19th Mancini Science Symposium

May 9th, 2013
Volume III
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
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Shooting Stars

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Professor Weitz
Abstract

Shooting stars are seen all over the world at different times of the day. Its debris quickly enters Earth’s atmosphere, causing the star to break into pieces from the colliding particles. The debris can reach Earth’s surface which allows astronomers to learn about this rock. Astronomers can predict when meteor showers are going to happen, how long they will occur, and how many will be scene. This happens sporadically throughout the year, which has allowed astronomers to name them from their constellation they originated in. Shooting stars can show off different colors which means they are made of different particles. Polluted air and daylight causes us to not see shooting stars. Also since most of the world is the ocean, we cannot always detect the stars because no one lives in the ocean. Astronomers do have satellites up in space that can detect these shooting stars and meteor showers. With that being said, it is best to predict when they will be occurring so they can protect their equipment.

The sky is enormous seen from the human eye. It is a very mysterious element to our world. At one point in our lives we’ve looked up at the dark night sky and have seen the smallest light flash by. We stop out of excitement and cannot help but to smile, as if it paralysis’ us. We wish that it would happen again so we could have a chance to see its beauty all over again, but we know that waiting for it, is like waiting for a thunderstorm in Phoenix, Arizona. You never know when you will see one again. One of the most thrilling things that we as a human can experience on Earth is witnessing at shooting star. It is always a pleasure to see a shooting star while gazing up at the night sky. The very first time you witness a shooting star; you will be in awe and will always remember that moment. It will catch your eye for a split second, but will still excite everyone around. Its pure beauty seems to impress everyone. Its beauty impresses us even in its short amount of time it is lived. The way it flies through the sky is impeccable, but yet
seems so simple to the human eye. Some even wish upon a shooting star, in hopes that their wish will come true.

Shooting stars have been seen for as long as anyone can remember, but in reality, it is not really a star. It is a streak of light flying in Earth’s atmosphere. It is hard to determine the first sighting of a shooting star because they have always occurred and occur so frequently. Shooting stars are little bits of dust and rock, which they call meteoroids, fall towards Earth’s atmosphere. When they get close enough to Earth’s atmosphere they start to burn up which makes a meteor. If any part of the meteoroid survives burning up and hits the Earth, the remaining parts of the meteoroid is called a meteorite. On average, a meteoroid enters the atmosphere between 10 and 70 km/sec. This is extremely fast and looking from our view, they are so small and just disintegrate. The particles have been compared to a grain of sand, which for us on Earth; it is pretty hard to see. Shooting stars can occur during the day time when the sun is out as well, you just cannot see them because of the sunlight. It is said that one of the best times to see the most beautiful shooting stars, is in the hours before down right before the sun starts to show light. Also a great time to witness a meteor shower is when the moon's phase is close to new moon so that the sky is darker. Scientists have stated that approximately 1,000 tons to 10,000 tons of meteoric material enters earth surface each day. These particles cannot always be found because almost two thirds of Earth is made up of water. With these water bodies, obviously there are no people around to witness meteors. There could be so much debris that we do not even know about, but would be impossible to find. Also, the world is always half dark, causing it to be hard to see the debris in the sky twenty-four seven. Another factor of not being able to see a shooting star is when people live in the city. There are so many lights that block our chances of seeing these bright shooting stars. It is as if it is just not dark enough to see them.
Also, the polluted world that we live in makes it harder to see the stars. This material is not always sited but in some areas of the world it is easier to find. Even though we cannot see these shooting stars during the day, they are definitely occurring. Although at night, you can see one about every ten minutes. An example of when an asteroid hit the earth is Barringer Meteor Crater which hit in Winslow, Arizona in 1997. This was the first feature on Earth to be recognized as an impact crater. With that being said, there have been over 100 impact crater sitting’s since then.

There are also meteor showers that we can witness from Earth. Witnessing these showers from Earth, we can only see little ones. These are celestial events but they are very hard to see go all the way through the sky. With this being said, there are many, many shooting stars that we cannot see. When meteor showers occur, it is more promising that you will see a falling star. Meteor showers are when you see multiple meteors at once, in the night sky. Meteor showers occur when Earth passes through debris that was left by a comet as it orbits the Sun. Meteor shower particles travel in parallel paths, and at the same velocity. They will all appear to radiate away from a single point in the sky. This radiant point is caused by the effect of perspective. It is similar to parallel railroad tracks converging at a single vanishing point on the horizon when viewed. These shooting stars do not always just explode into millions of pieces. If a meteor does explode into big chunks, it is said that it has a composition of stone or metal. If a meteor fragments into tiny pieces, it indicates a grainy composition of particles. There a certain times of the year where you will see hundreds of shooting stars lighting up the sky. With this being said, it can also be a waiting game. They will not always start at a particular time and they might go shorter or longer than expected. They have documented annual sitting’s of these meteor showers and have named them after the constellations from where the shower appears to be coming from.
The brightest meteor show is Leonids. This shower occurs November 15-20 and is the most impressive meteor shower. Thousands of meteors per minute just light up and storm the sky. Scientists have observed Leonids showers and have identified that the most beautiful showers occur approximately every 33 years. The last shower that was lighting the earth's sky was in 2002 and is not expected to be repeated until 2028.

Perseids occurs on July 25 - August 18. It usually has its peak on August 12th with more than 60 meteors per minute. It is not as active as Leniods, but is the most widely watched shower.

Another name for a frequent meteor shower is Orionids. It occurs on October 16-27. This shower can last for a week with 50-70 shooting stars per hour at its peak. Orionids meteor shower, showers the earth with meteors from the Halley's Comet which orbits the sun every 75 to 76 years.

Quadrantids meteor shower occurs on January 1-6. Quadrantids came from the debris of an asteroid called 2003 EH1. The debris entered the earth's atmosphere in January 2012 and allowed astronomers and other earth observers a light show that lasted a few hours.

Geminids meteor shower is seen on December 7-15. Geminids and Quadrantids are similar because they came from debris of an asteroid but Geminids came from a near-earth asteroid called 3200 Phaeton. The Geminids can show up to 40 meteors per hour at its peak.

As you can see, there are quite a few annual sittings of these meteor showers that people can see as well as very unique names. As stated above, they get these names by the constellation they appear to originate from. With all of these scheduled showers, it gives the world a great privilege to experience such a beautiful scene. When meteor showers are predicted, people will
go out in the middle of nowhere away from the city light, so they can witness this site that is indescribable. Some people make it quite an event and will stay up the whole night. It is also a great date idea if you want to go a romantic route and impress your significant other. It is said that even though you could witness these amazing meteor showers, there will be that special one that will stick out and last in your heart forever.

There are impeccable colors that shooting stars can format into. This image documents the appearance of a wide spectrum of colors produced by the object as it hurdles toward Earth. They are predicted to first be red, then white, and ending in the color blue. With this image in your mind, I am sure you are thinking, “How beautiful”. With that being said, when we see shooting stars, all we see is a white light that does not last very long. The colors of a shooting star may also indicate the minerals that make up the falling star. Different elements emit different colored light when they burn. Iron is one of the most common elements found in meteors and glows yellow. Silicates glow red and a green glow indicates the presence of burning copper. Another factor that determines the color of a shooting star is its speed. The air in front of the meteor is compressed to high pressures if it is faster. It then produces a higher temperature. A fast meteor will be seen as blue, while a slow meteor will be red or even orange. Understanding how, why, and when these colors appear is the science of spectroscopy. Spectroscopy is the science of the measurement of light that is reflected and then emitted by different materials.

I’m sure that people wonder how we know that these shooting stars occur if we cannot see them all, well, NASA has eight cameras that are located in Alabama, Georgia, Tennessee, and New Mexico that record meteors as they fall. These cameras catch even the littlest light and helps astronomers learn more. Yes, you could always use telescopes but these cameras are more efficient use for our astronomers. Meteors are very important to NASA (National Aeronautics
and Space). They need to be able to detect when a shower may occur so they can protect all of their equipment. Even a tiny meteoroid can cause severe damage on satellites and other spacecraft. NASA needs to be able to shield their equipment in order to utilize their data and work efficiently. It is stated that NASA satellites Olympus and Chandra, have both been struck by meteoroids and the collision with Olympus proved fatal. NASA has a vision to: reach for new heights and reveal the unknown so that what we do and learn will benefit all humankind. NASA was established by President Dwight D. Eisenhower in 1958.

As you have read, shooting stars are a gift that we get to witness here on earth. They show off a bright light as they fall into Earth’s atmosphere and its debris can even reach the Earth. Though we might not see too many, they can make an impact on your smile. People will see hundreds in a lifetime if they choose to go out of their way to do so, while others will catch a lucky few. So next time you are out on a dark night, take a glimpse at the stars, and make a perfect wish.
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Abstract: Physics is in the daily life of a sport. There are major contributions that physics has on football, soccer, tennis and baseball. Physics in sports can include topics such as, force, acceleration, aerodynamics, center of gravity, centripetal force, coefficient of restitution, energy, friction, magnus force, momentum, projectile motion, and work.

Some people might not know, but physics plays a very important role in sports. It affects the way athletes perform each sport that they play. Each sport has a wide variation of physics in it. The basic laws of physics must be understood in order to know how it plays a role in the sport. Football, soccer, tennis, and bowling have many different and interesting facts about them. Physics plays a significant role in every sport. Some of the physics in football and other sports are; force, acceleration, aerodynamics, center of gravity, centripetal force, coefficient of restitution, energy, friction, magnus force, momentum, projectile motion, and work.

The definition of force is a pull or a push upon an object “resulting from the objects interaction with another object” (Physicsclassroom 2012). In the National Football league, force is such a great way to explain a tackle. The picture above is Seattle Seahawks defensive back Marcus Trufant who explosively slammed the Eagles receiver Greg Lewis with such great force that he could not keep the ball in his hands (Higgins 2009). Force plays an important role in most sports. The ability to tackle someone with great force means that the person will have a better chance of winning a game. Newton’s second law is where Force = mass x acceleration (Wood 2013). If the acceleration and mass of the object or person is known, the force can be calculated.
In physics, acceleration is, “the rate of change of velocity as a function of time” (Zimmerman 2011). The acceleration of implement is -9.8 meters/second squared while in flight. All objects and people fall to the earth at the same rate of acceleration of gravity. It does not matter how much the object weighs, it will always fall at the same rate of acceleration. Gravity is -9.8 m/s $^2$. In sports and in life, gravity is acting vertically. It does not matter how much the weight of the implement is, the acceleration is going to be the same. Every second, vertical velocity of the person playing football decreases by 9.8 m/s every second. Calculating and measuring acceleration is related. $\Delta V =$ change in velocity and $\Delta T =$ change in time. 

Acceleration $= \frac{\Delta V}{\Delta T}$. To better understand this, “the change velocity is the difference between the current value and the last value of the velocity, or, the change in velocity is equal to the final velocity minus the initial velocity ($\Delta v = v_f - v_i$)” (Wood 2013).

Aerodynamics is important in sports. The definition of it is related to the flow of air around something. The air around a ball in sports can affect the speed and direction of the object. The stiches on a football can affect the way the ball is thrown. Another example is if a smooth ball were to be thrown, the air molecules go around the ball and to the backside of it and they come together to push that smooth ball frontwards. In most cases the pressure is less in the back than the front of the ball. If the ball is being thrown in an un-even surface, turbulence is what happens as the air flows over the ball. (Wood 2013). Below is a picture of different shape balls and the way it is affected in the air.

![Diagram of different shapes of footballs](Winterwitch 2012)

The center of gravity of the body is useful knowledge. Every athlete is made up of components that have different weights. A persons’ weight is the sum of their leg weight, arm weight, etc. The distribution of these weights is symmetrical is the center of gravity of the body. An example of this is if an athlete has more mass on the top of his body. It will affect the tackle or hit. The center of gravity will be closer to the top part of the athletes’ body. In sports, there are
two different properties of the center of gravity. The location of one depends on the shape of the athletes’ body. If an athlete bends their legs, this lowers the center of gravity position. Also, the center of gravity can be outside of the body. An example of this is if the body is hollow, it will be placed elsewhere in the air (Wood 2013).

Centripetal force plays an important role in physics and sports. A force has to exert a body in order for the velocity to change. A body that performs in a circular motion has a direction that is changing all the time. The linear velocity is also changing which is perpendicular to the radius of the circle. “This is the reason that the discus always starts its flight at a direction perpendicular to the arm of an athlete” (Wood 2013). Centripetal force is why the change in the direction of a body in turning motion. It goes in a circle and always will. The only way for this circular motion to occur is if some resultant force acts on the body with a different direction in the center of the circle. The formula for it is \( F_c = M(\text{angular speed})R \) and \( m \) is body mass, times the angular speed and \( R \) is radius of the circle. The centripetal force is the one that is exerted by the hand of the thrower when talking about throwing a ball. In discus throwing, the hand is always turning until the athlete makes the throw. The force that is being exerted on the discus fulfills the “aforementioned direction requirements” (Wood 2013). Another example is with cyclist that race. When a cyclist is racing in the arena track, it has inclinations that are higher than 40 degrees. The reason why the arena track is set up this way is because it provides the forces acting on the athlete with the right proper direction that happens to be centripetal. Below is a picture of two motions combine to for projectile motion.

To obtain the percentage of speed that a ball that bounces on the floor retains, coefficient of restitution is what can be used. The equation is \( e = \frac{V_{after}}{V_{before}} \). The larger the parameter of the ball is, the more elastic the collision will be which means that the fewer the energy losses.
When a ball drops from a particular height, the outcome of the height after the ball bounces again will be higher with a greater coefficient of restitution. That equation is $e = \sqrt{\frac{h_{after}}{h_{before}}}$. An example of this is that a basketball bounces better times than a tennis ball. $E$ is also dependent on the ground and the type of ball. Every ball will bounce differently on different grounds such as grass or concrete.

Energy is one of the most important factors in sport. The definition of energy is “power which may be translated into motion, overcoming resistance, or effecting physical change; the ability to do work” (Fairlex 2013). In sports energy does not lose or gain. There are different types of energies. Kinetic energy is of motion (Freudenrich 2012). Potential energy is when an object is moved to a certain height (Wood 2013). Half a ton of force sounds like a lot but according to John Melvin the body can handle twice that much. The impact must be well distributed and not only affecting one part of the body. The football players’ equipment is what handles that job. It spreads out the energy. Another interesting fact is that researcher’s rate a field’s shock absorbency with “a metric called G-Max. In order to measure this, the object or person that approximates a human head and neck is dropped from a height of 2 ft. A low G-max basically means that the field is what absorbs the energy. The field in this case absorbs more energy than the player. Trufant and Lewis which are the players mentioned earlier, landed on grass which has a cushy G-max of over 60” (Higgens 2009). In normal cases, people think g-forces deal with astronauts. In football, it can boost g’s as well. There are only a little bit of things that can match g-load of the football tackle. Below is a picture of the way it is measured.

(Figures 2009).

Friction is when the resistance to motion of two objects that are moving. Friction is important in sports like bowling and curling. There can be friction between two football players as well. There is static friction and kinetic friction. Kinetic friction is when the athlete is moving or sliding. Static friction is the friction before the athlete slides. The friction resistance on a ball can make it slow down when playing a sport like tenpin. Also, it can have the same affect when
bowling. In football, air resistance can act as friction as well. It is the resistance between the surface of an object of person and the air. Air is very important when playing a sport where the ball is to be thrown in the air. Another sport is swimming. Swimming has water and air resistance as well (Wood 2013).

Magnus force plays a very important role in sports too. Some important shots taking in football are because of a spin to the ball. Same goes for soccer. In soccer, they used this technique for free kicks and making goals. A curved ball can easily go into the goal. A question can be asked, what force is it that defects the ball this way? Isaac Newton tried to explain the curved paths of tennis balls. Rayleigh and Magnus in 1742 came up with deflection in the path of cannon balls. “What they realized was that the force responsible for their curved path (and also the force that affects a football trajectory), is related to the interaction between the spinning object and the air that surrounds it” (Woods 2013). This can compare to an aerodynamic force when an object is spinning. The summary of what happens when a ball is spinning is that the rotation motion drags the air around it which changes the way the balls goes. Below is a picture of magnus force on a ball.

(Mkapln 2008).
Momentum is another vector that we can compare in sports. It is quantity of motion, \( P = mv \).

Conservation of Momentum is a type of momentum. Momentum is conserved in a closed system but in all reality, in sports, the world is not closed. Momentum is lost when a ball hits the bat. The ball is squished and then it is back to normal. In sports, using a heavier bat or racquet increasing running speed or hand speed can maximize momentum. Angular momentum is moment of inertia and angular velocity. Counterpart to mass is the moment inertia. It is when the resistance of an object is changed because of its angular speed. Figure skaters are a good example of angular momentum. A spin is the first position. The spinner pulls their arms to lessen their moment of inertia. After that, the angular speed increases (Wood 2013).

Projectile motion is involved within sports too. A ball can be thrown to have a vertical and a horizontal velocity. Once the ball is thrown, gravity has an effect on the ball and the horizontal component velocity will not change. Vertical velocity ends up getting smaller when the up path. On the top of this parabola velocity will be zero. Magnitude increases downwards and the vertical changes direction. Distance increases and time interval increases during this time. Below is the projectile motion picture.

![Projectile Motion](image)

(Wood 2013).

The importance of physics in sport is now obvious. It can determine the amount of pounds a knee can take before breaking. It affects the way athletes perform each sport that they play. Each sport has a wide variation of physics in it. In bowling, friction is very important. In soccer, the magus force is what curves the ball. The basic laws of physics must be understood in order to know how it plays a role in the sport. Football, soccer, tennis, and bowling have many different and interesting facts about them. Physics plays a significant role in every sport. Understanding the basics of physics; force, acceleration, aerodynamics, center of gravity, centripetal force, coefficient of restitution, energy, friction, magnus force, momentum, and projectile motion will give a great outlook on sports and physics.
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Ashley Ono

The Super Massive Black Hole in the Center of Our Galaxy

AST112

Professor Jenny Weitz
The Super massive Black Hole in The Center of Our Galaxy

Abstract

Black holes are mysterious objects in our galaxy to so many people. Black holes are almost completely dark objects that let no light escape because of their strong gravitational pulls. Sagittarius A is a massive black hole in the center of our own galaxy, the Milky Way.

Many people are familiar with the term “black hole.” When thinking of a black hole, many people picture a huge black “hole” in space sucking things in. But what really is a black hole? Black holes may be amongst the strangest and most commonly misunderstood objects in our universe. Conceptually, they are not that complicated. Black holes are actually remnants of very massive stars with gravity so strong that not even light can escape. Black holes can contain several times the mass of our sun in a space no larger than a city.

So how are these fascinating objects formed? Well most stars, like our sun, end their lives peacefully by gently shedding their outer layers into space. But stars exceeding about eight times the mass of our sun have a more dramatic end to their lives. These massive stars die when they can no longer fuse atomic nuclei in their core. This does not necessarily mean that the star runs out of ‘fuel’, but rather that the stars core has enough iron that fusing together atoms to make new elements actually costs the star energy. After lacking an energy source, these stars cannot hold themselves up against the relentless struggle with gravity and their outer layers come crashing down. When this happens the star’s core undergoes drastic changes and become resilient to further compression. With
the star now out of balance, an explosion called a supernova occurs. These supernovas can outshine an entire galaxy and can be seen from across the universe. After a supernova the core remains. This dense area of subatomic particles then has a couple different paths it can take. For a star with less mass than 20 suns, the core holds together as a neutron star. But for stars more massive than that the core transforms and a black hole is born.

Although black holes are “black” because no light can escape from them, scientists still have ways to detect them. One way astronomers locate black holes is by finding them in orbit around other stars. When this happens, gas is sucked off the stars and spirals down a disk through the event horizon. The gas in the disk is heated to millions of degrees and emits strong x-rays.

The largest black holes are called “super massive.” These black holes have masses that are more than one million Sun’s put together. Scientists have found proof that every large galaxy contains a super massive black hole at its center. The formation of such black holes and how they affect the evolution of their host galaxies are not well understood by astronomers. In the past twenty years, astronomers have collected enough evidence through the observed motions of gas and stars to convince ourselves that something very massive lurks at the center of our galaxy. The super massive black hole in the center of our galaxy, the Milky Way, is called Sagittarius A. The first dynamical
evidence of this super massive black hole came from the motions of the ionized gas
streamers of the mini-spiral orbiting Sagittarius A. This black hole has a mass equal to
about four million suns and would fit inside a very large ball that could hold a few
million Earths. Although its very large mass, Sagittarius A is very faint. In fact, it is the
most under luminous super massive black hole known to astronomers. Our neighboring
galaxy, Andromeda, in comparison has a black hole 20 times the size of ours. So, why is
the super massive black hole in our galaxy so dim? An astronomer named Tatsuya Inui
from Kyoto University in Japan stated, “We have wondered why the Milky Way’s black
hole appears to be a slumbering giant, but we realize that the black hole was far more
active in the past. Perhaps it’s just resting after another major outburst.” Based on
astronomers observations it turns out that approximately 300 years ago, Sagittarius A let
loose, expelling a massive energy flare. Data taken from 1994 to 2005 revealed that
clouds of gas near the central black hole brightened then faded quickly in X-ray light.
This super massive black hole in the center of our universe was a million times brighter
three centuries ago, and it must have unleashed an incredible powerful flare causing it to
become faint.

Scientists have made much progress in studying and observing this black hole.
Since 1995, high resolution near infrared studies have observed a compact cluster of
early-type stars surrounding the radio position of Sagittarius A. Very accurate stellar
positions can be estimated in order to keep track of the motions of these stars, which are
moving very quickly around Sagittarius A at speeds up to three million miles per hour.
Referring back to Kepler’s laws of motion, the orbital velocities and the positions of the
bright stars can be used to estimate the mass that must be contained within their orbits.
The result of the enclosed mass is about 4.6 million times the mass of our Sun. And how exactly have scientists been making these observations?

One way that scientists have been observing Sagittarius A is a telescope system called the NuSTAR, the Nuclear Spectroscopic Telescope Array. The NuSTAR is positioned to make several important studies about our own Galaxy, the Milky Way with unprecedented sensitivity. The high energy X-rays observed by NuSTAR pass through undiminished unlike low energy x-rays which are subject to strong absorption from gas.

Another way to gather observations about this black hole is NASA’s observatory called the Chandra X-ray Observatory. Images taken from this observatory have detected X-ray flares about once a day from Sagittarius A. The flares have also been seen from ESO’s Very Large Telescope in Chile. A new study provides a possible explanation for these mysterious flares. The suggestion is that there is a cloud around Sagittarius A containing hundreds of trillions of asteroids and comets, which have been stripped from their parent stars. An asteroid that undergoes a close encounter with another object, such as a star of planet, can be thrown into an orbit headed towards Sagittarius A. If the asteroid passes within about 100 million miles of the black hole, it would be torn to pieces by the tidal forces from the black hole. These fragments then would be vaporized by friction as they pass through the hot, thin gas flowing onto Sagittarius A. A flare is
then produced and eventually the remains of the asteroid are swallowed by the black hole.

Some astronomers in from UCLA believe that there are many smaller black holes surrounding the central super massive black hole, Sagittarius A. The UCLA astronomers spotted four objects that seem to be black holes and neutron stars in binary systems within just three light-years of the central black hole. These observations led the team of astronomers to estimate about 10,000 or more black holes and neutron stars are swarming around Sagittarius A. Every million years, a black hole or neutron star is swallowed by Sagittarius A. That will increase the size of this black hole by about three percent over the next billion years.

As you can see, many astronomers all over the world are observing and studying the black hole in the center of our universe. They have made so many discoveries so far, and continue making more.
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APA formatting by BibMe.org.
Sun’s Equilibrium
PVCC Astronomy 101
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April 19, 2013
Professor Jenny N. Weitz
Abstract

The Sun is fairly stable. Moreover, the Sun has been fairly stable for billions of years, allowing the continuous existence of life on Earth for another five years or more. The Sun's lifetime is about 10 billion years, meaning that after this time the hydrogen in its core will be depleted. The Sun will then evolve into a red giant, consuming Mercury, Venus and the Earth in its expanded envelope. The Sun is currently 5 billion years old. In this research is to find out how the sun is being "supported". We assume that this mechanism is hydrostatic equilibrium, but to be sure I made research through the derivation.

"You may as well go about to turn the Sun to ice with fanning in his face with a peacock's feather." Shakespeare (1606) The Sun is one out of billions of stars, the brightest, and the closest star to Earth. The Sun rotates once every 27 ½ days. The Sun is now a middle-aged star, meaning it is at about the middle of its life. The Sun formed over four and a half billion years ago and has used up nearly half of the hydrogen in its core. The sun will not last forever but the sun will continue to burn through the hydrogen for another five billion years or so, and then helium will become its primary fuel. You may think the Sun will die soon, but it will keep shining for at least another five billion years. The Sun's outer layer called the photosphere and has a temperature of 6,000 degrees Celsius or 11,000 degrees Fahrenheit. Deep within the core or very middle of the Sun the temperature is about “27 million° Fahrenheit. That’s pretty hot!” (Educational Foundation 2012). Its core is under its atmosphere. The sun is a huge sphere of glowing gases that produce energy and light, which make life on Earth possible as we all know. The temperature of the sun varies tremendously, and not in ways you might realize. It is hotter
than anything in the whole universe. “The Sun’s diameter is about 870,000 miles wide. The Sun is 109 times wider than Earth, and is 333,000 times heavier. That means if you put the Sun on a scale, you would need 333,000 objects that weigh as much as the Earth on the other side to make it balance” (Educational Foundation 2010). Equilibrium is a fancy word for "stability". There are two major forces at work within the Sun. First is the explosive power of the Sun's nuclear fusion reactions. The Sun is powered by the equivalent of millions of nuclear bombs going off all at once, every second. That power should be enough to throw plasma beyond the orbit of Neptune. However, the Sun's mass generates a very strong gravitational field, which tries to crush the Sun into a tiny dot of matter. So the equilibrium is the balance between the outward thrust of the Sun's energy balanced with the attractive gravity of its mass, like a firecracker wrapped with rubber bands. In about 5 billion years or so, the Sun will begin to run low on its hydrogen fuel; the solar reaction will begin to weaken. The "balance" will fail. The gravity of the Sun will cause it to shrink - a little! According to Chang the sun is “corresponding to a shrinkage rate of about 5 feet per hour. The diameter of the sun is close to one million miles, so that this shrinkage of the sun goes unnoticed over hundreds or even thousands of years” (2012). But the compression caused by gravity will increase the pressure and temperature in the Sun's core, and at some point the pressure will be high enough to begin fusing the plentiful helium into oxygen and carbon - re-igniting the Sun's fire and causing it to swell to 50 or more times its size. This will be the "red giant" phase of the Sun's final life, and will incinerate all of the inner planets.

The Sun's interior is in hydrostatic equilibrium. “Deep in the sun's core, nuclear fusion reactions convert hydrogen to helium, which generates energy” (National Geographic 2010). The Sun is fairly stable; we don't see it oscillating wildly in and out, and we don't see it flickering like a candle about to go out. Moreover, the Sun has been fairly stable for billions of years, allowing
the continuous existence of life on Earth. Gravity has a destabilizing effect. The tendency of gravity is to compress the Sun. Studying such complex magnetic motions inside our star can help scientists understand the complex magnetic fields around the Sun that lead to the eruptions that can cause space weather effects near Earth and other objects in the solar system. Ultimately, research into these constantly changing magnetic fields may lead to advance warning of such dangerous activity, which can send radiation, particles, and magnetic fields toward Earth and sometimes disrupt technology on our and other planets. What has kept the Sun from collapsing? If the Sun were to collapse inward under its own gravity, it would crunch down to a black hole in the course of a few hours. Obviously, such a catastrophe hasn't happened.

According to the picture the Sun is kept stable by its internal pressure. Just as pressure increases as you dive deeper and deeper into the Earth's oceans, so pressure increases as you dive deeper and deeper into the Sun. By the time you reach the Sun's center, the pressure has reached a value equal to 340 billion times the air pressure at sea level here on Earth. It's a general rule that gas flows from regions of high pressure to regions of low pressure. (The pressure difference is what makes air leak out of a punctured tire.) Within the Sun, therefore, pressure creates an
outward force, from the high-pressure core to the low-pressure surface. This is in contrast to gravity, which creates an inward force. When the force due to pressure exactly balances the force due to gravity, a system is in hydrostatic equilibrium. The Sun's hydrostatic equilibrium is stable and self-regulating; if you tossed a little extra matter onto the Sun, the inward force of gravity would increase. Impey stated that “The temperature within a star is controlled by the heat flow from the nuclear reactions in the core” (2012). However, the resulting compression would increase the pressure inside the Sun, resulting in an increase in the pressure force just sufficient to balance the increased gravitational force.

Energy is carried away from the Sun's core by radiative diffusion and convection. Energy is generated by nuclear fusion in the Sun's hot, dense, high-pressure core. However, the energy generated is ultimately radiated away from the Sun's surface, nearly 700,000 kilometers away. How is the energy transported from the core to the surface?

Furthermore, there are three fundamental ways of transporting energy from hot regions to cooler regions: (1) Conduction: energy is transported by the small-scale random motions of atoms or molecules. One atom jostles the atom next to it, which in turn jostles the next atom. 2) Convection: The heat moves with the fluid. According to Layto and Freudenrich “rising movements of hot gas next to falling movements of cool gas and it looks kind of like glitter in a simmering pot of water” (2011). Energy is transported by large-scale circular 'convection currents', as hot fluid rises and cold fluid sinks. Convection works best in opaque fluids, and radioactive diffusion works best in media which are transparent, or at least translucent. 3) Radiative Diffusion:
energy is transported by photons flowing from warm, bright regions to cool, dark regions. There, boiling motions of gases (like in a lava lamp) transfer the energy to the surface. This journey takes more than a million years. Conduction works best in opaque solids (metals are particularly good heat conductors). Right above you can see the concept of the solar interior reveals the boiling convective zone, the interface layer and the relatively calm radiative zone.

Inside the Sun, conduction is ineffective because the Sun is not solid. Energy is transported by convection in the outer regions of the Sun. Energy is transported by radiative diffusion in the inner regions of the Sun (the inner 70 percent). Sunlight is a form of radiation that is radiated through space to our planet without the aid of fluids or solids. The energy travels through nothingness! Just think of it! The sun transfers heat through 93 million miles of space. Because there are no solids (like a huge spoon) touching the sun and our planet, conduction is not responsible for bringing heat to Earth. Since there are no fluids (like air and water) in space, convection is not responsible for transferring the heat. Thus, radiation brings heat to our planet. The Sun's interior can be probed by helioseismology. The radiative zone of the Sun is by no means perfectly transparent. On average, photons in the radiative zone travel only two centimeters (about an inch) before being scattered in a random direction by an encounter with an electron. The photons stagger about on a random walk, or "drunkard's walk" which is staggeringly inefficient at bringing them to the convective zone. Ryden identified that “It typically takes about 170,000 years for energy generated by fusion in the Sun's core to stagger its way to the Sun's surface”.(1980)

If the Sun isn't transparent, how can we be sure that our models of the solar interior are correct? Fortunately, theoretical models of the Sun's interior can be tested using helioseismology,
the study of the Sun's vibrations. By looking at the Doppler shift of light, (you can see the formula) coming from the Sun's surface, we can see the Sun vibrating in and out. Just as studies of seismic waves tell us something about the Earth's interior, studies of the Sun's vibration tell us something about the Sun's interior. Like a beaten drum or a ringing bell, the Sun vibrates at many frequencies simultaneously. (A musician would say the Sun has many 'overtones'.) The frequencies at which the Sun vibrates depend on the sound speed within the Sun, which in turn depends on the pressure, density, and chemical composition within the Sun.

\[
v_a = \left( \frac{1 - v_a/c_s}{1 + v_a/c_s} \right) v_e
\]

At any point within a star in hydrostatic equilibrium the underlying pressure supports the weight from the overlying material. Gravity were greater than the gas pressure, the star would contract. On the other hand, if the gas pressure were greater, then the star would expand. In a stable configuration, the two must balance. Gas pressure in any layer thus is just equal to the weight on all the matter above that given layer, in the same manner that the pressure at any depth in a pool of water equals the weight of the water above that depth, hence the term hydrostatic equilibrium. An immediate consequence is that gas pressure must increase inward toward the center of a star. The Sun is currently in this stable state and will remain so for another 5000 million years. At this point all the fuel in the Sun will have been used up and, since it is no longer able to generate an outward radiation pressure, gravitational contraction will begin again. Over the past few hundred years, there has been a steady increase in the numbers of sunspots, at the time when the Earth has been getting warmer. The data suggests solar activity is influencing the global climate causing the world to get warmer." (Whitehouse 2004)
Conclusion

In this research I have learned so much starting sun is so hot and it is held together by the gravity. Is the sun is in hydrostatic equilibrium; the sun is neither expanding nor contracting. It is sitting nicely in some equilibrium configuration and mostly shrinking. The sun is like a bell if you kick it, it rings. The sun is like a bell continuously buffeted by many small kicks.
Reference


I putted most of the links attached at last page if is needed.
Butterfly Nebulas

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Abstract

This paper examines one group of planetary nebulas called butterfly nebulas, and explores their composition, evolution, and information astronomers have gleaned from observations of the various known butterfly nebulas. Following a brief discussion on planetary nebulas in general, and establishing a distinction between butterfly nebulas and the other types of nebula, a specific butterfly nebula, M 2-9 will be used as a model to understand the complexities of its genre, the butterfly nebula.

Butterfly Nebulas

Ironically, in our universe, one of the places humans have yet to explore is the universe. Beyond Earth there exists the great unknown, a place of mystery that for some is an un-ignorable call to turn their gaze to the stars, past their home world Earth, and pursue the mysteries they possess. One area of study that astronomers focus on is the life and death of stars. That in itself is a vast topic, and a small piece of this study is devoted to understanding planetary nebulas. Even then, there are many types of planetary nebula, each with their own complexities to explore. This paper narrows its vision to one of the types of nebula, the butterfly nebula and focuses on defining what a butterfly nebula is, its formation, characteristics, and contribution to understanding stars.

Planetary nebulas are formed during a star’s life cycle, specifically from the death of a low mass star. A low mass star will fuse hydrogen into helium, then when the core runs out of hydrogen, it begins to fuse helium, which causes a chain reaction and allows the star to burn outer layers of hydrogen as well. After this, the star will begin to fuse its core into denser and
denser elements until it has fused into carbon. Once this happens, the star no longer has the
energy to continue fusion and begins to cool. The star will eject its outer layers into space as a
gas cloud, and the UV radiation emitted from the exposed core will ionize the gas, making it
glow. This glowing gas cloud that surrounds the carbon core is called a planetary nebula
(Bennett, Donahue, Schneider, & Voit, 2010, p. 344).

Among planetary nebulae, there are four
general types\(^1\): Round, Elliptical, Bipolar, and
irregular (Balick & Frank, 2002, p. 443). These
categories are basic in nature; meaning that within
each, there variations within each type. Balick and
Frank consider a butterfly nebula to be bipolar
because between the lobes, its “waist is pinched
into the center,” which resembles a butterfly, hence
the name. This is different than their other
subdivision of bipolar nebulae they call “bilobed” since it does have two lobes, but they are
connected to a smaller round or elliptical nebula (2002, p. 443).

![Planetary Nebula Types](image)

While all types of planetary nebula are created by low mass stars in a similar way,
analysis is needed to determine why there are different types of planetary nebula instead of one
common occurrence. While there is much research needing to be done, and with the lack of a
“single explanation that fits all of the observations” of the shaping of planetary nebula (Balick &

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\(^{1}\) The image to the right shows the four main types of planetary nebula, as well as sub categories for each (Balick & Frank, 2002, p. 452).
Frank, 2002, p. 439), it is believed that planetary nebulas evolve into their shape “when the mode of mass loss abruptly changes” (Balick & Frank, 2002, p. 439). And all planetary nebulas have a form of disk or torus except for round planetary nebula (Balick & Frank, 2002, p. 454).

Comparing pictures of each type of planetary nebula would seem to suggest that of all of them, the bipolar nebula would be the most complex to understand due to their shape. Balick and Frank agree with this suggestion, and go a step further to assert that the “structure and kinematic patterns of butterfly [planetary nebula] are much more complicated and diverse than for bilobed [planetary nebula]” (2002, p. 443). Within butterfly nebulas themselves, it seems some are formed by “Hubble Flows, radial outflows” that have velocities that “increase linearly,” while others have constant speeds with a “radial offset” instead (Balick & Frank, 2002, p. 447).

Simply put, very hot gases with temperatures of 20000 C or greater, are projected into space at one million kilometers per hour. The reason the butterfly nebulas take a symmetric shape like a butterfly or hourglass is believed to be due to either magnetic forces or accretion within a bipolar system, or the internal pressure of a ring of dust called a torus² (Balick & Frank, 2002, p. 454). This “funnels” the expanding gas and creates the symmetric butterfly-like shape (Dickinson, 2012, p. 172). There is evidence that this type of bipolar planetary nebula is caused by a binary system at its center. For example, the torus, or disk, at the waist of planetary nebula M 2-9 is created by one star’s gravity pulling the other’s loosely held gas and throwing it out into space around the two stars (Dickinson, 2012, p. 168)

² A torus is a geometric shape easiest imaged as the shape of a doughnut (Weisstein, 2013).
An interesting way that astronomers use to observe planetary nebulas and their movement is to use a technique similar to time photography. By taking pictures over time and “stitching” them together (Balick & Frank, 2002, p. 447). This along with a spectrograph can give scientists clues to a nebula’s composition, and other information such as rotation patterns or the “driving force” behind the nebula’s characteristics. For example, when analyzing the blobs at the outer edge of the butterfly nebula M 2-9, it is found that these “features are 60% linearly polarized and red shifted with respect to the core;” this means that they are made of dust and “the radiation from them is reflected light rather than intrinsic emission” (Corradi, Balick, & Santander-Garcia, 2011, pp. 2-3)

The previously mentioned butterfly nebula, M 2-9, is a classic example of its class. This butterfly nebula has a binary star system at its center, with what is believed to be two disc tori\(^3\) at the center as well (Castro-Carrizoo, et al., 2012, p. 1). These rings were formed by two separate ejections estimated to be about 500 years apart and it is postulated that this was the catalyst for the nebula’s formation (Castro-Carrizoo, et al., 2012, pp. 3-4) These two mass loss events are assumed to be caused by radiation pressure on the dust (Peretto, Fuller, Zijlstra, & Patel, 2007, p. 11), and through the ejection, created the rings that give the two lobes their shape (Castro-Carrizoo, et al., 2012, p. 7). And further analysis suggests that the binary system within M 2-9 is a dwarf paired with a red giant, which accounts for the role in the timeline of ejection and overall shape that is observed (Castro-Carrizoo, et al., 2012, p. 8)

\(^3\) These two rings are shown in the image to the left (Castro-Carrizoo, et al., 2012, p. 3).
The discovery of a binary system within M 2-9 gives an exciting opportunity for scientists to observe a binary star system’s late life cycle and suggests a new way for butterfly nebulas to be formed. It gives data that can be used to study the interaction of two stars orbiting each other, how that affects the area around them, and the effect two separate mass ejections within a short time\(^4\) have on forming and shaping planetary nebula and how mass loss is affected by radiation pressing on the ring of dust.

\(^4\) M 2-9’s two ejections are believed to have been separated by 500 years (Castro-Carrizoo, et al., 2012, p. 4).


The Truth Behind Asteroids

By: Jorge Ozuna

4/18/13

Astronomy 112-19693

Professor Weitz
Abstract

Have you ever wondered how asteroids are formed? Or how dangerous they can be if one was to hit mother Earth? Well if you did, you are in the perfect place because in this essay I will be answering both of those questions with great detail. Throughout this essay I will be talking about the magnificent objects in the atmosphere that we know as asteroids. My first paragraph will be background information of asteroids and explaining exactly what they are and how long they have been around. My second paragraph will be about how asteroids are made, what they are made of and how they form into belts. This paragraph will contain many interesting statistics and will be one of my main parts of the projects. Paragraph three will contain my personal opinions and thoughts on the formation of asteroids. My next paragraph will contain many fascinating statistics and testimony from people who have had close encounters with asteroids hitting Earth. Also, this paragraph will touch base with famous myths of asteroids and their potential dangers. Last and definitely not least, my last paragraph will have statistics on asteroids hitting the Earth and peoples testimony on close encounters with these situations. My goal for this project is to learn as much as possible about asteroids and to inform you about these fascinating objects.

Ever since I was a little kid I have always been attracted to asteroids and how they work and thanks to the movie Armageddon it has made asteroids that much more fascinating to me. For those who are not familiar with this movie, the plot is about a humungous asteroid that is headed straight to Earth and has the destructive capability to wipe out the entire Earth. Of course, Armageddon is a Hollywood movie and not everything that happened in that movie is true. Asteroids are sometimes referred to as minor planets or planetoids, are rocky, metallic bodies
that revolve around the Sun like planets (Asteroids). In fact, asteroids have their own orbits around the Sun and they rotate on their axis just like the Earth. Asteroids are ancient remnants of the earliest years of the formation of our Solar System more than four billion years ago (Meteorite.org). That means that asteroids have been around since the formation of our solar system! Asteroids come in many irregular shapes and sizes, and unfortunately just like the asteroid in Armageddon, one exists that is just as large! In 1801 while making a star map, Italian priest and astronomer Giuseppe Piazzi accidentally discovered the first and largest asteroid orbiting between Mars and Jupiter (Asteroid Belt Facts). Giuseppe named this asteroid Ceres after the Roman goddess of the harvest, of growing plants, and motherly love. Ceres which is 940 kilometers (about 583 miles) across consists of 25% of all the asteroids in the solar system (Space.com). The good news about that last fact is that in comparison to Ceres, the rest of the meteors are very small. It is scary to think that an asteroid is so big; in fact, it is so huge that it is considered a dwarf planet. For those of you who are not familiar with dwarf planets, it is, “A celestial body orbiting a star that is massive enough to be rounded by its own gravity but has not cleared its neighboring region of planetismals and is not a satellite (Smith).” In other words, a dwarf planet is its own category of objects in the solar system that is not big enough to be a planet but is bigger than moons; another example of a dwarf planet is Pluto. Pluto is no longer considered a planet; it is a dwarf planet just like Ceres. What makes Ceres very interesting is that it has massive amounts of water, which is very uncommon in asteroids or any object in the solar system. Ceres is a prime target of extra-terrestrial life because of its supply of water and its size. Imagine that, an asteroid that can wipe out the entire Earth and is the home of aliens! These objects that we call asteroids are truly fascinating and I regard them as wonders of the world. Thanks to them, we don’t have to share this planet with enormous, terrifying dinosaurs.
A very common misinterpretation is that asteroids and comets are the same, but that is not the case. What distinguishes an asteroid from a comet is what they are composed of. Asteroids are made up of metals and rocky material, while comets are made up of ice, dust and rocky material (Coffey). Asteroids formed closer to the Sun where it was too warm for ice to remain solid. Comets formed farther from the sun where ice would not melt. That is why Comets contain ice and asteroids do not. In addition, as comets approach the Sun they lose material with each orbit because some of their ice melts and vaporizes to form a tail. The obvious difference between these two objects is the tail. The heat from the Sun causes ice and other materials on a comet’s surface to heat up until they vaporize; the vapor is what is seen as the tail of a comet. Another characteristic that distinguishes these two rocky bodies is their orbital patterns. Comets tend to have very extended and elongated orbits, many times going more than 50,000 AU from the Sun while asteroids tend to have shorter, more circular orbits. Another difference between an asteroid and a comet is in the numbers of each. There are only 3,572 known comets, but there are many millions of asteroids (Asteroid Belt Facts). By using these measures that I just talked about, scientist differentiate asteroid from comets. In order to locate an asteroid, you will have to look through a very expensive telescope at the orbit of Mars and Jupiter. In this space, you will find the home of millions of asteroids which is called the Asteroid Belt, also referred to as the Main Belt. In the Main Belt you can find 200 objects that are 60 miles (100 km) in diameter and almost 1 million objects over 1 km in diameter (Asteroids Formation Discovery Exploration). That is absolutely amazing, you can only imagine how enormous this belt is because last time I checked, you cannot buy a telescope at Wal-Mart that lets you see this beautiful asteroid belt. What I also found to be very cool is that just like in the movie Armageddon, asteroids are very
cold, to be exact the average surface temperature of an asteroid is -100F. In the movie, the astronauts that landed on the asteroid had to wear special cold suits because they would freeze to death if they didn’t. If anyone ever wanted to set foot on these magnificent objects, you would have to wear cold suits similar to what the astronauts wore in the movie Armageddon.

Before doing my research, I had no idea of these statistics that I have talked about so far, so hopefully you are as fascinated as I am about asteroids. To know that there is an asteroid out there that has the capability of destroying our planet completely is pretty overwhelming to say the least. Thanks to Giuseppe Piazzi for discovering Ceres, which is the mother ship of all asteroids, we gained the knowledge that planets and moons are not the only gigantic objects in outer space. With all the technology these days, I am ecstatic about the possibility of gaining more knowledge on these objects that live in the orbit of Mars and Jupiter. I can only imagine how much more information we will learn about asteroids in the near future and maybe one day, just like in the movie Armageddon, we will be able to travel and set foot on an asteroid. Hopefully, it will be just for sight seeing and taking pictures and not to blow it up to prevent it from hitting mother Earth. The sky is the limit when it comes to learning new material and only time will tell if technology gives us the opportunity to have close encounters with asteroids. On the other hand, we necessarily don’t have to go to asteroids to learn more about them, sometimes they come to us! Apart from students and professors who are interested in learning about how asteroids are formed, how they maneuver and where they come from, regular people who do not care about asteroids just want to know how much of a threat they are to us. Are they as dangerous as Hollywood movies set them out to be? Do they really have the strength and capability of destroying human life? The truth about asteroids and their dangers will be explained in a way that will blow your mind.
The threat of an asteroid causing massive damage to our planet is very realistic and can happen. In fact, it has already happened before, sixty five million years ago an asteroid 10 kilometers in diameter struck the Yucatan Peninsula in the Gulf of Mexico. “The explosion created was enormous, immediately destroying everything within a radius of 500 kilometers, the shock wave from the impact travelled hundreds of miles causing large scale fires, triggered huge tsunamis and a chain reaction of volcanic activity and earthquakes (Cuk).” If you can picture the end of the world, this would be a perfect description of that picture, it was that horrifying. Billion of tons of dust were thrown into the atmosphere and carried around the globe by super strong winds that prevented sunlight from shining on the planet. The result was darkness for many months which caused temperatures to drop dramatically. This is the catastrophic event that led to the extinction of more than half of all the species on Earth including the dinosaurs (Corbett). The good news about this day that changed the planet forever is that it is extremely rare and more than likely will not happen in our lifetime. Asteroids with a diameter of between 1 to 2 kilometers impact the Earth every 100,000 years or so and are also capable of causing damage on a global scale and could even threaten our existence. What we should be really worried about is the smaller objects of around 50 meters in diameter because they hit the Earth around every 1,000 years (The Threat to Earth). These smaller objects can be very dangerous to human life because they have the capability of destroying a large city. “In 1908 an asteroid 50 meters in diameter entered Earth’s atmosphere and exploded over a remote area of Russia; the explosion created was the largest ever in modern human history, 1000 times greater then the atomic bomb which landed in Hiroshima, laying waste to an area of over 2,000 square kilometers (Asteroid Belt Facts).” It is pretty scary how an object that is 50 meters in diameter can cause such devastation. Like I said earlier, asteroids orbit around Jupiter and Mars, and in order for an
asteroid to hit Earth, it must leave its orbit and travel into Earth. Small asteroids tend to intersect with Earth’s orbit around the sun and gravitational forces pull these asteroids away from their orbit and into Earth’s orbit. As the asteroid enters the atmosphere, it increases drag force and velocity, which erodes the asteroid making it smaller as it approaches the surface of the Earth. As soon as the asteroid reaches the Earth’s atmosphere, it is no longer called an asteroid, it is now known as a meteor. If the meteor survives the trip onto the Earth’s surface, it changes names again from a meteor to meteorite (Lallanida). It is quite a process for an asteroid to hit the surface of the Earth, but it is definitely realistic. It is common for asteroids to reach the atmosphere but never reach the surface of the Earth. The asteroid ends up burning in atmosphere thanks to erosion by the high velocity and drag force it creates as it travels in the atmosphere; this is a shooting star. Shooting stars are very beautiful and in reality, are asteroids that failed to hit the Earth’s surface. A couple months ago, a shooting star did not fail to reach the Earth’s surface, a meteorite exploded in Russia that left 1,000 people injured. “Described by NASA as a "tiny asteroid," the meteor's explosion created a blast in central Russia equivalent to 300,000 tons of TNT, adding that the incident was a once-in-100-years event (Black).” Residents of Russia were lucky that this meteorite did not hit any buildings or houses directly, it crashed in a frozen lake but the shock waves were strong enough to cause damage to 3,000 buildings. An eye witness described the explosion by saying, “A fireball had exploded and it wasn't an aircraft (Black).” Another eye witness was recorded saying, “There was panic, people had no idea what was happening.” This meteorite was later confirmed to be 50 feet wide and weighted 7,700 tons. If a meteorite that exploded in a remote lake that was only 50 feet wide caused so much damage, imagine what kind of damage an asteroid of 1km wide could do?
I hope we never get to answer that question; one can only use our imagination. Asteroids are truly spectacular and there is much more to them then huge rocks that can crash in our planet and cause massive damage. These mysterious objects are not going anywhere either, as long as we are around, they will stick along for the ride. With the help of my essay, I hope you learned new material on asteroids. I am glad I received the opportunity to write this essay because I learned so much from my research about these objects that grabbed my attention since I saw the movie Armageddon.
Bibliography


Betelgeuse

A Review of An Amazing Star

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Astronomy 112

Professor Jennifer Weitz

April 18, 2013
Betelgeuse

In this creative research paper I will be discussing the amazing star Betelgeuse. I will talk about the life of the star, from its birth till its expected death. I will also include some interesting myths and facts about Betelgeuse as well. Upon completing ones reading of my essay, one will have a better knowledge of one of the most intriguing stars in our solar sytem!

What are stars? “Stars are massive shining spheres of hot gas, the closest of which is our Sun. Stars are primarily made of hydrogen, smaller amounts of helium, and trace amounts of other elements. Even the most abundant of the other elements present in stars are only present in very small quantities. Those stars which you see with your naked eye in the night sky all belong
to the Milky Way Galaxy, the huge system of stars that contains our solar system” (Greene, 2007). The star that I find most intriguing is Betelgeuse. Betelgeuse is the eighth brightest star in the night sky, and the second brightest star in the constellation Orion. It is estimated to be about one thousand times the size of our sun, and has an absolute magnitude of -6.02. The diameter of Betelgeuse is approximately 1.3 billion miles! Today I will discuss the lifecycle of the red supergiant Betelgeuse. From when the star was first discovered, the cycles and phases it has since passed through, to the approximated death of the star, and what will entail when that happens. I will also give interesting facts about the amazing star known as Betelgeuse.

Betelgeuse is estimated to be about eight to ten million years old, with approximately one million years of life left as red supergiant. The next phase will be to explode into a type II supernova, and then turn into a neutron star or a black hole. Scientists believe that the star was formed during the big bang, is a first generation star, and gave birth to some, but not all of the stars in the constellation Orion. After the big bang Betelgeuse began its life as a protostar. This is the earliest stage in the lifecycle of a high mass star. A protostar is a large mass that forms by contraction out of the gas of a giant molecular cloud in the interstellar medium. For each solar mass star, it will last about 100,000 years before going to the next phase, which is becoming a main sequence star. Since Betelgeuse is so massive, and the size is constantly changing there have been many estimates of how close it is to Earth, and how big it actually is. I have checked many sources that approximate Betelgeuse at 18 solar masses, which would mean it spent 1.8 million years of its life as a protostar. The next phase is to become a main sequence star. A star will stay in this phase of its life depending on how long it is able to fuse hydrogen in its core. As we know, stars will leave the main sequence when they run out of hydrogen and start fusing heavier elements starting with helium and ending with iron. The more massive a star is, the
faster it will burn through the elements. Betelgeuse being a supergiant star means that it likely only spent a few million years as a main sequence star before burning up all of its hydrogen and becoming the red supergiant that it is today. It is so enormous that it is believed to be at the end of its current phase and should go Type II supernova within the next million years. For Type II supernovae, mass flows into the core by the continued formation of iron through nuclear fusion. Gravity is what gives stars their energy. “Once the core has gained so much mass that it cannot withstand its own weight, the core implodes. This implosion can usually be brought to a halt by neutrons, the only things in nature that can stop such a gravitational collapse. Even neutrons sometimes fail depending on the mass of the star's core. When the collapse is abruptly stopped by the neutrons, matter bounces off the hard iron core, thus turning the implosion into an explosion.” Since Betelgeuse is larger than five solar masses it will likely become a black hole when this happens. In my opinion the most interesting cycle of a star’s life is when it becomes a black hole. Black holes are very intriguing and perplexing. Though we have a great amount of information about black holes, scientists are discovering new things every day. It is mind blowing to think that nothing can escape the gravitational pull of a black hole, not even light can! “Black holes are places where ordinary gravity has become so extreme that it overwhelms all other forces in the Universe. Once inside, nothing can escape a black hole's gravity — not even light” (Van der Marel, 2013). In fact the gravitational pull from a black hole is so strong that it is believed to warp time and space around it!! Time travel anyone?

Now that we have discussed the life cycle of the incredibly massive star Betelgeuse, I want to share some speculation about the star, and also share some scientific theory about it as well. Is Betelgeuse a ticking time bomb? Scientists say that Betelgeuse is an unstable star, which has been blowing off gas, pulsating, and on the verge of going supernova. The problem is
that it is impossible to given a good a very accurate timeframe as to when. Betelgeuse could go supernova tomorrow, or it could take a million years. Until we are able to probe the core of a star, there is no way to determine its chemical and physical composition. Quite a few people out there think all hell is going to break loose when Betelgeuse goes supernova. Many people had predicted the end of the Earth, and the internet is flooded with articles concerning the event as part of the Mayan 2012 calendar. I wonder how those people feel as we sit in the year 2013, and the world never came to an end?

“But here are the scientific facts (theories and conjectures based on reason):

One day Betelgeuse will appear as a giant explosion in the sky, which may be 4 times the size of a full moon. Most scientists believe the star is far enough away from Earth that the explosion blast and various particle rays emitted will not affect us drastically (if at all). This star is a huge mass of hydrogen gas that is (or did) going through a fusion process that changes the matter into heavier elements. It is one of the largest stars known in the universe to human astronomy. On June 9th, 2009 it was presented to The American Astronomical Society that Betelgeuse was shrinking. Calculations from 1993 to the present show a 15% decrease in the stars diameter. It is a pulsating star, whose brightness changes with the density of its atmosphere: 0.2 – 1.2 brightness magnitude, which makes it one of the 10 brightest stars in our sky. Betelgeuse is surrounded by many layers of dust and gas that it has already blown off through a very strong stellar wind and surrounds the star in a ring of solar dust. Betelgeuse is projected by science to be only 6 – 10 million years old. Science says the star had a core made of hydrogen and thermonuclear fusion has already run out at its core, thus gravity has contracted the core into a hotter and denser state. This process fuses helium into carbon and oxygen which produce enough radiation to swell out its outer layers of hydrogen and helium. The red star is relatively rich in
nitrogen compared to a less evolved star like our Sun (Lambert 1984). In 1995 astronomers found an enormous bright area more than 2,000 °K, hotter than the surrounding surface of the star (Gilliland & Dupree, 1996). Betelgeuse’s diameter is roughly 500 times that of the Sun. If and when it turns into a supernova the threat to Earth would be from the blast waves. Is Betelgeuse one of the “smoking stars” to which Nezahualcoyotl referred in his 15th century Aztec prophecy? It probably will not cause any direct physical destruction, due to the huge distance between Betelgeuse and the Earth. But then again” (Scienceray, 2009).

Even when Betelgeuse burns through all of its elements, and goes Type II supernova, it is way too far away from Earth to pose any real threats to mankind. What I do find interesting is that it was a supernova that made life on Earth possible, as they produce elements that are heavier than iron. So, in a sense you could say that we are all made from stars! How cool is that? Supernovae occur all of the time, but if you put it into the perspective of a human life, they are several generations a part. The last one to occur was in 1604, and is sometimes referred to as Kepler’s Supernova. Kepler’s Supernova was much further away than Betelgeuse (about 15,000 light years further away), and could be seen for up to three weeks during the day. It is speculated that when Betelgeuse goes supernova that we will be in for a spectacular sight that would not be as bright as the sun, but would rival that of our moon! If you placed Betelgeuse in the center of our universe it would extend past the planet Jupiter! Its name is from the Arabic armpit, and it is near the right shoulder of the constellation Orion.

Betelgeuse is indeed a very interesting star, and we are finding new information about it every day. Scientists believe it will be one of the next stars to go supernova, and that our solar system is long overdue for other supernovae to occur. This means that we should see stars in our galaxy to go supernova approximately every hundred years or so. As we all know these
calculations are estimated guesses and cannot be confirmed one hundred percent until we find a way to probe the core of a given star. The introduction of the HR diagram, has given us insight to be able to better understand the lifecycle of a given star. We are able to categorize stars based on their temperature and luminosity. This also allows us to determine the size of certain stars as well. As we have learned earlier, the size of a given star will let us know the path that it takes in its life. The bigger a star is, the faster it will burn through its elements, and the shorter lifetime it will have. With the technological advances of now and those to come in the future, who knows what will be possible to detect going forward. Will we find new life? Will we discover other sustainable planets, stars? Will we be able to time travel, take special aircrafts to tour our galaxy? The beauty of science and astronomy in particular is exploring the unknown.


Pre-Map Navigation

Daniel Pope

3/20/13

Astronomy 111

Professor Jennifer Weitz
Abstract

How did the sailors long ago make it across the vast oceans, without a GPS or even maps? How where they able to sail for weeks and never become lost? Well, they used the one thing that a sailor couldn’t forget at home even if he wanted too. The one thing that sailors couldn’t leave at home was the stars. For thousands of years our accent ancestors used the stars and other celestial objects to guide their travels. From the moon to the thousands of stars, just looking up could mean your looking the right way. Over this paper the reader will learn the basic to the advanced ways or navigation using the stars.

Celestial Navigation

“Celestial navigation, also known as astronavigation, is a position fixing technique that has evolved over several thousand years to help sailors cross oceans. Celestial navigation uses "sights," or angular measurements taken between a celestial body (the sun, the moon, a planet or a star) and the visible horizon (Princeton, 2012)”.

History

The history of Celestial navigation is extremely vast. There has been thousands of new discoveries and inventions dating back before pre-recorded history. Most of the credit goes to the Arabs. Most of the celestial bodies are named after or from Middle Eastern languages. The Middle East has been using the stars for almost from the beginning of time. They used it not for sea travel at first but as for hunting in far lands and to navigate there way back home. The Middle East wasn’t the only ones to use the stars in history. It is know that the Vikings using the Sun and the Polar star to sail a line of longitude to sail there was to North America. “In 1714 a Board of Longitude was set
up in Britain and a prize of £20000 was offered to encourage the discovery of a means of accurately determining longitude at sea. Between 1735 and 1760 John Harrison, a Yorkshire man, clockmaker and genius developed clocks and watches (chronometers) that worked at sea (CROWSON, 2008).

**Navigation using Polaris**

“The main star that aids navigation is Polaris, the Pole Star. It is one of the brightest stars in the sky, sits over the North Pole and never veers beyond 1 degree of true north, so it's possible to approximately judge the cardinal points (north, south, east, west) from its location in the sky (Ordnance, 2013).”

The easiest way to find the north Polaris or the North Star is to find the Big Dipper. The Big Dipper is a grouping of seven starts in the Ursa Major constellation. If you follow the panhandle all the way down to the bowl part of the scoop the last two stars will line up and point you directly into Polaris (North Star). Once you have found the North Star all other directions are relatively easy to find.

**Navigation using Orion’s Belt.**

“One of the most recognizable constellations in the winter and spring sky is Orion, the great hunter. He is visible in both the Northern and Southern Hemispheres, although he seems to be standing on his head if you are looking at him from "down under" (Ward, 2007).”
To find Orion’s belt step outside during the evening and look into the southwestern sky if you’re in the northern hemisphere and look for three bright stars that are very close and line up to be almost straight, if you are in the southern hemisphere just look for the same thing but in the northwestern sky. To find Orion’s sword just look for a grouping of stars that also make a straight line directly below his belt, this grouping of stars points down toward earth and also points to the south, but the sword is a less reliable guide when it is off-vertical, this is when it is lower in the sky. So if it’s not vertical with earth do not trust this way of direction because it could be pointing to more to the east or west. Knowing that the sword of Orion’s belt points down to the south, now the travelers have two points of direction.

**Navigation using the Stars.**

Using the movement of the stars can tell you the direction of east and west. The moon and stars rise in the east and set in the west, so the travelers can roughly find directions. Travelers can find their way but picking a current position of a star and then following which direction it moves in. “To use this method: Put a stick in the ground and put another longer stick 2-3 feet in front of it. Line up a bright star as if it were in a rifle sight (aligned with the top of the two sticks). Keep looking at the sticks for about 15-30 minutes. Over a period of time, check whether the star moves up, down or to the right or left of the line made by the two sticks (Ordnance, 2013).”
Navigation using the planets.

Navigation with the planets is very similar to navigating with the stars and the sun, they to rise in the east and set in the west. But they may not be at the same bearing the next time you look at them, even if you look at the same time of night. Because of the planets own orbital path the planet may be more north at certain times in the sky or other times more southern. But the planets current position in the sky will be constant for a week and will change or a course of a month to a year. Know this you will also be able to find you east and west directions. “The most useful things the planets can do is help us to hold a course. We might use the stars to find direction, let’s say we are heading southeast one morning and Venus is brightly showing the way then it is a great way to hold a steady direction, particularly if the terrain is confusing (Chichester, 2013).”

Sextant

Known to mostly sailors it is a commonly using tool in celestial navigation. The American Thomas Godfrey invented the Sextant in 1730 but at the same time another inventor in London, a mathematician John Hadley in 1731 also invented it and to this day his clams the credit. “To use a sextant, one points the telescope portion towards the horizon, makes adjustments to correct error based on index and dip, and then sights the celestial body as it is reflected by double mirrors, and moves the arm of the sextant down so that the body appears to just touch the horizon (N/A, 2010).”
**Chronometers**

“(clocks) were a vital part of navigation during the seafaring days as well. John Harrison invented the first chronometer in 1762 and won a contest with it! Little did he guess where his prize winning invention would take civilization in later years (Bradish, 2011).”

Having to be wound every couple of hours the chronometers would keep the time accurate and they could track how the stars would move. Used with the sextant and a compass, this piece of equipment was the start to over sea trading. The compass was invented in China, which could now keep the sailors in control of traveling in a single direction. Marco Polo was the first European to visit china and he came back with the compass, and Christopher Columbus used to compass to find is way to the new world.

**Summary**

From the beginning of time the Stars has always been there, and with them there they have been guiding us along on our travel and into modern history. The Stars may be the one single factor that bought us to where we are today. Without the stars for navigation there would have never been continental trading which made the advancements into modern technology.
References


Magnetic Resonance Imaging
with “Spin” Physics

Kaitlan Porter

Physics 112
Dr. Casey Durandet
November 19, 2012
Abstract

Magnetic Resonance Imaging is a medical imaging technology that produces detailed images of internal organs, tissues, and bones. This technology utilizes spin physics along with non-iodizing radiation across a magnetic spectrum to produce this innovative image that is critical to the medical field in diagnosing diseases and injuries. The spin physics is imperative and essential to this technology that has become a foundation block of medical diagnosis and expertise. This medical technology only continues to advance and innovate to further serve as a key component in medical diagnosis and non-invasive procedures.

Introduction

Magnetic Resonance Imaging (MRI) was an imperative advancement for medical technology. This imaging technology gave physicians the ability to see the internal body in great depths in a non-invasive matter. An MRI device is composed of a magnet, magnetic gradient coils, an RF (radio frequency) transmitter and receiver, and a computer that controls the acquisition of signals and computes the MR image. Every component of this device is imperative and necessary for the MRI image to be produced. Medical imaging was confined to only ionizing radiological imaging before this; which limited their capabilities to produce detailed imagery of the body’s tissues and organs.

History

MRI technology has come to light through the work of several devoted people in history. In 1936, Physicist, I.I. Rabi demonstrated the phenomenon of nuclear magnetic resonance. Years later in 1946, Felix Bloch and Edward Purcell independently added to the development with the discovery of using wave lengths to detect nuclear resonance signals. This monumental
discovery gave birth to the nuclear magnetic spectroscopy\textsuperscript{1}. These two discoveries are the foundation of MRI technology and modern chemistry. In 1971, Raymond Damadian showed that “nuclear magnetic relaxation times of tissues and tumors differed.” It was this discovery that pushed the medical world to consider using nuclear resonance for detection of diseases. In 1975, Richard Ernest proposed the idea of using magnetic resonance imaging using frequency and phase encoding with the Fourier Transform\textsuperscript{1}. Ernest’s works are the basis of modern MRI technology. “Edelstein and coworkers demonstrated imaging of the body using Ernst’s technique in 1980. A single image could be acquired in approximately five minutes by this technique. By 1986, the imaging time was reduced to about five seconds, without sacrificing too much image quality.” The ability to produce such a detailed image in a matter of five seconds was a large leap forward in medical technology. In 1993, the development of a Functional MRI was introduced, making advanced MRI opportunities a reality\textsuperscript{3}. This gave physicians the ability to have the test performed quickly with high efficiency which also made the ability to have the results returned in a fast manner. MRI technology is constantly innovating to produce enhanced images of higher degree.

**Creation of Magnetic Field**

There are several components about MRI technology that make it far different from any other medical imaging technique. Unlike CT (computed tomography) scans and X-rays, MRI does not depend on ionizing energy\textsuperscript{4}. This is much safer for the patient. MRI instead utilizes a magnetic field to redirect the axes of the spinning nuclei to produce the image\textsuperscript{4}. Coupling multiple fields is what makes imaging with the long wavelength and low energy magnetic resonance signals possible. The magnetic current is generated through the magnetic coils. The nuclei of atoms, act as magnets that can be manipulated to line up in a specific way with the emission and absorption of non-ionizing radiation energy; this manipulation of atoms in addition to calculated spin physic along with the magnetic field produced from magnet and magnetic coils, are what allows the image of great detail to be produced\textsuperscript{1}. The spin physics come from the nuclei of an atom being composed of protons and neutrons, when there is odd numbers of each, an angular momentum or “spin” is produced\textsuperscript{5}. The spin “generates a magnetic moment” which allows the rotating magnetic field to act on the atoms that are acting as “tiny magnets with a north and south pole.” The magnetic field acting on these atoms along with magnetism causes them to align to produce an image. Without an external magnetic field acting on the atoms, the orientation of the nuclei would be “random and cancel each other out.” This technology is the only safe non-invasive procedure that yields detailed images of the body’s organs, soft tissues and bones to make diagnoses of diseases and injuries.

![Diagram of MRI process](image)

**Figure 2\textsuperscript{1}**

Combination of Fields to Create “Spin” Physics
Basic MRI

MRI has two different basic imaging types produced that are based on their relaxation time. The relaxation time, is the period of time that it takes for the protons to regain their equilibrium state again. There is a T1, which is longitudinal, meaning that the nuclei are parallel to the magnetic field or there is T2 which is transverse, meaning that the nuclei are aligned in a perpendicular manner. There are two components that differentiate between the two basic MRIs. The first component is, Repetition Time (TR), this is the time between continuous RF(Radio Frequency) pulses. Echo Time (TE), is the second component, this is the “time between the arrival of the RF pulse that excites and the arrival of the return signal at the detector.” T1 MRIs will have a short TR and a short TE while a T2 will have a long TR and a long TE. The differentiation between the two causes different aspects to be bright and different aspects to be dark. The T1 have “CSF(Cerebral Spinal Fluid), Increased Water – edema, tumor, infarct, inflammation, Infection, hemorrhage (hyper-acute or chronic), Low proton density, calcification, flow void” all dark while the “fat, sub-acute hemorrhage, melanin, protein-rich fluid, slowly flowing blood, gadolinium, laminar necrosis of an infarct will be bright(white).” T2 will have “Low Proton Density, calcification, fibrous tissue, Paramagnetic substances – deoxyhemoglobin, methemoglobin (intracellular), iron, hemosiderin, melanin, protein-rich fluid, and flow void” dark while “increased water – edema, tumor, infarct, inflammation, infection, subdural collection and met hemoglobin (extracellular) in sub-acute hemorrhage is going to be bright.” The T1 will have the white matter brighter than the grey while the T2 will have the grey matter brighter than the white matter. T2 is much smaller than T1 with a time of 25ms to 250ms while T1 is 250ms to 2500ms. These two different MRIs give physicians the ability to analyze the body in different degrees. Having both a T1 and T2 image can help physicians see things more clearly and help them diagnose any possible diseases. This is all due to the ability to manipulate the atoms when combining multiple fields with “spin” physics.

![Image](image-url)
Speciality MRI

Functional MRIs were introduced to the medical world in 1988 when Seiji Ogawa’s and his colleagues discovered that small veins in the brain give extra contrast to the image, this MRI is more advanced than a basic MRI. This discovery was known as the BOLD effect: Blood Oxygenation Level Dependent. The brain has more blood flow when its active, this extra blood flow requires more oxygen with more carriers and some often get left behind. The magnetic distortion by deoxyhemoglobin is lessened due to this which causes the BOLD effect in the small veins of the Brain. This allows physicians to assess brain function in a non-invasive matter by analyzing where in the brain this extra contrast is projected. They lay the MRI images over a generic brain map that specifies which areas should be stimulated by a certain motor skill. These MRIs have to be done at a very fast rate because the increase in blood flow is very rapid as well. This was a critical medical advancement.
Interventional MRIs have quickly become the method of hope with cardiovascular procedures. “iCMR refers to catheter-based procedures using MRI rather than conventional radiographic guidance. iCMR promises further to blur the distinction between medical and surgical therapeutics by permitting surgical-quality “exposure” in minimally invasive procedures.” iCMR is praised by the medical community because it involves catheter procedures that are able to be performed without X-ray exposure for the patients and staff. However, the medical leap is that these procedures open the door for several procedures to be performed that were only possible by performing “open surgical procedures before.”

Interventional MRIs do require Real-Time imaging during the procedure; real time imaging means that there is, “image acquisition and display to clinicians, completely refreshed 1–10 frames per second, depending on the application, within a short delay (approximately 250 ms)” This MRI procedure is possible because of nuclei of blood and tissue have magnetic moments or “spin” that will align in a magnetic field. When this field is exposed to radio waves, spins become energized and will emit radio signals (“relax”), a process that can be detected by sensitive radio hardware. The timing of radiofrequency pulses and magnetic field gradients are what determines the image contrast while the biochemical and physical properties of body tissues offer and array of possible images based on “tissue composition, distribution, and motion, not merely on atomic density as in x-ray.” This procedure is far more time efficient and safer for patients than performing an open surgical procedure. One problem that seems to be presented in with this MRI is that there is a lack of clinical-strength catheter devices available which are necessary to execute the Interventional MRI. This procedure has not yet been utilized in an active manner with several aspects being investigated and tested. In the future, the hope is that, “iCMR will provide several imaging advancements, “such as image-guided ablation to treat cardiac rhythm disorders, minimally invasive extra-anatomic bypass and beating-heart valve repair.” It is ground breaking in that “not only can iCMR provide surgical-grade exposure for clinicians, it can visualize the immediate effects of treatment upon target tissue.” iCMR guidance for “transcatheter cardiovascular procedures” has the ability to transform the way interventionists operate, allowing them to perform procedures with minimal invasion that was not at all possible with any other conventional imaging prior to this.
Medical Significance

It has been discussed thus far that MRI imaging was life changing for the medical world in the sense that it allowed for the first non-invasive procedure that had the capabilities of diagnosing diseases and injuries that would have otherwise only been detected through a surgical procedure before. Before this MRI technology physicians used CT(computed tomography) and X-rays for radiological imaging for diagnosis. These both rely on ionizing radiation that is not safe for any person, including the person administering the radiological procedure. Both procedures are limited by the inability to “visualize low-contrast tissues and structures with acceptable levels of patient radiation exposure.” When having an X-ray done, physicians were limited to really only having the bones being distinguishable. This did give them the ability to diagnose those with broken or fractured bones but nothing past that. CT scans are also limited in that there is a differentiation in bodily organs and bones but they are not clearly projected. MRI imaging gave physicians the capability to diagnose labrum ligament tears in a patient’s shoulder that would have otherwise only been seen through invasive surgery. MRI technology has also given the world the capabilities of diagnosing cancer, diseases and the ability to assess cranial activity with BOLD effect. This effect has given the medical world the opportunity to learn so much about Alzheimer’s, Parkinson’s, and epilepsy and many other neurological diseases. It has also been used to diagnose and track the progression of arthritis. Among helping diagnose multiple sclerosis. This technology saves lives every day with several cancers being detected much earlier than before because it requires a scan that takes minutes instead of an “exploratory” invasive surgery to assess if there is a possible cancerous tumors. MRI technology is not perfect with several areas of research for continuous advancement of this intricate yet very enlightening radiological procedure. Spin physics is the key component of this monumental achievement. The manipulation of multiple fields with nuclei to align in a specific manner is key to the MRI technology and success.

Conclusion

Radiological Technology is constantly evolving and developing to help with diagnosis of diseases and injuries. MRI technology is not only a stepping stone of radiological technology but one of largest advancements in the history of medical radiology. Through the developments of medical radiology, there was advancements in the physics world, chemistry and even biology as well. Physics is a foundation block of MRI Technology. Without “spin” physics, the ability to capture images to such a detailed degree, in multiple fashions, would not be possible.
Bibliography


The Physics of Bird Flight

by Kian Pourkay

PHY 112

Dr. Durandet

April 14, 2013
Abstract: This report will cover the fundamental physics behind how birds fly. In order to fully explain avian flight the anatomy of a bird will also be explained to better understand how forces such as lift are created. In addition all the other forces governing flight such as drag, thrust and air resistance will also be explained. Finally this report will compare the flight of birds to those of the modern day aircraft.

One of the most fascinating phenomena of nature is the flight of birds. How do these wonderful creatures soar through the air effortlessly and defy the laws of gravity. It is something that everyone marvels at and a dream of every child to be able to soar through the clouds. But how do these birds actually propel themselves into flight. The answer to that question involves some extraordinary evolutionary adaptations that allow birds to use the fundamental principles of physics of allow them to take flight. Evolutionary adaptations such as wing design and feathers are what help allow the bird to take flight high above the sky. But other anatomical features such as light strong hollow bones are also intricate parts of what allow birds to take flight. Birds have evolved very well to take flight but that does not mean there task is simple or easy, for instance it still take a lot of energy for a bird to initially take off but once the bird does take flight they can use mother nature to their advantage. Using the wind and air currents help birds conserve their precious energy while still creating the lift needed to keep them gliding through the air. Although taking off might be considered the most difficult task for a bird landing is not such an easy task either. The bird must adjust the wing angle to create drag to slow its speed down in order to be able to land. Bird flight is something truly amazing but upon further examination it becomes obvious that flight is not something magical but with the right evolutionary traits and using the fundamentals of physics, it can be achieved. There are several important principles involved with flight and the first and most important ones has to do with creating lift which allow a bird to get off the ground and into the air. Bernoulli’s principle plays in an important role in how lift is created through the differences in pressure across the top and bottom of the wings. Other important forces such as thrust, drag, and air resistance all play important roles throughout avian flight. Understanding the principles governing flight have allowed humans to create the airplane, which applies the same forces of physics to create lift and fly. Understanding the system behind bird flight is largely responsible for what of the greatest engineering feats of mankind. The airplane allows people to go all over the world in a relatively short amount of time and all this was possible by observing and better understanding the physics behind flight.

In order to fully understand how birds fly the anatomical features that allow the bird to fly must be examined. An important necessity for birds to fly is weight. Birds must be light and agile and many of their physical attributes have been developed to eliminate weight while still having overall strength and stability. “The evolution of flight has endowed birds with many physical features in addition to wings and feathers. One of the requirements of heavier-than-air flying machines, birds included, is a structure that combines strength and lightweight. One way this is accomplished in birds is by the fusion and elimination of some bones and the "pneumatization" (hollowing) of the remaining ones. Birds have found other ways to lighten the load in addition to hollowing out their bones. For instance, they keep their reproductive organs (testes, ovaries and oviducts) tiny for most of the year, greatly enlarging them only during the breeding season.” (Ehrlich 1998) As Ehrlich notes, this shows how important it is for the birds to reduce weight as much as possible. One of the first things most will note is that birds have wings and that allows...
them to propel through the air. Although all birds do have wings the ones which actually take flight have important characteristics which allow flight. According to Videler, “Wings of all flying birds have important common features: they all consist of an arm and a hand part.” (Videler 2005 p 26) Wings are an essential part of bird flight and are an integral component of balancing forces of air that air created when the bird flaps its wing. It is essential that the bones of the bird are hollow, light, and strong which all contribute to the process of flight. Another critical aspect of the wings is its shape. The shape of the wing determines the type of flight for the bird. Feathers also play an important role in flight as some of the feathers located on the wing and tail act like a hand allowing the bird to create a flapping motion.

Bird’s wing anatomy

The wing skeleton
The wing skeleton is similar to a human arm. The upper arm is shorter than the forearm and the finger bones are coadunate. Between the shoulder and the wrist is a long tendon. The primary and secondary remiges (flight feathers) are attached to the hand and forearm parts of the wing like a fan. The bones are very small compared to the overall size of the wing.

Feathers
Birds have got different types of feathers: fluffy down feathers for isolation, contour feathers and specialized flight feathers, called remiges on the wing and retrices on the tail.

The primary remiges (violet) are attached to the wing hand. They get longer and more pointed towards the wingtip. Usually there are 11 primaries.

The secondary remiges (blue) have a rounded edge and get smaller towards the elbow. Their number can vary from 6 to 32 single feathers dependent of the wing shape.

Above the remiges are several layers of coverts (green). They help to form the smooth aerodynamic shape of the wing. The closer to the arm bones the smaller the feathers are. They are bigger on the top side of the wing.

The Alulae, thumb feathers (dark blue), on the top of the wing hand work like the airbrakes of a plane.

The scapulare, shoulder feathers (orange) form the transition from the wing to the bird’s body.

Figure 1. Details the anatomy of a bird wing skeleton as well as it feathers.
The anatomical developments of the bird allow it to take flight but how does the principles of physics apply to the flight of the birds. To understand the principles of physics governing flight the flight of the bird will be broken down into several steps. The first step is the takeoff, much like that of an airplane, the second step is the gliding phase, and finally comes the landing. For birds the most difficult and energetically demanding portion of flight is the takeoff. This takeoff phase requires a great deal of energy and is the most difficult part of flying. Birds use their wings to create a force called lift which allow the bird to go up in the air. To get that initial lift birds will begin flapping their wings and running directly towards the wind and due to the shape of the wings there is lift. To understand how lift allows the bird to fly up the principles of air pressure must be examined. As a bird is running in the direction directly facing the wind a difference in pressure is created due to the shape of the birds wings. Due to airfoil design of the wings which create a difference in pressure where at the top of the wing the faster air reduces the pressure while the slower air below the wing raises the pressure. The air pressure on top of the bird acts likes it sucking the bird up while the increased pressure from below actually pushes the bird up. This is what is known as lift. One of the fundamental principles in physics which can apply to fluids or air in this instance is Bernoulli's principle. Bernoulli's principle describes that when a fluid, or in this case air, increases its velocity its pressure will decrease. The airfoil shape of the wings of both birds and airplanes use this principle to create lift. A separation of air is created due to the uneven shape of the wings across both the top and bottom of the wing. In addition the air that is being separated at the front of the wing must rejoin the back to ensure that a vacuum is not created. Since the surface of the wings at the top is longer and curved upward the air moving across it is moving at a faster velocity that the air travelling across the bottom. As Bernoulli's principle states the faster air creates less pressure and hence the bottom of the wing will create a greater pressure creating what is known as lift.

Figure 2. Describes the airfoil design of a bird wing and how lift is created by the differences in pressures created by the high velocity of air above and slower velocity below the wing.

Figure 3. Shows the similarities and the airfoil design of both a birds wing and the wings of an airplane.
Now that the birds have done the hard part and expended all that energy to create lift and get up in the air, how do they defy gravity and stay up in the air. There are a couple of techniques that birds can use to ensure they stay up in the air while expending less energy. The first example is soaring, in which the birds make use of air currents to hold them up. There are three kinds of air currents that are especially helpful to soaring birds. “The first is thermal air currents which develop in places where the air is warmer in one spot than an adjoining area, such as a paved road alongside a snowy field. Even on a very cold day, the sun will heat the pavement at least a few degrees more than the snow. This slightly warmer air is slightly lighter than the colder air, and rises. This rising air current can lift very light objects, like feathers and hollow bones. The birds that most often take advantage of thermals (like the hawks that fly along coastlines) usually have very wide wings and tail. This makes the area of their wings very large compared to their body weight” (Learner.org) Secondly there are updrafts which are created when air hits some sort of cliff or building which creates a rush of air to the top, which a bird can utilize to carry itself up. Finally birds can use the wind to their advantage. When the wind is moving towards a bird the bird can spread it wings and hold itself up, once again due to the airfoil shape of the bird wings. These first examples are ingenious ways that birds use mother nature to conserve energy and stay aloft in the air. But there is also another way in which the bird can stay up in the air and that is by way of flapping its wings.

These pictures above illustrate the point above how birds will use the currents to glide through the air without expending much energy. The second photo on the right is a good visual about how air will funnel through a cliff and a bird can use that rising air to lift into the air.

Overall there are several different forces that act on a bird during the course of flight. The initial force of lift which is created by the movement of air across the wings of a bird. The force opposing this lift force is the downward force of gravity.. Birds can continue to glide in the air so
long as enough lift is generated to counteract the downward force of weight or gravity. Thrust is the force that is propelling the bird or plane forward. This can be generated by the backward push of a birdwing or can be generated by a jet engine. The force of thrust propelling an object forward is due to experience another force in the opposite direction called drag. Drag is friction between the moving object and the air. It is also known as air resistance. In order to reduce drag or air resistance a bird or plane will have a very streamlined and aerodynamic body. It is becoming evident that the physics of bird flight is very similar to that of jet airplane with the obvious differences being that the airplane creates thrust and lift with the jet engines.

Figures: These two pictures describe the different forces acting on both a bird and a plane. Notice that both have the same forces of drag, thrust, lift, and weight acting on each.

Flight is such a marvelous feat and the fact that birds are able to what seems like effortlessly fly through the air makes it even more spectacular. It is incredible to see how evolutionary adaptations allow birds to defy gravity and take flight. But the real beauty is that birds are not really defying gravity but using their adaptations as well as the fundamental principles of physics to propel themselves high above the sky. Birds using their wings to create an airfoil that allows a pressure difference to create lift, is also a founding principle of Bernoulli. Thrust, drag, air resistance are also integral parts of the mechanics behind avian flight. As a child I had always been mesmerized by the way birds take off and fly away, how was that possible? Would I be able to flail
my arms run and fly away. I now know that would be a hopeless task but understanding the physics behind how birds fly is paramount. Modern aeronautics utilize these principles every single day when we travel by plane, so it important to understand that the same principles that govern how birds fly apply to airplanes as well. Just comparing airplanes and birds and its easy to see the similarities. But these are similarities are not just accidents or simply a coincidence, they are the achievement of science and technology to understand all the fundamental principles involved in flight. By studying how birds fly humans have created airplanes that make travel all over the globe remarkably simple. Although the technology and the mechanics involved in an airplane are anything but simple, knowledge of the forces of lift, drag, thrust and air resistance make it easier to understand how airplanes work. It is truly remarkable to see how the observation and understanding of how birds fly was used to create airplanes. The ability to travel by plane gives people a chance to explore all over the world in a duration of hours. It is pretty amazing to see the similarities between how birds fly and how those same principles have been applied to modern airplane flight today.


Abstract

The art form of photography has gone through some major changes in its history. It started out as a dark room, with a small pinhole in one of the walls, displaying an image on the opposite wall, to becoming one of the most advanced pieces of technology one can own. The developments have allowed people to make businesses with their photography talent, and the everyday person to capture a moment in a photographic memory.

Introduction

In the past, portraits could only be afforded by the wealthy. There was a painter that would paint for hours on end of a wealthy person, who had to stay completely still for the entire period of time. With the invention of the Camera Obscura, the wealthy were still the only ones who could afford to create photos with this object, but it opened up many opportunities for employment. For one century, artists and photographers used this technology, and there have been much advancement with cameras because of the basis the Camera Obscura set. With all the different types of cameras made after the Camera Obscura, there is one man that stands out from the rest with one of the biggest discoveries on how to create an image, without being an artist. That man was a French leading theatrical scene designer, Louis Jacques Mandé Daguerre. His creation lead to dozens of new cameras invented within a century, including one of the most effective photo making processes, the Collodion Process, which gave way to the invention of film photography. Advancements in computer technology allowed for the invention of the digital camera, which saved their images on digital media, like a memory card or on camera memory, to than be transferred onto a computer. This is the style of photography that consumers are most familiar with, because this is the technology that has been in use since the 1990’s.

Early Forms of Photography

There are known documentations that dates back to the fifth century B.C.E., that states ideas on how light can reflect off an object, and pass through a pinhole into a dark container, and reflect an inverted image of that object. Although there have been several other instances with similar ideas, the Camera Obscura’s credit was given to Leonardo da Vinci in the year 1490. The Camera Obscura consisted of a dark room, with one wall containing a small pinhole, the reflection of the outside objects would display through the pinhole, inverted, on the wall opposite to the pinhole. In order for painters to capture the image, the placed canvas sheets on the wall, and painted the scene by tracing the reflection.

Although the Camera Obscura was successful for those who had the talent to paint the pictures, and could afford to make the room, it was too impractical because the artist wasn’t able to take the room, or in some cases a free standing building, around in order to paint other things. There were a few other camera systems created after the Camera Obscura that still
required an artist to paint the scene or portrait, but they didn’t have as great of an impact as the Camera Obscura for the next few centuries. A more compact system needed to be created, and it was done so, by a French leading theatrical scene designer, Louis Jacques Mandé Daguerre in the year 1839. Daguerre constructed a device, called the Daguerreotype, which was a portable box, and allowed light to enter through a larger pinhole to expose the image on the other side. The major advancement in the Daguerreotype was that anybody could create the image, because there wasn’t any painting involved in creating the image. In order for the image to be created, a silver-plated copper sheet needed to be treated with iodine, which allowed the image to be formed when exposed to light. The image needed roughly around twenty minutes of exposure time in order to create the image. The image that was created on the sheets came out as a negative image, so in order to reverse the colors and make the photo correct, the image needed to be treated with mercury vapor. To prevent further exposure from light, the plate was than washed with saline solution after the vapor process, which created the long lasting image.

Although this allowed virtually anybody to make photographs, the supplies were expensive. Unfortunately, this could only be used by the wealthy as well. A new process was developed shortly after the Daguerreotype that printed to paper, making it more affordable, but the different chemicals that were used weren’t reliable, and that caused the photos to fade away. In the year 1849, Frederick Scott Archer saw this issue and took it head on. He wanted to design a process that would be printed on a substance that wouldn’t fade away, and have the ability to make copies of the photos made. The process he came up with was called the Collodion Process, or wet plate process. This new process didn’t require as expensive supplies with the camera. This camera system looked similar to that of a Daguerreotype, but now it had a lens. The body was adjustable to allow the photographer to focus on his subject. The adjustments allowed the photographer to adjust the focal length with respect to the lens. The Collodion Process was known as the wet process because a glass plate needed to be coated with a combination of potassium iodide, and ether mixture, than exposed while wet before the
solution evaporated. When the exposure was finished, a negative image was made on the glass plate, but since it was on glass, it allowed people to create copies of the image on other pieces of glass, paper, and tin.

A few other versions of the Collodion Process were developed all consisted of similar preparation and development process, just changing the material type the exposure took place on. One of the most popular Collodion Processes was the Tintype. This became very popular because it allowed everyone, even people in the lower class, to get his or her pictures taken. Tintypes were made on small iron plates, and photographers opened up businesses and took the images for people for a fee. Since they were made on iron, the images lasted for many years, allowing the client to keep their images and memories for centuries.

Figure 3
Example of Tintype Photograph

Development of Film Photography

Further developments from the Collodion Process lead to different forms of film camera to be invented. A film camera is a very basic form of technology that some people still use today. A film camera consists of three main things, the optical element, film, and the camera body. The optical element can consist of one lens, know as a fixed or prime lens, which will only allow the produced image to be as magnified as the lens is. The other styles of optical elements consist of many lenses that work together to allow on to control the zoom of the picture they are taking. Most lenses throughout the 1900’s were fixed lenses. It wasn’t until the Single Lens Reflex, or SLR, was introduced that optical elements had the capability to zoom onto a subject that was being photographed. One of the iconic film cameras from the earlier part of the twentieth century was the field, or view camera. The field camera was made of a wooden body, and accordion style sides, to allow the photographer to adjust the focal length, to allow the camera to focus.

The lenses were interchangeable, and each had their own magnification, as well as mechanism. These mechanisms controlled how long the shutter, or opening of the lens, stayed open to expose the film sheet in the camera, as well as the ability to adjust how large the opening was. This opening is known as the aperture, which can still be found in most of the cameras in today’s market. The film sheets that were used in the field cameras were large pieces of chemically altered films, that when exposed, would take on an image of what was being
photographed. The film only made three colors, red, blue, and green. The earlier forms of film cameras and field cameras didn’t have flash built into them, like the cameras of more recent times. In order to take a photograph, the object needed to be in some sort of lighting conditions, to allow the film to create an accurate photograph. This is necessary because the film is light sensitive, so light needs to reflect off the object, and than into the camera by passing through the lens and hitting the film sheet. When lighting conditions weren’t ideal, photographers were able to use a hand held flash that they had to set off themselves, to expose the object with light. Typically, the handheld flash made a large white spark, which gave off a white smoke as well. The smoke was helpful because it diffused the light coming of the handheld flash, giving a more realistic lighting condition. Within a few years, updates were made to the field camera, allowing it to become handheld, but still too bulky for a consumer to take around on a vacation or to take pictures of their families. A few decades go by before probably the most iconic camera series of all time is made, the instant print film cameras. Although there were a few companies to produce these cameras, nobody was as successful as Polaroid. When first released in 1972, the camera was known as the Magic Camera, because it was able to print out a picture right out of the camera, and an image would show up within minutes. Although the systems were a bit expensive when they first came out, this was the most ideal camera for consumers to date because it allowed for a handheld camera to be taken around wherever the consumer wanted, and the pictures were printed automatically. This saved the consumer time and money because they didn’t have to get the film developed, or develop the film themselves. One of the limitations that occurred with the instant print cameras was that the consumer wasn’t able to make copies of their photos, because that required negatives of the photos. Also, there wasn’t a way for there to be larger versions of the photograph to be created. For these reasons, some consumers used cameras with standard rolls of film, which created negatives of the images taken. With negatives, one is able to create multiple copies, and manipulate an image by enlarge or shrink an image to a desired size, or even make small corrections to the image, like coloring out an object in the background. With the flexibility of traditional film, more advancements were made with standard cameras and SLRs. With standard cameras, the consumer was limited by the lens as to how close a subject had to be in order to take a clear photograph, but with Single Lens Reflex, or SLR camera, a new advancement opened up. SLR cameras had the ability to change out lenses, which most cameras at the time weren’t able to do so, except the unpractical field camera. Early SLR lenses were fixed, but developments happened to create zoom lenses, telephoto lenses, and wide-angle lenses. Each one of these lenses had an adjustable aperture, some larger than others, and was able to be controlled on the camera as to how long their shutter would stay open. A telephoto lens typically had a larger magnification than a fixed lens, and also had a larger focal length. A larger focal length allowed for there to be a greater depth of field, which allowed the photographer to have a foreground, middle ground, and background in his or her photograph. With a wide-angle lens, the foreground tended to have the illusion that it was closer than it actually was, and same sort of
principle with the background, except it seemed further away. Both of these lenses were
great in respective situations, but a zoom lens had the ability to have qualities of both a
telephoto and a wide-angle lens. With a zoom lens, the focal point was adjustable, and
having multiple optical elements inside the body of the lens allowed for there to be
adjustable magnification. Depending on how the photographer adjusts the lens
determines whether it will have qualities like a telephoto lens, or a wide-angle lens, or
something in between. Once again though, people using film cameras wanted something
better and more practical, so that the hassles with film would become obsolete.

**Digital Photography**

With advancements in electronics and technology, cameras were able to be produced with
the ability to save their photos not to film, but different forms of digital media, like a
memory card. Since the cameras had electronic parts in them, they needed to have some
sort of power supply inside them in order to create an image, and this was achieved by
using batteries. Since most of the mechanical parts in film cameras became obsolete, and
they were replaced by electronic components, it allowed for cameras to be produced
smaller than ever before, some even having the ability to fit into a pocket. Since the
photos could be saved onto a form of digital media, the pictures were able to transfer to a
computer and now were able to be edited with software rather than by hand. With photo
editing software, one can adjust or change color, remove or add something to the picture,
make corrections, enlarge or shrink and image, and even combine images together. In
order for a camera to generate an image, an image sensor replaced the film. This process
is done very similarly to that of a film camera. When the camera is pointed at a desired
subject, the display screen shows what is about to be photographed, because the object
reflects light through the lens and onto the image sensor. When the picture is taken, the
shutter closes, and the image sensor is able to electronically form what was taken. In
early development of digital photography, most cameras consisted of a fixed lens, but
within a few years, were quickly replaced by zoom lenses. Another advancement in
digital photography was creating a digital form of the very successful SLR, which is
called a Digital Single Lens Reflex camera. DSLR cameras also use zoom lenses,
telephoto lenses, and wide-angle lenses. Some DSLR cameras even have the ability to
use old film SLR lenses, for those who converted from film to digital.
The optical capabilities of DSLR lenses worked just like their film counter parts, the
focus, aperture, zoom capabilities, and focal lengths all worked the same. One of the
advantages of using a digital camera over film was that digital sensors allowed one to capture
video on the same device by placing the camera in a different mode. This allowed a
consumer to capture not only a still shot of a memory, but can capture a set point in time by
taking a video. This also helped out
photographers and businesses because it

![Example of a Modern DSLR Camera](image)

Figure 6
allowed them to advertise or produce in video format or picture format. One of the capabilities a DSLR has over a standard digital camera is how the image sensor is blocked by a mirror that displays what is reflected through the lens, and shows the image in a view finder. The importance of this is the precision it allows one to achieve. Keeping the sensor covered allows the photographer to adjust the lens for the most accurate reading, since it is coming straight through the lens. When the picture is taken, the mirror flips up, and the reflected image comes through the lens and hits the sensor. Some more recent advancements in digital cameras include GPS tracking built into the camera, incase the camera gets lost, or if someone wants to know exactly where they were in the world when the took a specific image. Also, the ability to wirelessly share images on the camera to a computer, or even a cell phone is a quality that many manufacturers are developing, some who have already made this technology possible.

Conclusion

The art form of photography has gone through some drastic changes throughout its existence. Going from artists painting a portrait, to a room with a pinhole in one wall and tracing the formed image, to the combination of chemicals that formed an image when exposed to light, the rise and fall of film photography, and finally, the modern day digital camera. Although not all forms of photography have been successful in creating long lasting images, many of them were. Whenever the technology seems to hit a plateau, a new form of photography comes around and makes the previous version on the verge of extinction, like the film to digital photography transformation. It is hard to say where digital photography will be in ten years, will it be obsolete? Will it be gone all together because of the advancements in cameras in cell phones? Or will it keep progressing at the speed it has been going?
Bibliography

Milky Way Galaxy

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AST 111

Professor Weitz
Abstract: The Milky Way Galaxy is a spiral galaxy that has billions of stars inside of it including our Sun and our own planet Earth. We have a few neighbor galaxies including Andromeda and the Large and Small Magellanic Clouds. While the other galaxies out in the universe are interesting our own Milky Way has some incredible sights for us to see and more mysteries than we have time to talk about. With a vast selection of constellations each with their own history and a massive black hole in the center of our galaxy there is something for everyone to be excited about. The origins of our galaxy and the large array of objects inside of it have been the source of speculation and curiosity for thousands of years. It truly is a force to be reckoned with.

The Milky Way Galaxy is the galaxy Earth and many other planets call home. The name Milky Way is a Latin translation of “Via Lactea” which is derived from the Greek word “Kiklios Galaxios” which means milky circle.(2007). Democritus was the first to create the idea that the Milky Way contained distant stars and William Herschel made the first map of the galaxy in 1785.(2007). The Milky Way consists of approximately two hundred billion stars.(Our Own). Our Sun is part of this large number of stars. So you can only imagine how massive our galaxy is compared to the size of our tiny planet Earth. It is considered a spiral galaxy and has three main parts to it.(Our Own). The disk, the central bulge, and the halo.(Our Own). Our galaxy's disk has four spiral arms and is full of young stars aging anywhere from a million to ten billion
years. (Our Own). The bulge is at the center of the galaxy and is a high density region that contains old stars aging at about ten billion years. (Our Own). The halo surrounds the disk and has a low density of older stars and a large amount of dark matter. (Our Own).

Learning about the Milky Way is exciting but being able to walk outside and see the galaxy is fascinating. The Milky Way has many different aspects to it and is a beautiful sight to see.

The Milky Way can be seen in the night sky without the aid of telescopes. To observe it you must be in a place free of light and pollution and the night sky must be cloud free. (The Milky). The galaxy will appear as a band of light stretching from one horizon to another. (The Milky). This band of light is actually billions of individual stars but since our eyes can’t distinguish between them all it appears as a large band of light. (The Milky). In this band of light you will see dark patches. (The Milky). These dark patches are from clouds of interstellar gases. (The Milky). Radio telescopes can see through these dark patches however and they show spiral trails of material from our galaxy. (The Milky). Our galaxy has a bulge of stars at its center where a black hole is believed to be located. (The Milky). The galactic center is in the same direction as the constellation Sagittarius that can be seen in our night sky. (The Milky).

There are many sights to see in the sky from down here on Earth. Almost everything we can see with the naked eye is part of the Milky Way galaxy with a few exceptions. (McClure, B.). One of the most notable sights is the little and big dipper. The big dipper
is actually not a constellation but just a star pattern. (McClure, B.). It is a part of Ursa Major which appears to look like a bear. (McClure, B.). The big dipper consists of the tail and hindquarters of the bear. (McClure, B.). Ancient stories tell that blood spilled from the bear from hunters is what gives autumn leaves their color. (McClure, B.). The little dipper is part of Ursa Minor and was used to navigate out in sea by the Phoenicians and Greeks. (McClure, B.).

Another sight to see in the sky is the Northern Star. Another name for this star is Polaris. (Kaler, J.). This star marks the North Celestial Pole. Polaris is actually slightly off the pole and eventually will be not be by the North Celestial Pole anymore. (Kaler, J.). The North Star is the end of the handle of the Little Dipper. (Kaler, J.).

The Milky Way has spirals or arms that branch off from the center of it. (Orion Arm). Orion’s arm is a minor spiral arm in which the Sun is located. (Orion Arm). It received its name because the stars by the Sun are in the constellation Orion about two thousand light years away. (Orion Arm). This includes Orion’s belt which we are familiar with. This arm is a zone where new stars have been created by a wave called the density wave. (Orion Arm). These stars then illuminate the interstellar medium around them. (Orion Arm).

The Milky Way as we all know is home to our planet Earth. Many people wonder if there can be life on other planets and the best way to figure this out is to look for Earth-like planets. (Than, K.). At the moment we believe there are tens of billions
Earth-like planets orbiting stars much like our own. (Than, K.). Scientists believe one in six planets are rocky and orbit their star as close or closer than Mercury does to our Sun. (Than, K.). Scientists also believe their are about two hundred billion stars just in our galaxy. (Than, K.). Maybe one day we can find life.

The Milky way is a very large galaxy. It is about one hundred and twenty thousand light years across. (Wethington, N.). The galaxy is warped also. (Wethington, N.). This is because its neighbors the Large and Small Magellanic Clouds have been pulling on the dark matter in the Milky Way which causes warping. (Wethington, N.). The halo of the galaxy makes up for ninety percent of the mass of the galaxy in dark matter. (Wethington, N.). This is telling us that all we can see with our eyes and telescopes in only ten percent of what is really out there. (Wethington, N.). We know that there is dark matter because the speed of galaxies rotating around the center is quicker than what it would be if only the mass we can see with our eyes would be rotating around the center. (Wethington, N.).

As far as quantity of stars the Milky Way is right in the middle. (Wethington, N.). Galaxies like IC 1101 have over one hundred trillion stars while galaxies like the Large Magellanic have around ten billion. (Wethington, N.). The Milky Way has around two hundred to four hundred billion but the most you can see with the naked eye from Earth’s surface is about twenty five hundred. (Wethington, N.).
The Milky Way is also full of dust and gas. (Wethington, N.). We know the galaxy has dust because we can only see about six thousand light years from Earth and our galaxy is about one hundred thousand light years across. (Wethington, N.). Dust and Gas only make up about ten to fifteen percent of normal matter though with stars taking up the remainder. (Wethington, N.). The dust makes seeing into space difficult and this is the reason for the use of telescopes like infrared. (Wethington, N.).

Most people may not know this but we actually have a black hole at the center of our galaxy. (Wethington, N.). Sagittarius A is the center of our galaxy and it has a black hole with a mass of about forty thousand suns. (Wethington, N.). The size of the black hole is fourteen million miles across. (Wethington, N.). There is mass trying to get into the back hole. (Wethington, N.). This is called the accretion disk. (Wethington, N.). This disk has the mass of four million suns. (Wethington, N.).

A question a lot of people usually ask is how our galaxy formed and when. New research says that the Milky Way was formed by a collection of dust and gas and stars from preexisting small galaxies in the local universe. (Buser, Roland). The process is said to have began about twelve billion years ago. (Buser, Roland). Our disk and spiral is said to have came from galaxies combining at different angles and velocities. (Buser, Roland). In present timer the Milky Way is part of a local cluster of galaxies in the outer edge of the Virgo supercluster. (Buser, Roland).
Just recently a group of scientists are believed to have discovered the answer to a long standing problem. Astronomers discovered a large cloud of gas surrounding the Milky Way that weighs as much as all of our stars in our galaxy (NASA's). The size and mass has to still be confirmed but if it is a mystery will be solved (NASA's). This cloud is being called a halo and is thousands of light years wide. It is composed of hydrogen with some oxygen and other elements (NASA's). The temperature, size, and mass were all gathered from an X-ray observatory named Chandra (NASA's). Scientists believe the mass in this cloud is the answer to some missing baryon problem (NASA's). These baryons are subatomic particles that make up atoms in our galaxy (NASA's). Theories over the creation of our galaxy predict there should be much more of these particles than what we actually see (NASA's). The ones we’ve accounted for are only half the amount there should be (NASA's). Scientists believe the other half of these baryons are hidden within this cloud of gas (NASA's). They believe that the cloud of gas is as heavy as ten to sixty billion stars (NASA's).

Another interesting thing to learn about our Milky Way Galaxy is that two scientists recently announced that it is surrounded by a ring much like Saturn (Irion, Robert). this ring is composed of stars that are believed to have come from a galaxy we consumed (Irion, Robert). The ring is about twice as far from the center of our galaxy as our Sun is (Irion, Robert). It includes hundreds of millions of stars and has not been seen yet because it is in the plane of the Milky Way’s disk (Irion, Robert). This is where our solar
system lies (Irion, Robert). The ring is about one hundred and twenty thousand light years wide (Irion, Robert). Past astronomers had seen smaller arcs and formations around the galaxy but nothing to the size of this discovery (Irion, Robert). They are said to have came from dwarf galaxies and globular clusters that was dissipated in the Milky Way’s strong gravitational field (Irion, Robert). This event could have taken place as long as ten billion years ago (Irion, Robert).

Even with all this information about the Milky Way Galaxy there is still many questions waiting to be answered. This is only the tip of the iceberg and there is so much more detail and depth to study and learn when taking on such a large subject like the Milky Way Galaxy. Every year more and more information will become available to us as astronomers and scientists do more research and seeing how our view of the galaxy and its contents evolve over time is fascinating. It’s truly amazing how human’s views about space and the universe changed from believing the world was flat and we were all that existed to knowing that we are a tiny planet in a solar system that is inside a galaxy that is a part of a cluster of other galaxies that are all part of a much larger universe. Only time will tell what is to become of us and our Milky Way Galaxy. The next time you are outside take a few minutes, look up into the night sky, and just bask in the glory of our amazing galaxy and be happy that you were lucky enough to be given the opportunity to be a part of it. It truly is breathtaking.
Works Cited


The Milky Way
In this paper you will find information about different Galaxies especially our home Galaxy, the Milky Way. It will first begin with an in depth explanation about what a galaxy is and the components that it has. This paper will also include details on the different types of galaxies such as elliptical, spiral, and irregular galaxies. After the introduction of Galaxies, information about the structure of galaxies is given. In this part of the paper is found the main components that make up a galaxy. This is where the bulge, disk and halo of a spiral galaxy are clarified. It is then when we introduce our home galaxy referred to as the Milky Way. Where the Milky Way is located, where it got its name, what is our galaxy made up of and what it looks like to us are all answered in the following paragraphs as well as provides information regarding the surrounding galaxies, how far away they are from us and the affect that the Milky Way has on them. Lastly, the importance of the Milky Way to us and to its neighboring galaxies is exposed in the closing paragraphs.

“When you look at the stars and the galaxy, you feel that you are not just from any particular piece of land, but from the solar system” (Dubinski). The universe is vast beyond imagination. Within the universe lie many galaxies. A galaxy is large gravitational bound system that has various components, such as stars, dust, asteroids, and a sun. There are many types of galaxies, such as elliptical, spiral, and irregular galaxies (McNally). Elliptical galaxies are galaxies that have a spheroid or elongated spheroid shape. When looking at it, one can only see two of its three dimensions, and the lights it illuminates is smooth and bright, but as you go further from the center the light dims (McNally). Irregular galaxies are simple, they have no
regular symmetrical shape, and they have regions of elemental hydrogen gas and population 1 stars which are young hot stars, and the dust that surrounds irregular galaxies makes it near impossible to see all the stars within its galaxy (Finkbeiner).

Last but not least comes the spiral galaxy, which has three important components that make it up. Its bulge, disk and halo. The bulge of the spiral galaxy is spherical and is located at the center of the galaxy along with mainly its older stars. The disk that surrounds it contains dust and gas along with younger stars. Then comes the halo of the galaxy, which is a loose, spherical structure that is located around the bulge, and some of the disk. The halo is unique because it has what knows as globular clusters which are clusters of old stars (Tate). The Milky Way Galaxy is a spiral galaxy within this universe and is special since within it hold the solar system that contains Earth, the only know planet to sustain life.

To begin with, the Milky Way Galaxy, which is known as a barred spiral galaxy (McNally). The Milky Way Galaxy can be described as an island in the universe, that consists of billions of stars, gas, and the dust within it that is all held together by a strong gravitational force that forms a massive disk that is surrounded by a halo of globular clusters (“The Milky”). The solar system that the earth is located in lies within the Milky Way Galaxy. The Milky Way though is very unique, it belongs to the Local Group of 30 galaxies in which the gravitational center lies between the Milky Way Galaxy and the Andromeda Galaxy (“The Milky”).

To say where the Milky Way is actually located in the universe is hard to explain, since the universe does not really have a center point of location on a large scale, but it is easier to explain in a much smaller scale. As stated in the last
paragraph, the Milky Way belongs to the Local Group of galaxies, and the Local Group is towards the edge of a group of small superclusters called the Local Superclusters ("List"). The Local Group covers around a 10 million light year diameter ("List"). To describe the Milky Way is a bit complicated, but the galaxy is incline about 60 degrees to the ecliptic, and its Galactic North Pole is near the beta Comae Berenices, the Galactic South Pole is near alpha Sculptoris, and the center of the Milky Way Galaxy is towards the direction of Sagittarius (McNally). The Milky Way in a larger sense is a small speck in this vast universe.

The Milky Way is a spiral galaxy, so its name explains how it looks like. The Milky Way from the point of view of the Earth from one of galaxy's spiral arms will look like a hazy band of white light during the night (SPACE.com Staff). The Milky Way is brightest towards the Galactic Center, and the surface brightness is low because of the gases and dust that fill its galactic disk and this causes problems to see its bright galactic center, and even more difficult to see in bright urban and suburban areas with all the air pollution ("Milky Way's"). With all the debris, gases, dust and air pollution its hard to see the Milky Way clearly.

The Milky Way is important for various reasons. The Milky Way contain the solar system that inhabits Earth, the only know planet in the entire universe to sustain life. The biggest reason to why the Milky Way is an important component in the universe. Another reason why it's important is because the Milky Way is because it can give humans a better understanding of how the universe's galaxies work since Earth lies within the Milky Way. With these two reasons it shows how important the Milky Way Galaxy is.
Secondly there are various galaxies that surround the Milky Way. The closest galaxy to the Milky Way is the Canis Major Dwarf. This galaxy is an irregular galaxy that has a mass of one billion solar masses. The Canis Major Dwarf Galaxy is about 25,000 light years from the sun and 42,000 light years from the center of Milky Way Galaxy. The Milky Way and the Canis Major Dwarf Galaxy are slowly merging together and in the next billion years ("The Universe").

Another galaxy that is near the Milky Way is the Sagittarius Dwarf Galaxy. This galaxy is an irregular galaxy that is about 10,000 light years in diameter ("The Universe"). The Sagittarius Dwarf Galaxy is said to be torn off by the Milky Way’s gravitational pull according to astronomers. The interaction between these two galaxies is somewhat violent. According to astronomers Sagittarius was one of the brightest of the Milky Way’s satellite galaxies, but the powerful gravitational pull of the Milky Way has torn Sagittarius apart ("The Universe").

These two are the closest galaxies to the Milky Way. Canis Major Dwarf being the closest to it, and Sagittarius being the second closest to the Milky Way. They are around the Milky Way just about 25,000-45,000 light years away from the Milky Way. With these two galaxies being the closest, the other galaxies around the Milky Way are relatively far.

The Milky Way Galaxy is important to these two galaxies, and other dwarf galaxies around it. Since dwarf galaxies are about 1% the mass of the Milky Way, about a dozen of them orbit the Milky Way, Canis Major and Sagittarius Dwarf Galaxy being two of them and also the closest ("The Universe"). The Milky Way being a relatively large galaxy the affect it has can be massive on its neighbors.
The Milky Way has a major effect on these two galaxies. To start off, the Canis Major Dwarf Galaxy is merging with the Milky Way due to its gravitational pull. Over the next billion years it will be apart of the Milky Way. The Sagittarius Dwarf Galaxy on the other hand be being torn apart due to the immense gravitational pull on the Milky Way. It is safe to say that the affects that the Milky Way has on these two galaxies are not positive.

In conclusion, the Milky Way is a unique galaxy within the universe. Being the only galaxy known to man that contains a planet that sustains life. A galaxy that is a spiral galaxy with its bulge in the center, disk that surrounds the bulge with dust, and the halo around it with older stars. The affects that the Milky Way has on the its two closest neighbors, the Canis Major Dwarf and Sagittarius Dwarf Galaxy are immense. Overall, the Milky Way is an important part of this immense universe that humans call home.
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The Colors of Nearby Stars

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4/18/13

Astronomy 112

Professor Jenny N. Weitz
Abstract: The stars that are nearby and can be viewed from Earth are not all burning the same color. The colors of the stars include; blue, white, yellow, red, and orange. From observing the color, astronomers can give a rough estimate of the temperature and also what stage of its life that it is in. The color of a star also has to do with what spectral class it is in, which categorizes every star based on certain properties.

If one were to look up at the night sky, with no instruments at all, just with the naked eye, all of the stars that they would see would appear to be the same color. They would all be twinkling. However, some of them would be bigger than others and some would be brighter than others. But, if one were to use a sufficient telescope, they would see that in fact not all of the stars that are viewable from Earth burn the same color. Of the stars that can be seen from Earth they would range in color from blue to white to yellow to orange and to yellow. There are many different factors that cause such a diverse range in color groups. Some factors are the size and mass of the star, how old the star is, and how hot the star is. A combination of these factors can produce variations in the stars color. And likewise, we can approximately determine the temperature of a star based on its color. One can also tell the color of a particular star based upon the spectral type that the star belongs to.

When looking at the size of stars compared to the color and luminosity of them, it can be different at both ends of the spectrum. For example, a main sequence spectral O type star will be very big and very blue, and a Red Giant is obviously very big and it is red. There is no direct correlation between the size and mass of a star and the color at which it is burning. “High-mass stars have a mass eight or more times that of our sun. They are a thousand to a million times more luminous than the sun, and around ten times bigger in diameter” (Stars Great and Small).
Another example would be if one were to compare a White Dwarf and a main sequence M spectral type star. The White Dwarf is a small star that is very dim but is also very hot and it appears white. A White Dwarf has a temperature of around one hundred thousand Kelvin (Stars Great and Small). But a main sequence M spectral type star will also be very small and also very dim but it will appear to be red. However, that star will also be much cooler than the White Dwarf.

The color of a star can also be a sign of what stage of its life that the star is in or how old or young the star is. The lifetime of a star all depends on the size or surface area of the star (Russell B.). A star that is near its death will go through different stages and different colors. As the core of a star starts to expand and push out, it becomes a Red Giant, which means that it will be larger than a main sequence star but it will also be cooler and in turn it will burn red. A White Dwarf, which also means that the star is near the end of its life, will be small, very hot but not very bright and it will be burning mostly white in color. As far as main sequence stars go, they can also burn white or red. The rate at which fusion occurs and the core burns depends on the size of the star (CSIRO). The lower right hand portion of the main sequence will burn red because they are cooler stars but they will not be nearly as big as the Red Giants which are also the same color, these stars will be closer related to the size of the white dwarfs. The middle portion of the main sequence will burn colors orange and yellow. These stars are in the same section as our sun. Stars similar in size to our sun will have a main sequence life span of about $1 \times 10^{10}$, or 10 billion years (CSIRO). They will not be as hot as the white dwarfs, nor will they be as cool as the red giants, which is why they will be colored differently. They will also be bigger than the stars below them on the HR diagram and they will be smaller than the stars above them on the chart. Now all of the stars on the upper left hand portion of the main sequence on the
diagram, will burn either whitish or bluish in color. These stars will be burning at a temperature of higher than twelve thousand degrees Kelvin (Jasem). Following the pattern upward from the other two portions that were previously described, one can presume that these stars will be hotter and also bigger than the others. These are the stars that will be burning white or blue with the very top of the main sequence being the blue stars. All of the stars on this portion of the diagram will be closely related to the size of the red giants. However, we know that the red giants burn red in color and these stars burn blue or white. These stars will be very big and very hot and very bright which is why they burn the color that they do. These stars will be between fifteen and ninety times the mass of our sun (P. Lenz). White dwarves are also very hot and they too burn white. But as we know, they are very small, smaller than our sun and much smaller than this portion of stars on the main sequence. Since all of these stars are considered to be on the main sequence, this means that they are beginning or middle stages of their lifetime. Later in their lives, these same main sequence stars, no matter what color they are, will become red giants and white dwarves.

Neither of the previous two concepts discussed provided a direct correlation with the color of a given star. The only true factor that has a direct correlation with color is the temperature of a star. No matter what stage of life the star is in, every star that is at a certain temperature will burn the same exact color. Blue is the hottest color and it carries the most energy (Col). A white dwarf will burn white because it is very hot and a main sequence star that also appears to burn white will be the same temperature as the white dwarf. The same concept applies to red giants and main sequence stars of the same temperature. Red Giants will burn around five thousand Kelvin and lower but they are so luminous because of how large they are, white Dwarves will burn about twenty five thousand Kelvin or higher but they are very dim
because of how small they are (Evans). The HR diagram will always have at least two
categories, temperature and luminosity, or brightness. This chart also provides us with a direct
correlation to size. As previously stated, the cool and dim stars will be on the lower right hand
portion of the chart and the hotter bright stars will be on the upper left hand portion of the
diagram. If one were viewing such a chart, then every star of nearly the same temperature would
be burning the same color, no matter the size or luminosity. The HR diagram may also
sometimes provide us with another category that directly relates to temperature when viewed
solely on the chart. This is the spectral type. Stars are categorized into the following spectral
type classes; OBAGFK. These classes relate to temperature because the hottest stars are in the
O class and the coolest are in the M class. O stars burn between 28,000 K and 50,000 K, B stars
burn 10,000 to 28,000 K, A stars 7,500 to 10,000 K, F stars 6,000 to 7,500 K, G stars 5,000 to
6,000 K, K stars 3,500 to 5,000 K, and M stars burn at 2,500 to 3,500 K (Soper). So following
the rules of the spectral classes, just like temperature, white dwarves and upper left main
sequence stars will all be in the O class. Red giants and lower right main sequence stars will all
be in the M class, and our sun is in the G class.

Even though all of the stars, except for our sun, appear to shine and twinkle the same
color, their actual colors range all over the color wheel. The size and surface area of any
particular star does not have a direct correlation to what color that star burns, although there is
some relation as to where it is at in its life. One star will go through different phases in its life,
first it would be a main sequence, then it would expand into a red giant, and then it would
become a white dwarf before it dies. In its main sequence phase, where it would spend the
majority of its life, there is no specific spot it could be placed (main sequence stars range in size
and color). Then when it becomes a red giant, it would expand, possibly decrease in
temperature, and it would burn red. Next as a white dwarf, it would shrink in size but increase in temperature and burn white. The only true correlation to a star’s color is the temperature at which it burns. A star that is burning at a very high temperature, twelve thousand degrees Kelvin or higher, will be burning in the white to blue range. Stars that are around the temperature of our sun, about nine thousand to five thousand degrees Kelvin, will be ranging from orange to yellow. And lastly, stars that burn less than five thousand degrees Kelvin will be mostly burning red in color. There is a system that classifies all of these stars in to spectral types; that is OBAFGKM. Most simply put, O stars will burn blue, B stars will burn light blue, A stars will burn white, F stars will burn green, G stars will burn yellow, K stars will burn orange and finally M stars will burn red.
Bibliography


The HR Diagram

Temperature and Color

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Schematic Hertzsprung-Russell Diagram
What is Human Papillomavirus (HPV)?

By: Mary Rzayev

Chemistry 152

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April 11, 2013
Abstract

Human Papillomavirus (HPV) is a virus that is contracted through sexual contact with a previously infected individual. The virus will continue to expand if not diagnosed in time. It can lead to serious medical conditions such as cervical cancer in women and prostate or anal cancer in men. There are many different types of HPV, but the most common type is genital HPV. With the new research and development of new vaccinations Gardasil and Cervarix were invented to help prevent the virus. Gardasil contains virus like particles that when injected into the human body helps the immune system fight the actual virus.

History

HPV was first recognized in the 1930s by Dr. Richard Shope of Rockefeller University. The disease originated from a rabbit strain which resembled horn-like warts on the infected rabbits. Shope took it upon himself to experiment the disease by taking samples of the warts, grinding them and then injecting them into the healthy rabbits. The rabbits later showed signs of the warts. The cause of the warts was not determined, but Shope wanted to understand what the cause was. Shope did not at the time name the warts as HPV but he definitely knew they were caused by a virus of some sort. Later in 1949 Scientists found that the HPV virus was related to skin warts by using an electron microscope. As more studies progressed, information started to emerge about the virus. In the 1970s the women that were being diagnosed with cervical cancer were told that the cancer was linked to a sexually transmitted disease due to genital herpes. Eventually Doctors came to a conclusion that cervical cancer was a result of herpes. This was proven as an incorrect theory by Harold zur Hausen which in 1976 discovered that HPV may be the cause of cervical cancer instead of herpes. Following this assumption Hausen proposed his theory by finding a strand of HPV in the cervical cancer tumor. With this new information vaccines were developed in order to prevent further spread of this disease. Along with these findings it was noted that HPV was also linked to prostate cancer in men.

Diagnosis and Symptoms

HPV is categorized into two sections high risk and low risk. A high risk HPV is at the stage where the cancer has developed. In this stage, it is very hard to diagnosis since there are no visible symptoms. With a low risk HPV the individual will begin to notice genital warts appearing.

For women, these genital warts can be noticed:

- inside and around the vagina
- the vulva
- cervix, and groin
- in or around the anus
For men, the warts would be found:

- on the penis
- on the scrotum
- thighs or groin
- similar to the women in or around the anus

Keeping watch for these symptoms is crucial to detecting HPV early. Annual pap smears are recommended for women to ensure that everything is normal. During the Pap smear testing session a HPV DNA test is conducted. This tests a sample of cells by observing the genetic make-up of the HPV, which in turn may detect the type of HPV present. Although for men there is no annual test to identify cancer, there are prostate tests that can check for cancer.

![Prevalence, %](image)

**Tests done with abnormal Pap smear results**

There are different tests that are conducted when there are abnormal Pap smear results. The main tests include, Colposcopy, Schiller Test and a Biopsy. The Colposcopy is a test that gives the doctors a detailed image of the cervix. The Schiller test is when the cervix is coated with an iodine solution which in turn will help indicate the presence of abnormal cells. The healthy cells turn brown indicating that they are normal and the abnormal cells will have a white or yellow color to them. The third test that is a biopsy, this is when a sample of the tissue is removed from the cervix and is observed under a microscope.
**Treatments**

There are multiple treatments for HPV depending on the severity of the disease. For high risk, which is the growth of abnormal cells on the cervix, treatments include; Cryosurgery, Loop Electrosurgical Excision Procedure (LEEP), and Cone Biopsy. For each treatment plan, the tissue is the main focal point due to the fact that the abnormal cells preside there. During the Cryosurgery procedure the abnormal tissues on the cervix are frozen using liquid nitrogen which prevents further growth onto more tissue. The LEEP procedure is when the infected tissue is removed using a wire loop. Cone Biopsy is the physical removal of a cone shaped sample of tissue from the cervix. When the individual is in the low-risk stage the only symptom that must be dealt with is genital warts. Treatments for this include; Electrocautery, Laser therapy and prescribed cream. One possible therapy for low-risk patients is burning warts off of the infected area by using an electrical current; this is referred to as Electrocautery. Similar to this, a concentrated light source is used to destroy any warts. This simple process is laser therapy. Finally, it can be as simple as applying cream on the warts. These are prescribed creams specifically for HPV. Some examples are Imiquimod (Aldara, Zyclara) and Podofilox (Condylox). The Imiquimod cream increases the strength of the immune system so that it fights off the HPV infection. The Podofilox destroys genital warts where applied. There are a few recommended over-the-counter drugs that may be used as well. These may include; Salicylic acid and Trichloroacetic acid. Products that contain salicylic acid work to remove layers of the wart at a slow pace but are not directly applied to the wart. Trichloroacetic acid also burns off the genital warts. Although this disease can never be fully defeated, these treatments are used to relieve an individual of symptoms they are experiencing. Without a cure, it is found that HPV can disappear based on an individual’s immune system.

**Vaccine and Prevention**

In 2006, a vaccine by the name of Gardasil is invented. Gardasil was manufactured by Merck, Inc. Another vaccine that was later introduced in 2009, Cervarix is manufactured by Glaxo Smithkine. These two different vaccines are used to treat different types of HPV, for example the Gardasil vaccine is used to prevent the HPV type 6, 11, 16 and 18. This vaccine is used to prevent 90% of genital warts, 70% of vaginal cancer, and 50% of vulvar cancer. The Cervarix vaccine is used to prevent HPV types 16-18; this prevents the cause of 70% of cervical and anal cancer. Both vaccines are recommended for girls from the ages of nine to twenty-six. These vaccines are used as early prevention. Along with vaccines, there are safety precautions that can be taken to further prevent the chances of getting HPV. One way is to lower the risk of getting HPV is to avoid skin to skin oral, anal or genital contact. The use of a condom can prevent spreading the infection to another individual. HPV usually lingers in a person’s body where he/she may not know they have the infection. With this being said, using these safety precautions will help prevent even the smallest risk.
Along with vaccines for many other diseases, Gardasil and Cervarix contain virus like particles, also known as VLP. These virus-like particles are made of protein shells which consist of strands of proteins that mimic the actual virus. This makes the human body’s immune system recognize the actual virus when it enters the body. The VLP in the vaccines have the same outer
L1 protein coat as do the real human papillomavirus. The only difference is that the VLP do not contain the genetic material the HPV particles contain, making the particles in HPV more dangerous and non-infectious in VLP. Once these particles are injected, the immune system reacts or responds to it immediately. The body releases antibodies which in turn attack the L1 proteins that are located on the HPV particle. These antibodies prevent obtaining the disease in the future with the immune cells fighting off the HPV virus as soon as it enters the body. The antibodies coat the virus and stop it from exposing its genetic material, and fighting the spread of the HPV particles. Both vaccines, Gardasil and Cervarix are made of these VLP which consist of protein shells. Every papillomavirus contains a shell that is made up of these proteins. For example Gardasil, this vaccine contains L1 proteins for all the four types of viruses in the infection which are 6,11,16,18. Proteins in turn consist of amino acids. The amino acid is made of an amino group, a carboxyl group and a hydrogen atom.

![Fig 5](image)

**Side Effects of Vaccinations**

As mentioned before, Gardasil and Cervarix are the two vaccines used to prevent HPV. Just like any other medication, vaccine or treatment, these two also have side effects. These side effects range from minor to severe and have led to much controversy although they are FDA approved. Gardasil has caused severe side effects, including death in some girls. Some of the minor reactions or side effects are headaches, vomiting, fatigue, muscle and joint contraction/pain, dizziness, loss of appetite, itching, rashes and swelling of the injection site. The more severe side effects are strokes, seizures, stomach pain, chest pains, hair loss, personality changes, insomnia, hand and leg tremors, nerve pain, menstrual cycle changes, fainting, swollen lymph nodes, loss of vision and hearing, heart problems, shortness of breath, autoimmune problems and paralysis. The most severe case within all the above listed is death. While taking these vaccines to prevent the disease, it may cause worse outcomes which have no treatments. On the other hand Cervarix has shown less serious side effects. Some of which include: mild fevers, headaches, dizziness, fatigue, nausea, diarrhea, insomnia, running/stuffed nose, sore throat/cough, tooth pain, muscle/joint pain and swelling/redness/bruising of the injection site.
The more severe effects are; severe stomach pain, swollen glands, easy bruising or bleeding, confusion, body aches, chest pain or shortness of breath. When comparing the two, cervarix is obviously the safer vaccine.

**Statistics**

According to the Centers for Disease Control and Prevention, as of February 2013, there are an estimated 110 million cases of sexually transmitted infections (STI’S) in the United States. These sexually transmitted diseases (STD’s) are ranged from Syphilis, Gonorrhea, Hepatitis B, HIV, Chlamydia, Trichomoniasis, HSV-2 and HPV. Based on the research conducted on groups of both men and women, HPV by far was the highest sexually transmitted disease in the United States. With the large amount of infections, the total medical costs are an estimated $16 billion. With about 20 million new cases of STI’s every year, it is mainly targeted at the younger generation ranging from ages 15-24. This is about more than half of the cases reported. Along with this, the ratio of the infections among men and women is 1:1; 49% for men and 51% for women. With the fact that there are 79 million cases of HPV infected individuals, studies have shown that the vast majority of sexually active partners are at risk of contracting HPV at one point in their lives. Although this is true, 90% of these infections can be cleared on their own by an individual’s immune system. This usually takes about two years from the time of contraction.

![Graph showing estimated number of new and existing (total) sexually transmitted infections](image)
Conclusion

Human Papillomavirus is an infection that needs to be taken into serious consideration due to the fact that it can be life threatening if not detected in time. Although there are no immediate visible symptoms, both men and women should routinely get check-ups to assure they are not at risk. After doing extensive research, I have come to realize that this topic is extremely underestimated. Not too many people understand that they may be at risk. I was very surprised to learn about all the different types of dangers involved in this infection. I was even more shocked to learn about the severe side effects of the two vaccines that are made to help prevent the contraction of HPV. Many girls have taken these vaccines not knowing the true side effects, but since the doctors recommend it you would believe this is something very good for yourself. After reading the different stories of different girls and how they have been affected by the vaccines it makes me hesitant of them. There was a case of one girl that took the Gardasil vacation and on the third time she died after the second day. I personally feel that Cervarix is less severe as Gardasil but at the same time it still has its negative side effects. With the enhanced technology in our generation it is very crucial that a better solution can be brought to light.
Bibliography


Proton Beams, Cancer’s Nemesis

Adora Saieed

Physics 112
Dr. Casey Durandet
April, 17, 2013
ABSTRACT

Cancer has long been well known as one of the leading causes of death. With the help of science and advanced technology, the medical system has developed many forms of therapy to treat it, from chemotherapy, radiotherapy, to surgery, proton beam radiation, and other methods that are designed to target the cellular growth of cancerous tumors and eliminate them. All treatments except proton therapy, have detrimental consequences and crucial side effects on the overall well being of a patient's body. In proton therapy, a proton accelerator emits a beam of positively charged particles at a high speed, producing high energy that causes the destruction of the cancerous DNA without damaging the healthy tissue. In this Paper, a brief history of proton therapy, post therapy positive results, the anticipated evolution of cost effectiveness, and the technology involved in it, will be presented in greater detail, to show why it is important to advocate this therapy as a primary option for cancer treatment.

HISTORY OF PROTON THERAPY

The particle physicist Robert Wilson first introduced proton therapy in 1946, as a replacement for X-ray therapy because it is more effective in damaging the cancerous tissue while keeping the healthy tissue that is engulfing it safe. Largely, that is due to the speed at which the beam of protons is shot, and the level of precision available in targeting the deeper layers of cancer tumors using protons. Wilson clarified that the capacity for precision in proton therapy is the critical and defining factor in therapy choices, because it affects the dosage given in each treatment session. Dosage proportion and distribution is essential in minimizing the overall damage being inflicted on the body afterwards (Reed, and Brunson, 1093).

Moreover, the earliest of proton beam radiation conduction occurred in California, at the Lawrence Berkeley Laboratory in 1955. It wasn’t until 1970 when proton therapy was sought out in research facilities. Approximately two decades later, hospitals caught on to the therapy and have consistently worked on improving the technology used to target cancer in its many shapes and forms (Smith, 556).

In 1968, a five-year-old boy’s life was to be altered forever. He was diagnosed with Lymphocyte Predominant Hodgkin’s cancer. When put under intense treatment, the cancer responded well to X-ray radiation, but the damage the X-ray radiation was to endure on his overall health was to be discovered over the course of time through out his life. His general health was to be compromised for as long as he lived. His thyroid glands became fully dysfunctional; thus, he was forced to take thyroid medication for the remaining of his life. The parts of his body that were directly beamed upon with X-ray radiation were not able to grow simultaneously with the rest of his body, which caused many health issues, including lack of stem cell growth, undeveloped muscles, and heart valve malfunction and subsequent replacement (Chui, 26). The consequences he has had to live with are a prime example as to why a more efficient cancer therapy should be sought out, advocated, and supported; moreover, a treatment that presents less damaging
results over a prolonged period of time, while remaining effective for a short term. The advocated branch of therapy suggested in this paper is known as proton therapy.

Proton therapy is an external form of radiation that concludes the acceleration of protons (ionizing particles) in a machine known as a particle accelerator. The machine allows for a beam of protons to penetrate the cancerous tumor, which causes the DNA of those cells to be damaged beyond repair. As a result, cancer cells can no longer grow or divide to reproduce. The dividing difference between X-ray radiation and proton radiation is that with proton therapy, a more significant dosage of radiation can be applied to the cancerous tumor without the major concern that of the concentration of the beam and its side effects. The beam penetrates the tumor as such high speed leaving the surrounding tissue undamaged, while X-ray radiation isn’t as precise in targeting the tumor without harming the outer tissue, especially with such a high dose (Mayani, 186).

To explain the dynamic of proton therapy, it is important to understand the nature of cell tissue, what defines its nature and what is responsible for its function as a cell. Every cell is made up of molecules that contain atoms with a central nucleus. Surrounding the nucleus, there are revolving negative charges known as electrons. In the nucleus, protons and neutrons reside. By nature, positive polarity is attracted to negative polarity, which is the sole reason positive charged particles such as protons are able to change the structure of an atom by pulling the electrons out of their orbiting pattern. This causes the electrons to be weaker, and incapable of continuing to revolve around the nucleus. The resulting shift in an atom’s polarity is called ionization. Through ionization, altering the genetic information of a cell and preventing cell division is made possible (Mayani, 187). The image below gives a visual understanding of an atom’s basic structure (Anderson, 1):

Proton therapy’s success and superiority over other forms of treatments that use particles such as gamma rays and neutrons, is due to the relationship between the energy of a proton at the moment of its release, and its ionization energy at the end of its
They appear to be inversely proportional, while the dosage and the ionization per area unit are directly proportional. In other words, when a proton beam is directed towards a cancerous tumor, it penetrates the cell tissue linearly, and then ionizes it using the proton’s energy until it stops. The high energy at which the proton penetrates the tumor prevents more concentration on the healthy tissue surrounding the cancerous cells and focuses is where the beam comes to an end. As a result, the proton causes essential damage to the cancerous cells at whatever depth they reside, while keeping the tissue surrounding it unharmed (Wilson).

The figure below explains a graphic relationship between the proton’s energy and the depth of tissue that is being ionized (Wilson):

![Figure](http://www.physics.harvard.edu/~wilson/cyclotron/Bob_Wilson_Radiology.html)

The rates for success using proton therapy in combination with other treatments show a lower risk in many post therapy chronic diseases. For example, in 2012, a clinical review of esophageal and gastroesophageal junction cancer conducted by the Mayo Clinic showed that chemotherapy in combination with X-ray radiation therapy produced a post treatment fatality rate of 70%-80% over the course of 5 years. Deaths related to the two therapies combined were mainly a result of Cardio Pulmonary toxicity, or heart and lung failure. Deaths following chemotherapy and X-ray radiation in the first year were calculated to be 8% of total patients. Deaths following preoperative chemotherapy and X-ray radiation were up to 33%, and postoperative therapy conducted 20% death rates. The toxicity risks result from the of X-ray radiation dosage given to patients, in order to work effectively while racing time and cancerous cells’ ability to divide and reproduce rapidly, along with the heart’s mass exposed to the radiation. With proton therapy, it was shown that the dosage required to treat a heart tumor, was 66% less than the dosage required through conventional X-ray radiation therapy. This type of comparative therapy results lead to a significant reduction in toxicity related deaths (Stafford et al., 4). The table
below explores the assessed risk percentage difference between conventional therapies and proton beam therapy (Stafford et al, 6)

<table>
<thead>
<tr>
<th>Radiation delivery technique</th>
<th>Risk of radiation-Induced cancer, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intensity modulated x-ray beam</td>
<td>30</td>
</tr>
<tr>
<td>Electron beam</td>
<td>21</td>
</tr>
<tr>
<td>Conventional x-ray beam</td>
<td>20</td>
</tr>
<tr>
<td>Intensity modulated electron beam</td>
<td>15</td>
</tr>
<tr>
<td>Intensity modulated proton beam</td>
<td>4</td>
</tr>
</tbody>
</table>

Data from Mu et al. [39].

Furthermore, to explore proton therapy in a deeper sense, it is important to view it from patients’ perspectives. In 2006, a hair salon owner from Redland California, Ann Hughes, was diagnosed with breast cancer through her yearly mammogram. One of her clients worked at the Loma Linda University Medical Center (LLUMC), where proton therapy for breast cancer was under study, and suggested it as an option worth investigating. Mrs. Hughes took the opportunity to look into it, which lead to her eventual recovery. In the process of her investigation, she was welcomed by a warm, caring medical team that explained to her the most basic details regarding the study, the procedure, and the therapy’s dynamic. Dr. David A. Bush (M.D., radiation oncologist at LLUMC) listed the reasons why LLUMC uses proton therapy, which included the medical team’s emphasis on eliminating as much unnecessary radiation as possible to the healthy tissue surrounding the cancerous cells. Sparing healthy tissue through proton therapy instead of X-ray radiation is possible through hypofractionation, the ability to provide higher doses in lesser time, with positive results and the exclusion of most side effects known through other therapies. In other words, fewer proton beam sessions will be needed, while higher volume of proton beams can be provided in each session. In return, the result is a shorter therapy, which allows the disease less time to spread and an eventual quicker recovery. Controlling the disease as quickly as possible with minimum damage is the essential factor in proton therapy (Preston et al, 2).

To put matters into perspective, the image below shows the difference in radiation dosages and range of exposure to radiation between X-ray radiation and proton beam therapy for breast cancer (Preston et al, 2). Also, it provides visual evidence and a conquering motivation to support this form of therapy.
Now that the benefits of proton therapy in comparison to other conventional cancer therapies have been introduced and clarified, the next important piece of this treatment that is to be presented is the technology used to allow the beams of protons to penetrate the body at precise angles, target the cancerous cells and demolish them without creating any additional internal damage. The proton accelerator consists of a cyclotron that is connected to a series of electromagnets that are attached to a gantry. The gantry is the entrance to a nozzle, through which the beam of protons is directed by 21,000 pounds of magnets into the targeted tumor. Using a magnetic field, the cyclotron allows for protons to accelerate to two-thirds the speed of light, causing it to rotate in a spiral path. The proton particles are carried out in a linear form (beam) through the electromagnets to the gantry, where it is bridged with the nozzle and able to target the areas in need of therapy. This is done through its ability to rotate 360 degrees to achieve the explicit angle necessary to penetrate the tumor without corrupting the surrounding areas. The patient is usually prepped in stages before being placed inside of the machine, where the nozzle is located directly above him/her (Chui, 29).

That is the main frame of the particle accelerator. However, there has been some modification to the procedure involving the preparation of patients prior to being positioned in the machine. Originally, foam molding for the immobilizing device was to be created for each patient individually, depending on his or her anatomy and physical proportion. The immobilizing device serves to keep the patient in place, and allows a necessary level of comfort and stillness in order for the beam of protons to penetrate the body at an accurate angle to target the cancerous cells (Preston, 3). In 2010, there was a new version of the immobilizing device being developed that would reduce the number of times the patient needs to go in for preparation. Less preparation decreases the amount of time wasted before starting treatment, decreases patient discomfort and anxiety, and allows for more patients to be treated during the day. Published in the “Proton Treatment and Research Center” newsletter in 2010, Dr. James M. Slater provides a specific
description of the new technology designed and installed at LLUMC, and is quoted below:

“A proprietary precision patient positioning alignment system (PPAS), popularly known as the robotic positioner or robot, will calculate and adjust patient alignment automatically so as to place the treatment target within 1 mm of the patient’s treatment plan. In addition to the PPAS, the system features a new modular immobilization device that offers comfortable support as the robotic arm moves the patient into position to receive the proton beam. A computerized, three-dimensional scan of the patient’s anatomy pinpoints the size, location, and coordinates of the tumor target volume, doing so with sub-millimeter precision.”

This new explicit technical development allows for a higher ratio of success due to the controlled stillness of the patient, the near perfect accuracy rate of penetrating the tissue and achieving damaging the DNA make up for cancerous cells; meanwhile, the patient is comfortable and is not concerned about the aftereffects of the performed treatment. There are approximately ten facilities that are performing proton therapy in the United States, including Florida, Massachusetts, Texas, California, and Oklahoma. Other sites are under construction in Michigan, Arizona, Washington and other states. Proton therapy is still more expensive than other forms of therapy, but a large number of scientists are constantly working on minimizing the cost of this treatment, making the particle accelerator smaller in size, and allowing for more patients to be treated. This minimizes the fatality rates associated with other treatments from consequential side effects. This form of therapy is growing, the technology is consistent in progression, and the results are profoundly positive. Thus, it is important to learn and support the efforts, time, and the finances invested in continuing research and technological advancement with the intent to save more lives, and provide a higher quality of life for those inflicted with cancer.

CONCLUSIONS

Proton therapy is a cancer treatment that concludes shooting a beam of positively charged particles into a patient’s body, using advanced technology that allows for a higher level of comfort, along with fewer side effects than other therapies such as chemotherapy, X-ray radiation, and surgery. The beam of protons penetrating through the cancerous cells and tumors, is highly effective in damaging the genetic make up of those cells, paralyzing them and consequently eliminating the possibility of reproduction, which leads to the eventual death of those cells. Meanwhile, the tissue surrounding the diseased areas is left unharmed due to the doctor’s ability to control the particle’s speed which controls the depth within the tissue and the tumor the protons release their energy to destroy the rapidly dividing cells. This therapy is preferred, although it is still more expensive than other forms of cancer treatments because in conventional treatments, the energy released through radiation cannot be controlled in regards to the depth of tissue. In other words, due to the limitations associated with controlling the energy release through radiation, serious damage to the surrounding tissue can result in irreversible health issues over a short period of time following an operation or general treatments. Statistics show a lower percentage of death over the course of 5 years post treatment when using proton
beam radiation. Also, another statistic conducted by the Mayo Clinic Research Center shows lower risk of post treatment provoked cancer with a difference in percentage ranging from 11% to 26%. This evidence provides the scientific proof as to the importance and success of proton therapy. It is essential for doctors and scientists alike to work on proton therapy, making it more available to the public. Many proton beam radiation facilities are in operative mode, while others are under construction all around the United States. This provides hope for those who are to face this destructive disease, with a high chance of survival while keeping a large portion of the overall health intact. People shouldn’t suffer through the after effects if they don’t have to. Proton therapy is an accelerating solution that is progressing quickly, and in positivity and great intention, humanity awaits.


Abstract

Neutron stars are one of the choices for the last life stage of a star with the mass higher than 8 solar masses. A neutron star’s composition is made of various components that will be discussed. The history surrounding this star is complex and includes various important scientists. The emissions releasing from a neutron star has a very unique background theory and leads us to many other understandings of star death.

Neutron Stars

Stars have a life process much like humans, they are born, live for many years then they die. Each star has a specific star life and star death. The life and death processes of stars rely on one important attribute – mass. The mass of the star determines what stages the star will go through in its life time, how long it will live and lastly the end stage of its life. For a star with the mass greater than eight solar masses, known as high mass giant stars, go through the life cycle starting with an interstellar cloud of gas and dust, changes into a big main sequence star, the next stage is a type II supernova, the death stage can be one of two stages; a black hole or a neutron star (Reefer to Figure 1). The stage of a neutron star is a very complex stage; this form of the star has a different composition than when the star was first born, can be located differently, and the
first sighting of a neutron star was important to learning about how stars die.

(Figure 1: PHY 1050)

The discovery and information founded was not the doing of one scientist in particular, but various scientists. The first hypothesis of a neutron star’s existence was made by Lev Landau in 1932. Landau hypothesized the existence of neutron stars by first examining high mass stars and finding that towards the end of a high mass stars life a star is formed that is made up of a single dense nucleus (Yakoclev & EtAl, 2012). Lev Landau’s discoveries of the neutron star lead to two other scientists to investigate the star, these two men were Walter Baade and Fritz Zwicky. Baade and Zwicky presented that the neutron star was formed by remnants of a supernova. Baade and Zwicky explained supernovas as a collapse to the neutron-star state which produced cosmic rays (Engineering and Science, 1974). The fist actual sighting of a neutron star was made by Jocelyn Bell (a student of Anthony Hewish at the time). Bell discovered the star with an early form of a radio telescope. Bell and Hewish along with their team had monitored and studied the emissions coming from the radio telescope for a couple months before releasing any information about the phenomenon. They wished to not release any information about the emissions because they wanted to make sure they had gathered concrete evidence of what they were seeing. Bell and her teacher Anthony Hewish realized that they had
found a star that was described by Baade and Zwicky years earlier. The star they found was approximately 10 kilometers around and was about the mass of the Sun and was spinning at a high rate (Gledenning, N.D.). The energy the neutron star gives off; known as pulsars was founded by Anthony Hewish in 1974 (Goddard Space Flight Center).

Anthony Hewish explains what type of energy emits from neutron stars. The energy emitted from a neutron star was founded using a radio telescope. The radio telescope picked up a form of radiation waves that were never before seen. These waves became known as pulsars, or pulsating radio sources. Pulsars can simply be described as spinning neutron stars that have sprays of particles moving approximately at the speed of light streaming out above their magnetic poles (Reefer to Figure 2). Pulsars were better explained with the finding of the Crab Nebula. Through finding the Crab Nebula, it was discovered that pulsars are magnetic (Goddard Space Flight Center).

![Figure 2: Goddard Space Flight Center](image)

The Crab Nebula is the most famous neutron star that was formed during a supernova explosion. Crab Nebula is located in the constellation Taurus in 1054 A.D. The Crab Nebula was founded by Jon Bevis. The Nebula was about 30 kilometers in size and rotated approximately at a rate of 30 revolutions per second; which a very fast rate (Dwivedi, 2012) (Reefer to Figure 3).
The discovery of the Crab Nebula leads astronomers to more information about the links between neutron stars and types of supernovae, more specifically supernovae known as gravitational collapse supernovae (Lattimer, N.D.). Since the first discovery of the pulsars to now there has been around 350 known pulsars detected (Dwivedi, 2012).

(Figure 3:Dunbar,2008)

Landu explains neutron stars to have a composition of mainly electrons and nuclei. The outer crust is nuclei and electrons, the inner crust is superfluid neutrons and normal neutrons, and the core is made up of superfluid neutrons, superconducting protons and lastly electrons (Reefer to Figure 4). The most solid outer crust of the neutron star is iron-like and is only a few kilometers thick. One important fact about this layer of the neutron star is that it is infused with a gigantic magnetic field, which can alter the structure of the atoms inside. The alternations made to the atoms forms them into long skinny strings, these long skinny strings of atoms can only survive in the conditions provided by the crust of the neutron star. A reaction called the neutron drip occurs deep into the neutron star. The neutron drip is when the nuclear forces cannot hold a large extra amount of neutrons into the nucleus, so neutrons then begin to “drip” out. Close to the core of the neutron star is where nuclei exist, along with some various proton and electrons. A
The unique quality of neutron stars is that they have something called superfluid inside them near the core; a super fluid is a special state of matter that causes particles to flow in consonance.

(Figure 4: Miller, N.D.)

Neutron stars are one of the choices in the last stage in a high mass star’s life cycle. The finding and information about this type of star was because many various scientists discovered or hypothesized about the reality of the star existing. We know a lot more about the make-up, the formation and the detection of neutron stars then when they were first discovered.
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Type II Supernovae

By: Austin Shetterly

Professor Weitz

Astronomy 112

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Abstract

This is a research paper dedicated to the topic of type II supernovae. First I will inform the reader about the differences of type I and II supernovas. Then will be educating the reader about this type of supernova, through causes, effects, and various other subjects. The paper will be divided into three major categories: the introduction, body, and conclusion. The body will be based around my research of this topic. Type II supernovae are one of the most fascinating occurrences in our universe and this paper is a tribute to that.

Supernovas are truly amazing occurrences in the field of astronomy. Not only do they provide beautiful images of a fascinating event, they also provide astronomers with information to reveal truths about our universe. The event of a type II supernova is extremely noticeable in deep space observation because they are explosions of a star. The images that many take of supernovae result from the post-explosion, and contain crab nebula of dust particles, neutron stars, or even black holes. Keith Cooper from the magazine *Astronomy Now* had a very impactful insight to the aftermath and relevance of dust from a supernova. Cooper states:

This immense amount of dust has been beyond expectations and, if all supernovae spew out this much dust, it helps explain why young galaxies that we can see existing in the early Universe, which have high rates or star birth and death, are so dusty. The dust, however, isn’t a nuisance to be wiped away – this is the material that goes into building new planets, moons and even life. The iron in your blood and the calcium in your bones all came from supernovae like SN 1987A, as mostly did the oxygen we
breath and the carbon in our constituent molecules (dying Sun-like stars that turn into red giants rather than supernovae also produce lots of dust containing some elements such as oxygen and carbon), (Cooper, 2012). This is why supernovae are so important in explaining the history of the universe. Everything around us including ourselves came from the aftermath of a supernova. This event is crucial to the field of astronomy and is quite interesting pertaining to their massive explosions.

A supernova is an explosion of a massive star that exerts a high quantity of energy. These explosions happen quickly and are commonly a result of fusion (Nave). There are two main types of supernovae, type I and type II. Type I supernovas are explosions and deaths of a white dwarf (Supernova - types). Our sun has the potential to become a white dwarf in the future, and if the core is carbon-based a type I supernova could possibly occur. The resulting white dwarf will also have to be a part of a binary system for this type of supernova to happen. There are two major factors that contribute to a type I supernova. First the white dwarf cannot become more massive than 1.4 solar masses (Supernova - types). If the white dwarf is larger than 1.4 solar masses a type I supernova will not occur. The second factor pertains to the binary system. If the white dwarf’s companion star is a red giant some of its matter will be drawn to the surface of the white dwarf in an accretion disk (Supernova - types). If these two factors become present of the white dwarf a type I supernova is a likely outcome. The Firefly encyclopedia of Astronomy also helps to contrast type I and II supernovae. In research astronomers classify the types of supernovae by their spectrum and light curve. Type I supernovas occur in all kinds of galaxies and show no detectable hydrogen in spectra, this
is peculiar because hydrogen is very common in the universe. Also the encyclopedia states that type II supernovae occur in the arms of spiral galaxies because no one has discovered one in an elliptical galaxy. Type II supernovas also contain normal abundances of hydrogen and come from massive red giants, (P. Murdin & M. Penston (Eds.), 2004). This is briefly the explanation of type I supernovas in comparison with type II. It is important to know about both of the main types of supernovas, and how they are different from one another. Now you know about type I supernovae, and briefly about type II, which I will go more in depth about.

The type II supernova, like type I, is also an explosion of a star that is relatively larger than type I, and is caused differently. A type II supernova is basically the collapse of the star’s core. This action results in a matter of seconds and results in a massive, and marvelous explosion. The images that many people see or think of when talking about supernovas, is the aftermath of a type II explosion. F. W. Giacobbe from the *Electronic Journal of Theoretical Physics* talks in depth about how a star performs a type II supernova. Giacobbe states, “A Type II supernova explosion involves an adiabatic (or nearly adiabatic) superheating process in fusing matter shells that fall inward toward collapsing iron cores at the centers of relatively massive stars,”(Giacobbe, 2005). This scientist goes on to discuss multiple theories about the different causes of type II supernovae and which ones can be misleading and which are correct. The main point taken from Giacobbe is that the star is heating up due to irregular fusion, which is pulling those elements into the core of the star causing it to grow. That is a brief explanation about how this type of supernova occurs, but that is not the entire recipe for this event to take place. For a type II supernova to occur, the star must be massive. Typically type II
supernovae come from massive red supergiants. As these stars grow old (over a long period of time), they begin to produce layers of heavier elements into their interior (Type II Supernova). The core of these stars will not fuse elements heavier than iron, which creates a growing core of iron. This is important to the process of a type II supernova because of the ending result of a collapsing core. As the build up of iron continues in the core of a red supergiant, it will reach a state called Chandrasekhar Mass, which is typically 1.4 times bigger than the mass of the sun. With a core so massive pressure begins to build and the core approaches its time to collapse. Astronomers at the Center for Science Education at Berkeley State that two things happen when the core collapses:

The core collapses. Two important things happen:

- Protons and electrons are pushed together to form neutrons and neutrinos. Even though neutrinos don't interact easily with matter, at densities as high as they are here, they exert a tremendous outward pressure.

- The outer layers fall inward when the iron core collapses. When the core stops collapsing (this happens when the neutrons start getting packed too tightly -- neutron degeracy), the outer layers crash into the core and rebound, sending shock waves outward (Type II Supernova).

These two factors create the result of a type II supernova, and they happen in a matter of seconds.

The post-effects of a type II supernova begin to create new lives, or objects, in the space around them. The supernova is very bright, causing photos of them to be spectacular, and right after the explosion they can be 10 billion times more luminous than
our sun (Gal-Yam, 2012). The material that is released from the explosion becomes a part of an interstellar medium (Type II Supernova). This material then is used to form new planets and can be described as an incidental cycle. The core itself is left behind after the explosion of a type II supernova and the astronomers at the Center for Science Education at Berkeley also stated that:

If the mass of the core is less than 2 or 3 solar masses, it becomes a neutron star. If more than 2 or 3 solar masses remains, not even neutron degeneracy pressure can hold the object up, and it collapses into a black hole (Type II Supernova).

Even after such a massive explosion the core stays behind and can either become a neutron star or a black hole. The black hole exerts incredible forces of gravity and will pull the crab nebula and dust particles back into the center region, where the supernova took place (the core). The post effects of type II supernovae depend on a number of aspects but they will shine bright in space for a relatively short period of time, in respect to the universe’s time scale.

The phenomenon of a supernova has been a study of high interest in the history of astronomy. An explosion, which exerts high energy creating a vast amount of information to be obtained and studied, is influential to science. Astronomers at Sternberg Astronomical Institute in
Russia studied a particular type II supernova over an extended period of time. Their goal was to create a model for a presupernova of SN 1999em. They found countless realms of new research and state that by every growing day in the field of astronomy we learn more and more about supernovae. In talking about their work astronomer and physicist P. Baklanov wrote, “Recent years have brought more and more data on supernovae (SNe) in all ranges of the electromagnetic spectrum. Studying these objects is important both for understanding the physics of their explosions and for cosmology,” (Baklanov, 2005). Studying these events in the universe and trying to explain how they happen can be difficult, but with advancing technology the door to space is open and contains answers that the field of science must find.

Supernovae can be classified as one of astronomies greatest events. The death of a star seems harmless to most who are uninformed, but if that star is massive enough, it has been saving a finale throughout its life. Meaning that the superheated fusion that is taking place within the layers of the star are causing the core to hold heavier elements than normally. Finally the star cannot take the overload and collapses into a type II supernova. As quoted earlier the dust from the nebulas that remain from this event begin to form other objects in space and quite frankly formed our world and everything that is a part of it.

It is important to classify supernovas into their correct categories. This information helps astronomers and physicists to accurately collect data, providing them with questions that can be answered. The event of a type II supernova seems catastrophic, but in the universe there is a lot of space for such massive events to occur. As technology advances so will the understanding and knowledge of supernovae.
Images of the remnants of supernovae are quite spectacular, and are incredible tools for constructing models of the explosions. They can be used to track position as well as provide data from the neutron star that is usually left behind. The photos of supernovae are beautiful images that capture a truly fascinating event. I hope that one day the field of astronomy could capture a live viewing of a supernova, although waiting and predicting for such an event will be extremely unlikely.
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