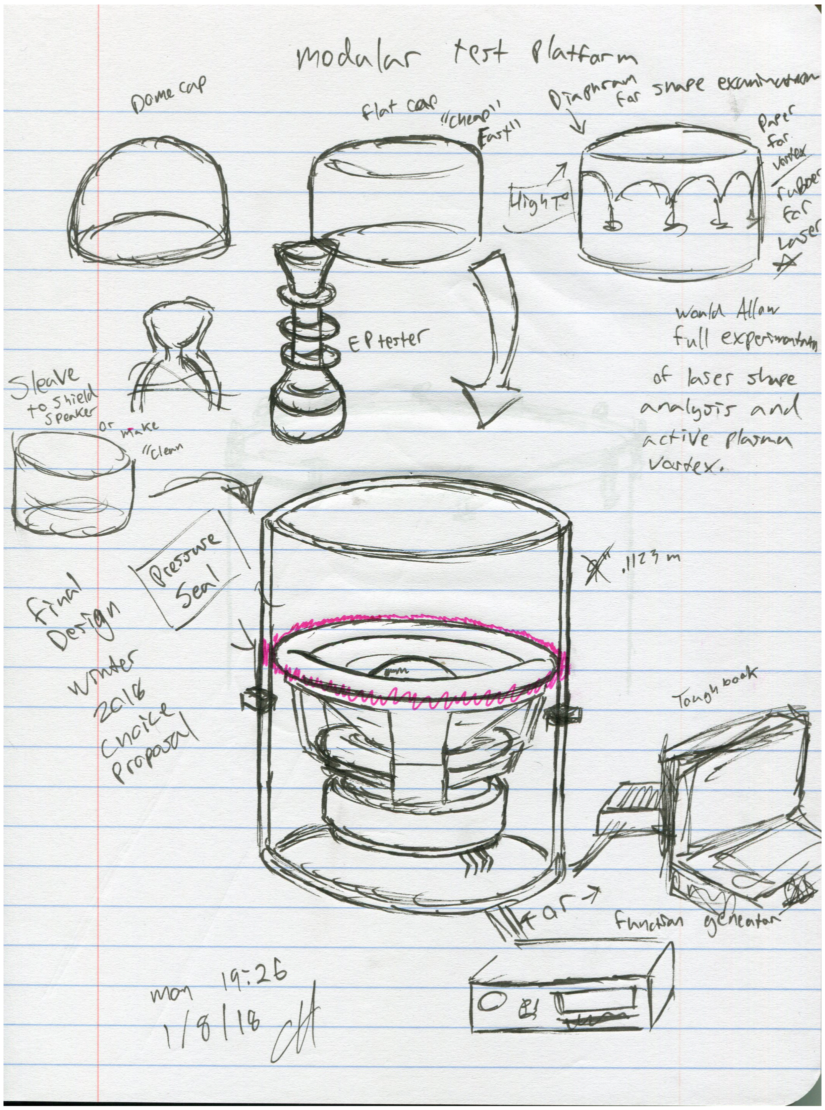


Figure 4: In-House Design and Assembly of Gas/Plasma Testing Chamber.

Maximum cost efficiency is a prime strategical factor in mission planning and aerospace engineering. In organizational and operational production, budgets are high due to outside manufacturing costs that occur when offering bids for outside organizations to design working high-performance airspace equipment and hardware.

In the laboratory environment at the academic level costs in developing and designing new technology and hardware systems can be maintained through the use of in-house manufacturing, volunteer or credited student labor, and networking within our student and faculty community for sourcing equipment. The focus of these experiments specifically designed to be modular and reusable.

When researching new methods through physics, chemistry, and engineering, test environments specific to the application sometimes need to be fabricated.

While we have an external resource Pasco in which we can rely on for some of our calibration equipment including a wave driver sound plates and a function generator, some of the equipment needed for this experiment must be engineered in-house (Figure 4). The scientific team for this project has fabrication experience, both at the academic and industrial level.

A. Hard Copy of Main Reference Materials:

Cymatics Soundscapes: And Bringing Matter To Life With Sound... DVD	Available on Amazon	DVD Set with experimentation videos and data	$30
Cymatics: A Study of Wave Phenomena & Vibration Hardcover – July 1, 2001	Available on Amazon	Full color reference material and instructions.	$58

2. Hardware Required for Recording and Documenting Experiments:

DSLR Camera (x2)		Allows for multiple angle recording of substance shapes and wave path shape of laser.	$4000 for 2 and lenses
Quad Ruled Composition Notebooks (x4)		Allow for notes to be taken and graphing	$20 for 4
Pro Tapes Measurement-Tape	Available on Amazon	paper tape with adhesive backing which can be used as a repositionable ruler.	$15
Infrared Thermometer	Available on Pasco & Multiple Locations	non-contact **infrared thermometer** measures up to 752°F (400°C) with built-in laser pointer to identify target area	$75
Laser Switch	Available on Pasco	Laser timing sensor which will be used with the laser and rubber diaphragm experiment to calculate the period of oscillation using a single point in path of motion.	According to Pasco website, photogates used in NSC physics labs should work as laser switch.
Visible Laser Diode Mirror (x3)	Available at Edmund Opitcs	specially coated to attain maximum reflection of visible laser diodes.	$54 for 3
Slow Motion Camera	Available at Adorama	Will allow us to view the path of the laser using the rubber diaphragm and mirror. Will allow us to look for vortex inconsistencies in later experiments	$10,000
Wireless Pressure Sensor	Available on Pasco	Make accurate and consistent measurements of gas pressure, regardless of ambient conditions, and explore how chemical reactions affect gas pressure.	$69
Sarasa Porous Pens	Available at Bookstore	Allow for Permanent and accurate journal entries.	$5
Sharpies Markers	Available at Bookstore	Make Engineering Marks & Measurements on equipment	$10
Digital Sound Level Meter	Available at Pasco and everywhere where else	provides greater accuracy and more sophisticated measuring capabilities than an analog meter.	$75

3. Hardware Required for frequency calibration:

Mechanical Wave Driver	Available From Pasco	Provides variable-frequency, variable-amplitude mechanical vibrations for the lab.	$180
Banana Plug Cord-Black (5 Pack)	Available From Pasco		$20
2 Meter Patch Cord Set	Available From Pasco		$20
Function Generator	Available NEW from Pasco. Available USED, everywhere else.	Outputs sine, square, triangle, positive and negative ramps with a frequency range of 0.001 Hz to 150 kHz in addition to DC	$775 Available ON CAMPUS! For FREE
Chladni Plates Kit	Available From Pasco	Allows continuous vibrations to be produced at measurable frequencies. Students can determine the resonant frequencies of the plates and examine the modes of vibration at any frequency.	$75
Elastic Wave Cord	Available From Pasco	Highly visible and produces good amplitude, making it ideal to use in demonstrations of standing transverse waves produced by the Mechanical Wave Driver.	$30
Ripple Tank	Available From Pasco	“If you study wave propagation, reflection, refraction or diffraction, this completely redesigned ripple tank system is a necessity in your lab” -Pasco	$320
Reagent Grade Lycopodium Powder, 500g	Widely available	Small, gas like particles Used in physics to visualize sound waves and electrostatic charge.	$100
CO2 Gas / Dry Ice	Widely Available	Gas which is safe and visible	

4. Materials Needed for Gas/Plasma Testing Chamber & Lycopodium Testing Chamber (MUST USE SEPARATE CHAMBERS TO AVOID DUST FIRE):

Low Range, Infinite Baffle, Marine Grade Speaker with concave structure. (x2)	JL Audio has a good match	Can be used to create pressurized sound chamber for gas/plasma and lycopodium testing at low frequencies.	$500 for 2
Mid-Range, Infinite Baffle, Marine Grade Speaker with Concave Structure (x2)	JL Audio has a good match	Can be used to create pressurized sound chamber for gas/plasma and	$580 for pair

		lycopodium testing at midrange frequencies.	
High Range, Infinite Baffle, Marine Grade Speaker with Concave Structure. (x2)	JL Audio ha a good match	Can be used to create pressurized sound chamber for gas/plasma and lycopodium testing at higher frequencies.	$300 for 2
Acrylic Cylinders & plates of various dimensions.			$900
Valves, Piping and gas components			$150
Paper Diaphragms of Varying Sizes (x3) *Possibly Drumheads*		Will be used for replication of Hans Henny experimentation & Calibration.	
Rubber Diaphragms (x3)		Will be used to record the sound and graph of physical sound wave.	
Drum Mounting Equipment			
1 Pint of Weld-On 4	Widely Available	Used to Fuse Acrylic surfaces together (literally a chemical melting and hardening process) in order to maintain a vacuum.	$20
Joint Sealing Compound (x5)	Global Industrial	Use with pressures to 10,000 PSI to full vacuums. Safe with most chemicals and gas.	$30 for 5 packs
Shop and Machining Resources @ NSC		Will need to use certain cutting equipment, sanders and drill press for engineering of gas/plasma chamber and lycopodium testing chamber.	

5. Outdoor Testing Equipment (Optional):

Sine Wave Power Inverter	Available from Amazon	This DC to AC converter allows for operation of Pure Sine Wave Equipment from battery power. Automatic Switching Enabled.	Self-Supplied
12v Marine Battery	Widely Available	Deep Cycle Battery for repeated outdoor testing.	$110

V. Timeline

Period	In Class	At Home	Goals
Week 1			
Week 2			
Week 3	• Shopping for hardware required for assembly of experimentation equipment. • Overviewing Designs and methods • Work with Physics Instructors for relevant Eqautions • Work with Chemistry Instructors for relevant chemistry Equations • Work with Math instructors for measurement and calculation methods	• Shopping for hardware required for assembly of experimentation equipment. • Networking with campus faculty for assembly assistance. • Preparing home environment for at home assembly work. • Researching known frequency ranges and combinations of tuning methods. • Reading Hans Jenny Material and Videos • Working on Design Features • Consulting with audio professionals, Chemistry and physics faculty. • Start working on abstract • Write Abstract	1. Aquire Equipment 2. Complete Measurements for chamber construction 3. Publish Proposal as new Plasma Vortex Theory 4. Home Lab Setup
Week 4	• building acrylic pressure chamber • Frequency Calibration • Recording Data and Video of Frequency Calibration. **Abstract Writing Workshop** • Edit Abstract	• Engineering Test Environment - Changes & Problems • Calculations related to Frequency Calibration • Organizing Video Sequences for Documentation. • Discussing Results with peers • Reading and Watching Similar Research Projects	• Start Testing with Wave Driver
Week 5	• Testing Noble Gas Ampoules / Micro Vortex Possible? • Finishing Chamber • Pressure Test Chamber • Lycopodium testing • Work on Abstract **Optional Draft Abstract Due to instructors (in Canvas)**	• Work on Abstract • Promote Vortex Theory • Watch and Edit Recorded Video for Report • Work on Report Journal	• Atttain Vortex Formation with Laycopodium
Week 6	• Test Noble Gas and Sound in Completed Chamber	• Make Hardware Adjustments • Work on Abstract	• Finish Abstract

Week 7	• Work on Plasma creating Plasma in the lab • Conduct Laser Experiment **Progress Report Session 1** **UW Abstract Due 2/13**	• Research Electromagnetic Propulsion and Plasma Theories • Make Hardware Adjustments • Work on Abstract	• Edit and Compile Experimental Video Footage •
Week 8	• Writing Results • Recording Video Documentation • Recording Promotional Video **Progress Report Session 2**	• Start Micro Documentary • Create Scientific Pages & Groups	
Week 9	• Recording Interviews of Scientists involved in Project • Introduce Scientific Journal for Publishing	• Work on PPT Presentation of experimental data • Work on Scientific Journal for Publishing **Research Presentation PPT draft due to instructors (in Canvas)**	• Draft Results in Scientific Journal • Demonstrate Plasma Vortex for Scientific Review
Week 10	• Work on Scientific Journal	• Edit Video Footage For Micro Documentary For Presentation and Social Sharing for scientific review. **Rehearsal of Presentation, Peer Review**	• Complete Scientific Journal for Publishing • Complete Micro Documentary
Week 11	**Final Presentations**		

Week 10

VI. Conclusion

The most significant challenge within this experimentation is the engineering of a container which both holds a pressure of gas / plasma and allows for experimentation with waves of sound. The configuration for the gas containment vessel using a waterproof speaker with a smooth concave surface is a new design which will be used to test new theories on the application of sound, physics and chemistry in aerospace engineering. To maintain a cost-effective experiment and to promote a scientific engineering process, much of the testing equipment will be manufactured in-house using faculty and student supplies and workmanship.

A secondary concern is sourcing of resources and time consumed during ordering and shipping process. While much of the research has been done to find materials lab ready hardware and components for this experimentation, hands on work must be done to construct improper containment vessel for vortex plasma.

Costs of experimentation, recording and documentation will be dramatically reduced through sourcing of academic resources such as a wave driver, plates, ripple pool, function generator and camera equipment.

VII. Discussion

The experimentations in this proposal will go hand-in-hand with literature and instruction taught within our school as a model for how to properly integrate science and engineering for a mission specific spaceflight application within any college level; graduate or undergraduate. Physics literature used for the measurement an observation of physical aspects of this experiment will come from “college physics a strategic approach” chapters 14, 15 and 16, with consultation from James Sloan and Davene Eyres. Chemistry Literature used for the measurements and calculations of observed chemical reactions to sound and increased KE will come from “Chemistry: The Molecular Nature of Matter and Change (Martin Silberberg, 7)”, with consultation from Morgan Gleaves and Kalyn Owens.

10002 Aurora Ave N Ste 36, Seattle, WA 98133   cory.hofstad@seattlecolleges.edu   (206) 701-9378

Bibliography

Robertson, G. A., & Webb, D. W. (2011). The Death of Rocket Science in the 21st Century. Physics Procedia, 20, 319–330.
http://doi.org/10.1016/j.phpro.2011.08.029

Goddard, R. H. (1920). A Method of Reaching Extreme Altitudes. Scientific American, 1(2supp), 101–107.
https://www.nature.com/articles/105809a0.pdf
http://www2.clarku.edu/research/archives/pdf/ext_altitudes.pdf
https://library.si.edu/digital-library/book/methodreachinge00godd

Dunbar, B. (2013, June 05). Konstantin E. Tsiolkovsky. Retrieved January 06, 2018, from
https://www.nasa.gov/audience/foreducators/rocketry/home/konstantin-tsiolkovsky.html

Naughton, R. (n.d.). Robert Esnault-Pelterie (1881-1957). Retrieved January 06, 2018, from
http://www.ctie.monash.edu.au/hargrave/rep.html

Garner, R. (2015, February 11). Dr. Robert H. Goddard, American Rocketry Pioneer. Retrieved January 06, 2018, from
https://www.nasa.gov/centers/goddard/about/history/dr_goddard.html
https://www.nasa.gov/centers/goddard/pdf/110902main_FS-2001-03-017-GSFC.pdf

Dunbar, B. (2013, June 05). Hermann Oberth. Retrieved January 06, 2018, from
https://www.nasa.gov/audience/foreducators/rocketry/home/hermann-oberth.html

Harbaugh, J. (2016, February 18). Biography of Wernher Von Braun. Retrieved January 06, 2018, from
https://www.nasa.gov/centers/marshall/history/vonbraun/bio.html

Emme, E. M. (1962). Aeronautics and astronautics: An american chronology of science and technology in the exploration of space, 1915–1960. Journal of the Franklin Institute, 273(1), 81.
http://doi.org/10.1016/0016-0032(62)90694-4
https://www.hq.nasa.gov/office/pao/History/Timeline/1930-34.html

S. (2016, September 20). Mars. Retrieved January 11, 2018,
Retrieved January 06, 2018, from
http://www.spacex.com/mars

Allenson, R. E. (1958). U.S. Patent No. 3029734. Washington, DC: U.S. Patent and Trademark Office.

Masters, Karen. "How much money is spent on space exploration? (Intermediate)." Home - Curious About Astronomy? Ask an Astronomer. Accessed January 12, 2018.
http://curious.astro.cornell.edu/about-us/150-people-in-astronomy/space-exploration-and-astronauts/general-questions/921-how-much-money-is-spent-on-space-exploration-intermediate.

Tsiolkovsky, K. (1911) "The investigation of universal space by means of reactive devices"

Jenny, H. (2001). Cymatics: A Study of Wave Phenomena & Vibration (Vol. I & II). MACROmedia Publishing. ISBN:1888138076

Jenny, H. (Director). (2006). Cymatics Soundscapes: And Bringing Matter To Life With Sound. MACROmedia Publishing.

Mould, S. (2017, September 28). Retrieved January 11, 2018,
Retrieved January 06, 2018, from
https://www.youtube.com/watch?v=C-V1uXeyGmg

Steve Mould. (n.d.). Retrieved January 11, 2018,
Retrieved January 06, 2018, from
http://stevemould.com/

Biggins JS,Warner M. 2014 Understanding the chain fountain. Proc. R. Soc. A 470: 20130689.
http://dx.doi.org/10.1098/rspa.2013.0689h

"Physicists explain 'gravity-defying' chain trick." Nature News. Accessed January 12, 2018.
https://www.nature.com/news/physicists-explain-gravity-defying-chain-trick-1.14523.

10002 Aurora Ave N Ste 36, Seattle, WA 98133 cory.hofstad@seattlecolleges.edu (206) 701-9378