19th Mancini Science Symposium

May 9th, 2013
Volume I
Foreword

For the previous 18 years, William L. “Hank” Mancini, PhD, coordinated and conducted these Annual Science symposia. In honor of this tradition and Dr. Mancini, we have renamed these symposia to the Mancini Science symposia. This 19th Mancini Science Symposium was held on May 9, 2013 in the Center for Performing Arts (CPA) at Paradise Valley Community College (PVCC).

Students enrolled in Astronomy, Chemistry, and Physics classes from PVCC participated in the event. Each contributor was responsible for selecting and researching his/her topic and preparing a paper. This 4-volume set contains all the research papers. A few students gave oral presentations of their project to their peers. Students themselves, via a voting process, chose the topics what were presented at this symposium.

As instructors and faculty advisors for this symposium, we want to thank and congratulate each participant for his/her effort, courage, and dedication. By participating, these individuals perpetuate this event annually. We are proud and honored to present the work of these individuals.

Casey Durandet, PhD
Scott Massey, PhD
Jennifer Weitz, MS
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Future Missions of NASA

Cora Anderson

April 19th, 2013

Astronomy 111 Course #19830

Professor Jennifer N. Weitz
Abstract

Over the past 55 years, NASA has made tremendous scientific discoveries in the field of aeronautics and aerospace research. Their past and current missions are monumental and they continue to answer our questions about ourselves and the universe. This paper discusses NASA’s brilliant plans and future missions into space.

The National Aeronautics and Space Administration, also known as NASA was established in 1958. NASA is a government agency in the United States responsible for scientific aeronautics and aerospace research (Wilson, 2011). It was established with a basic goal in mind, according to Wilson (2011), “To reach for new heights and reveal the unknown so that what we do and learn will benefit all humankind”. For ages, humans have looked up at the dark, mysterious, night sky in amazement and wonder. Our ancestors have asked the same questions that we do in this modern day. We think about what the universe is made of and the limitless possibilities it holds. We ponder about life on distant planets. Humans, even young children have always been intrigued by the mysteries of the planets and celestial bodies within our universe. NASA seeks to explore those questions and fulfill humankind’s need for answers through its research conducted in space missions. NASA has been successfully involved in many current and past missions. These missions have provided knowledge and hope to the human race as whole. NASA has also advanced technological capabilities, but none of this has been done without setbacks and challenges. Today I will be discussing future missions of NASA and what they entail, including plans to go back to the moon, missions to Mars, the continuous advancement of the International Space Station, the missions Euclid and IRIS, as well as challenges NASA faces and plans to proceed through them.
July 20, 1969 was the day United States astronauts first landed on the moon (Wilson, 2011). Not only was this a great historical mark in history, and an inspiration to the entire nation, but its accomplishment also broadened opportunities for future space exploration. It was planned that one day, NASA would bring astronauts back to the moon for long visits. This proclamation excited people and was well supported. These missions would proceed in order to gain knowledge for the progression of manned missions. The information received would improve sustainment and replacement of resources such as fuel (Future of Spaceflight, n.d.). This knowledge would increase the ability of humans to travel further and longer into space. The space vehicle chosen for the Constellation mission to the moon was reusable, held four passengers and was paired with a very sustainable lander (Wilson, 2007.) The mission and equipment seemed promising and practical.

Although the Constellation mission was cancelled in 2010, the mission plans offered great knowledge and the public still hoped that would return to the moon would happen in this life time. However, according to Miriam Kramer, writer for SPACE.com, Charles Bolden who is the chief of NASA, has recently stated, very blatantly, that this mission is no longer active and that NASA is going to let another agency take the lead on sending man back to the moon. NASA would like to shift their resources onto other manned missions such as Mars and an asteroid, which are very attainable goals (2013). As of now, NASA’s plans for manned missions to the moon are completely cancelled. Only time will tell if one day American astronauts will return to our moon.

However, missions to another planet are becoming more promising. Mars has always captured the interest of humans through education, media and entertainment because of its terrestrial or “Earth-like” nature. Our hopes of finding life on Mars are still in the forefront.
Researching more about Mars continues to be a hot topic after the recent successful landing of the rover Curiosity. NASA has even more exciting plans for Mars, which seems to be the focus of their resources after cancelling the previous Constellation mission. NASA is skipping what was meant to be a stepping stone to landing manned space crafts on Mars. Instead NASA is forging ahead, planning to practice landing humans on an asteroid, and then Mars. Manned missions to Mars are being planned for the 2030’s (Kramer, 2013).

Unmanned missions, however, should be launched into action within the next several years. An example would be the launch of the InSight lander. Although NASA has sent numerous missions to explore the surface of Mars, InSight will explore far inside of the planet. Not only will this answer questions about the formation of this terrestrial planet, but it will answer questions about births of other terrestrial planets in our solar system (InSight… Introduction, n.d.). InSight will investigate materials, temperatures, collisions to the planet and other physical events. The technology used will detect and evaluate deep inside the Martian planet. This will increase our understanding of Earth-like planets, and the variety of unique ways they form from the core to the crust (InSight… Science, n.d.). Understanding the formation of terrestrial planets brings us one step closer to finding traces of life on Mars, or in the future, on a distant terrestrial planet. The information gathered will be valuable.

Another mission to Mars will occur in the year 2020. As part of NASA’s commitment to Martian exploration, another rover will be launched to explore the surface for roughly 687 Earth days. This rover will be large and will use similar techniques to the Curiosity rover mission that have become proven and true methods, such as the beneficial method of lowering the large rover slowly to the ground with ropes. It will also use the new technology developing to advance our
science of travel in order to one day bring humans aboard on missions to the planet. This mission is still in development (2020, n.d.).

A third area of interest for future missions would be the International Space Station. As humans we are striving to explore beyond our planets boundaries. By working together with space agencies from other nations, NASA has allowed astronauts to live and learn in space on the International Space Station. The vast structure measures about the size of a football field and has been orbiting, continuously occupied by astronauts for over a decade now (International, 2012). According to Boen (2013), beneficial research on many subjects has been conducted on the massive spacecraft, including the effects of the environment on humans, medicine technology and pictures of geological and agricultural events occurring on Earth. The many nations that came together on International Space station have one basic goal in mind- to better humankind through fundamental science and research (Boen, 2013). The crews for Expedition 36 through 40 to board the International Space Station are already assigned and the final member of crews for Expedition 41 and 42 are being chosen, which means there are no plans to slow down the research (Kauderer, 2013). There are also many missions to come through sending supplies, research materials and more astronauts into space.
Not all of the future missions to NASA involve bringing humans to other planets though. For example, according to Greicius, the mission Euclid is sending a technologically advanced telescope into outer space to explore something we are pretty unfamiliar with—dark matter and dark energy (2013). In outer space, telescopes are not limited by the obstructions of the atmosphere or to certain wavelengths of light. Galaxies light years away are easier to view. Surveying galaxies far away can clarify how dark matter works. Dark matter is mysterious because unlike the atomic matter we are familiar with on Earth, it influences the universe gravitationally does not blend with or emit any sort of light. Dark energy is what is causing the universe to expand (Greicius, 2013). “NASA has joined the European Space Agency's (ESA's) Euclid mission, a space telescope designed to investigate the cosmological mysteries of dark matter and dark energy” (Greicius, 2013). Greicius states that in seven years, Euclid will be sent into space where it will hover near Earth and will explore and record distant galaxies for six years (2013). Hopefully, this mission will expand science theories on dark matter and dark energy, which is very unknown to us yet makes up the majority of our universe and will continue to cause it to shift and expand as it has in the past (Greicius, 2013).
The Interface Region Imaging Spectrograph, known as IRIS will be sent to the sun to gather research about its solar energy and movement of matter through the lower portion of the sun’s atmosphere. Learning about this mysterious portion of the atmosphere will help create understanding of surface events such as flares, winds and eruptions. Finally, technology has been obtained that can measure and observe the intense heat of the layers of atmosphere around the sun (Zell, 2013). Zell states “IRIS is the first mission designed to simultaneously observe the range of temperatures specific to the chromosphere and transition region at very high spatial and temporal resolution -- going beyond earlier missions that were lower resolution or did not cover a wide range of temperatures” (2013). The amazing computer modeling and instrumental techniques of this mission are sure to advance knowledge and establish theories about the lower atmosphere of the sun.
NASA’s goals span far. However, the space agency does face major challenges. For example, some researchers state that NASA’s goals are unattainable with their given budget and changes need to be made abruptly. Disagreements on NASA’s budget and plans in the future could provide setbacks to the ambitious plans of the space agency. Suggestions for the budget deficiency include an extensive rearrangement of funds throughout the agency, and increasing of the budget, or decreasing of spending (Scientists, 2012). An article states that “‘More cost-sharing partnerships with other US government agencies, private sector industries, and international partners’” (Scientists, 2012) is another viable suggestion. According to Kane (2013), NASA has a new investor in the Space Technology Mission Directorate, or STMD. The STMD organization will join several other organizations in the investment of space technology for NASA. President Obama has requested almost $700 million to be decided upon in congress. This new investor could be very helpful to NASA in reaching their long-term goals.

NASA has already cut programs such as the Constellation mission which was a huge chunk of the budget and a stepping stone to sustaining life on other planets. However, they are
using their budget and resources for more valuable and attainable missions such as manned missions to Mars, telescopes, and unmanned mechanical missions to other planets in our solar system. (Cooney, 2010).

Other issues NASA faces are the well-being of their astronauts in such a unique environment. Gavert states “There are five major health and safety issues important in the pursuit of being number one and they are: (1) Radiation (2) Hearing (3) Habitability/Toxicology (4) Extravehicular Activity (EVA) (5) Stress” (2000). NASA is constantly working to combat these issues to make manned missions with more safety, security and comfort. By solving these issues, astronauts can extend their stays in space. As of now, astronauts are doing well in the International Space Station and manned missions are being heavily pursued and that is a great sign of NASA reacting to these challenges.

NASA is aspiring to reach great heights. It is inevitable that one day people will step foot onto the surfaces of foreign planets and the mysteries of the universe will come closer to being solved. Perhaps, in the distant future humans will even find a trace of life on another planet. Through missions to the Moon, Mars, continuous missions to the International Space Station, telescope missions such as Euclid, and the mission IRIS. NASA has plans to overcome challenges and advance technology in order to achieve future missions.
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Hydroelectric Power – Renewable Energy Sources

Mary Anchelle Arciaga
26 November 2012
Phy112
Dr. Casey Durandet
Abstract

Hydroelectric power was one of new energy source that used water to generate power. Water from the reservoir was the source of potential energy, and as it flows and passed through the penstock, turbine, and generators, it will convert to electrical energy. Hydropower plant can generate different power depending on what types of methods/machines should use.

Introduction

 Thousand years ago, Greek built a mill where the concept of hydroelectric power idea was developed. Dam was the popular source of hydropower plant. Dam used both potential and kinetic energy to generate power. The water that was restored on the head of the dam, known as the “Reservoir” occurred a potential energy. As it flows through the penstock, it started converting the potential energy to kinetic energy. When the turbine started to turn, it generated a mechanical energy and converted to electrical energy as it goes through the generator. Hydroelectric power can generate power depending on the type of methods should use. Those methods can be Power form Dams, Run-of-River, Tidal Power, Wave Power, and Ocean Thermal Energy Conversion (OTEC).

 In every community, this project (hydroelectric power plant) can build in either small or large scale, depends on how high was the demand on the electricity for the certain area. There were also pros and cons on building hydroelectric power.

 But how does this happen? Is there any equations used to generate a power and released to the community? These questions will be answer in this chapter.

History

Generators

“A generator was a machine that used to change the mechanical energy into an electrical energy”.¹ In 1831, Michael Faraday, a British scientist, physicist and chemist discovered the first generator. He used a copper disc to rotate between the poles of a horseshoe magnet which produced a direct current, known as DC. And that time, he built the first electromagnetic generator called as “Faraday disc”. He discovered that if a magnet was been moved through a loop wire and was moved over a stationary magnet, it conducted an electric current. Formally, he discovered the electromagnetic induction where the potential difference was generated between the ends of an electrical conductor that moves perpendicular to a magnetic field.¹

In 1832, Hippolyte Pixii, an instrument maker from Paris, France, discovered the first magneto electric generator. This generator was based on Faraday’s concept. Pixii used a spinning magnet, rotated by a hand crank, where the North and South poles passed over a coil with an iron core which produced a current pulse. He found that when the North Pole passed over the coil after the South Pole, the direction of current changed. Then he discovered the alternating current, known as AC. Later, he also discovered how to convert the AC to DC by adding the commutator (a switch that periodically reversed the current in an electric motor or generator).¹
Hydroelectric Power

Hydroelectric power came from moving water where it converted the potential energy into kinetic energy then converted to electric energy in an electric generator. The concept of building the hydroelectric power was introduced by Greeks thousand years ago. They built water mills next to rivers. As the mill turned because of the flowing water from the river, the wheel of the mill turned the gears and then moved the stones where it converted the kinetic energy into mechanical energy for grinding grain and pumping water (see figure 1). 3,4

In 1800s, the water wheels were used to power machines in European and American factories. Furthermore, people, then, realized that when water falling from a height turned a turbine, which was connected to a generator, produced electricity. In 1878, Cragside, England, it was where the first dam was designed to produce electricity. In 1879, Niagara Falls, a natural fall, powered the first hydroelectric plant. 4

Structure of Hydroelectric Power

When we heard the word “Dam”, first thought that came up to individual’s mind was the “Hydroelectric Power Plant”, because dam was built to control the river flow and it also created a man-made lake called the “Reservoir”, a source of water that passes through the dam. 5

An intake or gate of the dam opened to pull the water through the penstock. Through this pipeline, a pressure was built up and leads the water to a turbine. Turbine was made up of large blades which were connected to a generator. The turbine starts to turn once the water stroke on it. As the turbine blades turned, giant magnets, rotor, inside a generator rotated and passed to the copper coils, stator, which converted the mechanical energy into electrical energy, and produced an alternating circuit (AC) by moving electrons. 5

The transformer inside the power house, which usually located at the top of a power plant, took the AC and increased the voltage of the electricity generated here, then passed to the power/transmission lines, which carried a high-voltage of electricity to the households. 5

Excess water carried through the penstock was released through a draft tube, the outflow of the water, out the tailrace, and backed to the river downstream. 5
Machines/Methods to Generate Hydroelectricity Power

There are different ways to create electricity by using water. Those are the Power from dams (Potential Energy), “Run of River” (Kinetic Energy), Tidal Power, Wave Power, and Ocean Thermal Energy Conversion (OTEC).

**Power from Dams (Potential Energy)**

“One of the most common and used sources of hydroelectricity is dam power.” 6 Dams were the most common hydroelectricity sources because it can be set up just about anywhere there were some artificial obstructions in a flowing stream that created the pressure to turn a turbine, which used the famous Francis turbine (figure 3a), to turn drives an electric generator which produced energy.6,7,8 “The available energy therefore depends on the head of the water above the turbine and the volume of water flowing through it.” 8 But when constructing a dam, there were a lot of consideration to make like how it will affect the people living in that area, where the dam will built, and the effect on the ecosystem that was going to surround the dam.6 Dams provided a large water reservoir , which was the source of water that flow into the turbine through the generator for power output, can be controlled.8 Also, reservoir served as the storage of the excess water during rainy periods, which helped to stop the flood, and released it during dry spells, which helped for irrigation. 6,8 To compute for the power that a dam can produce, here is a given equation.

\[
\text{Potential energy per unit volume} = \rho gh
\]

where \(\rho\) is the density of the water (10\(^3\) kg/m\(^3\) ), \(h\) is the height of the water and \(g\) is the gravitational constant (9.8 m/sec\(^2\)).

The power \((P)\) from a dam is given by:

\[
P = \eta \rho ghQ
\]

where \(Q\) is the volume of water flowing per second (m\(^3\)/second) and \(\eta\) is the efficiency of the turbine.” (Equation 1) 8

**“Run of Rivers” (Kinetic Energy)**

“This method was typically used for smaller schemes which can generate less than 10MW.” 8 This method was almost the same in using dams. Instead of having a potential energy, which was occurred when the water was on the top of the dam, and converted to kinetic energy, once it struck the turbine, this method just used kinetic energy where the fast flowing of the water from the river of stream turned the turbine to generate electricity.8 It used the Pelton (figure 3b) or Kaplan (figure 3c) turbine. The height of the water was essentially zero, since it made a kinetic energy from the flowing water on the stream. The kinetic energy was converted to rotational energy of the turbine and the generator.8 “The available energy therefore depends on the quantity of water flowing through the turbine and the square of its velocity.”8 Partially submerged turbines, which used Pelton turbine, in this
method, engaged in a fast flowing run of water installation, while on the other hand, the slower flowing of the water used the submerged Kaplan turbines to extract the energy from the water flow.8

“During flood conditions the installation may not be able to accommodate the higher flow rates and water must be diverted around the turbine losing the potential generating capacity of the increased water flow."8 Although this type of installation was much less costly than dams, it was vulnerable to the variations in the rainfall or water flow which reduce or even cut off the potential power output during periods of drought.8 To compute for the maximum power of the turbine can produce, here is a given equation.

“The maximum power output from a turbine used in a run of river application was equal to the kinetic energy of the water impinging on the blades. Taking the efficiency $\eta$ of the turbine and its installation into account, the maximum output power ($P_{\text{max}}$) is given by

$$P_{\text{max}} = \frac{1}{2} \eta \rho Q v^2$$

where $v$ is the velocity of the water flow and $Q$ is the volume of water flowing through the turbine per second ($m^3/s$). $Q$ is given by

$$Q = A v$$

where $A$ is the swept area of the turbine blades.

Therefore:

$$P_{\text{max}} = \frac{1}{2} \eta \rho A v^3$$  (Equation 2)8

**Tidal Power**

Tidal power was also a newer technology like wave power that used to generate hydroelectric power. “Tugged by lunar gravity and stirred by wind and currents, the oceans’ tides and waves offer vast reserves of untapped power, promising more oomph than wind and greater dependability than solar power.”7 Most of tidal power generators were look like wind power generators but under water, where big underwater turbines were turned by using the changing tides of the water.6 To construct a tidal power plant, the engineers must find a bay with a large difference between its low and high tides.9 Huge quantities of water rushed into the bay during high tide, which was really needed for tidal power plant for the barriers across the bay made the water flow through the turbines as the tides came in and went out, as shown in figure 4.8,9 To compute for the power that the tidal power plant can produce, here is a given equation.

“The maximum power output from a turbine used in tidal power plant is equal to the kinetic energy of the water impinging on the blades, similar to the "run of river" calculation above. Taking the efficiency $\eta$ of the turbine and its installation into account, the maximum output power ($P_{\text{max}}$) is given by

![Figure 4: Tidal Power Plant](image-url)
\[ P_{\text{max}} = \frac{1}{2} \eta \rho A v^3 \]

where \( v \) is the velocity of the water flow and \( A \) is the swept area of the blades."^8

**Wave Power**

Like tidal power, this new technology was developed to generate hydroelectric power by using the waves out in the middle of the ocean. "These machines are very strange looking but are efficient at producing energy."^6 This method used the oscillation of the waves to generate power." Mostly; this was made of floating devices attached to a crankshaft underneath the water’s surface. As the devices moved up and down, they caused the crankshaft to spin which was attached to the generator and produced electricity."^9 There were different types of oscillation system that can use to generate power, as shown in table 1.

<table>
<thead>
<tr>
<th>Energy Conversion System</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oscillating Float System</td>
<td>Simplest and most common wave power plant. A float was inside a cylinder shaped buoy where the float moves up and down on the surface of the waves as they passed through the buoy.</td>
</tr>
<tr>
<td>Oscillating Paddle System</td>
<td>It used large paddles which were attached to the ocean floor to mimic the swaying motion of the sea plants in the presence of ocean waves. The paddles were fixed and followed the swaying motion of the waves to pump water through a turbine generator.</td>
</tr>
<tr>
<td>Oscillating Snake System</td>
<td>It used a series of floating cylindrical sections tied together and to the sea bed and maintained a position head on into the waves. The wave-induced motion used to pump high-pressure oil through hydraulic motors via smoothing accumulators and turned electrical generators to produce electrical power.</td>
</tr>
<tr>
<td>Oscillating Water Column</td>
<td>It was formed within large concrete structures which was open at the top and bottom on the shore line. The lower end was submerged in the sea and an air turbine was on the top. As the water rise and fall. It moves inside the structure and produced air to turned the air turbine and the generator.</td>
</tr>
<tr>
<td>Pressure Transducer System</td>
<td>A hydraulic pump system used a submerged gas-filled tank. As the gas in the tank compressed and expanded in response to pressure changes from the waves passing overhead causing the top to rise and fall. A lever attached to the center of the top turned pistons, which pumped pressurized water to generate power.</td>
</tr>
<tr>
<td>Wave Capture Systems</td>
<td>It used a narrowing ramp to funnel waves into an elevated reservoir. As the waves entered the funnel, the narrowed channel in the funnel causes the amplitude of the wave to increase. Water form a reservoir as the quantity of water raise above the sea level. Then, from this, the water can be release through a turbine located below the reservoir to generate electricity.</td>
</tr>
<tr>
<td>Overtopping Wave Systems</td>
<td>It was similar to the land based system but it focused waves onto a tapered ramp which cause the amplitude of the wave to increase.</td>
</tr>
<tr>
<td>Lever Systems</td>
<td>Movement of the lever arms forced fluid into a central hydraulic accumulator through generator turbine to generate power.</td>
</tr>
</tbody>
</table>

**Table 1: Types of Wave Power Plant^6**

Table 1 showed different types or methods of wave power plant but they can generate different value of power by using the wave length. *(See Appendix A for the illustration and picture of these oscillating system)*

"The wave power per unit length of the wave front \((P_L)\) is given by as

\[ P_L = \rho g a^2 \lambda / 4 T \]
where \( \rho \) is the density of the water \((10^3 \text{ kg/m}^3)\), \( a \) is the wave amplitude (half of the wave height), \( g \) is the gravitational constant \((9.8 \text{ m/sec}^2)\), \( \lambda \) is the wave length of the oscillation and \( T \) the period of the wave.\(^6\)

**Ocean Thermal Energy Conversion (OTEC)**

This type of method used the thermal condition of the water to generate electricity. Unfortunately, the conversion efficiency was very low because sea water can be heated by both Sun and energy heat from the Earth. As the Sun heated the water surface, the temperature on the water surface will be greater than in the depths of the water, where the energy source from Earth occurs.\(^6\) OTEC converted the heat energy of the water's surface into electrical energy by using the “Binary Electric Generating Plants”, as shown in figure 5.

“The conversion efficiency depends on the temperature gradient in the water and is determined by Carnot's Law.

Only sites with at least a 20\(^\circ\) temperature difference are likely to be economically viable. Unfortunately in most locations the temperature difference is much smaller than this. For a 20 degree temperature difference the maximum theoretical maximum efficiency is given by:

\[
1 - \frac{5+273}{25+273} = 1 - \frac{278}{298} = 7\%.
\]

Practical installations will also have large pumping losses as well as heat losses within the system which reduce this efficiency even further and overall conversion efficiencies of 2\% to 3\% are typical.\(^6\)

**Pumped Storage Plants**

It was a method where the power plant kept the water and reserved for peak period when the demand on electricity increase. Pumped storage pumped the water from lower reservoir to the storage pool above the power plant when the demand on energy was low, usually during night, since the electricity was cheap.\(^{15,16}\) Then water allowed to flow back into the lower reservoir through the turbine-generators when the demand on energy was high and a heavy load was placed on the system.\(^{15,16}\) In this case, the reservoir was the battery on the hydropower plant. It stored the power by keeping the water to the reservoir when the demand on energy was low and produced maximum power when the demand on energy increases by releasing the water from the reservoir.\(^{15}\) It showed on figure 6 how the pumped storage worked.
Small and Large Scale of Hydroelectric Power

“Small-scale hydropower is one of the most cost-effective and reliable energy technologies to be considered for providing clean electricity generation”¹⁰ “Run-of-rivers” was a sample of small-scale hydroelectric power, which can generates less than 10MW. ⁶ Although small-scale hydroelectric power was less expensive, and no need to have a reservoir to store the water, there were some advantages and disadvantages in this type of scale, as shown in table 2a.

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>An efficient energy source where it only took small amount of water flows to generate electricity and can be delivered as far as a mile away.</td>
<td>Suitable site characteristics required in order to take full advantage of electrical potential small streams.</td>
</tr>
<tr>
<td>A reliable energy source where it produced a continuous supply of electrical energy.</td>
<td>Energy expansion not possible because of the size and flow of small streams may restrict future site expansion as the power demand increases.</td>
</tr>
<tr>
<td>There’s no reservoir required because the water directly passed through the generator directed back to the stream.</td>
<td>Low-power in the summer months because during summer, there will be less flow of water, therefore, less power output.</td>
</tr>
<tr>
<td>It is a cost effective energy solution because the cost to build small-scale hydroelectric power is $1,000-$20,000 depending on the site electricity requirements.</td>
<td>There’s an Environmental impact, where stream water will be diverted away from a portion of the stream which can affect the ecology.</td>
</tr>
<tr>
<td>Power for developing countries because of the low-cost versatility and longevity of small-scale hydroelectric power and can supply electricity to small communities and villages.</td>
<td></td>
</tr>
<tr>
<td>Integrate with local power grid where if the site produced a large amount of excess energy, some power companies will buy back the overflow electricity.</td>
<td></td>
</tr>
</tbody>
</table>

Unlike small-scale, large-scale hydroelectric power plants can generate power at least 30MW-80,000MW. This was developed to produce electricity for government and utility projects.¹² If a small-scale hydropower plant used “run-of-river”, the large-scale usually used dams and reservoirs to hold the water from the river.¹² There were also some advantages and disadvantages on building large-scale hydropower plant, as shown in table 2b.

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Once the dam is build, the energy was virtually free.</td>
<td>It is very expensive to build.</td>
</tr>
<tr>
<td>No waste or pollution produced</td>
<td>Building a large dam will flood a very large area upstream, causing problems for animals that used to live there.</td>
</tr>
<tr>
<td>It can use for flood control and irrigation.</td>
<td>Finding suitable site can be difficult because it might have a negative impact on the residents and the environment may be unacceptable.</td>
</tr>
<tr>
<td>Water can be stored above the dam ready to cope with peaks season, when the demand on electricity increases.</td>
<td>Water quality and quantity downstream can be affected, which can have an impact on plant life.</td>
</tr>
<tr>
<td>Hydroelectric power stations can increase to full power very quickly, unlike other power stations. Electricity can be generated constantly.</td>
<td></td>
</tr>
</tbody>
</table>

Table 2a: Advantages and Disadvantages of Small-scale Hydroelectric Power¹¹

Table 2b: Advantages and Disadvantages of Large-scale Hydroelectric Power¹³
Relevance of Physics to Hydroelectric Power

By changing a magnetic field, it produced an electric current. In hydroelectric power, the potential energy, which was the water stored in the reservoir, converted to kinetic energy when it flowed through the penstocks. This kinetic energy was converted to mechanical energy when the turbine turned. The generator, which was attached to the turbine, produced an electrical energy once the turbine rotated a magnetic field inside the generator.

Electricity flowed into the wire when the electrons moved from one metal to the other one, the rotor and the stator.

The force generated by the penstock was the force used to rotate the turbine. As the turbine turned, it generated a work or energy done between the exerted force and angular motion between the blades of the turbine and the force acting on it. There were given equations used on different methods of hydroelectric power, but to further understand how it came up with that kind of equation, here was how they derived, especially using the equation on “Power from Dam”.

\[ W = \tau \cos \theta \omega, \]

where \( \theta \) was the angle between the torque/force (\( \tau \)) of the water from the penstock and the angular motion of the turbine (\( d\omega \)). The SI unit for work is Nm or Joule (J).\(^{14} \)

Power existed when the work was performed in a certain rate of time. We can expressed this by \( P = \frac{W}{t} \). The SI unit of power is Joule/sec which was equal to watts (W).\(^{14} \)

After knowing the basic concept of energy, energy can be defined into two different ways, Potential and Kinetic energy. Potential energy (\( PE \)) was generated when the water was still in the reservoir and it was converted to Kinetic energy (\( KE \)) once it flowed down to the penstock through the turbine, where KE was associated with mechanical motion of bodies. We can express KE by \( KE = \frac{1}{2}mv^2 \),\(^{14} \) where \( m \) is the mass of the water, and \( v \) was the velocity of the turbine as it spins. But in this case, the turbine generated an angular velocity which we can say that \( KE = \frac{1}{2}I\omega^2 \),\(^{14} \) where \( I \) was the moment of inertia exerted by the water and \( \omega \) was the angular velocity of the turbine.

Bureau of Reclamation

In American West, irrigation was really needed for agricultural living. At first, settlers used water from streams and the demand of water increased because of outstripped supply of water. As the demand on water increased, the settlers wanted to store the “wasted” water because of the runoff from rains and snow and maximized the used of water by making it available during dry seasons.\(^{17} \)

During 19th century, settlers encountered a scarce water supply that’s why they tended to farm near rivers for near access on water resources. Along the Salt River in the Arizona Territory, the settlers followed the footsteps of ancient native farmers and built irrigation systems to deliver river water to their crops.\(^{18} \) However, they couldn’t control the rivers , where they can
encounter scarcity on water when the rivers ran low or it might destroyed the crops when there’s a flood. The west flood control, water storage and large-scale irrigation projects were attempted by various groups and organizations were abandoned due to lack of funding and expertise.\textsuperscript{18}

"President Theodore Roosevelt realized that harnessing water was the key to supporting Western growth and development. The federal government had the resources to provide both funding and expertise for water projects the west desperately needed and wanted."

Pressure mounted for the Federal Government to build storage and irrigation projects. The government already invested for the America’s infrastructure, that’s why the Westerners wanted the Federal Government to invest also for the irrigation projects in the West. June 17, 1902, the congress passed the Reclamation Act which stated that the water users should repay the construction costs from which they received benefits.\textsuperscript{17}

From 1902-1907, Reclamation began about 30 projects in western states. In 1907, the secretary of Interior created an independent bureau within the department of Interior. Many problems were encountered while developing different reclamation projects. In 1923, the agency was renamed the “Bureau of Reclamation”.\textsuperscript{17}

In 1928, congress authorized the Boulder Canyon (Hoover Dam) Project, the biggest project, to flow to Reclamation from the general funds of the United States.\textsuperscript{17}

The Salt River Project (SRP) was the first federal project that was authorized under the Reclamation Act. It improved the existing dams and irrigation canals and builds new dams.\textsuperscript{18} "Reclamation's eventual construction of the final feature of the SRP, Bartlett Dam in 1940, marked control of the Salt and Verde Rivers."\textsuperscript{18} Between 1902 and 1940, the Phoenix area population increased by 60,000 people, primarily because water and power had become readily available.\textsuperscript{18}

**Hoover Dam**

There are many hydroelectric power plants can find in Arizona. The most popular one is the **Hoover Dam**. It was the largest dam in Arizona. It was made of thick-arch concrete structure, 726ft high and 1,244ft long. The concrete used to build this dam was 3.25M cubic yards and it weighed 6.6M tons. The source of water from the reservoir was from Lake Mead and the excess water from the penstock goes back to Colorado River. Its generator can produced almost 130MW of electricity instantaneously, while the whole power plant can produced over 2GW (gigawatts) of electricity instantaneously.\textsuperscript{19}

**Conclusion**

Hydroelectric power was the newest energy sources that reduced pollution. But there were some bad effects in the ecological environment. Still, in future, a lot of engineers may developed more efficient and ecological friendly hydroelectric power.
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19) Appendix B, in field interview
Appendix A

Oscillating Paddle System
(Source: http://ars.els-cdn.com/content/image/1-s2.0-S1364032111005351-gr2.jpg)

Oscillating Water Column
(Source: http://www.mpoweruk.com/hydro_power.htm)

Water Capture System
(Source: http://www.mpoweruk.com/hydro_power.htm)

Pressure Transducer System
(Source: http://www.globalspec.com/ImageRepository/LearnMore/201111/mod%202%20strain%20gauge%20pressure%20transducer4c397250b64f49cda47ce33add46e274.png)

Overtopping Wave Systems
(Source: http://static.ddmcdn.com/gif/wave-energy-3.jpg)
Appendix B

(Pictures taken during the in field tour in Hoover Dam)
**What's a Watt?**

Water is measured in gallons. Bananas are measured in pounds. Electricity is measured in watts.

<table>
<thead>
<tr>
<th>Term</th>
<th>Number Of Watts</th>
<th># Of 100 Watt Lightbulbs Powered</th>
</tr>
</thead>
<tbody>
<tr>
<td>One</td>
<td>1 watt</td>
<td>1</td>
</tr>
<tr>
<td>Thousand</td>
<td>1 kilowatt = 1000 watts</td>
<td>100</td>
</tr>
<tr>
<td>Million</td>
<td>1 megawatt = 1,000,000 watts</td>
<td>10,000</td>
</tr>
<tr>
<td>Billion</td>
<td>1 gigawatt = 1,000,000,000 watts</td>
<td>10,000,000</td>
</tr>
<tr>
<td>Trillion</td>
<td>1 terawatt = 1,000,000,000,000 watts</td>
<td>10,000,000,000</td>
</tr>
</tbody>
</table>

One Hoover Dam generator can produce 1,500 megawatts of electricity instantaneously.

---

**H, Medium and Low Head Dams**

Dams are categorized according to head, or the difference between the height of the water in the reservoir (forsbay) and the level of the water downstream of the dam (tailrace). The bigger the difference, the greater the water pressure to spin the generator's turbines. Dams are said to be "high head," "medium head," or "low head."

Hoover Dam, with a head of over 500 feet, is a medium head dam.

---

**Hoover Dam, with a head of over 500 feet, is a medium head dam.**

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**Challenges Met, A Nation Served**

Hoover Dam has transformed the desert. Productive farmland, thriving communities, and year-round recreation are all found in a region once considered wasteland.

The benefits of the dam extend far beyond the American Southwest. The lessons learned during the design and construction of the dam advanced the science of dam building, benefiting people worldwide.

Hoover Dam, one of the nation's most successful public works projects, is truly a marvel of engineering and the human spirit.
Shadow Puppetry

Mary Anchelle Arciaga

19 November 2012

Phy112

Dr. Casey Durandet
Abstract

Shadow puppetry was known for entertainment and arts. But this show can’t be created without the use of lights. What’s the relevance of Physics on Shadow puppetry? We know that light’s traveled $3 \times 10^8$ m/s and as the rays struck on an object, 3 rays might occur, Incident, Reflected, and Refracted Rays. There were also two kinds of shadow occurred during the shadow puppetry, the Umbra (dark Shadow) and Penumbra (light shadow).

Introduction

Shadow puppetry was known for entertainment and arts. It was easy to conduct a shadow puppetry. Shadow puppetry used leather, cardboard or paper (some other materials which can create a shadow) to make a colorful silhouette figures. The puppeteers (who controls the movement and voice of the puppets) was manipulated by using rod, the figures mimic the illusion of a living things (like human and animals) on a translucent cloth screen illuminated from behind to create a shadow.

Since shadow puppetry used lights to make shadows, it means that physics was also applied in this type of art. Light can travel $3 \times 10^8$ m/s. As light traveled and an object covered the light, it created a shadow which can be Umbra and/or Penumbra. There were some puppet shows used colors to make the performance much attractive. This can be done if the puppeteers used either colored lights and/or colored translucent papers.

But how do shadows was manipulated? How puppeteers can produce colored puppet shadow? How important the lights were for this art? Is it really related to physics? These were just some of the questions that can be answer in this chapter.

History

“Most historians believed that shadow puppetry was originated in China about 25,000 years ago during the Han Dynasty (206 B.C. – 220 A.D.). It was an ancient art in China. It was first created to comfort the heart aching Emperor Wu Han from deep depression because of the death of his most beloved concubine, Madam Li, from sudden illness. The emperor lost his interest on ruling his empire and turned back on his leadership duties.

His advisers did everything for Wu Han to cheer up but nothing brought him back from his sorrowful. Until, a finest artist created a shadow puppet of his beloved which was made of donkey-hide leather in such a way they can mimic the movement of Madam Li. The artist set up an illuminated silk screen and performed the puppetry of Madam Li, and the first puppet show was created.
Shadow

“Shadow was formed when the light is missing”. There were two kinds of shadow, the “Umbra” and “Penumbra”. Umbra was the dark part of the shadow, while Penumbra was the fuzzy part between the dark and the light (the light shadow). “Umbra was formed where no light falls and Penumbra was formed where there was some light falls, but some was blocked.” (Fig.3)

Figure 4 showed the effects of the colored lights to the multiple shadows. On the object, it was the light from the got into the screen because the light projected upward to the object. happened at the bottom of the light from the top source got into the screen. Figure 5 showed an experiment to this concept.

The size of the shadow depends on the distance of the light source to the object, and also the distance of the object to the wall/screen. It showed in figure 6.
Speed of Light

The speed of light in a vacuum was measured 299,792,458m/s or simply 3x10^8m/s, in scientific notation; but how did the scientists came up with this value?

Different scientists experimented and tested the speed of light by using different methods to come up with the right value of the speed of light with less or no error occurred. Table 1 showed the summary of different values of the speed of light that the scientists got.

It showed that the experiments started by using the Jupiter’s satellite, but before 17th century, light was already transmitted instantaneously. This was supported by position of Earth’s shadow during the lunar eclipse. Galileo doubted that speed of light was infinite so he used a lamp and a water clock to test the speed of light. By covering and uncovering the lamps, he manually measured the speed of light but this method didn’t even give an accurate answer. That’s why they didn’t include this method in the shown table. They started the history of light’s speed by using the method of Jupiter’s satellite.

<table>
<thead>
<tr>
<th>Date</th>
<th>Author</th>
<th>Method</th>
<th>Result (km/s)</th>
<th>Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>1676</td>
<td>Olaus Roemer</td>
<td>Jupiter’s satellites</td>
<td>214,000</td>
<td></td>
</tr>
<tr>
<td>1726</td>
<td>James Bradley</td>
<td>Stellar Aberration</td>
<td>301,000</td>
<td></td>
</tr>
<tr>
<td>1849</td>
<td>Armand Fizeau</td>
<td>Toothed Wheel</td>
<td>315,000</td>
<td></td>
</tr>
<tr>
<td>1862</td>
<td>Leon Foucault</td>
<td>Rotating Mirror</td>
<td>298,000</td>
<td>+500</td>
</tr>
<tr>
<td>1879</td>
<td>Albert Michelson</td>
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<td>299,910</td>
<td>+50</td>
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<td>Rosa, Dorsey</td>
<td>Electromagnetic constants</td>
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<td>+30</td>
</tr>
<tr>
<td>1926</td>
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</tr>
<tr>
<td>1947</td>
<td>Essen, Gorden-Smith</td>
<td>Cavity Resonator</td>
<td>299,792</td>
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<tr>
<td>1958</td>
<td>K. D. Froome</td>
<td>Radio Interferometer</td>
<td>299,792.5</td>
<td>+0.1</td>
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<tr>
<td>1973</td>
<td>Evanson et al</td>
<td>Lasers</td>
<td>299,792.4574</td>
<td>+0.001</td>
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<tr>
<td>1983</td>
<td></td>
<td>Adopted Value</td>
<td>299,792.458</td>
<td></td>
</tr>
</tbody>
</table>

Table 1: Different Measurements of the Speed of Light

Light Travel

“Light was a transverse electromagnetic wave that can be seen by a typical human.” The light also traveled in a straight line. “The propagating disturbance is what makes the light waves,” it was where electric and magnetic field created a right angle when they were disturbed to the direction of the propagation perpendicularly and made light a transverse wave.

As shown in figure 7, an electric field vibrated in many directions. It can
travel in any directions as long as it was perpendicular to the propagation enable for the polarized light to emit.

Light was produced by a single source (Incident Ray) and traveled along two different paths can arrive in the same point or canceled each other by destructive interference behavior when it struck into a plane. Reflection of lights occurred when the light traveled in a straight-line path (normal) in a homogenous medium (transparent medium), until some part of the ray bounced back and reflected into the first medium. In this case, the angle created by the incident ray will be same as the angle on the reflected ray, since the normal and the two rays were all in the flat surface and perpendicular to the plane. The rest of the incident ray which didn’t reflect became the refracted ray. It was called “refracted ray”, when the incident ray traveled and entered into the second medium of a transparent plane and the ray was bent at the boundary. This concept of how the lights were been reflected and refracted was known as “the Law of Reflection and Refraction”, as shown in figure 8.

Since the angles for incident and reflection ray were equal, therefore, $\theta_1 = \theta_1'$, where: $\theta_1$ represents angle for the incident ray, and $\theta_1'$ represents the angle for the reflected ray. This was also known as the “Snell’s Law”.

To compute for the angle on the refracted ray, here was a simple equation by Snell’s Law: $n_1 \sin \theta_1 = n_2 \sin \theta_2$. This equation was lead to a few rules regarding refraction.

First, if $n_2 > n_1$, $\theta_2 < \theta_1$, it means that when the incident ray was transferred into a higher index of refraction (like air to gas), the light ray bent towards the normal line. Second, if $n_2 < n_1$, $\theta_2 > \theta_1$, it was the opposite of the first rule, when the incident ray leaved a medium with higher index, it bent away from the normal line. It this case, a critical angle was existed where there shall be no refraction from high index to low index because the incident ray didn’t came to a stop, instead, it just reflected exclusively, this was also known as “The Internal Reflection”. Lastly, if $\theta_1 = 0, \theta_1' = 0$, means that “The only way that a light ray may cross from one medium to another without altering its course.“ The incident ray will not bend as it crosses over exactly perpendicular to the boundary of the two media.

The index if refraction can be measured by this equation: $n = \frac{c}{v}$, where $c$ is the speed of light in a vacuum which was $3 \times 10^8$ m/s, and $v$ is the speed of light in a given medium. The index of refraction in a vacuum was exactly 1, therefore the index in a given medium should be greater than 1. Table 2 showed the different index value in some different medium that were usually used in an experiment.

<table>
<thead>
<tr>
<th>Material</th>
<th>Index</th>
<th>Material</th>
<th>Index</th>
<th>Material</th>
<th>Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vacuum</td>
<td>1.00000</td>
<td>Glycerine</td>
<td>1.473</td>
<td>Flint glasses</td>
<td>1.57-1.75</td>
</tr>
<tr>
<td>Air at STP</td>
<td>1.00029</td>
<td>Sugar solution (80%)</td>
<td>1.49</td>
<td>Heavy flint glass</td>
<td>1.65</td>
</tr>
</tbody>
</table>

![Figure 8: Law of Reflection and Refraction](image)
### Table 2: Index of Refraction

<table>
<thead>
<tr>
<th>Material</th>
<th>Refractive Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ice</td>
<td>1.31</td>
</tr>
<tr>
<td>Typical crown glass</td>
<td>1.52</td>
</tr>
<tr>
<td>Extra dense flint, EDF-3</td>
<td>1.7200</td>
</tr>
<tr>
<td>Water at 20 C</td>
<td>1.33</td>
</tr>
<tr>
<td>Crown glasses</td>
<td>1.52-1.62</td>
</tr>
<tr>
<td>Methylene iodide</td>
<td>1.74</td>
</tr>
<tr>
<td>Acetone</td>
<td>1.36</td>
</tr>
<tr>
<td>Spectacle crown, C-1</td>
<td>1.523</td>
</tr>
<tr>
<td>Sapphire</td>
<td>1.77</td>
</tr>
<tr>
<td>Ethyl alcohol</td>
<td>1.36</td>
</tr>
<tr>
<td>Sodium chloride</td>
<td>1.54</td>
</tr>
<tr>
<td>Rare earth flint</td>
<td>1.7-1.84</td>
</tr>
<tr>
<td>Sugar solution (30%)</td>
<td>1.38</td>
</tr>
<tr>
<td>Glass, fiber</td>
<td>1.560</td>
</tr>
<tr>
<td>Lanthanum flint</td>
<td>1.82-1.98</td>
</tr>
<tr>
<td>Fluorite</td>
<td>1.433</td>
</tr>
<tr>
<td>Polystyrene</td>
<td>1.55-1.59</td>
</tr>
<tr>
<td>Arsenic trisulfide glass</td>
<td>2.04</td>
</tr>
<tr>
<td>Fused quartz</td>
<td>1.46</td>
</tr>
<tr>
<td>Carbon disulfide</td>
<td>1.63</td>
</tr>
<tr>
<td>Diamond</td>
<td>2.417</td>
</tr>
</tbody>
</table>

### Relevance of Physics in Shadow Puppetry

Simple black and white shadow puppetry just used a regular source of light and not translucent papers to create color on the show. In this case, the puppeteers put the figure behind the illuminated screen and mimic the figures that they made. The light ray from the source traveled and passed through the figure and the Umbra shadow appeared on the screen. As the puppeteer moved the figured, the figure kept covering the light and it was the time a penumbra (light shadow) was created too, as shown in figure 9.

Some rays from the incident ray (source of light) reflect to the figure which will scatter through the background of the screen and gave lighter source for the figure behind the screen. Then the refracted ray which entered the screen will emphasize the figure through the audience, as shown in figure 1.

To enlarge the figure on the screen, the puppeteer usually moved the puppets closer to the source of light. This happened because the object will almost cover the light and the Umbra (dark shadow) will be enlarge and appear on the screen. The Penumbra (light shadow) occurred when the source of light was partially obscured on the screen. 4

To give color on the shadow, the puppeteers usually used translucent papers so the incident ray of the light will pass through the colored paper and adopted and showed on the screen. When the papers passed through the translucent paper, it basically crosses the papers and the internal reflection occurred where the incident ray created a $0^\circ$ angle to the figure. Same procedures with the simple black and white puppetry were occurred in this one but with the used of colored papers or lights, as what shown in figure 4.
The light’s speed traveled $3 \times 10^8$ m/s in a vacuum. In this case the index of refraction was between the screen and the air. Let say that the screen was made of fiber glass, so the index of the fiber glass is 1.560, to compute for the speed of light passed through the screen, we used the equation $n = c/v$.

Where: $n = \text{index of fiber glass which is } 1.560$

$c = \text{speed of light in the vacuum which is } 3 \times 10^8$ m/s

$v = \frac{c}{n} = 1.92 \times 10^8$ m/s

Therefore, the ray of light traveled slower when it passed the screen, that’s why the audience can see the figure of the puppets and the light ray spread after it passed on the screen.

**Conclusion**

Shadows were basically can be seen everywhere when a source of light occurred. On the shadow puppetry, this kind art can’t be form if there’s no source of light.

The incident rays was came from the source of light, as it struck to the figure (puppet) some rays reflect behind the screen and scattered to lighter the background of the screen and some refracted rays where passed on the screen to emphasize the shape of the puppet and so the audience can see them clearly.

As the light struck on the figure, the dark shadow that the audiences see was the Umbra and once the puppeteer moved the figure, it start creating and showing the audience the Penumbra or the light shadow of the figure.

Translucent papers were used so the incident ray crossed the paper and give colored to the shadow on the screen.
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Constellations: The Beginning of the Formations

Kris Ayers

Paradise Valley Community College

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Professor Jennifer Weitz

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Abstract

I am going to introduce the topic about constellations and how they were formed. Many people don’t know who or what came up with constellations and hopefully in this essay I will answer that question. I will go through the history and theories of what people have said about how some major constellations were formed and I will also go through the astronomers who came up with this idea.

Constellations are imaginary formations that farmers, poets, and astronomers have come up with over the past six thousand years and maybe even longer than that. Constellations have stories behind them and have been passed on throughout the existence of our galaxy and universe. Constellations are named patterns of stars. The forty-eight ancient constellations single out only the brightest patterns (Kaler, J.B.). Trying to find each constellation in the sky is harder than it seems. You have to be experience have an educated background about this topic (Gibson S.).

There are eighty-eight known constellations in our celestial sphere. The Greeks made names for these star formations by taking the names from religious or mythological figures, animals, or objects. They founded and named forty-eight of these constellations. That is more than half of what we have discovered or made up today! There are many families of constellations, constellations that are either close to one another or have a relationship to a myth someone has made about them (Learning, E.). These families of constellations are named, as followed. The Zodiac family that includes twelve constellations that lies along the elliptic, which is the plane in which most of our Solar System lies. Usually, twelve constellations are listed in the Zodiac, but there is actually a thirteenth constellation that crosses the elliptic, Ophiuchus (between Scorpio and...
Sagittarius) (Learning, E.). The Ursa Major family consists of ten constellations circling the northern celestial pole. Next, The Perseus family includes nine constellations that are representing figures from the myth Perseus. Following that, the Hercules family consists of nine constellations depicting figures from the myth of Heracles. Following that family is the Orion family that includes Orion, Canis Major and Canis Minor, Monoceros, and Lepus. Also the Heavenly Waters or also known as the Cosmic Waters consists of nine constellations whose names are related to water. Next, the Bayer Groups includes eleven Southern hemisphere constellations depicting animals, named by Johann Bayer in 1603. Finally, last but not least, the La Caille Family that has thirteen Southern Hemisphere constellations named by Nicolas Louis de Lacaille in 1756 (Learning, E.). In 1928, the International Astronomy Union came along and set up a new way to categorize the constellations so people would have an easier way of differentiating which star formation was considered a constellation. They decided that twelve constellations are located directly on the ecliptic and are also know as “Zodiacs” (Gibson S.). Now days we have diagrams that allow observers to know the relative locations of the stars in the certain regions of the sky. They aren’t exact to where they are located but it gives an observer a nice ballpark idea of where to look and what stars to look for when searching for certain constellations.

Back then farmers had ideas that only some constellations were visible at certain times of the year. But as we all know that some different regions of the world have different seasons or don’t have seasons at all so when do observers know when to look for certain constellations? Farmers even used these constellations as time clocks of when to plant and harvest crops. This became an immense proposition to most farmers because
the dependence on the sky became a solid part of many farming cultures. There might even be a mystery about the sky that we don’t even know today that could tell stories about certain constellations in our galaxy.

Aristotle (384-322 BC) was a Greek philosopher who theorized about astronomy. Using only philosophical speculation (he did no scientific observations), Aristotle believed that the universe is spherical, finite, and centered around the Earth. Aristotle, like many others of his time, believed that the circle was the "perfect" shape, so the universe must be spherical, and all the orbits in it must also be circular. He also believed that celestial bodies were composed of ether (in addition to the four other basic elements believed to exist at that time, earth, air, fire, water). Aristotle's ideas were adopted by the Church and were not tested for over a thousand years, until Galileo, who was tried for heresy when his experimentation showed Aristotle to be wrong (Learning,E.).

Johannes Kepler (1571-1630) was a German mathematician who realized that the planets go around the sun in elliptical orbits. He formulated what we now call "Kepler's Three Laws" of planetary motion that
mathematically describe the elliptical orbits of celestial objects. For a few years
he worked with Tycho Brahe (Learning, E.).

Thomas Wright (1711-1786) was a British cosmologist. Wright was one
of the first people (along with Johann Lambert (1728-77) and Immanuel Kant
(1724-1804) who in 1750 speculated about the structure and origin of our solar
system and galaxy. Using religious and philosophical arguments, Wright
hypothesized that the Milky Way was a thin flat system of stars with our solar
system near the center and that there were other similar but distant star systems
(which he called nebulae) (Learning, E.).

Charles Messier (1730-1817) was a French astronomer who searched the
skies for comets. He compiled a list of 103 fuzzy objects (nebuleuse sans etoile,
or starless nebulosities) in space in order not to mistake star clusters, galaxies, and
nebulae for comets (for which he was searching). The Messier list has been added
to and now consisted of thirty-five galaxies, thirty open clusters, twenty-nine
globular clusters, four planetary nebulae, seven diffuse nebulae, and two
unconfirmed objects (which were mistaken for nebulae by Messier)
(Learning, E.).
The constellations have changed over time but not enough for astronomers not to have an idea about the whereabouts of these constellations. Today, numerous amounts of our constellations have been redefined so now we have to improvise on which star and constellation is which. For example, the Big Dipper’s handle will appear more significantly bent in about fifty years because of the motions of the stars within it as shows in the diagram (The Universe In The Classroom).

![Diagram of星座变化](image)

In 1929, the International Astronomical Union adopted constellation boundaries that defined the eighty-eight constellations that are in our night sky today (Constellations).

By knowing the positions of the constellations, it is possible to locate stars, planets, comets, and even some meteors that are approaching Earth. At the end of the sixteenth century, the first European explorers of the South mapped out a diagram that shows our austral hemisphere. Pieter Dirckz Keyser who was also in on this exploration in 1595 later added to the other constellations of the South hemisphere by the German astronomer Johann Bayer. Bayer published the first widespread celestial atlas of the western world: Uranometria (Gibson S.). This atlas was by Hevelius and the French astronomer Nicolas Louis of the Caille. Many others tried to promote their ideas, but
these astronomers finally decided on the list of the eighty-eight.

The ancient Greek tradition was to name stars by their position within a constellation. For example, Ptolemy refers to one star by the description "the reddish one on the southern eye," a star we now know as Aldebaran in the constellation of Taurus the Bull. But these descriptions could get quite involved. Ptolemy refers to another star in the obsolete constellation of Argo the Boat as "the northernmost of two stars close together over the little shield in the poop," a bit cumbersome if you are trying to learn the names of many stars (Gibson, S.).

When Al-Sufi, one of the greatest Arabic astronomers, published his own version of Ptolemy's Almagest in the tenth century, he introduced many individual star names. For centuries, bedouin Arabs had given names to bright stars -- for example Aldebaran and Betelgeuse -- since they regarded single stars as representing people and animals. Many of the original meanings of the names had been forgotten even in Al-Sufi's time, but some were direct translations of Ptolemy's descriptions. For example, the star name Fomalhaut (in the constellation of Pisces) comes from the Arabic for "mouth of the southern fish," which is how Ptolemy described it in the Almagest (Gibson, S.).

After the tenth century, the works of Ptolemy and others were re-introduced into Europe by the Islamic Arabs, and the Greek books were translated from Arabic into Latin, the scientific language of the day. Thus we know Ptolemy's work from its Arabic translation, The Almagest, not by its original Greek title. And it explains why we have a system of Greek constellations with Latin names containing stars with Arabic names (Gibson, S.).
Most of the constellations originate from the Latin language dating back from the Roman Empire. However, many times their meanings originated in the remote past of human civilization (McDonald Observatory, T.U.) Nonetheless, the limits of the constellations were then changed and revamped about this discussion subject until 1930, when the International Astronomical Union stuck their foot down and fixed these limits (Union, I.A.).

In conclusion, there is a wide range of constellations out in our galaxy. We might not even know about some and plenty will be created throughout out Earth’s existence. The constellations we recognize today have seen many changes over the millennia of human history. Some have their origins well and truly lost in the mists of time and some are recent in our history (Origins of Constellations). It is only a matter of time when a group of astronomers steps in and implements there own twist to the skies. This is an ongoing subject to our universe today and will it ever be conquered?
Bibliography


The Physics of Aesthetics and Art of Pole Dancing

Zane Von Banschbach

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Dr. Casey Durandet
Pole dancing does not bring to mind physics, or all the types of forces involved in the sport. A key aspect of being a successful pole dancer is being physically fit to handle all the forces. The history of pole dancing dates back to the 12th century and is very different in western civilization today. Competitive pole dancing is increasing in popularity and as a fitness substitute; however it is and always will be an art form of aerial feats with a side of physics.

Modern day pole dancing is known in the western world as exotic dance and is commonly associated with gentleman’s clubs. Western pole dancing has evolved from erotic dance to fitness, athletics, and sport. Not losing its aesthetically pleasing art form, pole fitness has progressed significantly in the past several years, both in the performing arts and in the industry of sports and health. Dancers from all backgrounds and countries “have used sexuality in dance to further social and economic interests.”[22] However, the pole dancing we know today was not always as socially accepted nor dominated mainly by females. An ancient traditional Indian sport known as Mallakhamb, can be traced back to the 12th century and is still practiced today. Only males participate in Mallakhamb, “mala means either ‘gymnast’ or ‘wrestler’ and Mallakhamb means either ‘pole’ or ‘of pole’ [9] [10]. The pole material is usually “teakwood” [9], due to its characteristics of a smooth surface and tough exterior. Standing at 255 centimeters (cm) tall, the pole has a base of 55 cm in circumference and a neck circumference of 20 cm, at the top of the pole is a knob with a radius of 13 cm. Mallakhamb developed skills such as “speed, reflexes, concentration, and co-ordination.”[10] This training increased an athlete’s “stamina, strength, and endurance” [10] and was believed to associate these skills and strengths in all aspects of sports and athleticism ranging from “Judo to Horse Riding to Gymnastics.”[10] In current times, 14 states in India compete at national levels in the sport. Another predominantly male sport is Chinese Pole, preceding the 12th century as a competitive sport using two vertical poles ranging from 3 to 9 meters. The men will jump from pole to pole which is “laced in rubber material” [10] and execute gravity defying tricks. This sport is less aesthetic and graceful as current western pole dancing. The acrobats of Chinese Pole would perform in costumes, sometimes with two or more performers who display skills such as “climbing, sliding down, stretching, and holding positions” [10] with strength. Many tricks such as ‘the flag’; using core and arm strength to hold a 90 degree angle between the pole and acrobat, are still being used to this day.

At the height of the great depression in the 1920’s, fairs would travel from town to town and set up tents where different performances would take place. One of the tents would house girls dancing suggestively on stage attracting crowds of men. The tent pole came to be known as dance pole, and thus Western Pole Dancing was originated. Over the years pole dancing venues have evolved from tents to bars in the 1950’s where burlesque became more accepted. By the 1980’s strip tease and pole dancing were popular in Canada and eventually moved its way into the United States. In 1994 “Fawnia Dietrich” [10] was the first to begin teaching pole dancing to “non-performers” and created the world’s first pole dancing school and instructional videos. Modern day pole dancing relies “heavily on dancing and fitness skills” [10] which were
originated from the acrobatic art of Chinese Pole and the athletic structure of the Indian tradition Mallakhamb.

Pole sport competition is highly competitive and is run by many organizations. One of which is an official non-profit organization for educational and charitable purposes, The International Pole Sports Federation (IPSF) was developed to unite pole sport athletes and their countries with one goal; to compete at the World Games and Olympics. Established in 2010 the bylaws and constitution of the IPSF was constructed to meet the Olympic requirements, including a world congress, and the following committees: executive, technical, safety, medical, ethics, marketing, athlete, accreditation, finance, and event. The world committee consists of one representative from each member’s country, consisting of 26 countries. The executive committee is the general management of the IPSF and consists of volunteers.

The IPSF also follows and supports the World Anti-Doping Agency (WADA) and abides by their rules for The World Anti-Doping Program, The World Anti-Doping Code, and the International Standards and Models of Best Practice. Political, social and religious views of the IPSF are neutral, they are a strict no discrimination non-profit organization.

The IPSF has three categories for athletes to compete in; women’s singles, men’s singles, and doubles. One day prior to the 2012 London Olympic Games, IPSF held their own World Games in London and also discussed how this founding world sporting event would contribute to pole sports future in the Olympic Games. Current updates can be found on IPSF’s ‘Facebook’ and on their main web page “pole sports.org”. Mainstream pole dancing sounds appealing, but at what cost? Would the Olympics take away the virtues which make pole dancing sensual and spontaneous, “forcing the art into a more masculine, objective, world of measurements, restrictions, linear direction and goals.”[5] A more fitness based gymnastics form of pole dancing would become known as the standard form of pole dancing, but it does “not represent the art, the soul, or the history of pole dancing.”[5] However, the push for pole dancing at the Olympics has caught the attention of the public eye. The “debate forcing people’s prejudices, fears and beliefs into plain view” [5] is a positive because these thoughts and beliefs are no longer “fester in the unspoken unconscious somewhere.” [5] If Pole dancing went to the Olympics “they would really have to water it down a lot because it is still considered a sexy dance. I think people will view it differently if it does get to the Olympics; which would be a positive thing to be mainstream because if it was watered down people might be able to accept it a little bit better rather than considering it to be something that is only seen in clubs. There is always going to be different interpretations of pole.” [17]

Pole dancing as a sport may be sexy, but it is very physically demanding as well. It involves muscle strength and power to lift your body weight and to hold positions on the pole. Kinetic energy (KE) represented by the formula KE=½ mass*velocity^2 and “comes from motion” [7] which can be calculated for the dancer. Potential energy (PE) represented by PE=mass*gravity*height “comes from position” [7], potential energy increases when the dancer
lifts themselves off the floor; the more height the greater the potential energy. Holding your own body weight up requires grip strength when doing pull ups on a bar horizontal to the floor; however, even grip strength is required when supporting your body weight on a pole perpendicular to the floor because now the dancer not only has to work against gravity, but also has a static friction force that must be applied to keep from sliding down the pole. Grip strength comes from a dancer’s hands and forearms; the quantity of force applied also depends on area of contact between the hands and the pole or other contact areas. There are other ways to grip the pole such as with pinching the pole with the legs, torso and arm, legs, and hands and many other varieties of grips and positions. An apparatus such as a lyria (an aerial hoop) has a smaller diameter than a pole and can taped for extra grip increasing the coefficient of static friction and decreasing the grip strength required to hold on. As a professional performer Chase Jarvis can be either above or below the lyria, “you can be in a split and just kind of sit there, but you can’t do that on a pole because no matter what you’re doing you’re going to get thrown off ‘cause you’re always on the side.” [19]

Key muscle groups that work together are the back and biceps which are often used for pulling, like climbing the pole. The pectorals, deltoids, and triceps are three muscle groups used mainly for pushing and lifting body weight out from the pole. Core strength is very important; this is because it eases movement adding grace and fluidity to the dance. This sport does require lots of upper body and core strength. The lower body is no different, from gripping the pole with your legs, to holding positions, the lower body must be just as strong as the rest. “I picture it as a workout, it’s my gym.”[18]

Flexibility I think is a physical aspect often over looked in many sports by spectators; a pole dancer may be able to lift their body weight, but that doesn’t allow them to perform extreme moves, if only a few basic ones. Top athletes are very flexible, not only does flexibility help with overall performance it decreases the chance of injury. Flexibility, strength, and power can be earned in the gym, but most of it comes from practice and working on skill sets. The Physical regiment for pole dancing does not typically include the gym; in other words, the best thing for the sport is to do the sport. Practice sessions are typically two and a half hours and include stretching, freestyle and singling out tricks. As a professional performer Chase Jarvis must be in excellent physical conditioning, pole dancing is a whole other animal than other aerial arts and helps improve his stamina, strength and “helps build flexibility.”[19]

The nutrition plan has more to do with performance and aesthetics. Let’s not forget that this is pole dancing and it does have aesthetic properties such as flow, gracefulness, and sexuality. A serious athlete or fitness fanatic understands that performance does not start in the gym, at practice, or on game day; it starts in the kitchen. How you operate throughout the day is a reflection of what you put into your body. You are able to perform to your fullest extent in all aspects of life by supplying your body with all of the proper amounts of nutrients each day. An interesting relationship between physics and biology is the “conservation of energy.” [6] This basic law of theoretical physics can be abstract mathematical principal stating “that there is a
certain quantity which we call energy, that does not change in the manifold changes which nature undergoes.” [6] The statement is saying “that there is a numerical quantity which does not change when something happens.” [6] In turn this nutrient from food is converted to the form of energy known as adenosine triphosphate (ATP), through a variety of energy producing pathways such as glycolysis, Krebs cycle and electron transport phosphorylation. Nutrition in the form of recovery is just as important for an athlete due to the high intensity training; muscles are constantly being broken down during training, practice, and in the gym. Supplying nutrients to the body’s muscles after training is how athletes become stronger and is critical for recovery. Nutrition is fuel for the body just like that of a car; you want to supply your body with premium fuel for ultimate performance not diesel fuel (8). Nutrition, energy, strength, power, flexibility, commitment, and training are required to be a successful pole dancer.

“I don’t eat anything processed; I try to stick to eating raw foods. Nutrition is more of a lifestyle; it definitely gives me an advantage. The way you eat affects your body; so you could work out all you want, it’s not going to help if you’re eating the wrong foods. If you eat a lot of bad foods your body doesn’t heal as fast, so you eat a lot of recovery foods like salmon or spinach. You are more likely able to train more and be more physically fit because you have this.” [19]

- Chase Jarvis

Sarah Collingham [12] demonstrates the physics of circular motion using a spinning pole in the video featured by “The Spin Doctors” [12]. During a spin there is a large force pushing Sarah outwards, away from the pole. Her hair flies outwards too as if there is there is also another force acting on it to cause it to move away from her axis of rotation. Both of these forces are the same and is known as the centrifugal force, it is caused by the inertia of the object as the object’s path is continually being redirected forming a circle. This force is “proportional to v^2/r, where v is the velocity and r is the distance from the center of rotation.”[20] The centrifugal force can be a reaction force corresponding to a centripetal force and acts in the opposite direction. Executing a pose while in circular motion is different than when simply executing a pose while static, she is not actually being thrown outwards at all during circular motion. At any point along the circle, draw a tangent line to her circular path and that will show Sarah’s direction of motion at that particular point. Newton’s first law states that an object at rest stays at rest and an object in motion stays in motion unless acted upon by an external force an object will move in a straight line. During a rotation Sarah’s body the object is trying to move off in a straight line tangent to the circle she is making. Using her muscles to hold onto the pole Sarah does not fly off during a spin, she is applying a force inwards. This inward force is known as centripetal force and is Latin for center seeking, this force it is necessary for any sustained circular motion and is responsible for pulling Sarah towards the center of rotation.[12] During rotation; if the dancer is at a constant speed, there will still be an acceleration[1]. This is known as centripetal acceleration it has a magnitude that can be calculated by taking the velocity squared over the radius. The acceleration is in the direction of the center of rotation (the pole)
The External force acting upon the dancer that produces the centripetal acceleration is the friction between the pole and the dancer.

Velocity is a vector quantity, meaning that it has a magnitude and direction. Velocity is represented by $V$ with an arrow; the arrow denotes that it is a vector [1]. Average velocity can be either positive or negative unlike average speed, this is because the displacement can have a positive or negative sign and average speed is an absolute value. The average time can be found by finding the change in the displacement ($x$) over the change in time ($t$) [1]. Instantaneous velocity is the limit of the average velocity as time approaches zero [1]. The right hand rule is a simple way of figuring out the vector’s direction of the angular velocity. By gripping the rotating object, with your fingers in the direction of the rotation, the extended thumb indicates the direction of vector. When the rotation is changed, the direction of the vector is reversed. When the angular speed is increasing over time the angular acceleration and angular velocity are in the same direction and are in opposite directions when the angular speed is decreasing with time [1]. During rotation if the angular speed (magnitude) of the dancer is increasing, the angular acceleration and angular velocity will be in the same direction because the acceleration will be acting in direction of the rotation. When the angular speed is decreasing the angular velocity will still have the same direction, but the angular acceleration will be in the opposite direction slowing down the rotation. Instantaneous velocity is the change in velocity over the change in time, as time approaches the limit zero [1]. Both average and instantaneous velocities are in units of meters per second squared ($\text{m/s}^2$). By finding the derivative of velocity over time you will have the acceleration of the velocity at any point [1]. This is relevant to the execution of tricks, the velocity of the dancer is not always constant, thus the instant in time when performing a trick the dancers velocity changes.

Acceleration, modification of an object’s velocity with time, effects the movement within the dancers’ choreography [1]. Acceleration can be positive and negative. For instance, Sarah is rotating on a pole with a positive velocity but is slowing down with a negative acceleration due to the friction force of the pole. Average Acceleration is the change in velocity over the change in time. Angular acceleration is similar to the concept of how changing speed leads to acceleration, changing the speed at an angle ($\phi$) leads to angular acceleration [1]. The average angular acceleration is the change in angular speed over the change in time. Instantaneous angular acceleration is the average angular acceleration as time approaches the limit zero. When the dancer is rotating on the pole (static axis) the angular speed and angular acceleration are the same for the entire body of the dancer, when the dancer is in a rigid (static) position.

Torque is perpendicular to the position forces, that is if force ($F$) and the position vector ($r$) from a chosen Origin ($O$) are on a plane $x$ and $y$ then torque is in the plane $z$. The magnitude of torque is dependent upon the position vector ($r$) when the force applied is constant. The larger the position vector the greater the torque and is measured in SI units, Newton-meter. The right hand rule can be used to help determine the direction of the torque vector. A dancer will apply
torque starting a rotation by pushing off the floor with force \( f \), which is a certain length \( r \) from chosen point \( O \); being the contact point(s) between the dancer and the pole.

An object interacting with its surroundings experiences friction. There are different types of friction, such as static and kinetic. Static friction keeps an object from moving by acting in the opposite direction of the force \( F \) applied. Kinetic friction is dealing with an object in motion; Newton’s second law states that the applied force \( f \) is equal to the kinetic friction force when the acceleration is zero. The kinetic friction force is acting in the opposite direction of the applied force, thus when removing the applied force the objects acceleration is no longer zero and begins to slow down until it reaches rest; due to the friction force. Friction can be applied many ways, such as pole dancing. For instance a dancer experiences static friction when grasping the pole and does not slide down the pole because the force being applied by the dancer is greater than the forces being applied to the dancer. A dancer encounters kinetic friction when sliding down the pole, however pole dancing does not simply take place on the pole; there are interactions with the floor during a competitive routine where both kinetic and static friction occur.

Work is defined as a force applied to an object over a given distance, “where the distance counts only in the direction of the force.”[7] Frictional work is essential to everyday life. There are microscopic contact points between an object and a surface; this is known as “work done by friction” [1]. Work can be either positive or negative of value depending on the vectors of force \( f \) and \( \Delta X \) (delta X); when both the vectors are in the same direction, work is positive. When the vectors are in opposite directions, work is negative. When calculating work, multiply the force \( f \) by the \( \Delta X \) and the SI units are in Joules (J). [1].Work done by a dancer sliding down a pole can be calculated by finding the force applied by the dancer to the pole and the distance slid. For example the force \( f \) applied by the dancer is five newton’s and slides a distance\( \Delta X \) of 1.5 meters to the floor, the dancer did 7.5 Joules of work.

Newton’s second law allows the net forces to be summed using the expression Net Force is equal to the mass times the acceleration (\( F_{\text{net}} = ma \)).[21] Newton’s second law can be used to help define angular momentum, stating, “The net torque on an object is equal to the time rate of change of the object’s angular momentum.” [1]. A pole dancer will experience this when rotating around the pole, an example of a move would be the ‘fireman’. When performing the ‘fireman’, the dancer spins around the pole not touching the floor. By having the dancer’s limbs and body snug to the pole the angular momentum will be greater than when the dancer is not snug to the pole. In order to slow down the angular momentum the dancer will increase their “moment of inertia”; decreasing the angular speed. [1]. Having no external torque applied conserves angular momentum; this means that angular initial is equal to angular momentum final allowing us to state that it is an isolated system with constants of mechanical energy, linear momentum and angular momentum.
Choosing the correct type of pole is dependent on many factors and changes with each individual. Factors to take into consideration when either purchasing a pole or choosing the correct pole to use at the gym are: what level of pole dancer you are, what type of tricks you perform or plan to perform, your mass, ceiling height, and what type of pole you are used to using. Types of pole materials include stainless steel, brass, chrome, and titanium gold. Stainless steel poles are for a more advanced pole dancer when performing inversions, but are great for twists, spins, and twirls. [3] Stainless steel poles may be aesthetically pleasing, but since it is highly polished and smooth, it is hard to grip thus it takes a more advanced dancer to perform tricks, such as inversions. Brass poles are very versatile; it allows a dancer to execute more advanced tricks such as leg holds, inversions, and shoulder mounts, without being so abrasive that the dancer loses the ability to perform simple tricks such as spins, twists, and twirls. [3] Brass is a softer metal composed of copper and zinc, thus is susceptible to scratches and requires frequent cleaning to be kept in top condition for dancing and can last many years. Chrome tends to have the characteristics of a stainless steel pole in looks and texture, but is slightly easier to grip; however, the finish is not as long lasting. [3] This pole is ideal for someone who wants to perform all types of tricks on all levels of pole dancing. Titanium Gold poles have an electronically coated surface that increases grip to simulate the texture of a brass pole with slightly less grip than that of brass. [3] This pole is an ideal alternative for those dancers who love the grip of a brass pole and the versatility of a chrome pole. Glow poles are made out of silicone (plastic) and are highly porous, meaning they have great grip but can cause burns if the dancer slides down the pole; these poles can be filled with LED lights.

Typical diameters of a pole are 50 millimeter (mm) and 45mm. [3] The 50mm pole is a little harder for beginners to grip because of the hand strength required. It provides greater surface area when executing moves making it easier to grip with your legs. The 45mm diameter is more of a novice level, not as much hand strength is involved as with the 50mm diameter. It is also great for someone with petite hands. There are a few types of poles; permanent poles are bolted in place at the base on the floor and the ceiling using mounting flanges, the pole being one solid piece. Removable poles are held in place by pressure, the force of the floor (normal force) acts towards the ceiling and the Normal force of the ceiling acts towards the floor through the pole, holding the removable pole stationary and safe for exercise and performances. Removable poles can be cut as one solid piece to match the height of the ceiling or the pole can come in multiple pieces easing the transportability. It is not recommended to have a removable pole on ceiling height greater than 12’ because the pressure used to hold the pole static will not be great enough or on a ceiling with a low static friction coefficient; such as tile, vaulted ceilings, or bare studs. [3] Semi-Permanent poles only need to be mounted in either the floor or ceiling. Stage Poles or free standing poles, can be used outdoors as well as inside; the stage located at the base of the pole sits on the ground and has a wide radius for stability, since there is no normal force acting upon the pole from the ceiling. For vaulted ceilings a simple mounting flange will not suffice so a vaulted ceiling adapter is required for the anchoring system. It is commonly thought that poles are static; however, most feature the ability to spin freely, a pin located at the base of
the pole can be removed to allow this feature. When a dancer is using a spinning pole versus a static pole, the dancer must exert more power to hold on to the pole because the momentum is greater on the dancer than when the pole is static.

Accidents and injuries are unfortunate but they come with the territory. Hanging upside down on a vertical pole, something is bound to happen eventually whether the static friction force is exceeded by the dancer or the equipment gives out. Bruises and bumps on shins, ankles, upper arms and inner thighs are common injuries for most beginners learning spins and climbing techniques. Pole burns are common on the inner thigh from leg holds and are caused by heat through friction between the pole and skin. Muscle soreness is common in starting a new activity and over use and over training can lead to injury, while training waste products and lactic acid are produced in the muscles cells. The amount of lactic acid is proportional to the amount of cortisol (a steroid hormone produced by the adrenal gland) released into the muscle cell breaking down the muscle along with lactic acid build up, causes soreness. Slipping and falling is an accident that can be seen on many ‘YouTube.com’ videos, can be caused by lack of strength, power, and friction. Gravity accelerates at 9.8 m/s^2 toward the center of the earth and the slight loss of static friction can send a dancer crashing to the ground. Losing and angle when performing a hold or executing a move may require more power and strength output from the dancer than they have, often leading to a fall or injury. Pole dancing is an extreme sport and serious accidents do happen, for example: “Debbie Plowman” [11] a young mother of two who had practiced pole dancing for two years. She was upside down just a foot above the ground when she lost her grip, fell on her head and caused serious spinal and spinal cord injuries paralyzing her from the chest down. Faulty equipment or improper installation of equipment can also cause accidents. Removable poles will fall over if the forces opposing on the floor and the ceiling are not great enough to support the dancer, for instance if the angular momentum and centripetal acceleration of the dancer is to greater than the static fore of the pole, the pole will give out. Lotion and pole dancing do not mix well, lotion makes it almost impossible to grip the pole. ‘Dry Hands’ is a liquid chalk that helps to keep a dancers grip from sliding. If your skin is too dry it is hard to stick to the pole; ‘Bees Wax’ is a great product to help with dry skin and it still allows a dancer to stick to the pole.[17][19]

One on Lindsay’s Role models, Jenyne Butterfly [13], a former US Pole Dance Federation Champion performs many physics defying moves in a competition including the ‘air shoulder mount’. A difficult move to execute, the dancer lifts there body to become parallel to the floor by applying a force through their hands holding her shoulder on the other side of the pole forcing here to be static relative to the pole. This is a great example of the rate of energy transfer with time is known as power. Average power is work done over time and is in units of watt’s; which is a Joule per second. Instantaneous power is the power output in watts for an instant in time and this is found by using the force (f) and the velocity (v) [1]. During the transfer of energy the concept of power is important, “in the design and use of practical devices, such as electrical appliances and engines of all kinds.” [1]. A pole dancer exemplifies power when their
energy transfers from potential to kinetic or kinetic to potential. A dancer will have zero potential energy when on ground level, but can have kinetic energy when moving around the pole. This kinetic energy can be transferred to potential when the dancer climbs the pole; an example is gaining height, this shows an output of power by the dancer. [13] External forces that Jenyne encounters include an applied force, a frictional force, a tension force, an air resistance force, and a normal force. The normal force is acting against an opposing object; in the case of a pole dancer when standing on the floor, the normal force is opposing gravity. When the dancer is on the pole the normal force is acting from the pole to the dancer at the contact point. Air resistance acts against the direction of the vector. [2] The following free body diagram is of a ‘Shoulder Mount’:

Figure 1 Shoulder Mount

\[ \sum F_x = 0 = F_{\text{hands}} - F_{\text{shoulders}} \]
\[ \sum F_y = 0 = F_s + F_{\text{core}} + F_{\text{legs}} - F_g - F_a \]
\[ \sum t = 0 = F_{\text{core}}(1\text{m}) + F_{\text{legs}}(1.5\text{m}) - F_g(0.5\text{m}) \]

Becoming a great performer takes heart, Gilbert Camargo loved to see the ladies perform and had never seen a male pole dance; he went with his friend (who is an exotic dancer) to a
club, saw a pole and started dancing. The manager said to Gilbert “come back next Saturday; you have a job!” [18]

“I really enjoy it you know, that’s the key. Practice and practice and practice and you get perfection” [18] – Gilbert Camargo

Gilbert has been performing for three years and is very passionate about the art. It took Lindsay Green three years of practicing on her own before she began to master the art and sport of Pole. For Lindsay it all started with a friend who happened to be an exotic dancer. Lindsay went and saw her perform; it wasn’t long before Lindsay’s friend was teaching her some moves on a shower curtain of a pole in Lindsey’s house. ‘Aerial Intensity’ was founded by professional pole competitor Lindsay Green, a performance team of “aerial acts that push physical limitations and capture a playful spirit.” [14] Lindsay also is an excellent teacher of the art, with 10 years of pole dancing experience. Chase Jarvis works for a company called ‘Scandalesque’ and has been doing acrobatics for 5 years. Chase met Lindsay Green at a performance where he was first introduced to pole dancing. In exchange for pole dancing lessons he teaches Lindsay and her team ‘Arial Intensity’, hand balancing, flips and other techniques. Chase had been doing parkour his whole life before he knew it was an underground sport and before it became more mainstream in recent years and lead to his development and career as a performer.

The sport of pole dancing does carry over into other aspects of life, “it’s part of you and it’s with you wherever you go.” [18] For Lindsay, increasing self-confidence and having a strong identity of who she is came from pole dancing.

“In high school I didn’t have anything that was my own, when I started pole dancing I completely changed how I felt about myself. Once I started doing it and got good at it, I felt that if I could do this I could do anything. Now I have that attitude when someone tells me I can’t do something, I just want to prove them wrong.” [17] -Lindsay Green

Standards for men in the sport are lower than that of women in certain aspects, men have an advantage in strength when executing advanced tricks but will tend to struggle with the more basic and intermediate tricks when first starting and the opposite is to be said for women starting the sport. “I think it’s slightly more acceptable for a male to be seen on a pole.” [17]. Women had a bad start in the sport because it was already viewed as a sexual dance when it started on the circus on the tent poles, because of this; women have to work harder to make pole dancing more
acceptable. “Females almost always captured more denunciation than their male partners because the middle-class reformers were obsessed with instilling the virtues of ‘true womanhood’.”[22]

The following free body diagram is of an ‘Allegra Box Splits’ [15]:

\[
\begin{align*}
\sum F_x &= 0 = F_{\text{hand1}} + F_{\text{hand2}} - F_{\text{leg1}} - F_{\text{leg2}} - N \\
\sum F_y &= 0 = F_s + F_{\text{core}} + F_g - F_a \\
\sum f &= 0 = F_{\text{core}}(0.4318\text{m}) - F_g(0.4318\text{m})
\end{align*}
\]
The following Free Body Diagram is of Lindsay Green [16] performing at the International Pole Masters Cup Championship:

Figure 3 International Pole Masters Cup Championship

\[ \sum F_y = 0 = F_s + F_{\text{legs}} + F_{\text{core}} - F_{g\text{legs}} - F_{g\text{core}} - F_a \]

\[ \sum F_x = 0 = F_{\text{hand1}} + F_{\text{hand2}} - N_{\text{hand1}} - N_{\text{hand2}} \]

\[ \sum \tau = 0 = (F_{\text{legs}}(1m) + F_{\text{core}}(0.6096m)) - F_{g\text{legs}}(1m) - F_{g\text{core}}(0.6096m) \]

The term pole dancing brings to mind: beauty, entertainment, excitement, strippers, and fitness. It typically does not bring to mind physics. A pole dancer continually undergoes changes of all types of forces; such as gravity, velocity, and acceleration. These forces can be physically demanding on the human body; being physically fit to handle the capacity of these forces is a key aspect of being a successful pole dancer. The sport of pole dancing has a long history in foreign
countries; being dominantly male, the sport is accepted as part of the culture. Western Pole dancing is not only openly accepted to the level of ‘Chinese Pole’ or ‘Mallakhamb’, it is however highly competitive and an art form none the less. Pole dancing is an aesthetic sport of gravity defying physics and artful performance.
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Hearing Intelligibility of Sound Waves and Hearing Aids

Zane Von Banschbach
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Dr. Casey Durandet
Around the world, approximately 120 million people suffer from some degree of hearing loss. It is well known that deafness is a common condition due to the delicacy of our hearing apparatus. The normal human ear has a broad audio frequency range. However, when the apparatus is damaged certain frequencies may no longer be detectible. A hearing aid will amplify the sinusoidal sound waves in order to create detectable frequencies for the nerve cells inside the cochlea of the ear. “Any hearing impaired or deaf person” is an applicant of being a hearing aid user to improve hearing intelligibility.

A person’s subjective impression about frequency of sound is known as pitch. A high vibration frequency will have a high pitch sound and a low vibration frequency will have a low pitch sound. The audio frequency range of a normal ear is sensitive to sounds ranging from 20 Hz (low frequency) to 20 KHz (high frequency), as a person ages the audio frequency range shrinks this is commonly known as hearing loss. A broad range of different frequencies of sinusoidal waves are the major makeup of most sounds (noise) we hear and are seldom associated with a pitch. Moreover, when complex sinusoidal sound waves consist of a “fundamental frequency vibration”, the pitch of the sound is identified as the fundamental frequency. Due to multiple frequencies between the ‘fundamental frequency vibration’ and ‘higher harmonics’. “This is true even when the higher harmonics are greater than that of the fundamental.” When the frequency of a sound is held constant, variations in pitch can occur due to several physiological aspects of our hearing system.

Perceived sound quality “depends in part of the audible frequency bandwidth and smoothness of frequency response” of either the reproduction or amplification system. Quality of sound is dependent on the way that this spectrum changes with time. Moreover “the number and relative amplitudes of the other standing-wave frequencies that makes up the complex sound wave.” Different resonances and frequencies in the quality of sound allow distinctions to be heard by the human hearing system allowing us to hear sounds and words. Sounds are distinguished by three properties pitch and quality which were mentioned above, the third property is loudness; “which depends partially on the amplitude of the vibrations the sound induces in our eardrums, which in turn depends on the magnitude of the pressure variation caused by the sound wave.”[1] ‘Threshold of audibility’ (the pressure fluctuation of a barely audible sound) for a normal ear is 2E-5 N/m², “which is less than one billionth of atmospheric pressure.” Harmful or painful sounds are 20 N/m² or about 10^6 times greater than standard atmospheric pressure (1E5 N/m² at sea level) [1]. It is difficult to measure sound’s pressure amplitude with an instrument thus, intensity and intensity level are the two quantities...
measured instead. Intensity \((I)\) of any wave type is defined as “the wave energy that crosses an area \(A\) perpendicular to the wave’s direction time \((t)\) divided by the area \((A)\) and time.” [1]

Equation 1

\[ I = \frac{\text{wave energy}}{A \cdot t} \]

Intensity is in units of energy known as Joule’s divided by the product of \(A\) \((m^2)\) and \(t\) (seconds) and thus can be defined in terms of Power \((P)\) as shown in Equation 1 above. Power is in units of J/s also known as a watt which leaves area in \(m^2\) in the denominator; making the units of intensity watt/ \(m^2\). [1]

Intensity level is defined as “a comparison of the intensity of one sound and the intensity of a reference sound” [1] on a logarithmic scale, not a measure of a sound's intensity. Equation 2 represents Intensity level \((\beta)\):

Equation 2

\[ \beta = 10 \log \frac{I}{I_0} \]

\(\beta\) is in units of decibels (dB) “where \(I_0\) represents a reference intensity to which other intensities are compared. The logarithmic scale for intensity level shows that “our ears do not sense that the loudness of a sound increases in direct proportion to either the intensity or intensity level of the sound.” [1] When the intensity of sound is 10 times greater (10 dB) our ears think the sound is twice as loud.
Figure 3 below represents a simplified version of a human ear. Sound energy is collected and directed by the pinna into the auditory canal and impacts the tympanic membrane. The pinna and auditory canal redirect the sound energy in such a way that the pressure variation on the ear drum is twice the pressure variation without the redirection of the sound wave. The change in pressure causes the tympanic membrane to vibrate. Behind the eardrum are three small bones collectively called ossicles the hammer, anvil and stirrup. The vibration energy from the eardrum is transferred to the ossicles which act as a lever system and increases the pressure on the oval window of the inner ear. The change in pressure is possible because the three bones alter in the amount of surface contact area with the oval window; each ossicle has a unique amount of contact area with the oval window, thus each ossicle produces different changes in the overall pressure fluctuation against the oval window. This increased pressure of the oval window causes the fluid inside the cochlea to fluctuate in pressure and the vibration stimulates hair cells creating an electrical current in the auditory nerve. The pressure change of the fluid and hair cells is sensed by a nerve cell along the basilar membrane. High frequency sounds are detected by nerve cells near the oval window and low frequency sounds are detected further away from the oval window as shown above in Figure 3. These nerve impulses travel to your brain where it is processed into noise.

Ninety percent of hearing loss involves damage to the cochlea this type of hearing loss is known as sensorineural and can be helped by a hearing aid. Aging, infections, head trauma, exposure to loud noise or fluid buildup in the inner ear can cause sensorineural hearing loss. Hearing aids are small electronic devices that restore or amplify “sounds that hearing-impaired people are missing.”
Hearing aids consist of four parts, a microphone, an amplifier, a receiver/speaker, and a battery. A microphone detects sound waves from the surrounding environment, converts the sound wave into an electric (audio) signal and sends it to the amplifier. The microphone has a diaphragm which vibrates when struck by sound waves. 

A very small electrical current is produced by the microphone; “referred to as mic level, this signal is typically measured in millivolts.” The signal is so small that in order for it to be useful it needs to be amplified. The amplifier has two circuits an input and output. The output is powered by a battery which is a direct current, meaning the power supply moves in one constant smooth direction, generating an even, uninterrupted signal. 

The input circuit comes from the microphone diaphragm in minivolts as an electrical audio signal. This circuit applies a “varying resistance to the output circuit to re-create the voltage fluctuations of the original audio signal.” Most amplifiers consist of a main transistor which contains semiconductors, “materials with varying ability to conduct electric current” such as silicone with added impurities. The added impurities allow additional space for either adding “free electrons” or “creating holes” where electrons can go, thus creating electrical charge when electrons move to free space or “hole to hole.” 

The batteries that power the hearing aids consist of three parts the anode (negative end), cathode (positive end), and electrolyte (medium between cathode and anode which prevents direct movement). The electrical difference between the cathode and the anode is from the buildup of electrons at the anode caused by the chemical reactions in the battery. The charge of a single electron \(-e\) is equal to \(-1.6\times10^{-19}\) coulombs and flow from the cathode (positive end) to the anode (negative end) through the circuit and back to the cathode (positive end). To recharge the battery, “change the direction of the flow of electrons using another power source.” 

As the transistor becomes more conductive the voltage increases; increasing the output volume. When the “amplifier increases the volume of the sound and sends it to the receiver/speaker.” The speaker emits a sound wave and sends it into the ear by turning the electrical signal back into its original form. These impulses vibrate the eardrum and move the hairs of the inner ear converting those vibrations into nerve signals.
There are many types of hearing aid styles, the smaller the hearing aid the shorter the battery life. Moreover, the smaller the hearing aid the more it costs. Digital hearing aids are the top sellers in the United States; just like analog hearing aids they amplify sounds. However digital hearing aids contain a computer chip that provides a clearer sound quality, increasing hearing intelligibility. It does this by analyzing the sound based on a person’s hearing loss and the listening situation; it then accommodates the output to the eardrum by adjusting the volume and pitch of the incoming sounds. Analog hearing aids can be set for certain environments just like a digital hearing aid; however they are being phased out. [2]

Cochlear implants are not a traditional hearing aid. A cochlear implant is for the profoundly deaf and works by bypassing the damaged parts of the ear and sends electric signals via the electrode ray not vibrations directly to the auditory nerve. [2] The implant is made up of an external (sound processor, microphone, processor) and internal (receiver and electrode ray) part. [2] The transmitter is not fastened to the scalp and ear but is fitted with a magnet to connect it to the internal receiver. [2] Between the receiver and electrode ray is a connecting wire which runs and electric current. This electric current puts off a magnetic field strength and can be calculated using the following formula in units of tesla [1]:

\[ d = I d \ell \times B \quad \Rightarrow \quad B = \frac{\ell}{T} \]

The baha hearing aid is a new bone anchored hearing aid bypass. This new hearing aid helps people with severe “sensorineural, conductive or mixed hearing loss” [2] by surgically implanting a device to the bones in the middle ear. The bone-anchored hearing aids (baha) hearing aid creates “vibrations in the skull and transmit those vibrations directly to the cochlea through a process called direct bone conduction.” [2] This type of hearing aid is for someone who cannot be helped by a normal hearing aid. Research has shown that wearing one hearing aid can actually “deteriorate hearing in the ‘good’ ear” [2] this suggests that two hearing aids should be worn rather than one.

Sound waves travel in sinusoidal patterns at different frequencies, pitch and intensity. The human ear detects these frequencies in a broad range from approximately 20Hz to 20KHz. When the hearing apparatus is defected in some way the nerve cells are unable to pick up certain frequencies. Hearing aids amplify the sound waves frequency to create vibrations in the hair cells.
to be picked up by the nerve cells in the cochlea which sends electrical impulses to the brain. I would suggest future studies and research be directed towards advancements of in bone-anchored hearing aids (baha). The ability to transmit vibrations through ‘direct bone conduction’ is much more effective than merely amplifying sound.
References


Are there Martians On Mars?

Author
Jared Becker
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Astronomy 111: The Solar System

Professor: Jenny N. Weitz
Abstract

Scientists have many questions that they have been working at continuously for answers about Mars having the ability to host life in the past, present or future. What is the potential for life on Mars? What is the chemical composition on Mars? What other life forms could we expect to find? These questions cannot be easily answered. But they do help to illustrate our search for other life forms that may exist beyond planet Earth or even our solar system.

The United States, National Aeronautics and Space Administration (NASA) and the Jet Propulsion Laboratory (JPL) have been sending spacecraft to Mars since the early 1960’s. These efforts were all part of the need to learn more about this giant red planet we call Mars and to expand our knowledge of the solar system. There have been about 40 missions sent to Mars, from three different countries over a span of 40 years and less than $\frac{1}{3}$ of the mission have been successful. We have a great desire and need to know what else is going on out there and if there are any threats to Earth or our civilization. Other than our own moon, Mars has had more visits from spacecraft attempts than any other object in our solar system and is time proven to be very challenging to say the very least. By the year 2001 there had been 30 missions to the red planet.
To get an idea of our observations and interests of Mars we can look at the effort we have put into researching Mars. The Mars missions have unfolded in 3 stages so far. The first stage consisted of four flyby missions, Mariner 3-4 and Mariner 6-7. These were the missions that started reaching out to our solar system and were tasked with exploring, the purpose was to simply fly by Mars and take as many pictures as possible. The second stage consisted of orbiters. The orbiter stage consisted of 12 missions; Mariner 8-9, Viking 1-2, Mars Observer, Mars Global Surveyor, Mars Climate Orbiter, 2001 Mars Odyssey, Mars Express, and Mars Reconnaissance Orbiter. The objective of this stage was to put spacecraft into orbit for long term. Since the space program had been growing and advancing that was a very practical objective. As technology and our own curiosity advanced we started reaching out for new capabilities and we began landing on Mars. The last and current stage of missions to Mars we are working on sending Landers and Rovers. This stage consists of missions like Viking 1-2, Pathfinder, Polar Lander /Deep space 2, Mars Exploration Rovers, Phoenix and Mars Science Laboratory.

N.A.S.A must take several issues into consideration when launching a spacecraft into outer space for exploration purposes. There are many safety issues on Earth that need to be taken into consideration. For example: The Space Shuttle uses two massive solid rocket boosters on the left and right sides to propel the spacecraft to its orbital altitude of 190 miles to 330 miles above sea level. Our latest mission to Mars launched on November 26, 201, out of Cape Canaveral Air Force Station in Florida at 10:02 eastern standard time. The carrier vehicle was a United Launch Alliance Atlas V-541 rocket and with payload it stands 191 feet tall. Just prior to launch when the vehicle was fully fueled it weighed about 1.17 million pounds, which is the equivalent of 14 big rigs fully loaded with cargo. There are several different vehicles used to launch equipment such as satellites, or in this case, Curiosity Rover into outer space. Each mission has different
equipment along with different mission requirements and objectives. These all play a role when engineers decide which type of vehicle to use. Two other large factors that play a role are the fuel demands and financial constraints, yes, all this costs money and who is picking up that tab.

On April 7, 2001, N.A.S.A. Launched the Odyssey Mission and was set to travel to Mars to gather images and information from outer space. Odyssey arrived in Mars orbit on October 24, 2001 and began gathering information. The Odyssey explorer was equipped with the latest and greatest technology of its time when it launched. The equipment on board is a gamma ray spectrometer that also has a neutron spectrometer and a high-energy neutron detector, a thermal-emission imaging system and a Martian radiation environment experiment. N.A.S.A. will use the several scientific instruments to map out the chemical and mineralogical properties of Mars. Odyssey has an impressive record that continues to grow. It has gathering information about the birth and history of the planet. With this information scientists can quickly learn if the planet has ever been a host to extraterrestrial life. Scientists can make conclusions about life on the planet when information has been provided about chemical elements and minerals that make up its surface. The present of water and the role it may have held on the planet is a large piece of the puzzle that scientists want answered. There are other missions that are still actively gathering information just like Odyssey.

It is easy to ask, “Is life on Mars”? Why don’t we know yet? But when these types of questions get asked, too often we forget all that goes into a trying to find out. It is important to understand where we as a civilization have come from technological, electrical, mechanical, chemical and biological. Then it is important to see the direction we are headed when trying to answer these
difficult questions about Mars. Problems that have been an issue in the past are failed seals on
the spacecraft that allow hot gases to escape and damaged the thermal protection foam, weight
management, having enough fuel but not too much, computer programmed operations, flight
navigation, and financial obstacles are common hurdles that N.A.S.A must deal with.

In 1984, a meteorite was found in the Allan Hills ice field in Antarctica, by an annual expedition
of the National Science Foundation’s Antarctic Meteorite Program. It has been labeled
ALH84001. Once it was found, it was preserved at Johnson Space Center Meteorite Processing
Laboratory. Not until 1993 was it recognized for its possible Martian origin. The Stanford Team
acknowledges that this is not one artifact that proves there was life on Mars. This one piece goes
with many other indicators that paint a larger picture about Mars.

"They include Stanford's detection of an apparently unique pattern
of organic molecules, carbon compounds that are the basis of life.
We also found several unusual mineral phases that are known
products of primitive microscopic organisms on Earth. Structures
that could be microscopic fossils seem to support all of this. The
relationship of all of these things in terms of location - within a
few hundred thousandths of an inch of one another - is the most
compelling evidence."

So far it has been grouped with 12 other meteorites that match a unique Martian chemistry that
has been measured by the Viking space craft that landed on Mars in 1976. ALH84001 is by far
the oldest of the 12 meteors we have so far. The meteorite is 4.2 pounds and about the size of a
potato. It is around 4.5 billion years old; Scientists believe it started out underneath the Martian
Surface 3.7 billion years ago. This is a time when the planet is thought to have been much wetter
and warmer. It is possible that a meteor impacted Mars and might have fractured the surface of the planet allowing water on the surface of the planet to go underground, thus forming an underground water system. That water would have been saturated with carbon dioxide from the planet’s atmosphere, and minerals where deposited in the fractures

Meridiani Planum is the second landing site of a rover we have successfully launched and landed on Mars and has possible proof of liquid water. Opportunity rover landed at this site on January 24, 2004. Meridiani Planum is a plain near the equator, and Opportunity rover is half way around the planet from its brother Spirit. Spirit landed at Gusev Crater and has been feeding valuable data as fast as it can transmit. Meridiani Planum was chosen as a landing site for Opportunity Rover in part because of an ancient layer of hematite nearby. Hematite is an iron oxidized element almost always formed in an environment that contained liquid water. There are approximately 5 different conclusions as to why there is hematite. For example, the hematite could have been a result of iron-rich lava and water would then have not been required. If water was present, which is the most likely answer, then the hematite came from iron intense waters of an ancient lake, or it could have been left behind from groundwater the percolated through layers of volcanic ash. In March 2013, Curiosity rover drilled into a rock that contains clay minerals. It does not prove among a shadow of a doubt that water was on the road planet, but it is one more strong point to make an argument that water was once present. One of the strongest points for water is the noticeable landmarks that resemble oceans, rivers and erosion from Earth. Some members from the European Space Agency measured enough subsurface ice to fill Lake Michigan twice.
The climate of Mars is vastly different than we are accustomed to here on Earth. This difference is largely due to the fact that Mars is further away from the Sun than Earth. Mars and Venus experience large temperature swings which could endure temperatures of 900 degrees F to 220 degrees F below zero. In contrast, on Mars the temperature can stand at a very happy 70 degrees F at the middle of the day near the equator. Another important characteristic for the atmosphere on Mars is that it is 100 times thinner than our atmosphere on Earth. This is important to know because our atmosphere on Earth helps to protect us from the powerful gamma and x-ray energy our sun emits. So the fact that Mars lacks this level of protection to some degree is important to consider. Some of the Sun's radiation might have had an effect on life that was once on Mars. Mars is also known for its large elaborate dust storms and has the possibility of choking life on Mars.

There is some fantastic information that points to life on Mars. There is also some very strong information that disrupts that idea as well. When we look at the potential for life on Mars we must take everything into consideration. This can sometimes be difficult because we could be missing one very small vital piece of information. It would not take much to destroy the potential for life on the red planet. Every day we are reminded how vital life is here on Earth and should not take advantage of it. Maybe it is a good thing that we have not found life on Mars. Maybe there is a reason for that. If there was life on Mars could it be a good thing? Would that make the planet more or less desirable from our point of view? These other forms of life could be extremely hazardous to our health and would require extensive testing. Maybe it would be better to find a planet that does not have life whatsoever. If that were the case that might make conditions easier for us to explore and one other element we would not need to worry about.
Work sited


Habitable Planets

Austin Bell

Paradise Valley Community College

AST111

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Professor Weitz
Habitable Planets

In this paper I will talk about how astronomers confirm new planet and also how they are able find new exoplanets in the habitable zone. In addition I will talk about the special telescope called Kepler and go in depth on the recently confirmed planets that the Kepler telescopes has found.

Planet Habitability is a term used for describing planets that are Earth like and have the ability to sustain life. In determining if a planet has the same qualities, studies focus on orbital properties, atmosphere, and potential chemical interactions. Another set of characteristics that planet habitability focuses on is luminosity, mass and high metallicity. In addition after these requirements are met the absolute requirement is if the planet has an energy source that can sustain life. After an energy source is found, whether a planet can sustain water is the second most important characteristic. Also planets that have Earth-like qualities have to be terrestrial or have a rock like surface and not be gaseous. Stability is an essential term when talking about exoplanets. Low First the orbit and rotation must be relatively similar throughout. If an exoplanet has a radical tilt or rotation the seasons may change rapidly or the planet could contain severe weather. Secondly the planet should rotate quickly so that the day and night cycle doesn’t
take too long. Finally another strength for a planet to have is to be able to spin fast enough to produce a magnetic field; this magnetic field will protect the planet from solar winds and ultraviolet rays. Low-mass planets are poor candidates for life for two reasons. First, their lesser gravity and atmosphere make retention difficult. Molecules would not be able to stay on the planet and reach escape velocity where they would leave the planets gravitational pull by solar winds and collisions from other objects. Geochemistry is assumed to have a degree in assuming if a planet could contain life. The biochemistry needs to have the same essential elements that are on earth that is vital for life, carbon, hydrogen, nitrogen and oxygen. Another set of factors that determine if planets could sustain life is whether it is in the habitable zone. The Habitable Zone (HZ) is defined as the range of circumstellar distances from a star within which a planet could have liquid water on its surface, given a dense enough atmosphere (The Habitable Zone, 2013).

The history of finding planets that could be habitable is a comparatively new topic for NASA and astronomers but, the techniques they use to find planets are derived from 17th century German Johannes Kepler. Keplers three laws of planetary motion are the three scientific laws used to define a planets speed, orbit and distance from its parent star. One of NASA’s recent missions called the Kepler mission is NASA's first mission capable of finding Earth-size and smaller planets around other stars. NASA is able to detect these exoplanets by building using a specially designed telescope called the Kepler instrument. This telescope is specifically designed
to detect light and is called photometer or light meter. A second method to look for stars is called the transit method. According to NASA “When a planet passes in front of a star as viewed from Earth, the event is called a “transit” (Van Dijk, 2011). On Earth, we can observe an occasional Venus or Mercury transit. These events are seen as a small black dot creeping across the Sun—Venus or Mercury blocks sunlight as the planet moves between the Sun and us. Kepler finds planets by looking for tiny dips in the brightness of a star when a planet crosses in front of it—we say the planet transits the star. Once the planet has been detected, its orbital size can be determined by how long it takes the planet to orbit once around the star and the mass of the star using Kepler's Third Law of planetary motion. The size of the planet is found from the depth of the transit (how much the brightness of the star drops) and the size of the star. From the orbital size and the temperature of the star, the planet's characteristic temperature can be calculated. From this the question of whether or not the planet is habitable can be answered.

In 2011 and 2012 it was an exciting time for habitable planet discoveries. The Kepler spacecraft discovered a planet orbiting a double star system. So in theory this planet will have to sets of sunrises and sunsets. The star system, known as Kepler-47, is located 4,900 light-years from Earth in the constellation Cygnus. Two stars orbit one another at the center of the system: One is similar to the sun in size, but only 84 percent as bright (Phillips, 2012). The second star is smaller, only one-third the size of the sun and less than 1 percent as bright. Kepler found two
planets orbiting this mismatched pair. The inner planet, Kepler-47b, closely circles the pair of stars, completing each orbit in less than 50 days. Astronomers think it is a sweltering world, where the destruction of methane in its super-heated atmosphere might lead to an extremely thick global haze. Kepler-47b is about three times the size of Earth. The outer planet, Kepler-47c, orbits every 303 days. This puts it in the system's habitable zone, a band of orbits that are "just right" for liquid water to exist on the surface of a planet. But does this planet even have a surface, possibly not. The astronomers think it is a gas giant slightly larger than Neptune.

Many stars are part of multiple-star systems where two or more stars orbit one another. Our own sun is a single, isolated star, with a relatively simple gravitational field that rules the motions of the planets orbiting it. “Astronomers estimate that more than half of the stars in the galaxy have companions. There are double, triple and even quadruple star systems. Any planets in such systems would have to navigate a complex gravitational field, tugged in multiple directions by multiple stars. In fact, for many years, astronomers doubted that planets could even form in such an environment (Phillips, 2012)”. Other interesting planets that the Kepler mission have discovered are two stars called Kepler-36b and Kepler-36c. These two planets are having close encounters; they are the closest to each other of any planetary system that Kepler has found. The inner world, Kepler-36b, is a rocky planet 1.5 times the size of Earth and weighing 4.5 times as much. It orbits about every 14 days at an average distance of less than 11
million miles, whereas the outer world, Kepler-36c, orbits at a distance of 12 million miles, about every 16 days, and is a gaseous planet 3.7 times the size of Earth. Astronomers believe Kepler-36c is 30 percent iron, less than 1 percent atmospheric hydrogen and helium and probably no more than 15 percent water. Kepler-36b by contrast, likely has a rocky core surrounded by a substantial amount of atmospheric hydrogen and helium, a "hot Neptune." The two planets have closest approach conjunction about every 97 days, when they are separated by less than 5 Earth-Moon distances. At those times Kepler-36c would present a spectacular view in the sky of the smaller rocky Kepler-36b and both planets would experience significant tidal forces. This system presents a puzzle as to how these two very different worlds ended up in such close orbits. Within our solar system, rocky planets reside close to the Sun while the gas giants remain distant. Finally another fascinating planetary system found by the Kepler mission is home to one of the smallest exoplanets. The planets are located in a system called Kepler-37, about 210 light-years from Earth in the constellation Lyra. The smallest planet, Kepler-37b, is slightly larger than our moon; measuring about one-third the size of Earth it is smaller than Mercury, which made its detection a challenge (Kepler, 2013). While Kepler-37b is in the habitable zone astronomers think, Kepler-37b does not have an atmosphere and cannot support life as we know it. The tiny planet almost certainly is rocky in composition; also the sun in star system Kepler-37b is similar to the sun in our own solar system, except it is much smaller and cooler. Kepler-37b and its neighboring planets orbit their star at a distance less than Mercury,
suggesting they are very hot, inhospitable worlds, Kepler-37b orbits every 13 days at less than one-third Mercury's distance from the sun (Kepler, 2013). The estimated surface temperature of this smoldering planet, at more than 800 degrees Fahrenheit (700 degrees Kelvin), would be hot enough to melt the zinc in a penny.

In conclusion as humankind’s has improved technology we have become increasingly aware that there must be other planets that could possibly support life. Various astronomers have studied what makes Earth able to sustain organic life and determine that planets must have certain luminosity, mass and orbital properties. Also thanks to the new leaps in technology such as the Kepler telescope which can see light years into space and detect planets with no visible light. Even though the search to find habitable planets have has been relatively new the Kepler telescope has found and confirmed 122 planets and 2,740 planet candidates requiring additional observation and analysis (NASA, 2013). Up to this point, Kepler had found just two planets in the habitable zones of their parent stars and both of them were considerably larger than Earth, but the spacecraft's latest discoveries include seven confirmed planets in two solar systems, including the smallest worlds yet found in a star's habitable zone. These discoveries are exciting because they tell us much more about rocky and gaseous planets, they show us how they can be diverse and we will then learn something as well for our own Earth. When passion and
technology come together we can find new and fascinating things about our solar system as long as we have the hunger for more knowledge.

Bibliography


Magnetic Resonance Imaging

Caress G. Bernardo

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Dr. Casey Durandet
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ABSTRACT

This paper reviews the physics behind magnetic resonance imaging or MRI. It also explains the history and the contribution of magnetic resonance imaging in the medical field. Moreover, the pros and cons of magnetic resonance imaging are discussed in the paper.

INTRODUCTION

Many deadly diseases and illnesses do not have cures. One crucial reason for that is the lack of knowledge on what causes these diseases and illnesses. The development of magnetic resonance imaging or MRI changed the way people diagnose diseases and illnesses. It began in 1946 with the discovery of magnetic resonance phenomenon of Felix Bloch and Edward Purcell independently. A discovery by both Bloch and Purcell presented that specific atomic nuclei placed upon a strong magnetic field will precess their magnetic moments around a known field of frequency. Resonance is a condition that can be observed by exposing the sample to radiation using radio waves and measuring precessional frequency interaction. In 1950 and 1970, nuclear magnetic resonance (NMR) was developed and utilized in the field of chemical and physical molecular analysis. In the early 1970s, Raymond Damadian proved that tissues and tumors have different nuclear magnetic relaxation times. Due to this discovery, scientists considered using magnetic resonance for detecting diseases and illnesses. In 1973, Hounsfield introduced X-ray computed tomography or CT scan and hospitals spent enormous amount of money for medical imaging equipment. Paul Lauterbur demonstrated magnetic resonance imaging on small test tube samples using a back projection technique in the same year. The last decade showed the progress of magnetic resonance imaging through the acquisition and reconstruction of techniques. The American College of Radiology changed the name of the technique from nuclear magnetic resonance imaging to magnetic resonance imaging because of the public confusion as there was a stigma associated with the word nuclear during the 1970’s. There were approximately 10,000 MRI units worldwide along with a confirmed 75 million annual MRI scans in 2003.
Magnetic resonance imaging is a radiology technique that provides images of body structures using magnetism, radio waves, and a computer. Before the development of MRI, it was believed that an object that is smaller than the energy wavelength of the imaging equipment could not be imaged. MRI gets around this limitation by creating images on the foundation of spatial variations in the phase and frequency of the imaged object. The images produced through magnetic resonance imaging are detailed and can identify any changes in the structure. It is an accurate technique in detecting diseases and is used to identify abnormalities such as brain aneurysms, stroke, tumors of the brain, and inflammation of the spine. Not only MRI can detect deformities in the brain and in the spinal cord, it can also evaluate problems with the heart. Furthermore, MRI is painless and does not involve x-ray radiation. Although there is no known side effect caused by MRI scan, its use of magnetic fields can intervene with metallic and electromechanical devices. These objects such as keys, jewelries, and coins can attract the magnet and distort the images. Not to mention, magnetic resonance imaging can provide high resolution anatomic structure similar with CT scan. Even though it is a more complicated instrument and has a longer process than CT scan, it can provide high contrast between different soft tissues.
**Basic Principle of MRI**

The theory on how a magnetic resonance imaging machine works can be explained in terms of physics. Every single MRI scanner varies little bit from the others and every sequence is a variation of a few templates or themes. The basis of most MRI sequences is spin echo or gradient echo techniques \(^6\). The hydrogen atom in the body has a spin. When there is no external magnetic field, the spin direction of atoms is random and cancels each other. On the other hand, if there is an external magnetic field present, the spins align with the magnetic field. By rotating the magnetic field orthogonal to the static field, the spins can separate from the z-axis with an angle or alpha. The z at the Larmor frequency or precess is rotated around by the bulk magnetization vector. As the precession gradually relaxes and with the xy-component reducing in time, there is an increase in the z component. A voltage signal is then produced by the xy component of the magnetization vector and this is the signal which MRI is measured in \(^5\).

**What is Spin?**

An essential natural property such as mass or an electrical charge. Spin can be positive or negative and it is in multiples of \(\frac{1}{2}\). Each neutron, proton, and electron has a spin of \(\frac{1}{2}\). A deuterium atom that contains one unpaired electron, one unpaired proton, and one unpaired neutron has a total of \(\frac{1}{2}\) electronic spin and a total of 1 nuclear spin. Particles that have opposite signs of spins can pair up to get rid of the observed manifestations characterized with spin. The unpaired nuclear spins are the important ones in magnetic resonance \(^1\).

**Hydrogen Proton**

A moving positive or negative electric charge creates a magnetic field. Its speed is directly proportional to the magnetic field. The faster the electric charge is, the larger the magnetic field it produces. Although a proton has a small electric charge, it spins about its axis very fast. Thus, it creates a magnetic field and act like a tiny magnet with a north and south pole \(^7\). In order to produce a MRI signal, it is important to have a source of hydrogen protons \(^8\). Water is the main source of protons in the body and fat is the second \(^7\).

**Magnetization**

A particle with a spin act like a magnet with a north and a south pole. A spin packet describes a group of spins undergoing a magnetic field with the same strength. When there is no magnetic field present, the directions of protons are random and cancel each other out. In the presence of magnetic field, some protons align with the magnetic field and some align against the magnetic field \(^7\). However, there will be a little bit more of protons that will align with the magnetic field creating a net magnetization parallel to the field. This net magnetization is where magnetic resonance signal comes from \(^8\) and also the reason why the signal noise ratio is higher in MRI scanners instead of a low field scanner \(^7\).
Planck’s constant

A low energy state has its poles aligned in order of N-S-N-S. On the other hand, a high energy state has an order of N-N-S-S. Particles can go from low energy state to high energy state through absorbing a photon. The energy of the photon being absorbed must exactly equal to the difference in energy of the low and high states. The formula $E = h\nu$ can be used to calculate the energy, $E$, of the photon where $h = 6.626 \times 10^{-34}$ J s (Planck’s constant) and $\nu$ is the resonance or Larmor frequency $^1$.

Boltzmann Statistics

Boltzmann statistics state that there are more number of spins in the lower energy state, $N^+$, than in the higher energy state, $N^-$, at room temperature. From Boltzmann statistics $(N^-)/(N^+) = e^{(-E)/(kT)}$, $E$ is the energy difference between the two energy level states, $k$ is Boltzmann’s constant which is $1.3805 \times 10^{-23}$ J/Kelvin, and $T$ is the temperature in Kelvin. Temperature is directly proportional to the ratio of $(N^-)/(N^+)$. As the temperature decreases, the ratio of $(N^-)/(N^+)$ also decreases. As the temperatures increases, the ratio gets close to 1. The sources of magnetic resonance signal are the energy needed to make the transition from lower energy state to a higher energy state and vice versa. MRI is a very sensitive tool in imaging objects since it can identify very small population differences in the states. The reason for the sensitivity of MRI is the
exchange of energy also called resonance under a specific frequency among the spectrometer and the spins. Moreover, natural abundance of the isotope and biological abundance are two factors that can affect the MRI signal. The fraction that contains a given number of protons, neutrons, and the atomic weight of nuclei is an isotope’s natural wealth. This is exemplified by hydrogen’s three isotopes which are ^1H, ^2H, and ^3H. ^1H has a natural abundance of 99.985%. The human body holds this natural abundance as a fraction of a type of atom which composes it.

Precession

This is when a spinning top spins around its axis. The top is being pulled by the force of gravity to make it fall down. The top’s precession is caused by the combination of the effects of gravity and the spinning motion. The same concept happens with a proton that is spinning in its axis. When it interacts with a strong magnetic field the proton will precess. The frequency of the precession is determined by Larmor equation, \( \omega = \gamma B_0 \), where \( \omega \) is Larmor frequency, \( \gamma \) is the gyromagnetic ratio, and \( B_0 \) is the magnetic field. The gyromagnetic ratio is different for each atom. To be able to efficiently transfer energy to the protons, a particular situation has to be created by the proton precessional frequency to which the resonance phenomenon can act upon to do enable the transfer.

Protons can go from a lower energy state to a higher energy state when a specific type of frequency called an electromagnetic ratio frequency or RF pulse is applied upon the Larmor frequency. This also means that the magnetization vector tips down towards the XY plane creating a tip angle of alpha. This angle serves as the RF pulse’s functional duration and strength.

RF Transmitter Off

Once the RF transmitter is turned off, three things occur; the energy absorbed from the RF is transmitted towards the Larmor frequency which then produces an MRI signal. Additionally, the spins begin to revert back to their original Mz orientation. In the beginning of the phase, excited protons start to dephase or decay in signal as part of T2 and T2* relaxation which are both the time constant.
**T_1 Processes**

When the net magnetization is parallel to the applied magnetic field at equilibrium, it is called equilibrium magnetization \( M_o \). In this arrangement, the \( Z \) component of magnetization \( M_z \) is the same with \( M_o \) and transverse magnetization (\( M_x \) or \( M_y \)) is not present here. \( M_z \) is also called longitudinal magnetization. In order to change the value of the net magnetization to zero, there should be enough energy to enable exposure of the nuclear spin system towards a difference in energy that is equal to an energy frequency between the spin states. The equation \( M_z = M_o \left( 1 - e^{-t/T_1} \right) \) explains how \( M_z \) go back to its equilibrium value. The equation that describes the net magnetization going back from the \( -Z \) axis to the \(+Z\) axis is \( M_z = M_o \left( 1 - 2e^{-t/T_1} \right) \). \( T_1 \) is called the spin lattice relaxation time and it is the time needed to minimize the difference of the equilibrium value of \( M_z \) and \( M_z \) itself by the \( e \) factor. 

**T_2 Processes**

The net magnetization begins to go out of phase when because each spin packet has its own Larmor frequency causing their magnetic field to be different. In this case, the net magnetization is located along the \( +Y \). \( T_2 \) is also known as spin-spin relaxation time and it is the time constant that explains the return of transverse magnetization, \( M_{XY} \), to equilibrium. 

\[
M_{XY} = M_{XYo} e^{-t/T_2} 
\]  

(1) 

The time to reduce the transverse magnetization by a factor of \( e \) is \( T_2 \) and it is less than or equal to \( T_1 \). \( T_1 \) and \( T_2 \) processes happen simultaneously. \( T_2 \) decay or the dephasing of the transverse magnetization occur as the longitudinal magnetization parallels back to the main magnetic field after a 90° RF pulse. Seconds after that, the majority of the transverse magnetization becomes dephased and the majority of longitudinal magnetization have reverted back.

**CONCLUSION**

Magnetic resonance imaging is a very useful technique in providing images of body structures making it an accurate tool in detecting abnormalities inside the body. Moreover, it is painless, safe, and does not involved x-ray radiation. The hydrogen protons associated with water and fats in the human bodies are the source of MRI signal. These little magnets spin about their own axis. Once placed in a magnetic field, they align with the field producing a net
magnetization. The equation $E = hv$ can be used to solve for the amount of energy an absorbed proton needs in order for a particle to move from a lower state of energy to a higher state. Electromagnetic ratio frequency or RF pulse is the frequency a proton needs to go to a higher energy state. When a proton spinning in its own axis interacts with a strong magnetic field, the proton will wobble or precess. Once the RF transmitter is turned off, the energy absorbed form the RF is retransmitted back to the Larmor frequency which then creates an MRI signal. In addition, the spins go back to their Mz orientation and protons begin to go out of phase causing the loss of signal.
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The Possibility Of Extraterrestrial Life On Other Planets And Possibly Other Galaxies

Miranda Blake 4/13/13

Astronomy 111

Professor Weitz
THE POSSIBILITY OF EXTRATERRESTRIAL LIFE

Abstract

The possibility of extraterrestrial life is a subject that has been talked about and researched for years. As long as it had been researched there is still no hard evidence on whether or not there are other life forms out there. There are many organizations and theories that were created for the sole purpose of further researching the possibility of intelligent life forms. SETI is one of the organizations that was created. Other topics surrounding extraterrestrial life are The Anthropic Argument and The Billion-Year Technology Gap. This paper will talk about: SETI, The Anthropic Argument, The Billion-Year Technology Gap, Drake Equation and the general idea of life on other planets.


SETI, which stands for Search for Extraterrestrial Intelligence, began in 1959. It was not created by one specific person as it involved many different people so it is hard to give credit to one specific group of people. They are based in the University of California in Berkley (Seti institute). During the 1960’s SETI was dominated by the Soviet Union. While it was dominated by the Soviet Union they frequently came up with strategies that were not ordinary. Many projects are done by SETI. One of these projects was called Project Phoenix (Seti institute). The objective of Project Phoenix was to examine multiple regions around 1000 Sun-like stars. The antennas used in this project were the world’s largest. In 1974 SETI beamed their own signal into space and they aimed it towards the M13 area of the universe (Seti institute). The signal was beamed in hopes that they would get some sort of signal sent back by another intelligent life...
form. Along with doing that they also have several radio telescopes that are used to try and receive signals from extraterrestrial lifeforms.

Some of SETI’s radio telescopes.

The Anthropic Argument is otherwise known as The Law of Human Existence. It can also be called The Anthropic principle, the three names are interchangeable. The definition of Anthropic is “relating to human beings or their existence”. An astrophysicist by the name of Brandon Carter proposed The Anthropic Argument in 1983 (“What is the anthropic principle”). According the the Anthropic Argument, the existence of human life depends on a couple of different things. It depends on numerous cosmological constants, and parameters (“What is the anthropic principle”). These cosmological constants and parameters must fall into a very narrow range of numerical values. We would not exist if a cosmological constant or parameter were off in the slightest. It seems that the universe has been created just right in order for us to exist (“What is the anthropic principle”).

There is no physical evidence stating that we are the only intelligent life in the universe and there is no physical evidence stating that we aren’t the only intelligent life in the universe.
With as many stars that are in the milky way, not to mention all of the other stars outside of the milky way, it is very hard to believe that there is absolutely no other intelligent life forms out there. The billion-year technology gap is believed to exist. This means that other life forms may have existed way before our time. It is believed by many experts that advanced civilizations could exist. These civilizations are believed to have existed for 1.8 gigayears (Sato, R., & Kazan, C. (2009, November 28). A physicist by the name of Enrico Fermi asked his colleagues a question in 1950 that is now very famous. His question was “Where are they?”. “If there are other advanced extraterrestrial civilizations, then why is there no evidence of such.” Fermi reasoned. Fermi wanted to know why there had been no sightings of UFOs in the Milky Way. Fermi’s questions and reasonings became known as the “Fermi Paradox”. The contradiction between high probability estimates of intelligent life but the lack of evidence for it is what the paradox is (Sato, R., & Kazan, C. (2009, November 28). Another question that somewhat relates to Fermi’s Paradox is the Great Silence. The question known as The Great Silence is as follows: “Even if space travel is too difficult, if life is out there, why don't we at least detect some sign of civilization like radio transmissions?” (Sato, R., & Kazan, C. (2009, November 28). There are planets that are older than the earth and the solar system combined. If these planets are so old then it is very possible that either A) There was at one point an advanced civilization and they died out before we existed or B) There is an advanced civilization somewhere out there and we just don’t know about it.
The Drake Equation is essentially a question asking if it would even be possible for other intelligent life forms to communicate with us if they existed. Dr. Frank Drake came up with an equation that included the terms needed to estimate the number of technological civilizations that could possibly exist in our galaxy (Seti Institute). This equation was presented by Drake for the very first time in 1961. All of the factors that are believed to play a specific role in developing civilizations are explained in this equation. The Drake equation is used and widely accepted in the scientific community. The equation goes as follows: 

\[ N = R^* \cdot f_p \cdot n_e \cdot f_l \cdot f_i \cdot f_c \cdot L \]

“\( N \) = The number of civilizations in The Milky Way Galaxy whose electromagnetic emissions are detectable, \( R^* \) = The rate of formation of stars suitable for the development of intelligent life, \( f_p \) = The fraction of those stars with planetary systems, \( n_e \) = The number of planets, per solar system, with an environment suitable for life, \( f_l \) = The fraction of suitable..
planets on which life actually appears, \( f_i \) = The fraction of life bearing planets on which intelligent life emerges, \( f_c \) = The fraction of civilizations that develop a technology that releases detectable signs of their existence into space, \( L \) = The length of time such civilizations release detectable signals into space.” (Seti institute).

A new study shows that dying stars may be able to host life ("Future evidence for," 2013). This information resulted from a study of earth-like planets that orbit white dwarf stars ("Future evidence for," 2013). If life does actually exist on these dying stars there might be a way to detect it sometime within the next decade ("Future evidence for," 2013). Researchers that were conducting this study found that oxygen could be detected in the atmosphere of a white dwarf star planet easier than they could detect oxygen for a planet very similar to earth that orbits a sun-like star ("Future evidence for," 2013). A white dwarf comes along when a star like the sun dies, it puts out its outer layers ("Future evidence for," 2013). A hot core gets left behind and it is called a white dwarf ("Future evidence for," 2013). A white dwarf is relatively the same size as earth ("Future evidence for," 2013). Planets that exist in habitable zones of white dwarfs need to be discovered before we are able to study them ("Future evidence for," 2013). The thing that astronomers are most interested in finding is oxygen. They are most interested in finding oxygen because in the atmosphere of Earth, oxygen is continuously replenished ("Future evidence for," 2013). Astronomers are still continuing their research on white dwarfs in hopes of finding evidence of life.

A study done in 2000 came up with some evidence of a theory stating that life on earth may have originated by chemicals that were extraterrestrial. This process is called panspermia. It is believed that meteor and comet collisions with the moon has provided evidence of compounds from space that could have possibly played a role in the spawning of life on earth 500 million
years ago ("Life From Extraterrestrial" 2000). The “Cambrian Explosion” is what the rapid diversification of animal types on earth is called. The cause of this so called explosion is unclear.

The topic of other intelligent life is a very popular one that gets brought up quite often and a topic that scientists are always looking for answers to. Many people refuse to believe that we are the only ones out there with as huge as space is. Hopefully within our lifetime we will find evidence of other life forms.

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Chemical Physics of Benzene

Megan Bradley

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PHY112
Dr. Casey Durandet
Abstract:

This paper is about how the fields of physics and chemistry interact. It will begin with the history and the first observers and their methods and will discuss how it affects chemistry and how it is practiced. I will focus on a benzene reaction and how its interactions can be explained using physics. There will also be an example of the calculations that pertain to a reaction and how it explains the course of the reaction.

Introduction:

The nature of science is to discover the truths about the natural world in order to better live in it. This is the truth of all sciences thus it makes all sciences intertwine with each other naturally, and as the fields of science become more advanced they become closer. This is very true for the physical sciences, especially physics and chemistry. Both are the keys to understanding nature and the world around us. Both are around us at all times and color our lives. Without either all of our modern inventions would not exist. Without both, medicine would be reduced to herbs and wives’ tales and electronics would be myth and magic.

The first man to twine the principles if physics and chemistry was Robert Boyle. He used a vacuum, created from air pumps, to preform experimentation on gasses, thus proving that air has density and does affect the operation of physics around it. It was then that he could postulate his corpuscle theory, that would later develop into atomic theory. He postulated this theory when viewing weight gain when metals were heated into calyces. He knew that physics would unlock the truth of elements and their nature. Today’s understanding of subatomic particles was only possible because someone learned about friction.

The unison carried on in 1785 when Charles-Augustin de Coulomb began to research Joseph Priestly's work on the law of electrical repulsion. He built the Torrison Balance to study the electrical force of a particle. It is a long cylinder through which a string hangs. The string is attached to a rotating cap at one end and at the other is a metal sphere that is charged with a charge denoted $q_2$. Another sphere is held at a fixed point and is charged with a charge of $q_1$. As the cap is spun the distance between the two spheres, denoted as $r$, and the force exerted on the spheres is calculated. This forms the equation known as Coulomb's Law:

$$F = \frac{kq_1q_2}{r^2} = \frac{q_1q_2}{4\pi\varepsilon_0 r^2}$$

This law changed the way the world looked at chemistry and how to manipulate chemical reactions to create a more favorable outcome. Gravity was once thought to be
the strongest force, then magnetism flexed its muscles. But now electric force showed power, it showed polarity and it could be measured for the first time. This also meant the smallest particle of matter now had a measurable charge. This changed the way chemists now look at reactions and how they work.

My favorite current work in the chemical physics field is the work being done by Filip Moučka, Ivo Nezbeda, and William R. Smith. They are doing fascinating research on the electric force fields on electrolytes. In their current experiments they are working with common NaCl derivatives that would be found in food and drinks and testing them in water, a common substitute for blood, 13. They have found that the charge on the single atoms can affect how the body intakes them and uses them, 13. This has serious implications on how they can be administered and how supplements can be created in the lab. It also means that the electrolyte fortified sports drinks may be useless unless they alter the manufacturing process.

That means a $1.602 \times 10^{-19}$ positive or negative charge, 12, is not only strong enough to not only make a force field around an atom, but that it can affect how the body works. This means that electricity may have more of an impact than just messages through the nerves. Electricity could be involved in our digestion and in the way ions are transmitted through blood. And physics equations were what brought this phenomenon to light.

Benzene was discovered by Micheal Faraday in a resin that was used by perfumers and pharmacists during the 1800s. After the resin was burned, a thin film like substance was left behind. He began running experiments on this substance in curiosity. It was in this left over that a brand new arrangement of carbons and hydrogen’s was found. The hexagonal structure contains six carbons and six hydrogen and one of the most stable structures found in nature.

The stability of the benzene makes reactions with other atoms difficult and restricted. The shared electrons make all of the carbons follow the rule of eight, a rule that states that all atoms want eight outer shell electrons. With this rule followed and the reactions with benzene so specific chemists turned to physicists to explain the biologically favored atom.

Physics of Benzene

Benzene is an extremely exciting molecule for physicists and biochemists, 5. It is composed of six carbons all in a ring format, 3. It also has an alternating pi bond, or second electron sharing shell, that circulates around the entirety of the molecule. This shifting makes it a very stable molecule and it can be used in all manner of medication.

The stability that the benzene molecule boasts is mostly due to the rotating cloud of electrons, 5. This can be explained using physics and logic. The thicker cloud of electrons that forms the pi bonds float over and under the ring itself and the sigma, or first, bonds make up the ring itself. In the middle of all this is the positively charged proton clusters
that make up the carbon nuclei these protons attract the electrons and pull them. The electrons do go towards the clusters but are going at such a high velocity that they merely have their trajectory bend a little. This bend is just enough to send the electrons towards the next carbon proton cluster. This process repeats over and over causing two swirling disks to encapsulate the molecule, giving it a buffer against the outside forces.

For physicists this molecule can have many more uses due to this protected nature. It always has a charge due to its migrating electrons, this rotating charge creates an electric field around its atoms. It also is easily excited meaning it can absorb, and give off, more energy, 14. This is extremely useful when looking at microprocessors and tiny electronic chips, 14. These electronics need capacitors and are too tiny for man to produce it for them. Using a metal, like gold, 14, to be the circuit any laying benzene on it the molecules will absorb charge from the circuit and store that charge in their pi bond, 14. At this time the benzene overlap in their most stable positions which allows conductance through each individually and is only a few molecules deep, 14.

Just because it looks simple to create this stable ring doesn’t mean it is. There is more to the equation than just shoving six carbons and six hydrogen together. One more thing stands in the way. The key is in the electrons. The electrons act in two distinct fashions, as a particle or as a wave. It is this split that causes some problems, specifically as a wave. If electrons were merely particles, they could just orbit around two nuclei. But as a wave, the waves must be in sync.

This idea is basic wave theory, if the crests and troughs meet at the same time than the wave is amplified and the wave is said to be in phase. But if the crest meets a trough than the wave is out of phase and will be cancelled,5. If they are cancelled than the electrons would cancel out, which will not make a strong bond. So the electrons that are in the same phase as they orbit their atom then they will over lap and bind the two atoms together. This is a new idea and explains why there is not a total reaction of the reagents in a reaction, 5. There really are very few other explanations as to why a reaction will leave half of its reagents unused if the equation states that they will bind, 5.

A way to overcome this setback is the idea of using lasers to interrupt the wave an electron has and force it into a certain wave, 5. This is a very new idea using the principles of resonance and the idea that wavelength and phase can be altered by energy input, 5. If this idea comes to fruition, the yield can be greatly altered and make the process far more profitable to the creators and would make research faster.

Physics can also explain the reactions between benzene and other atoms in various reactions in organic chemistry. A common reaction, which will be used as an example, is the synthesis of p-bromochlorobenzene from chlorobenzene. It uses a benzene with an attached chlorine atom and will react it with a boron ion to create a more substituted benzene. The reaction is:
\[ \text{Br}_2 + \text{FeBr}_3 \rightarrow \left[ \text{Br}^+ \cdots \text{FeBr}_4^- \right] \]

\[ \text{Br}^+ + \text{Cl}^- \rightarrow \]

\[ \text{Br}^- + \text{Cl}^- \rightarrow \]

\[ \text{HBr} \]

\[ \text{best} \]
As shown the Fe has a higher charge and plucks off a single bromine, leaving the other with a charge of $+1.06 \times 10^{-19}$. The chlorine pulls on the adjacent electrons making the carbon directly opposite to it a slight negative charge. The bromine then pulls the carbon to it and the electrons share their charge so that the charges can cancel out.

This explains why the bromine attaches where it does. Using this physics, different isotopes and blockers can be used to position substituents in more favorable positions in relation to each other.

Discussion:

I believe as time goes on micro physics and chemistry will grow closer and closer together. The fact that dark matter has been discovered means that the fields will work closely together in order to determine its nature and how it could impact our technology, medicine, and space travel. The discovery on neutrinos could have vast implications on chemistry and the formation of new compounds that could mean a new breakthrough for weapons, medicine, and also the study of genes.

The capacitors I mentioned earlier are still a few molecules thick, but in the near future, this may become a single molecule capacitor making nano technology easier. Physics will also one day give us insight into how electrons can flow so easily around benzene which will unlock the secret to a perfect superconductor. A superconductor means that power could be transported over the world with no loss. It would be more eco-friendly and would lower the strain on the power plants. It would make electric cars more and more viable as electricity became cheaper and cheaper.

In the medical field, a superconductor means that a synthetic spinal column could be synthesized. Paralysis could be truly cured and spinal defects could be easily fixed with surgery. This also means that diseases like cerebral palsy could be cured by replacing the damaged nerves with synthetic ones. The possibilities are endless in the medical field if a synthetic nerve could be developed.

The stability that benzene boasts can also be used in the modern sciences. If that stability could be used to create a better battery that will be more energy efficient and will also last longer. It would also allow the battery to be smaller than ever before. This would be another huge bonus for the electric car. It could go further and need less recharging. Also because the battery will become smaller, it would make the car itself far more efficient by making it lighter and faster. The drag would lessen considerably as the force of gravity dragging it down lessens.

The world is full of mystery and questions, all of which man yearns to uncover. It is our nature to be curious and try to understand our world. It is not merely ego, but also a necessity in order to survive in our hostile universe. The keys lie in what is too small to see, yet can still be computed. With physics and chemistry working hand in hand, there is nothing that cannot be accomplished. Nothing they cannot be proven. Nothing they cannot be solved. The whole universe is ours to explore, but only if we can figure out how to get there and survive in all sorts of places.
Appendices:

![Robert Boyle](http://www.biografiasyvidas.com/biografia/b/fotos/boyle.jpg)

Figure 1 Robert Boyle

![Charles-Augustin de Coulomb](http://wikiciencias.casadasciencias.org/images/5/51/Charles-Augustin_de_Coulomb.jpg)

Figure 2 Charles-Augustin de Coulomb

![Torrison Balance](http://etc.usf.edu/clipart/26600/26667/torsion_bala_26667_lg.gif)

Figure 3 Torrison Balance
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The Eagle Nebula: A Stellar Incubator

Danielle Cahill

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Astronomy 112

Professor Jennifer Weitz
Abstract: The Eagle Nebula is a stellar nebula in the constellation Serpens which is best known for its contribution to the research of star formation, photoevaporation, and evaporating gas globules. It is more commonly recognized for its Hubble Space Telescope Image which became known as “The Pillars of Creation” and graced magazine covers around the world. Astronomers are currently analyzing images of the eagle nebula to get a better understanding of the stages of star formation and how photoevaporation controls the final mass of stars. Looking into the Eagle Nebula provides a more detailed image into how stars are born into these stellar nurseries throughout the universe.

The Eagle nebula also known as M16 is located 7,000 light years away in the Southeast corner of the constellation Serpens. It is a giant star forming region of the galaxy which is half a degree wide. The stellar nursery is named for its resemblance of an eagle with outstretched wings and is also often referred to as the Star Queen Nebula, the cradle of the universe, a stellar incubator, and the Eagle’s Nest Nebula. The Eagle Nebula has been a focus of study for many astronomers since its first observation in 1745. It is most known for its famous Hubble Space Telescope (HST) image titled “The Pillars of Creation”, and for its unique production of young stars. Astronomers pay particular interest to the composition and life sequence of the numerous stars born within the Eagle Nebula.

The star cluster was discovered in 1746 by P.L. de Cheseaux but he failed to recognize some of the surrounding aspects which were later accredited to Charles Messier who is best known for categorizing these star clusters and later providing them with their preceding “M”
name. Most of the emission from this region comes from red ionized light from electrically charged hydrogen gases; and, it is a very bright object of focus in our night sky due to the luminous blue, young stars which compose this region as well. Most of the stars in this region are only about two million years old which is fairly young in astronomical terms. However, most of these stars only live a few million years in total. It is estimated that several new stars are formed each year within our own galaxy (National Optical Astronomy).

The Eagle nebula is centered on a star cluster of 60 stars of 8\textsuperscript{th} magnitude which is just visible to the naked eye. The star cluster can be easily seen on a dark, moonless night. However, what astronomers focus on is the glow from the gas which is produced by these stars (Eicher, 2013). A bright region of hydrogen and a dark molecular cloud is separated by the central aspect of the nebula which has helped astronomers study the process of photoevaporation. Photoevaporation is the process in which ultraviolet radiation from newly formed stars erodes the surrounding molecular cloud. When the photons interact with hydrogen or other light gases, it strips the lighter gases and leaves behind gas globules or EGG’s larger than our own solar system. On April 1, 1995, the Hubble Space Telescope transmitted detailed images of the nebula exhibiting star birth near the trunks of gases and dust in the HII region. Traditionally, stars are formed by clouds of gases and dust collapsing to form a protostar. As the star is forming, surrounding material falls onto it and increases in mass until it is halted by a stellar wind. Then, after fusion occurs, the star then shreds the excess material causing it to have the ability to be viewed at visible wavelengths. However, M16 seems to defy this process.
Because the molecular clouds are being eroded in this area, the stars are completing the star formation process prematurely. Nonetheless, some of these stars are massive enough to sustain fusion. These discoveries have shed new light on the characteristics of stars with masses smaller than 8% of the sun and caused astronomers to consider whether this could also be how brown dwarfs are formed and sustained (Parker, 1996).

The eagle nebula may be most noted for its tall clouds of gas and dust where stars are being formed. They are often compared to towers, fingers, and elephant trucks and are the size of our entire solar system. These towers are about 9.5 light years, or 90 kilometers, high and are constantly being eroded away by massive, hot, young stars through photoevaporation (The Eagle, 2013). These pillars within the Eagle Nebula are the focus of star production for astronomers. They are being examined at different wavelengths to determine how stars are being formed and what this tells us about star formation throughout the solar system.

The Eagle Nebula is classified as an emission nebula consisting of predominantly ionized hydrogen which classifies it as an HII region. The O and B classification stars at the center of the nebula emit the ultraviolet radiation which causes the hydrogen to be illuminated (M,16 The Eagle Nebula). An HII region is an ionized atomic hydrogen region which consists primarily of gas ionized by photons above the energy level of 13.6eV. They usually consist of hot O and B stars, and star clusters and are acknowledged by their massive star formation. HII regions can be observed at radio wavelengths where a multitude of emission lines can be detected. There are
three central processes which take place in these HII regions including photonization of equilibrium, thermal balance, and hydrodynamics (Ionized Hydrogen).

One of the most famous astronomical images of the 20th century was taken by the Hubble Space Telescope of the Eagle Nebula. It was titled “The Pillars of Creation” taken in visible light which clearly outlines the tall pillars in which new stars are forming. A later image was taken using near infrared imaging to examine the inside of the towers of clouds and dust to look at how the cocooned stars are forming.

The image released of the Pillars of Creation restored the tarnished reputation of the Hubble Telescope’s once blurry image. It was represented on magazines around the world and was even displayed on the Jay Leno show. It is now one of the most famous and notable astronomical images and one of the most fascinating areas of scientific study for astronomers (Cowen, 2002).

The UV light that surrounds the pillars hinders and influences star growth. The UV radiation erodes material while compressing gas and dust into collapsing stars. Astronomers Paul Scowen and J. Jeff Hester from Arizona State University are two astronomers who are known for their research into the Eagle Nebula. These astronomers took special interest in the protrusions near the tips of the pillars which have been called “evaporating gas globules” or EGG’s. They furthered their research into how the UV radiation stripping material from the newborn stars limits the size and number of stars across the galaxy. Hester used the Hubble Space Telescope images to hypothesize that currently thousands of stars are forming in the 73 known EGGs.
NASA then released a press statement officially dubbing the star region the “pillars of creation”. Recently, the images have been reanalyzed in infrared light waves rather than only visible light in order to overcome the difficulty of seeing past the dust which surrounds the column. This further research brought about new discoveries which proved that only 15 percent of the EGGs contain newborn stars, the rest did not contain enough gas and dust to create new stars. The star formation in this area is still under speculation by astronomers worldwide. Morton Anderson and McCaugh are astronomers who are focusing their studies towards the pillars of creation and the eagle nebula by using the Very Large Telescope in Chile and another group of Japanese astronomers using the University of Hawaii’s telescope are also noted for their research into the Eagle Nebula. Hester maintained that his original theory that the UV light limited the ultimate mass of stars forming in the Eagle Nebula held true, and that few of the EGGs studied contained stars. After three teams viewed the infrared images, Hester stated that the pillars contain an amount of gas equivalent to one thousandth of the sun’s mass which converts into stars each year. He went on to say that although he did not find as many stars in the EGGs as originally thought, “it is still a remarkably high star-formation rate.” He believes that we are currently seeing a brief period of extremely high star formation. Once astronomers are able to take sharper images at longer wavelengths, they may be able to learn more about star formation in this region (Cowen, 2002).

Another important image of astronomers’ attention is that of the region M16 which is a region of the Eagle Nebula which shows about 50 stars newly formed from the EGGs. Hester compares the formation of the star globule to an ice cream cone calling the new star the “cherry on top” and explains that the new images from HST are providing astronomers the ability to see star formation in the process and how this process controls the size and growth of stars. Hester
also explained that the Hubble pictures were the first images of such clear star formation through the process of photoevaporation. Hester states that the gases which are eroding away the stars are also feeding the stars’ growth and will continue to remain until the globules are completely uncovered and separated from the gas which they were drawing mass leaving the star on its own (Wilford, 1995).

The Eagle Nebula is an extremely important stellar region for astronomers to study. By looking into the stunning pillars of creation and the process of photoevaporation of the evaporating gas globules, astronomers can learn so much about star formation. Currently astronomers are attempting to learn about the stages through which stars form in this type of stellar nursery and how photoevaporation plays a process in determining the final mass of each newly formed star. As technology continues to develop and we are able to get a deeper, more detailed look into the Eagle Nebula, we can finally understand the early life stages of stars.
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Ancient Incan Astronomy
There have been many ancient civilizations and empires throughout history like the Greeks, Egyptians, and Chinese. These Empires ruled vast areas of land and countless amounts of people. All of these civilizations also had many contributions to science and discovery, including discoveries in astronomy. Another one of these amazing civilizations is the ancient Incan Empire. The Incas were an ancient people who lived in South America, arising during the 13th century. Soon after, their unique culture began to spread and within 400 years they controlled a larger amount of land than any other South American group had ever controlled. At its largest, over one million Incas lived in an area along the western coastline of South America (from Ecuador in the north to Chile in the south an area of over 375,000 square miles).

The Inca culture spread quickly by conquering other empires. They protected anyone who defended their Incan culture, and did the opposite to intruders. The overall leader of the Inca was called, oddly enough, the Inca and was considered to be a divine descendant of the sun god which is the most important god in their religion. The Inca had a polytheistic religion. The Inca leader had absolute power, and immediately below him in the social chain was his royal family. The royal family was made up of the Inca's siblings, parents, wife, and children. This strict hierarchy strongly discouraged an individualistic society and created a highly centralized society. Because of this centralized culture, they were very good scientists and made many discoveries and observations with a very unique perspective of what astronomy is and how to observe our night sky.

Astronomy played a key role in Ancient Incan Culture because they were a very agricultural group and they combined the two. In some places oriented pillars were carefully built on hills overlooking Cuzco, and when the Sun rose or set between the Pillars, it was time to plant at a specific altitude. They used many pillars so the timing would be very accurate from the high to low altitudes. It
was basically predicting the seasons by watching the sun cycle. The people would regularly make
sacrifices to their “Sun God” asking him to rise in the proper place so they could go ahead and plant
their crops.

Telescopes did not exist during the time of the Inca the way they exist today. The knowledge
they obtained was gathered from centuries of looking at the sky and keeping extremely close records of
what they saw. They only trusted the wisest and most holy people to record these observations which
usually gave them some considerable power. They recorded movements like the sun and moon cycle
over a year on knotted strings called quipus. By keeping track of the days between things like solstices
and equinoxes, the Inca could predict them in the future. Events like the winter solstice were actually a
very uncertain time for the Inca because the sun was in the sky for a diminishing amount of time each
day. There was always the worry of “Would or could the sun disappear for good?” This would obviously
be devastating because the Incan people were very sun-centered religiously. They built stone towers in
the capitol city of Cuzco at places along the horizon where the sun would rise and set when the solstice
and equinox would happen. This way they could compare from year to year.

Just like the Big Dipper or Orion, the Inca had similar constellation formations. The Inca were a
very nature centered and animalistic culture. They believed in an underworld, a present state (on earth)
and the cosmos (stars, sun, moon), and you went through all three stages throughout your life. There
are animalistic ideas and images in all three areas as well. The Milky Way was known as “Mayu” which
means “river.” Mayu flowed in the sky like a river and at the horizon met the Urubamba River and
continued to flow. They would see many other images in the night sky and make up stories for why they
were there and how they ended up there. For example, there was a star called the jaguar star and it represented the warrior god so when hunters were in the jungle, they would pray to that star.

As you can tell the Incan, although not long lived, was a very powerful and unique culture with some very interested perspectives in when it comes to astronomy and cosmology. Using ancient strategies the Inca were able to predict solstices and equinoxes in order to know when to plant their crops. They also had a very illustrated view of the night sky with constellations of animals and other objects. Overall they gave us a lot in terms of astronomical discoveries and observations. They also share some of our view points as astronomers, but definitely had other ideas involving the center of the universe and how life circulates. So even though the Inca only survived as a group for a little over a century, they accomplished more than most cultures do in thousands.
Bibliography


The Deep Black Hole

Steven Casey

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Astronomy 112

Professor Weitz
One of strangest creations in space is a black hole. Visualize an area in space that is created of nothing but “space and time”(Canright). Envision a place where there is only a way in and no away out. Imagine a thing in space that will destroy anything in its path. In this paper I am going to talk about how black holes are formed and the different types of black holes. Also, this paper will be about Gamma-ray bursts as well as jets that explode out of black holes. Next, I will inform you about the different sizes of black holes. Lastly, this paper will be about black holes slowing down star formation and the Schwarzschild radius.

There are three theories on the creation of black holes. The first theory on how black holes are formed is “if a star has more than nine solar masses when it goes supernova, then it will collapse into a black hole”(McDonald). This shows that a neutron star stops collapsing because of the strong nuclear force. This is a force that stops the center of the atom from collapsing. “However, once a star is this big, the gravitational force is so strong that it overwhelms the strong nuclear and collapses the atom completely”(McDonald). Now there is nothing left of the star besides infinite density. Also, another way that black holes form is “two neutron stars will be locked in binary relationship”(McDonald). Then the energy lost in gravitational radiation helping the neutrons spiral towards each other. After they merge the neutrons will most likely form a black hole. Steven Hawkins created the third theory and he said, “trillions of black holes were produced in the big bang theory”(McDonald).

There is a new study that came out using data from “NASA’s swift satellite and Fermi Gamma-ray shows that high speed jets launched from active black holes”(Reddy). "What we're seeing is that once any black hole produces a jet, the same fixed fraction of
energy generates the gamma-ray light we observe with Fermi and Swift”(Reddy). The process before the high speed jet launch is “gas is falling toward a black hole spirals inward and piles up into an accretion disk, where it becomes compressed and heated”(Reddy). Then in the inner part of the disc “is the point of no return material becomes accelerated and races outward as a pair of jets flowing in opposite directions along the black holes spin axis”(Reddy). When these jets interact they “contain particles moving at the same speed”(Reddy). Also, when these jets interact they give off the most extreme form of light called gamma rays. Although, “we don't fully understand how this acceleration process occurs, but in active galaxies we see jets that have operated so long that they've produced trails of gas extending millions of light-years”(Reddy). Following this further, there are also Gamma-ray bursts “the most powerful explosion in the universe”(Reddy). “Astronomers believe that the most common type of Gamma-ray bursts heralds the death of a massive star and the birth of a stellar-mass black hole”(Reddy). Gamma-ray bursts are extremely fast because some jets have been clocked at “99.9% the speed of light”(Reddy). “When the jet breaches the star's surface, it produces a pulse of gamma rays typically lasting a few seconds”(Reddy). Lastly, the high-speed jets that are blasted from black holes have many similarities in spite of their different masses and age.

Black holes come in different sizes and astronomers measure the size of the black hole by the Schwarzschild radius. “The Schwarzschild showed that any mass could become a black hole if that mass were compressed into a sufficiently small sphere—a sphere with a radius R, which we now call the Schwarzschild radius”(Stein). The Schwarzschild radius can calculate anything from a galaxy, planet, or even an orange and
the mass has to be compressed. In addition, “The Schwarzschild radius for the Earth is
approximately one inch, meaning that you could squish the entire mass of the Earth into a
sphere the size of a basketball and still not have a black hole: light emitted from that mass
can still escape the intense gravitational pull”(Stein). Then to finally make a black hole
the object has to be squeezed into a ball the size of a Ping-Pong ball. Also,
Schwarzschild’s discovery is very significant because “it wasn’t until later in the
twentieth century that it was shown that any star with a mass larger than twenty times that
of the Sun would eventually collapse and become a black hole—a number much smaller
than Michell’s original calculation”(Stein). There is one surprising element to the
Schwarzschild equation and that is the larger the mass the lower the density of the black
hole. “That’s because the Schwarzschild radius increases in proportion to the amount of
mass—an object with twice as much mass as the Earth will have a Schwarzschild radius
that is twice as large as the Earth’s”(Stein). Lastly, “every time you double the mass in a
Schwarzschild radius black hole, thus doubling the radius, the density decreases by a
factor of 4”(Stein).

Black holes are complex and there are a couple different types. The first black
hole I am going to discuss is the Stellar black hole. The Stellar black hole is the most
common type of black hole. Stellar black holes form main sequence stars that are about
10 to 15 times the size of the sun. The reason main sequence stars evolve into a black
hole is because they “run out of nuclear fuel in their cores”(Millis). Then there is a
supernova explosion. “Supernovae are the most dynamic and energetic events in our
universe”(Millis). The supernova explosion is so bright that it would put off more light
then an entire galaxy of a billion stars.
The next type of black hole formation is the super massive black hole. “Super massive black holes measure in the hundreds of thousands of solar masses -- one solar mass equals the mass of the Sun -- up to billions of solar masses, these objects possess immense power”(Millis). Super massive black holes are found at the center of galaxies and they help hold galaxies together. For example, “their gravity is so immense, because of their incredible mass, that even stars hundreds of thousands of light years away are bound in their orbits”(Millis). Also, one thing that is unique about black holes is their density. “This is because the density at the core of normal black holes becomes infinite”(Millis). The black hole contains a lot of mass with no volume. Lastly, despite their size astrophysicists still do not know how they are formed.

Scientists have discovered a new type of black hole that is bigger than they previously predicted. NASA research shows that there are black holes the size of “10 to 40 billion Suns”(Space). “Scientists refer to them as ‘ultramassive’ black holes, not to confuse them with ‘supermassive’ holes”(Space). Also, there are only a few examples of ultramassive black holes because they are in far galaxies about 1.3 billion light years away. These ultramassive black holes are more familiar than astronomers reasoned.

A survey, conducted by author Julie Hlavacek-Larrondo of Stanford University and her team, showed that at least ten out of 18 galaxies they studied had black holes that may weigh up to 40 billion times the mass of the Sun(Space).

In addition, ultramassive black holes are most likely not as rare as astronomers thought said, Julie Hlavacek-Larrondo of Stanford University. Also, “to estimate the size of these ultramassive holes, Hlavacek-Larrondo and her colleagues analyzed the X-rays and radio waves generated by black holes when they destroy the gas, dust, and stars near them”(Space). After examining the X-rays and radio waves Larrondo found that the black
holes were “roughly 10 times larger than expected”(Space). This shows that, astronomers do not know how black holes relate to their galaxies. Lastly, “It looks like the behavior of these huge black holes has to differ from that of their less massive cousins in an important way”(Space).

There was a study done at NASA’s Jet Propulsion laboratory in Pasadena, California on “nearby galaxies suggest active black holes can squash star formation”(Clavin). “The study was to understand how active galactic nuclei affect star formation over the history of the universe, we investigated a time when star formation was most vigorous, between 8 and 12 billion years ago”(Clavin). In NASA’s laboratory study they found galaxies were forming stars 10 times faster 12 billion years ago. Also, “NASA’s laboratory found that many of the galaxies were incredibly luminous, more then 1,000 times brighter than our Milky Way galaxy”(Clavin). Lastly, this shows that, “active black holes at their cores produce fewer stars than galaxies with less active black holes”(Clavin).

There was a rare explosion in space that created our galaxy’s youngest black hole. The black hole is called W49B, it is 26,000 light years away and it is located in our Milky Way galaxy. “Then the supernova explosions that destroy massive stars are generally symmetrical with the stellar material blasting away more or less evenly in all directions”(Lopez). Although, the supernovas material in the outer edges was ejected much faster then the material in the middle. “Then by tracing the distribution and amounts of different elements in the stellar debris field, researchers were able to compare W49B to the theoretical models of how a star explodes”(Lopez). “For example, they found iron in only half of the remnant while other elements such as sulfur and silicon
were spread throughout”(Lopez). Also, the astronomers checked to see what kind of
objects were left behind during the explosion. “Most of the time, massive stars that
collapse into supernovas leave a dense spinning core called a neutron star”(Lopez).
Usually, astronomers can find these neutron stars “through X-ray or radio
impulse”(Lopez). Lastly, “A careful search of the Chandra data revealed no evidence for
a neutron star, implying an even more exotic object might have formed in the explosion,
that is, a black hole”(Lopez).

There are hidden black holes in the universe that many people do not know about.
“A search using archival data from previous Chandra observations of a sample of 62
nearby galaxies has shown that 37 of the galaxies, including NGC 3627, contain X-ray
sources in their centers”(Grier). These x-ray sources are powered by supermassive black
holes. “The survey, which also used data from the Spitzer Infrared Nearby Galaxy
Survey, found that 7 of the 37 sources are new supermassive black hole
candidates”(Grier). This study shows that the number of galaxies that have black holes is
greater than researchers have predicted. “This shows the ability of X-ray observations to
find black holes in galaxies where relatively low-level black hole activity has either been
hidden by obscuring material or washed out by the bright optical light of the
galaxy”(Grier). Lastly, “these new results suggest that the mass of the supermassive black
hole and the rate at which the black hole accretes matter are both greater for galaxies with
greater total masses”(Grier).

After doing the research to create my paper, I have a better understanding of black
holes. I truly enjoyed learning about black holes because there were many things I did not
know. For example, I did not know there was more than one type of black hole. Also, I
did not know there were jets that shoot out the middle of the black hole. Lastly, the most important information I learned is you do not want to get near a black hole.
References


Effects of Electromagnetic Fields on the Human Body
Abstract

Electromagnetic fields are an inescapable part of modern society. The International Association of Research on Cancer (IARC) lists EM fields as “possibly carcinogenic,” though there exists little in the way of conclusive data to support this. On the other hand, EM fields have been used in medical science to diagnosis - in the cases of magnetic resonance imaging (MRI) - as well as to heal - such as when dealing with chronic ununited fractures. The study of how EM fields interact with the human body can only become more intense as time progresses.

Interaction between human beings and electromagnetic fields is a modern inevitability. Every appliance, every new technological convenience, generates an electromagnetic (EM) field and while the strength of this field is, of course, variable, the exposure is more or less consistent. It seems impossible to weather even a single day without coming into contact with a cell phone, a computer, or something as innocuous as a power line. Given this, it is important to understand the way such fields affect biological processes - be it negative or positive impact.

Before examining the ways EM fields interact with the human body it would be prudent to first explain what, exactly, it is. Simply put, EM fields are “clouds” of both electrical and magnetic energy that surround an object that has both voltage and current flowing through it. The electrical component of the field is present regardless whether or not there is a current flowing through the conductor of the object; the magnetic component is proportional to the current [1]. EM fields also emit two types of radiation: non-ionizing (low to mid range in frequency and generated by common appliances such as microwaves, computers, cell phones, and so on) and ionizing (mid to high range frequency and produced by such things as ultraviolet light, some x-rays, and gamma rays) [2]. The values of some of the most commonly encountered sources of non-ionizing emissions are listed in Figure A, below [8]. Due to the presence of EM fields - and consequently EM radiation - in daily life their relevance to various diseases has been extensively researched, to various effect; however, the results of such epidemiological studies have motivated the government to set limits on the allowed field radiation created by power sources and similar limitations placed on the specific absorption rate (SAR) and current density have also been proposed [3]. While there are those who would question the virtue and authenticity of such studies, the “As Low As Reasonably Achievable” (ALARA) rule, as well as general caution, tend to take priority over skepticism [3].

In order to properly address the issue of EM fields and biological reaction to these fields, it is necessary to first understand the mechanism by which they interact. The EM field must move through the human body in order to enact any change upon it, it achieves this movement by using “narrow fluid ‘gutters’” that exist between cells - the same route taken by such things as hormones and antibodies - due to the low electrical impedance they exhibit (in contrast to cell membranes) [4]. It is estimated that this intercellular space carries ninety-percent of the EM fields a body experiences, be they part of an outside current or the intrinsic current naturally produced by the human body [4]. To get into these intercellular spaces the EM field must penetrate the varying kinds of tissues - the permeability and conductivity of tissue varies
depending on the type of tissue and affects the overall distribution of the field within the body (a chart of these values can be seen in Figure 1, on the following page) [5].

### Magnetic Fields from Household Appliances

<table>
<thead>
<tr>
<th>Appliance</th>
<th>Distance of 12 Inches</th>
<th>Distance of 24 Inches</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hair Dryer</td>
<td>Bg – 70</td>
<td>Bg – 10</td>
</tr>
<tr>
<td>Window A/C</td>
<td>Bg – 20</td>
<td>Bg – 6</td>
</tr>
<tr>
<td>Color TV</td>
<td>Bg - 20</td>
<td>Bg - 8</td>
</tr>
<tr>
<td>Dishwasher</td>
<td>6 – 30</td>
<td>2 – 7</td>
</tr>
<tr>
<td>Refrigerator</td>
<td>Bg – 20</td>
<td>Bg -10</td>
</tr>
<tr>
<td>Can Opener</td>
<td>40 – 300</td>
<td>3 – 30</td>
</tr>
<tr>
<td>Microwave Oven</td>
<td>1 – 200</td>
<td>1 - 30</td>
</tr>
<tr>
<td>Washing Machine</td>
<td>1 – 30</td>
<td>Bg - 6</td>
</tr>
<tr>
<td>Power Drill</td>
<td>20 - 40</td>
<td>3 – 6</td>
</tr>
<tr>
<td>Computer Monitor</td>
<td>2 – 6</td>
<td>1 - 3</td>
</tr>
</tbody>
</table>

Measurements in milligauss; Source EMFRAPID Program June 2002
Bg = Measurement indistinguishable from background levels

**Figure A**

To interact *directly* with living matter, then, EM fields utilize three basic methods of coupling - that to low frequency electric fields, to low frequency magnetic fields, and absorption of energy from EM fields [7]. To measure the way in which EM fields and biological tissues interact the Specific Absorption Rate (SAR) distribution must be measured - the equation of which yields a measure of the energy absorbed that may manifest as heat, as well as providing a numerical figure for the internal EM fields that may result in non-thermal interactions [5]. The equation for finding the SAR value (in units of W/kg) is as follows:

$$\text{SAR} = \frac{(\sigma |E|^2)}{\rho}$$

With $\sigma$ representing the conductivity of the tissue (the values of which can be found in Figure 1) in units of S/m, $E$ representing the root-mean-square electric field magnitude in units of V/m, $\rho$ is the tissue mass density in units of kg/m$^3$ [5]. SAR values, however, are known to vary even within a single organ - whether due to sample freshness, post-mortem metabolic changes, or so on - and it is important to take multiple samples from each organ being examined [5]. The EM power, once inside the body, will dissipate - this can value can be found by:

$$P = rJ^2 \text{ (W/m}^3)$$

where $J$ represents the current density and $r$ is the material resistivity [6]. Power absorption can also be expressed using rms values of $E$ and:

$$P = \sigma E^2 \text{ (W/m}^3) \text{ [6].}$$

This interaction between the low-frequency magnetic fields and the human body creates an induced electric field as well as a circulating electrical current - the magnitude of this induced field, as well as the current density, as directly proportional to the conductivity of the tissue, the radius of the loop being travelled, and the magnitude and rate of change of the magnetic flux density [7].
The potential negative effects of exposure to EM fields has been of considerable interest ever since the first suggestion of carcinogenic properties was suggested. It has been noted during in vitro studies that there exists the potential for sensitivities to EM exposure that involve cerebral Ca$^{2+}$, as well as a wide variety of other such calcium-dependent mechanisms, some of which involve bone-growth, intercellular communications regulating cell growth, and so on; such sensitivities have also been recorded in other cell types, such as ovary cells, bones cells, and nerve cells [4]. However, the membrane potential of the majority of cells is about 0.1V during rest; that this exists across the whole of the plasma membrane ends up creating a kind of “electric barrier of 105 V/cm” - much greater in magnitude than either any studied induced or intrinsic current in the intercellular space [4]. It should be noted that the parameters for these observations are “viewed cautiously by biologists” for being supposed to exist outside the boundary of possibility [4].

Exposure to EM fields may also result in thermal reactions. When exposed to a 915 MHz dipole antenna with a power output of 0.25 W - making it comparable to a standard Global System for Mobile Telecommunication (GSM) cellular phone - it was found that the thermal distribution within a human head netted a SAR of approximately 1.6 W/kg, a temperature increase of 0.11°C [6]. Another study following parameters of a 0.25 W antenna operating at frequencies of 900 and 1800 MHz found that the brain’s temperature rose, at its peak, 0.1°C [6]. Both of these results were found to create only a negligible, non-effective temperature rise.

![Graph showing variation of electromagnetic properties](image.png)

**Fig. 1.** Variation with the frequency of the electromagnetic properties values of three representative tissues: blood, fat and muscle.
On top of these findings, there exists quite a bit of skepticism with regards to the negative effects expected of EM field exposure. One critique of the studies that link EM fields to the development of cancer and childhood leukemia is that all data gathered fails to follow the “existence of a biological gradient or dose response relationship” - that is, in the case of EM fields, “less” is somehow worse than “more” [9]. The claim that EM fields - particularly EL fields, those produced by common objects such as cellular phones or computers - can cause cancer fails to meet these simple criteria. That is, there is simply no known chemical or other potentially dangerous substance that fails to do more intensive damage at higher doses. The implication, then, is that those who claim to suffer from cancers or leukemias induced by exposure to EM fields are suffering a kind of folie à plusieurs, a mass delusion, an illness brought on not by actual causes, but by the pathological expectation of the thing [10].

Contrary to the purported negative effects of exposure to EM fields, there are a number of measurable beneficial applications of exposure. In particular, pulse electromagnetic fields (PEMF) are especially useful in medicine. Exposure to a radiofrequency (RF) electromagnetic field, for instance, is used to induce hyperthermia in order to treat localized cancerous tumours - hyperthermia is induced by having multiple sources of the RF in specific phases and amplitude [3]. EM fields are also used to diagnosis various medical disorders via magnetic resonance imaging (MRI) [3]. Using specialized therapeutic units, it is possible to beneficially alter some pathological processes, while leaving “normal” processes unaffected [11]. These units function by running a current through the treatment coils, creating a magnetic field that enters the body, cast, or non-metallic brace and induces a voltage and current inside the tissue [11]. A list of conditions beneficially affected by PEMFs are listed in Table I [11].

<table>
<thead>
<tr>
<th>Condition</th>
<th>FDA approved</th>
<th>Controlled study</th>
<th>Treatment time</th>
<th>Success rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fracture nonunion</td>
<td>Yes</td>
<td>Prospective and double blind</td>
<td>3-6 mos</td>
<td>75-95%</td>
</tr>
<tr>
<td>Failed joint fusions</td>
<td>Yes</td>
<td>Prospective</td>
<td>3-6 mos</td>
<td>85-90%</td>
</tr>
<tr>
<td>Spine fusions</td>
<td>Yes</td>
<td>Prospective and double blind</td>
<td>3-6 mos</td>
<td>90-93%</td>
</tr>
<tr>
<td>Congenital pseudoarthrosis</td>
<td>Yes</td>
<td>Prospective</td>
<td>6-12 mos</td>
<td>70-80%</td>
</tr>
<tr>
<td>Osteonecrosis (Hip)</td>
<td>No</td>
<td>Prospective</td>
<td>6-12 mos</td>
<td>80-100%</td>
</tr>
<tr>
<td>Osteochondritis dessicans</td>
<td>No</td>
<td>Prospective</td>
<td>3-9 mos</td>
<td>85-90%</td>
</tr>
<tr>
<td>Osteoporosis</td>
<td>No</td>
<td>Prospective</td>
<td>Life</td>
<td>85-90%</td>
</tr>
<tr>
<td>Osteogenesis imperfecta</td>
<td>No</td>
<td>Prospective</td>
<td>Life</td>
<td>-</td>
</tr>
<tr>
<td>Chronic tendinitis</td>
<td>No</td>
<td>Double blind</td>
<td>3-4 mos</td>
<td>85-90%</td>
</tr>
<tr>
<td>Chronic skin ulcers</td>
<td>No</td>
<td>Double blind</td>
<td>3 mos</td>
<td>85-90%</td>
</tr>
</tbody>
</table>

*Conditions currently unapproved by the FDA, in the United States, are being treated extensively elsewhere in the world with this technology. Results in osteogenesis imperfecta suggest a substantial reduction in fracture rate is possible in this rare pathological state and nonunions in these patients behave, during PEMF treatment, as they do in the general population.

Rate dependent upon anatomical site and effectiveness of ancillary immobilization.

Rate dependent upon severity classification.
Further research is being done in order to determine more uses for EM fields, as well as to determine any other potential effects of exposure. For instance, in vitro studies allow individuals to examine and evaluate specific tissue and cellular interactions with EM field exposure on local levels in a specially controlled environment (though this fails to mimic natural conditions, which are apart of a complete complex system) [6]. The benefit to these in vitro studies lies primarily in the fact that it allows individual components and factors of exposure to be examined without being complicated by the entire biological process, allowing potential models to be established and applied to the "natural" setting, then modified to fit the particular setting. Another potential application of EM fields in the medical field relates particularly to PEMFs and concerns "diabetic and alcoholic neuropathy" - that is damage done to the nerves of the peripheral nervous system as a result of diabetes or alcoholism related issues [11]. Experimental data shows that PEMFs effect the axoplasmic transport (the transport of mitochondria, lipids, and so forth), protein synthesis in neurons, as well as angiogenesis (the process through which new blood vessels are created via pre-existing vessels) [11]. More potential applications of, at least, PEMFs are described in detail, courtesy of C. Andrew and L. Bassett, in Table IV [11].

<table>
<thead>
<tr>
<th>Conditions</th>
<th>Supporting experimental data</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Acute myocardial ischemia (heart attack)</td>
<td>Animal data showing decrease in infarct size, (acute effects on blood flow and angiogenesis, effect on superoxide dismutase, nitrous oxide)</td>
</tr>
<tr>
<td>2. Acute cerebral ischemia (stroke)</td>
<td>Same as above.</td>
</tr>
<tr>
<td>3. Cancer</td>
<td>Animal data demonstrate decreased growth and invasiveness of Meth A sarcoma in BalbC mice, encapsulation, cell and nuclear changes.</td>
</tr>
<tr>
<td>4. Dental (periodontal disease, edentulous jaw and extraction sockets)</td>
<td>Animal data show decrease in bone resorption in jaws, increased osteogenesis in tooth extraction sockets and an improved bacterial flora spectrum.</td>
</tr>
<tr>
<td>5. Diabetes (adult onset)</td>
<td>Clinical benefits on blood glucose reported, secondary to Ca++ effects on insulin secretion.</td>
</tr>
<tr>
<td>6. Diabetic and alcoholic neuropathy (insensate skin, ulcers, and charcot joints)</td>
<td>Effects on axoplasmic transport, neuronal protein synthesis, Ca++ neurotransmitter effects at synapse, and angiogenesis.</td>
</tr>
<tr>
<td>7. Ligament tendon healing</td>
<td>Animal data showing improved healing, increased collagen and GAG synthesis, increased angiogenesis.</td>
</tr>
<tr>
<td>8. Peripheral nerve transection and crush</td>
<td>Animal data showing increased protein synthesis, axon migration and function.</td>
</tr>
<tr>
<td>9. Spinal cord injury</td>
<td>No direct evidence but data bearing on neuropathy and nerve transection may prove beneficial, particularly in crush injuries when sensory and motor evoked potentials are still present.</td>
</tr>
</tbody>
</table>

It should be said that electromagnetic fields exhibit a wide array of effects on the human body - be they primarily negligible or largely beneficial. Before expanding on the actual data, I must admit to the fact that the more of it is rather dated - more modern studies were locked...
beyond viewing the abstract, unless one were to pay for the paper itself. However, reviewing the data I was able to collect, I feel confident in saying that the medical applications for EM field exposure will only grow as we become capable of controlling individual factors even in complex systems such as those found inside the body. Reviewing the data collected by Andrew and Bassett - and this particular paper was authored in 1992, published 1993 - it is safe to say that at least some of these potential uses of PEMFs in the medical field came to fruition. I admit, too, to being primarily interested in the biological aspects of the topic despite being tasked with focusing on the physics; I am, after all, majoring in the biological sciences and I have a marked preference for phenomena that I can get my teeth into. Given the chance, I would take working the tumor over managing the carcinogen. That being said, I did find the sheer variety of application impressive - it was simply not something I had thought much of before - and my knowledge of the potential ill effects began and ended with blasé pop culture digs at cellular phones causing brain tumors. I am pleased to say, then, that over the course of this paper I have better familiarized myself with, at the very least, the skeleton of the topics related to electromagnetic fields and their interactions with organisms.
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What You Didn’t Know About Type 2 Diabetes and Meglitinides

Oshea Chaudhary

CHM152
Dr. Massey
April 17, 2013
Abstract

Diabetes mellitus, also known simply as diabetes, is a chronic form of diabetes that can alter one’s lifestyle forever. Diabetes, in short, is when a person has high blood sugar either because the pancreas cannot produce enough insulin or the body cannot react correctly with the sugar. It is important to correct and control the blood sugar so that it does not lead to further health problems. This paper addresses what diabetes is, what causes it, what factors contribute to diabetes, and how it affects diabetics. The details of a type of medication known as Meglitinides that can help control blood sugar are also discussed.

Introduction

History of diabetes

The term “diabetes” itself was coined by Greek physician, Aretaeus, during the 1st Century B.C. meaning “to siphon”. The reason behind this word choice was because one of the symptoms found in patients was that they had an increase in releasing urine. The true term for diabetes though is “diabetes mellitus” meaning “honey-sweet” because often the patients’ urine was of sweet. Most people recognize diabetes mellitus as the disorder in which the pancreas does not produce or respond correctly with the sufficient amount of insulin.

It was only until the 17th Century when London physician, Dr. Thomas Willis, did further tests by sampling the patients’ urine to determine whether the patients had diabetes or not. This method of blood sugar monitoring was used quite commonly up until the 20th Century.

Following in 1921, two Canadians, Frederick Banting and his assistant, Charles Best, were able to concoct an extract, now known as insulin. During the 1960s, Dorothy Frank, developed unique urine strips so that diabetics could test their blood sugars to determine if there was sufficient amounts of sugar present, not enough or none at all. Then, in the late 1970s, the insulin pump was fashioned, which was intended to impersonate the body’s regular discharge of insulin. These same pumps are used today, but have been reformed. The insulin pumps have been designed to be compact and have the ability to be placed in small carrying areas such as one’s pocket or attached to the loop area of a belt. With today’s technology, there are several more methods to maintain a healthy lifestyle of a diabetic.
Defining terms

There are two main types of diabetes known as type-1 DM and type-2 DM. Other types of diabetes include gestational diabetes, pre-diabetes or chemical diabetes, diabetes insipidus, steroid induced diabetes, type-3 diabetes, double diabetes, and brittle diabetes².

The main difference between type-1 diabetes and type-2 diabetes is that people with type-1 diabetes do not have enough insulin in their bodies and type-2 diabetics have either a less amount of insulin or the body cannot react correctly to the insulin³. Formerly known as the juvenile-onset or insulin dependent diabetes, type-1 diabetes accounts for approximately 5-10 percent of diabetics. Typically, type-1 diabetes requires insulin shots because the body’s immune system rescinds the cells that will release the insulin, ultimately eradicating any insulin production from the body. Insulin is required in the body because it aids cells in breaking down food to produce energy. Type-2 diabetes, on the other hand, is formerly known as the adult-onset or non-insulin dependent diabetes because it typically occurred in those who are 40 years and older. However, it is not uncommon to see those younger than 40 with type-2 diabetes. Approximately 90-95 percent of those who have been diagnosed with diabetes are considered type-2 diabetics. Type-2 diabetes is caused when the pancreas cannot breakdown the sugars, so it cannot respond properly to the insulin³. Insulin is a protein hormone that is concealed in the pancreas that aids in regulating the concentration of glucose in the bloodstream.

Signs and Symptoms

One of the main causes in today’s society for diabetes is being overweight. Other causes that can increase one’s chances in having diabetes are alcohol and high amounts of stress. A few of the symptoms that type-2 diabetics will experience include:

- Excessively urinating
- Blurry vision
- Unexplained fatigue
- Irritability
- Being very thirsty
- Having a numbing feeling in the hands or feet
- Wounds or hurts that take an extreme amount of time to heal⁴

If not treated or controlled in time, diabetes can lead to heart disease, stroke and foot/leg amputation. Diabetes is also the highest source of blindness and kidney failure³. It must be stressed that there has not been any cure found for diabetes. There are only medications and a healthy lifestyle to control it.
**Type 2 Diabetes**

What many people may not know is that out of the two most common types of diabetes, type-2 diabetes is the most common\(^5\). It is also known as “adult-onset” or “non-insulin-dependent” because typically those who have type-2 diabetes are adults and it does not require insulin injections to control the blood sugar levels\(^4\). Type-2 diabetes also occurs when there is a considerable amount of sugar in the bloodstream (also known as hyperglycemia) or when the body’s cells resists the insulin, therefore, not enough insulin is produced\(^2\).

Type-2 diabetes can be avoided by being active and eating healthy foods. It can be regulated through exercising, changing one’s diet, conducting regular blood sugar tests, and taking the appropriate medicine to keep the blood sugar controlled\(^6\).

The two leading ways people with type-2 diabetes check their blood sugar is by the A1C test or by using a finger stick. The Hemoglobin A1C is a specific blood test that is taken at a doctor’s lab or office two to three times a year to measure the usefulness of the drugs that the diabetic is taking to prevent high blood glucose levels. The finger stick, on the other hand, can be done at home and by the diabetic himself. The finger stick test will measure the blood sugar at that moment in time, giving the person with diabetes a chance to adjust their food schedule to maintain his or her sugar level\(^6\).

**Studies show...**

There have been several studies performed to identify causes or links to diabetes. For example, one of the recent studies shows that diet soda and soda may increase one’s chances of getting Type-2 diabetes by 33 percent\(^8\). This ultimately makes sense when one relates the amounts of sugar in the sweet drinks to how diabetes is caused. The sugar drink is certainly linked to causing obesity, which is also one of the leading factors of diabetes. Also revealed in a 2011 study, is that eating almonds may help those with Type-2 diabetes control their blood sugar levels\(^9\). The most prevalent study shown has been of relating one’s age and ethnicity. Research has shown that type-2 diabetes occurs more commonly in aged (those who are over the age of 40) Latinos, African Americans, Asian Americans, Native Hawaiians, Native Americans and Pacific Islanders\(^5\).

**Types of Medications for Treatment**

1. **Biguanides**- Block the liver from making sugar  
   EXAMPLE: Metformin (brand name: Glucophage)\(^6\)
2. **Sulfonylureas** - Raise the amount of insulin in the body
   EXAMPLE: Glyburide (brand name: Diabeta, Glynase Prestab, Micronase)⁶

3. **Meglitinides** - Raise the amount of insulin in the body
   EXAMPLE: **Repaglinide** (Brand name: Prandin)⁶
   EXAMPLE: **Nateglinide** (Brand name: Starlix)⁶
4. **Thiazolidinediones (TZDs):** Help the body use insulin better  
   EXAMPLE: Pioglitazone- (brand name: Actos)\(^6\)

![Thiazolidinediones (TZDs) molecule](image1)

5. **Dipeptidyl Peptidase-4 (DPP-4) Inhibitors:** Raise the amount of insulin in the body after a meal  
   EXAMPLE: Sitagliptin- (brand name: Januvia)\(^6\)

![Dipeptidyl Peptidase-4 (DPP-4) Inhibitors molecule](image2)

**Meglitinides**

**How it is Administered**

People with type-2 diabetes often have to take oral medications in order to maintain a good level of blood sugar. Meglitinides are a type of medicine that diabetics may take in order to help control the blood sugar. The two generic names of medication under Meglitinides are Repaglinide and Nateglinide\(^6\).

**Repaglinide**

Specifically, Repaglinide is taken before meals throughout the day. It helps the body to break down sugars because it stimulates the release of insulin and aids in preventing high blood sugar levels. This type of medication is also known for reducing the A1C by 1 point. The goal is to have a lower A1C number because this indicates that there is a good control on the blood sugar in the body. It is imperative that no one except for those with type-2 diabetes take this medication\(^10\).

**Nateglinide**

Nateglinide is taken orally to help control type-2 diabetes. The main use of Nateglinide is to reduce the amount of sugars in the body by simulating the pancreas to release insulin. It can
be combined with others medications to aid in regulating blood sugar levels and can also be used for other uses unlike Repaglinide medication. Nateglinide is similar to Repaglinide in the aspect that it must be taken before any number of meals the diabetic has in a day\textsuperscript{11}.

### Mode of Action

In order to understand why it is important for the body to have enough insulin, it is necessary that the mode of action of Repaglinide is understood as well. Repaglinide is able to lower the body’s blood glucose level by stimulating the pancreas to secrete insulin. The medicine stimulates the release of insulin from the beta cells that are in the pancreas by inhibiting K\text{ATP} channels, therefore opening the calcium channels to release the insulin. It is important to remember that Repaglinide cannot function without the presence of fully functioning beta cells because the beta cells are what produce the insulin in the body. Insulin’s purpose in the body is to stimulate cells to absorb any excess amount of glucose from the blood\textsuperscript{12}.

Nateglinide’s use is to lower the blood sugar levels by stimulating insulin from the pancreas just as Repaglinide does. The medicine interrelates with the ATP potassium channel (K\text{ATP}) in the membrane of the beta cells in the pancreas\textsuperscript{14}. The depolarization of the beta cells opens the calcium channel which allows for the calcium to flow and the insulin is then

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Figure 3\textsuperscript{13}. Diagram of how the medicines react in the body
released\textsuperscript{14}. Because there is a release of insulin, there is a better chance for blood sugar levels to decrease and be relatively normal\textsuperscript{14}.

**Health Risks**

One of the main side effects that both the medications will cause is a change in blood glucose level. As a diabetic or a person who is familiar with a diabetic, it is imperative to recognize the indications of low and high blood sugar. If the medication causes low blood sugar or hypoglycemia, typically it is recommended to eat or drink something that contains sugar to bring up the blood sugar level. Hypoglycemia symptoms include\textsuperscript{11}:

- Shakiness or dizziness
- Sweating
- Nervousness or irritability
- Headache
- Sudden mood or behavior change
- Pale skin
- Hunger
- Clumsy or erratic movements

The symptoms are very similar to general diabetes warning signs. The medications can also cause hyperglycemia or high blood sugar levels. These symptoms are very similar to the hypoglycemia and general diabetes symptoms. Hyperglycemia should always, though, be controlled immediately, as well as hypoglycemia, because it can lead to severe problems and/or life-threatening conditions. Side effects of using Repaglinide and Nateglinide medications can include heart failure, stomach pain, muscle pain, chills, and breathing problems. It can also cause weight gain and changes in cholesterol and triglycerides, a type of fat in the blood that the body needs\textsuperscript{11}.

**Conclusion**

It is amazing to me that even though diabetes is very common today, it still does not have a cure. As I researched, I found there were multiple studies on diabetes on how to control it and how it could be caused, but none yet on how to stop it. If only the world was a perfect place. The only ways as of now is to maintain the blood sugar levels by exercising, eating a healthy diet and checking the blood glucose levels around meal times. As representative of those who have family and/or friends who also have to maintain sugar levels, I find that it is easier to help them by keeping a positive attitude and aiding in eating things in proportion and if possible, with less or no sugar.

Since researching, I have seen the numerous amounts of medicine offered for diabetics to help control blood glucose levels. I see a very promising future for diabetics in having a cure. It
is only a matter of time when a scientist or researcher comes across a cure, but until then the diabetic will have to continue to take the meds prescribed. Because there are various types of diabetes medicine, the diabetic really has to be careful and see which one works the best for him or her because each medicine works in a diverse way to control the blood sugar. Of course, doctors will always be there to assist in this significant decision-making situation. I have learned that diabetics do not have to do things much differently than non-diabetics, except for truly focusing on their own bodies and diets, which is why I believe that is possible to lead a healthy and normal lifestyle with diabetes.
References


Transformers

By
Johnathan Cheney

Physics 112

November 19, 2012

Dr. Casey Durandet
Transformers, what do you think of when you hear the word, transformers? Most people think of the best selling movie, “Transformers” starring Shia LaBeouf. However, there will not be any transforming cars in this. That is not what I am referring about when I say transformer. The device I am speaking of have many types of devices that all consist of many shapes and sizes that all do the same exact thing but as for a reference of these devices one comes to mind. This device happens to be a circular box that power lines connect to. You might have seen one of them on top of poles at the corner of some streets. This is actually where one type of transformer is found. A picture of this example of a transformer is shown below:

![Transformer Diagram](http://edisontechcenter.org/Transformers.html)

The first transformer was invented by three men named Ottó Bláthy, Miksa Déri, Károly Zipernowsky of the Austro-Hungarian Empire. They designed and used the transformer in both experimental and commercial systems but it was not completely up to par. Soon after, Lucien Gaulard, Sebstantain Ferranti, and William Stanley perfected the design of the transformer. By 1886 it was being produced and used. Their invention is still being used today, although the transformer now has a few minor upgrades because of how advanced our technology is today.
This transformer uses an alternating current system. To explain the alternating current, it goes through a coil, causing a voltage to go through a parallel coil. In which the result of both these things happening is something called EMF, also known as Electromagnetic field. An EMF is a power converter that transfers electrical energy from one circuit to another circuit which created something called inductively coupling. Inductively coupling is “coupling of two circuits by means of the mutual inductance provided by a transformer”. (M. Whelan) Also known as transformer coupling. Because of “inductively coupling” or “transformer coupling“, the electrical energy will travel from the primary circuit to a transformer. From here the voltage will severely increase which will allow it to travel long distances with little to no loss of actual electrical energy. Then it is transferred along power lines for long distances until it gets to another transformer that is meant to “step down” the voltage or reduce the voltage. Then it can transfer that energy in one of two ways. These two methods are either AC power or DC power. AC power as explained above was a current that goes through a coil causing a voltage to go through a parallel coil. DC power is circuit that is a direct current that has two wires through which the current in the circuit flows from a source of electricity through a load and back to the source.

AC and DC circuit caused a scientific war between Thomas Edison and Nikola Tesla on which was a better power source. Thomas Edison was supporting DC power
because DC was the power he had discovered first but it was not a controlled enough power. Edison than made an agreement with Telsa that if he could find a way to control it better he would give him fair share of credit. Although when Telsa found a way Edison declined in paying Telsa for helping him. Telsa resigned right after from Edison and started to fight for credit for this invention.

“DC power was mainly in use in the 1880’s and it was hard to transmit over a long distance because you need a high voltage on a skinny wire or a low voltage on a wide wire. High voltage on DC is very dangerous, and with low voltage the wire would have to be so thick that it would not be practical. Also with high voltage it could not step down the voltage so it could be used with home light bulbs. With AC power you also use high voltage to move the electricity down a long wire. AC becomes more practical because once you send the power to the destination; you can use a transformer to change the voltage down to a manageable level. The power is stepped down several times by the time it reaches your home. The power line coming into your home is at 240 volts, from your breaker box it is split into lines of 120 volts for most of your home sockets and 240 for appliance sockets. (The main home socket in Europe and other parts of the world is 240 volts)” (M. Whelan) upon reading this quote, AC power shows it is more efficient in general in your house possible.

Now, you might have not have know is that “there are transformers all over every house; they are inside the black plastic case which you plug into the wall to recharge your cell phone or other devices. These types are often called "wall worts". They can be very large, as in national utility systems, or it can be very small embedded inside electronics. It is an essential part of all electronics today.” Each of these is one of two basic types of transformers. These two types are either a “step up” transformer or a “step down” transformer.

AC power makes it possible to have other types of common yet unique transformers. For instance there are autotransformers, polyphase transformers, leakage transformers, resonant transformers, and audio transformers. Each of these transformers are different in some way besides the name. Autotransformers are similar to normal transformers in some ways like the winding and different in others. They are different due to the fact that, “On each end of the transformer core is an end terminal for the winding, but there is also a second winding that connects at a key intermediary point, forming a third terminal. The first and second terminals conduct the primary voltage, while the third terminal works alongside either the first or second terminal to provide a secondary form of voltage. The first and second terminals have many matching turns in the winding. Voltage is the same for each turn in the first and second terminal. An adaptable autotransformer is another option for this process. By uncovering part of the second winding and using a sliding brush as the second terminal, the number of turns can be varied, thus altering voltage.” (ThomasNet) We actually have dealt with autotransformers before in one of the labs that we had. We used one of these autotransformers in a lab to convert to 240 volts.
The picture on the right is that of a Polyphase Transformer. As you can see there is a noticeable size difference between the two. Polyphase Transformers are commonly associated with three phase electric power. It is a common method that is used with transmitting large amounts of high voltage power. Whereas leakage transformers currents are kept at a low voltage because it helps prevent overload. “Leakage transformers have a loose binding between the primary and secondary winding, which leads to a large increase in the amount of inductance leakage.” Resonant Transformers are a type of leakage transformer but they depend on the loose pairing between the primary and secondary winding and on external capacitors. They can transmit high voltages like the autotransformers. Finally the audio transformer, it was originally found in early telephone systems, which are still used today. They help isolate any interference and they send one signal through multiple electrical circuits. “Because these transformers can serve multiple functions, such as preventing interference, splitting a signal, or combining signals, they are found in numerous applications. Amplifiers, loudspeakers, and microphones all depend on audio transformers in order to properly perform.”

If you ever consider owning a standard transformer you will be expecting to pay around $62,524.00. Although on the bright side, their life expectancy is about 20-30 years. But then you may have to take into consideration of problems that may occur during those years such as Radiator and Cooler Replacement, Bushing Replacement, Leak Repair, Gauge Replacement and Calibration. Replacing these parts are not a cheap fix. There are companies out there that do specialize in the field of transformers.
In conclusion, Transformers are a big part of our lives. They have been around since the 1880’s and still are being used today, just more modified. They once were using a DC current until Telsa found a way to control the current, and made a more efficient way to use it which is where alternating current came about. This is what we used in our transformers today. There are a range of transformers used to power certain technologies we use in our everyday life varying from autotransformers to Polyphone transformers. Wherever electricity is, you can guarantee that some form of transformer was used to get you that electricity. Since electricity was industrialized there was need to distribute electricity to the population, and that’s where transformers come into play. I do not ever see getting rid of transformer but more technological modifications in the future.
Sources:


How we know the Earth is Round

Alexia J. Colman

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Professor Jenny Weitz
Abstract

This paper explores ten of the many reasons why humans know that the earth is round. The first scientific reason is based on the moon and how it orbits around the earth. The second scientific proof for the earth being round is how ships look when they are on the horizon. Another interesting idea that has proved the earth is round is how star constellations vary depending on location and time. Something that could easily test if the earth was round is the shadows that are created when sticks are placed in the ground. If the world was flat, two sticks in different locations would produce the same shadow. The existence of time zones was created because the earth is round and the time of the day needed to correlate with where the sun is located in the sky. These are only a few of the reasons that are described in this paper. I will go more into depth as each topic presents itself.
Growing up as a child, it is natural to learn about Columbus sailing the ocean blue and discovering The Americas. We all learned about how Magellan was able to sail west and go completely around the round. Although we were able to learn about earth being round from the historical stories, we never really learned the scientific reasons for why human now know the earth is round. In science, there are at least ten complete reasons for why the earth is round.

The first scientific reason is based on the moon and how it orbits around the earth. Zabludoff stated that Aristotle noticed that during lunar eclipses, which are when earth’s orbit places it directly between the Sun and the Moon creating a shadow in the process, the shadow on the Moon’s surface is round. If the earth was flat, the shadow on the moon during lunar eclipse would be a flat parallelogram shape rather than a partial spherical shape (Zabludoff). The Foucault pendulum is a simple device that proves that the earth rotates and is a spherical shape.

The second scientific proof for the earth being round is how ships look when they are on the horizon. If someone has been to the beach lately or anywhere near an ocean, they might have noticed something interesting. While watching the horizon, if there was a ship approaching a
person would be able to notice that the ship would not just simply appear on the ocean (Lightmand, A., & Sadler, P). The ship would emerge out of the waves and they would see the front of the ship first and then slowly see the entire ship. A smaller example of this phenomenon would be watching an ant climb around an orange. If an experimenter placed an ant on the side of the orange and then watched from the back side of the orange, they would see the ant crawl up towards the top of the orange. It would seem like it was approaching from within the orange. An experimenter would see the head of the ant first and then slowly the rest of the body.

Another interesting idea that has proved the earth is round is how star constellations vary depending on location and time. As Aristotle was travelling the world, he noted that there were stars that he saw in Egypt that he was not able to see in northerly regions of the earth. He also stated that the farther a person goes toward the equator, farther known constellations go towards the horizon and are replaced with different stars. This would not happen if the world was flat!

Something that could easily test if the earth was round is the shadows that are created when sticks are placed in the ground. If an experimenter places a stick diagonally in the ground, a shadow will be produced. As time passes throughout the day, the shadow will start to move around and create a circular pattern.

If the world was flat, two sticks in different locations would produce the same shadow. The earth is in fact round which gives humans several advantages. One of them is that someone can see farther if they are higher in elevation, than if they were lower in elevation. If someone were to stand on a flat plateau and use binoculars, they would be able to see a far as they could. If that same person were to climb to the highest they could, they would be able to see so much farther, than when they were on the flat plateau. Even if there were no buildings, trees, vehicles, and towers, that person would still be able to see a great amount farther than in a lower location.
Most people have been able to go on a plane ride, but have probably never thought about what is actually happening while they are in the plane. While travelling across the world, planes do not fall off any edges, which is what would happen if the earth was flat. Planes have the ability to circle the entire earth without stopping which proves that there are no edges to fall off of (Simanek). If someone were to look out of a window, in a trans-Atlantic flight, they would be able to see the curvature of the earth in the horizon.

![Image of curvature](image)

Why would earth be any different in shape than all the other planets in this solar system? The only thing that makes earth different from the other planets is the fact that scientists have yet to find life on those other planets (Simanek). However, there are so many other characteristics that keep earth in the same boat as the other planets such as the way all the planets orbit, the size, and the shape of the planets.

In 1610, Galileo observed the moons of Jupiter rotating around the planet (Gronwall). The example he compared it too was small planets rotating around a larger planet. Galileo’s observations were able to show that other planets such as Venus and Neptune were also in a spherical shape (Gronwall). If earth was flat, there would be no way to assume anything about earth or any other planet because no one would have anything to compare it to. A flat planet would change everything we know about the solar system including gravity, speed, and the movement of any object!
The existence of time zones was created because the earth is round and the time of the day needed to correlate with where the sun is located in the sky. When it is 12:00 pm in New York, it is 12:00 am in Beijing because they are on opposite sides of the earth and one side has the sun directly in the sky and on the other side it has no sun in the sky at all. When it is 12:00 pm in New York, it is 1:30am in Adelaide, Australia. This is because New York is approximately 330 degrees away from Australia. The earth rotates on its own axis which creates the different time zones (Simanek). On one side of the earth, the sun is shining, while on the other side it is dark and vice versa. If the earth was flat, a person would be able to stand in The United States and see that in Beijing there is light shining down from the sun.

Another reason why the earth is round is the study of gravity. Since a sphere has a consistent shape, no matter where someone was to stand on it, they would have exactly the same amount of sphere under them. An example would be if an ant were standing on a crystal ball. The only indication that the ant would be moving is that its feet are moving. On a flat plane, the center of the mass is in the center. The force of gravity would pull a person toward the middle of the plane. If someone were standing on one side of the plane for instance in the US, gravity would be pulling you in toward the center of earth near Europe, not towards the ground like in a spherical surface.
Finally, if all of the reasons stated above did not prove that the earth is round, technological advances would be able to. There are so many images that technology has been able to get that have been taken from outer space though satellites. Not only are there photos of the spherical earth, but humans have been fortunate enough to have travelled to outer space and see with the human eye that earth is indeed spherical rather than flat.
References


