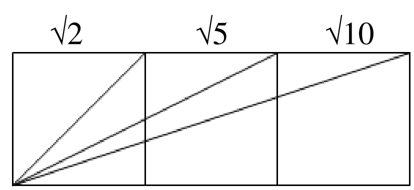
Chapter 15. **Wheels Within Wheels**

In this chapter we will expand our vision to consider problems in cosmology. Following the great breakthroughs pioneered by Newton and the development of the calculus, the scientists of the 18^{th} century believed that they were on the verge of fully understanding the universe. They declared an Age of Enlightenment and embarked on a project to explain the universe as a gigantic clockwork mechanism despite problems understanding something as deceptively simple as rotational motion. As awareness grew about the particle nature of physical systems, complexity led to the development of statistical methods and the study of thermodynamics. By the time quantum mechanics and relativity arrived on the scene in the early 20^{th} century, the clockwork ideal began to resemble more the Wonderland clockwork revealed at the mad tea party and the strange space-time reversals of Looking Glass Land.

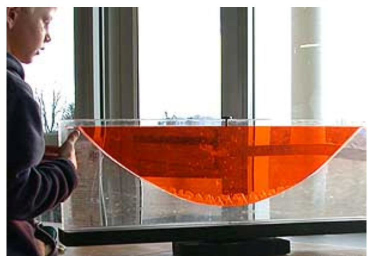
Following the unified theory presented in chapter 13 and the conical theory of gravity in chapter 14, we may perhaps regain some of the original vision of an orderly universe. We discovered that even with quantum mechanics and relativity in an ever-changing world there are universal constants. Each constant that consists of two or more component variables expressed in appropriate units resembles a little machine with gears that adjust among themselves under any change of circumstances so that the overall value of the ensemble of components always remains constant. This is true for $\hbar$, c, G, e, and ε_o – the five physical constants we use as our building blocks of the physical world. And of course secondary constants are just more complex "gear" systems consisting of several interacting constants. Then we found that the constant rest masses of particles were also composed of fixed relationships among these basic constants, and the whole physical machinery floats in a kind of space that is built up from points, gaps (or neighborhoods), straight lines, circles, and spheres. The unity of mass and energy derived from relativity allows us to include the dynamic aspect of a particle with its "rest" mass. A quality of space involved with the proton rest mass has a constant quantum unit that is almost exactly **1 meter** and **all** atoms are anchored in that quantum unit of space. Furthermore, there is a scale-shifting gear, symbolized in these essays with % and based on the fundamental dimensional shifts inherent in orthogonal straight lines. This device allows us to range freely from microcosm to macrocosm.



In this chapter we will specifically discuss the nature of inertia, rotation, and the puzzling situation in which modern physicists commonly now believe that about 95% of the universe consists of "dark energy" (68% of the total) and "dark matter" (27% of the total), while only about 5% consists of "ordinary" physical matter. It seems that the larger our body of knowledge about the cosmos grows, the larger the volume of the unknown becomes – indeed a sad state of affairs. (For example, see http://science.nasa.gov/astrophysics/focus-areas/what-is-dark-energy.)

Newton's Bucket Experiment Redux

First, let's address the problem of inertia. In one of our early discussions we brought up the problem faced by Newton when he noticed that water in a bucket at rest has a horizontal surface, but water in a spinning bucket has a concave surface. From our discussion of gravity in the last chapter we can predict right away that the concave surface is a rotated parabola. We also know that there is a rotating tilted cone whose edge is parallel to the axis of rotation of the bucket (and the center of the concave parabola). Our next insight is that the bucket serves as a wave guide, and the liquid water allows us to see the gravitational-kinetic warping of space-time that occurs when the bucket rotates. From the concave surface we can "see" the rotating gravity cone and the plane that slices through it.



Parabolic shape formed by a liquid surface under rotation.
(**Wikipedia**, "Parabola")

The Observer is the Prime Mover of the system. In what is often called an "inertial" frame, the observer stands outside the system and interprets the interactions of the system's components. In what is called a "non-inertial" frame, the observer takes a position in which he is not "inert" and detached relative to a dynamic system but is "riding" on some component of the system that is in relative motion. In the latter situation physicists claim that Newton's first law does not hold. The observer is viewing from a position biased by involvement in the mass-energy of the system rather than strictly as an observer detached from the mass-energy of the system. Classical physics is somewhat inside out. Newton's laws hold when you stay detached and can imagine the forces but can't actually feel them. When you get involved and can actually feel the forces, it seems that Newton's laws do not hold. Yet you cannot test Newton's F = ma law to find a force or a mass without applying a force to the system!

For example, when riding in a smoothly cruising car (at constant velocity) with the windows covered, you are in equilibrium with regard to the car, even though the car is moving. But when the car brakes or turns, you feel a force. This is the reaction of your body mass to a change in the kinetic status of the car. Newton's third law sort of holds, -- but with respect to different frames. The car pushes on your body, and your body pushes on the car, because the car wants to turn, but your body wants to keep going straight. As the car turns, the centrifugal force ("center fleeing" -- your body wanting to keep going straight) is equal to a centripetal force ("center tending" -- the car wanting your body to turn with it around a central point). From the "outside" observer's viewpoint, a body in motion wants to maintain its "inertial" motion and direction -- that is, motion with respect to an "inert" reference frame -- (Newton's First Law of inertia.)

This inertial tendency is opposed by the pressure of the car forcing the rider to swing in a circular arc about a center point – (Newton's third law of action-reaction). So the outside observer thinks he sees the inertial momentum as a tendency of the rider to move tangent to the circular path, and he thinks he also sees an acceleration that pushes the rider toward the center. Physics is about resistance to the way things are (the car turning) and resistance to changing the way things are (the rider's tendency to continue straight). The "inside" observer, who is a passenger riding in a car with no window, may have no idea the vehicle is moving fast during constant smooth forward motion (he may have dozed off), but when the car turns, he suddenly feels a centrifugal inertial push to one side and may imagine some new force is acting on the car – which is true. This is his truth. **The external observer sees, but does not feel, what is going on. The internal observer riding in the curtained back of the car feels, but does not see, what is going on.** As far as the internal observer is concerned the car may have encountered a strong gravitational force pulling him to one side against the car door. According to Einstein's "equivalence principle" centrifugal force is the same as gravitation in his elevator analogy (think of the car suddenly accelerating or braking). Most physicists call centrifugal force a "false force" despite its clear visual perception by the external observer and actual pressure sensation felt by the rider. The physicists focus on the "centripetal" force where the car nudges the rider inward toward the "center" of the curve described by the car's motion and ignore the sensations felt by the rider as irrelevant, although a sudden stopping of the car might result in injury to the rider. To me, when physicists start to deny what people feel, they have entered the realm of nonsense physics. To deny that the sun goes around the earth is nonsense. To deny that the earth goes around the sun is also nonsense. Here is such a situation described in a physics text.

"The discussion of uniform circular motion is often complicated by the mistaken introduction of a *centrifugal* (center fleeing) force. Suppose you twirl a stone in a circle at the end of a string. Your hand will experience an outward force. This leads some to believe that the stone is trying to move radially outward. They regard uniform circular motion as an *equilibrium* situation in which the inward pull balances an outward centrifugal force. This is false! The outward force on the hand and the inward pull on the stone are equal and opposite forces but they act on *different* bodies." (Harris Benson, **University Physics**, 105-106.)

Experiment: Put a small rock in a cloth pouch that closes with a draw string. Tie a longer string to the draw string and then swing the pouch with the rock around your head. You will feel the rock pull against the string as you swing it, and you will have to hold the string tight as you swing the rock. At the same time the pouch pushes the rock toward your hand. If you are outside in a clear space, you can swing the rock around your head a few times to observe and feel the dynamics of the system and then let go. The moment you let go, the rock will fly off from the point at which you released it in a straight line tangent to the circular path it had as you swung it. This shows that the rock when set in motion tends to go in a straight line, except when it is held by the "wave guide" of the string and the pouch. In an "inertial frame" (observed from outside) the rock moves in a circle with centripetal "acceleration" produced by tension on the string (resulting in the pouch pushing the rock inward). In the "non-inertial frame" of the rock, the rock is in equilibrium between the pouch's force pushing the rock and the rock pushing against the pouch. The pouch pushes against the rock with equal and opposite force that the rock pushes against the pouch until the pouch and string are released from your grasp. The string holds the rock in a circular path because the electromagnetic forces in the string and pouch are stronger than the rock's tendency to move straight. These so-called EM forces are due to the **photonic cancelation of the space** between the string and pouch molecules, not by a "force". If the rock were swung fast enough, its inertial momentum would become strong enough to break the "bonds" that hold the pouch and string together by canceling space, and the rock would continue in a tangential motion. Benson's argument above is only concerned with the way the force of the string and pouch on the rock causes it to deviate from its otherwise linear tangential motion. This is fine. He does not tell you that when you release the string (reduce your applied force to zero), the rock flies off forcing the pouch and the string to follow along with it. In that case the rock wins the tug of war.

If the force were due to a real tug-of-war contest where one puller pulled on the rock and the other pulled in the opposite direction on the rock, the rock would feel stress trying to pull it apart. If one puller lets go, the rock heads toward the other puller, not at 90 degrees to the pullers. The same thing happens if the rock is just suspended in the pouch and gravity "pulls" it downward, pressing against the pouch. When the string is released, the rock and pouch head straight downwards. This shows the relation between inertia and gravity. Usually gravity is not considered a fake force. It is classed as one of the four fundamental forces. It may be misunderstood and misinterpreted, but it is definitely not "fake". Or is it?

The radius along the string from hand to rock and the tangent of the rock's free flight form a right angle. The real question here is how does the 90-degree transfer of energy from the tangential free flight to the centripetal force occur? If someone punches straight at you, you can deflect the punch effortlessly by simply pushing the fist from the side at 90 degrees. If the fist's momentum is entirely forward, it has no resistance to sideways motion. Yet when we swing the rock in a circle, the rock seems to have a momentum that is oriented 180 degrees from the pull of our hand on the string.

Close observation shows that centrifugal force is different from and a conjugate complement to gravity. From a global perspective gravity is **convergent** toward a center of mass, and kinesis is **divergent** from a center of mass. The circular motion of the rock is due to **a wave guide effect that distorts the globally divergent tendency** of kinesis. The string and pouch plus the solidity of the rock act as a wave guide that keeps the kinetic system from flying off in all directions. Innate motion between two objects can only occur in two fundamental ways: (1) to or from the center of mass; (2) orthogonal to a hypothetical radius (i.e., tangential to a circular motion). If forces (such as gravity) are involved, the two motions may become combined in various ways, and if the forces are constant between the two objects, the interaction behaves like a conic section. If the forces change, then the interaction becomes unpredictable.

Principle of Observer Physics: Never let a physicist (or a doctor, or a politician)

convince you that something you feel is fictitious or unreal. Whatever you feel is real. The challenge is to observe the situation closely and discover the true forces at work that cause that feeling. In twirling the rock **you** are pushing momentum into the rock to make it move in a straight line. **You** are also pushing the rock to swerve out of a straight line via the string-pouch mechanism. You, the observer-participant, have created a system with conflicting tensions that put stress on your body (not to speak of the rock, the pouch, and the string), so you are responsible for the equilibrium that consists of the tension of conflicting forces as you whirl the rock around you. Thus you feel your hand pulled one direction and you also exert force with your hand in the opposite direction. YET YOU ARE TOTALLY RESPONSIBLE FOR BOTH FORCES! It is like the simpler situation when you push against a solid wall. You push, and the wall pushes back. You stop pushing, and the wall stops pushing. When you release the string, you totally relax **your swing-push and your string pull**. The tension in both directions disappears. We will come back to the orthogonal problem in more detail after we do Newton's bucket experiment.

Experiment: Fill a bucket partially with water and suspend it with a rope. Twist the bucket and rope until it is wound up quite a bit. Hold the bucket still until the water and bucket reach equilibrium. Release your hold on the bucket and let the bucket begin to spin. As the bucket spins, the friction of the water against the bucket sides gradually imparts spin to the water. After a few moments the water will climb the sides of the bucket and form a concave parabolic shape as you view it from the side and reach equilibrium with the bucket's spin. Why is there a difference in the shape of the water if both situations are in equilibrium?

Newton's bucket experiment clearly shows us the relation between gravity and kinetic motion. Newton's bucket experiment is done in an earth gravitational field. When the bucket is suspended motionless on a rope, it is in gravitational equilibrium. The suspension cord's pull via molecular bonds equals the earth's pull via "gravity". Earth gravity also "pulls" the bucket and the water downward, and the water has no cord attached to it, so it therefore on average tends toward the bottom of the bucket due to gravity. The average kinetic motion of the water particles bumping around thus distributes them evenly in the bucket, with bias toward the bottom and the density distribution of water according to pressure and depth. The density of the particles keeps them at an average level of height. Thus the surface of the water forms an apparent plane (straight line when viewed sideways) of the particles bouncing back and forth between the walls. This "straight line" is actually the average of all the zigzag curved trajectories of the upward or downward moving particles and the horizontal particles. Under earth's gravitational influence the upward moving particles have considerable density and bump into each other following zigzag chaotic paths that are vaguely elliptical. Particles with upward motion generally do not have enough speed to escape the average density level, and so they fall back. The trajectories are slowed by collisions among the particles, but a few energetic particles still escape into the atmosphere causing some water to evaporate. These escapees are too few to influence our system within the time frame of our experiment, so we ignore them. We also ignore minor issues -- such as surface tension -- that don't affect our experiment significantly.

As we begin to spin the bucket, the water particles continue in their usual pattern. But the particles that happen to strike the moving wall of the bucket are given additional rebound motion by the bucket's new motion. This added rebound motion is gradually imparted to the rest of the water particles through mutual collisions, and the water as a whole gradually catches up with the bucket. The two then spin together. They are now once again at rest relative to each other.

However, the water's upper surface becomes concave. The water starts to "crawl" up the sides of the bucket and sink in the center. If we increase the speed of the bucket's rotation, the water will creep higher and higher on the bucket wall, and the concavity will become deeper and deeper.

On the microscopic level the individual water particles continue to bump around in their vaguely elliptical -- but now more circular -- orbits. At first glance with microscopic vision we might not notice that anything had changed. Yet, from the macroscopic level, we clearly see that the water is distributed very differently in the bucket. The shape of the collection of water particles is determined by the gravity-kinetic system.

The difference in the water's shape is caused by a **major system-wide change away from the initial conditions** of the system. An important initial condition was that the bucket and collection of water particles initially were not moving relative to each other on the average. There was no motion other than the random thermal kinetic motion of the water particles. The bucket particles also moved, but due to rigid chemical bonds they mostly just vibrated and did not move much relative to each other. They did not change the bucket shape or intermix with the water. The system was in equilibrium and stayed that way **as long as no energy was input into the system**.

The observer then intervened and started the bucket rotating. This changed the initial conditions. The observer added new energy to the system in the form of the bucket's spin. The system then evolved over time until a new equilibrium was achieved. This new equilibrium involved the bucket spinning and the water spinning. The two seemed to be rotating at the same relative speeds, so, barring an external "inertial" reference frame, we couldn't tell from examining the speeds that there was any relative motion. However, the extra energy changes the system's whole energy structure. The additional energy that starts the spinning distributes itself throughout the system to reach a new equilibrium. The bucket slows down a little bit from the initial spin we give it (assuming it is spinning without friction with any external apparatus) by transferring momentum to the water, but it still rotates with considerable added angular momentum, and the average speed of the water particles increases significantly.

The change in bucket speed is not very noticeable, but we **can easily observe** the change in average speeds of the water particles in the bucket. The shape of the bucket has NOT changed due to the spinning, since the molecular bonds holding it together are stronger than the forces associated with the rotation. Also the influence of earth's gravity has NOT changed. The only way the water particles can express the change in their average kinetic energy is to change their overall distribution in the bucket. Disregarding any changes in density, since we are not spinning the water that fast, this means that the **shape of the overall collection of water particles** must change relative to the bucket's shape!!

To know that a change has taken place, the observer must have **memory** of the previous state of the system -- the initial conditions before he started the bucket spinning. If he has Alzheimer's or has "lost" his memory in some other way, he won't realize that the water is different from "before" and will just assume that this is how things are and perhaps always have been.

The water's collective shape bends by shifting the average distribution of particles away from the center of rotation. The center remains relatively still, and the outer wall is moving fastest. So the most kinetically active water particles redistribute according to their relative speeds, and the largest number gather at the wall, while the less kinetic particles gather further in from the wall, and the least kinetic particles are found in the middle at the axis of rotation. The pattern forms a rotating parabola. Since there are now more speedy particles than before, the level of water near the wall rises, and the level of water near the center sinks in contrast, reflecting an interaction between earth's gravitational pull and the extra kinetic momentum of the water particles. This can be explained by assuming that the bucket is rotating and thereby creating a zone of greater velocity near its wall as compared to the it's center. We might suppose that there is a special attractive force in the bucket's wall that draws the water there if we have lost our memory of the change in the system's kinetic status, and that would be a reasonable judgment.

The rising of the water near the bucket's wall in apparent "defiance" of gravity is equivalent to **antigravity**. The “pull” of earth's gravity is just the tendency of the earth’s system to relax back to its state of equilibrium and unity. If we stop the bucket’s spinning, the water will gradually relax back into its prior level condition. In free space with no influence of earth's gravity, and in the absence of rotation, the water tends to form a globular shape in the bucket. The slightest rotation of the water in the bucket spreads all the water toward the bucket wall. If the water is not rotated and has no contact with the bucket, it will remain as a glob in the center of the bucket regardless of how fast the bucket rotates. The "rotating space station" phenomenon uses this principle to create a zone of artificial “gravity”. (An astronaut can go to the center to experience zero gravity or go to the rim to experience artificial “gravity” in the form of the centrifugal force.) Thus kinetic motion is the opposite of gravity. The wall of the bucket acts as a wave guide to hold the water in the bucket. Otherwise the kinetically excited water flies out of the bucket. Without any other points of reference we can not tell that the bucket is rotating just from examining the bucket alone. The number of water particles remains more or less constant. The additional kinetic motion added to the water particles gives the show away, and the overall distribution of water particles tells us exactly how the system as a whole is moving -- once we use the initial condition of the system as our reference frame. Without that knowledge we might never know things could be different until we studied the micro-scale dynamics of the water. Eventually someone would transcend the local dynamics and infer from the centered radial symmetry the existence of an inertial rest frame against which all the internal dynamics arise. That observer would then realize that someone, at some time set the system in motion – and that person was none other than the observer who put herself in that situation in the first place.

The story of Newton's bucket has nothing to do with Mach's principle and the influence from far flung galaxies. That is a red herring. It has everything to do with the observer's initial frame of reference with respect to the system and how the observer subsequently modifies the system kinetically. Also, there is no force “pushing” the water molecules toward the center of the bucket. The bucket is only a wave guide that curbs the tendency of water molecules to move tangential to the bucket’s edge relative to the bucket’s center.

<u>Principle of Observer Physics</u>: **The Observer always (directly or indirectly) determines the initial conditions of any system as its Prime Mover, and that choice determines the subsequent time evolution of the system. Memory lapse is no excuse, because careful observation of the system leads to recovery of any lost memory. Assumption of responsibility grows as an observer traces back to his own initial creative impulses.** It may only take a few steps to get the whole picture.

We discover that the notion of inertial mass derives from the resistance of the observer to what he observes. This is easily demonstrated. A truly detached observer has no way to determine the inertial mass of any object. Inertial mass is a subjective notion and thus a subjective bias on the physicist’s part – for example, toward acknowledging centripetal forces over centrifugal forces. That is OK, because all the other constants that define a universe are also the arbitrary subjective definitions imposed by the observer on his reality. However, it is important to realize that inertial mass is a convenient label used to describe how we as participants in the universe we have created are able to interact with our own creations from a certain preferred viewpoint. If we choose to step out of the role of participant, then we at best retain only a universe described in terms of space and time – something along the lines of the Reciprocal Universe proposed by Larson (1959, et al.) in which all notions of mass are banished from physics and represented only as an interaction of space and time. In Observer Physics we choose to retain the notions of mass because they relate to our sensory experiences, and physics without tangible sensory experience is rather drab. The other side of that retention is that we must deal with sometimes uncomfortable experiences of pressure, stress, injuries, and the death of our physical body – all of which form interesting diversions from the eternal immortality of the Observer as Pure Uninvolved Witness. With this preliminary exploration of centrifugal “force” and Newton’s bucket phenomenon we can now get back to the question of how rotational force transfers across orthogonal dimensions.

Tops, Gyroscopes, and the "Quantum" Nature of Angular Momentum Vectors

A gyroscopic top nicely displays the various components of a solid rotational system. The central axis of an upright top spinning rapidly on a flat supporting surface remains motionless while the remainder of the top's structure rotates around the axis. In free space with no friction the top just spins on and on. In the absence of a reference frame we can not tell the top is spinning unless there is a way that the observer can detect inertial effects having defined their existence in some way such as we saw in the case of Newton's bucket. Also there is no way to tell whether a top is spinning clockwise or counterclockwise, because rotational direction is entirely relative to the observer's viewpoint.

In a gravitational environment a base of some sort must support the central axis to prevent a spinning top from falling toward the center of the gravity well. The spinning top has a torque. If we are just interested in the magnitude of the torque (τ), we can find it by multiplying the distance from the pivot point at which the turning force is (or was) applied (r) to initiate spin, times the force (f), times the sine of the angle (θ), the direction force takes with respect to the line between the point of application and the pivot point.

* $\tau = r f (\sin \theta)$.

However, the torque also has a directional orientation. So, to include the notion of directionality, torque about a pivot point usually is described mathematically in terms of vectors. If $r\rightarrow$ is a vector describing how far from the pivot point the torque is applied with a certain force $f\rightarrow$, then the torque $\tau\rightarrow$ is the vector cross product {×} of the "displacement" distance vector times the force vector.

* $\tau\rightarrow = r f (\sin \theta) = (\mathrm{r}\rightarrow)\ \{\times\}\ (\mathrm{f}\rightarrow)$.

This mathematical model creates a problem because of the way vector analysis is defined and taught. Almost every introductory physics text has an early chapter that introduces vectors. Diagrams show that vectors behave in space in certain ways. These mathematical behaviors correspond nicely to physical behaviors. Operations for the addition and subtraction of vectors are developed that correspond to these behaviors. Then we come to the subject of multiplication. Multiplying a vector by a real number is no problem. We just enlarge the vector by the multiple of the absolute value of the real number. But two other major types of vector multiplication are also defined. One is called the "scalar" or "dot" product {.}.

* $(\mathrm{A}\rightarrow)\ \{\cdot\}\ (\mathrm{B}\rightarrow) = \mathrm{A\ B}\ (\cos \theta) = (\mathrm{A}x\ \mathrm{B}x) + (\mathrm{A}y\ \mathrm{B}y) + (\mathrm{A}z\ \mathrm{B}z)$.

So, for example, if you know the (x, y, z) coordinates for a pair of vectors, you can use this method to calculate the angle between them.

The third type of vector multiplication is called the "cross" product {×}. The cross product {×} of two vectors (A→) and (B→) is defined to be a third vector (C→) that is normal to the plane formed by the two vectors. In terms of magnitude only, the cross product is defined as:

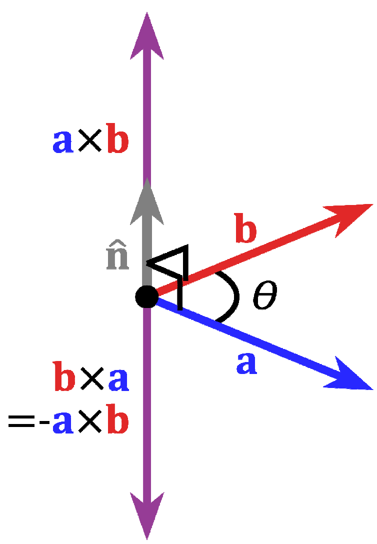
* $\mathrm{C} = \mathrm{A\ B}\ (\sin \theta)$.

However, the cross product is defined to be a vector, which means it must have a directional orientation as well as a magnitude.

* (C→) = (A→) {×} (B→).

By conventional definition vectors are understood to be mathematical objects that have magnitude and direction. So the vector (C→) must have a direction. It is like an arrow with a pointed tip aimed in a particular direction. Unfortunately a vertical line normal to the horizontal plane formed by the two vectors (A→) and (B→) involved in rotation goes in two directions -- up and down!! So the mathematicians and physicists arbitrarily declare a "right-hand" rule such that you curl the fingers of your right hand in the direction the first vector is multiplied against the second vector. (The angle or sequence is with respect to an axis frame.) Then you extend your thumb upward like a hitchhiker. That is taken to be the direction of the cross product vector. The convention is then that to get the vector that goes down (- C→), you have to give the thumbs down sign and multiply the vectors in the opposite order. Thus,

* (B→) {×} (A→) = - (A→) {×} (B→)



So cross product vector multiplication is anti-commutative, and care must be taken when the mathematical procedure is applied to model certain physical situations. The physical reality of a spinning top is that which way it is spinning depends entirely on the observer's point of view.

The angular momentum description also uses this method, since momentum is vector in nature. Here (p) is linear momentum and (r) is a radial displacement from the origin of a rotation. (Note: Planck's constant has the same units as angular momentum.)

* l→ = p r (sin θ) = (p→) {×} (r→).

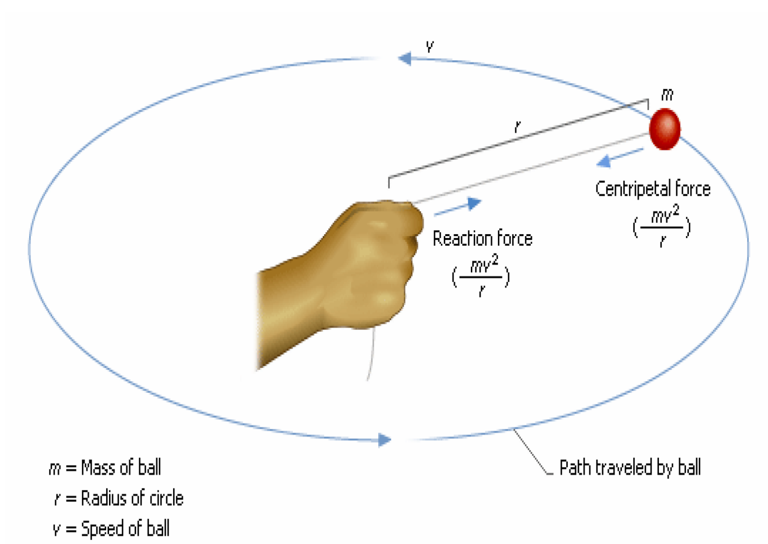
"The definition of angular momentum for a point particle is a pseudo-vector **p** × **r**, the cross product of the particle's momentum vector **p** = *m***v** and its position vector **r** (relative to some origin). Unlike momentum, angular momentum does depend on where the origin is chosen, since the particle's position is measured from it." (Based on **Wikipedia**, "Angular momentum".) The cross product of two vectors is called a "pseudo-vector", because, in addition to the momentum, it also gives us the axis of rotation, which is a "two headed" vector pointing half north and half south (physically depending on how you look at the system, and mathematically depending on which order you perform the vector multiplication, clockwise or counterclockwise). True vectors only have one arrow head (direction).

For a circular path with constant speed we have

* $l\rightarrow = p\rightarrow r\rightarrow = m\, v\rightarrow r\rightarrow.$

Here *v* is the innate linear velocity of the particle, and *r* is the radius vector pointing from the orbiting object to the center that it orbits (or vice versa).

We can think of the particle moving in a circle at constant speed as a wheel rotating in place at constant speed with a mark on the edge moving past a stationary mark next to the edge of the wheel. Or we can think of it as a wheel with a mark on its edge rolling along a horizontal plane at constant speed. The wheel rolls one circumference distance ($2\,\pi\, r$) every revolution. The distance traveled by the wheel per unit of time tells us the wheel's forward speed and the rotational speed. So, if the "particle" mass is 1 kg, and the radius is 1 m, and the speed is one rotation per second, then the wheel travels $2\,\pi$ meters in 1 second, and the momentum is $2\,\pi$ kg m/s. This is the linear momentum of the wheel rim and also the angular momentum of a particle with similar motion in a circle. (There are more details, but this is a simplified view.)



The misleading label *v* in the drawing suggests that *v* is for velocity (linear motion). This is very common; although they often say "speed", they still use *v*. Though the ball curves, the motion still has a linear relation to the radius. The speed is $2\,\pi\, r\, /\, T$, where *T* is the period of one complete cycle.

In the case of a ball tied to a stiff string and swung in a circle, there is a force pulling inward along the string that the swinger must exert to keep the ball moving in its circular path. The centripetal force (drawing the ball toward the center) is the mass of the ball times an acceleration that the swinger applies to shift the ball's direction. The swinger feels the tug on the string as the ball tries to continue in a straight path ordained by its inertial momentum. That is the "centrifugal" reaction force. So the acceleration must be continuous to maintain the circular path. Note also that, if the ball is in a pouch, and the pouch is tied to the string and swung, the ball will "feel" itself pressing against the pouch with the same force that the swinger feels he has to exert on the pouch via the string to keep the ball swinging in a circle, but it will seem to come from the pouch on the other side of the string.

The same ball hanging vertically in a pouch by a string is just a variation of Millikan's famous "oil drop" experiment:

* $qE = mg$,

The string holds the ball in equilibrium against the force of gravity by virtue of its equal but opposite electromagnetic force of cohesion as a string (and pouch).

It is a dangerous pseudo-scientific brainwashing to teach people that effects they can physically feel are "fake" forces; yet this is very common in the literature. Some day you may find yourself in the torture chamber being told that the painful things happening to you are not real, -- just imaginary sensations. When the CIA testifies to Congress that water-boarding is **not** torture, but merely a systematic method of informal intelligence gathering, -- but the recipients of the technique are not present to testify about their experiences, -- you may suspect that somebody is putting a bit of spin on their testimony.

Here is an example of this sort of "fake" physics propaganda from the Internet.

> You have probably heard of **centrifugal (center fleeing) forces.** ***Centrifugal forces do NOT exist. There is no outward force on the object that is rotating!*** REMEMBER: Centri-FUGAL = FAKE FORCE! Ever swung an object on a string above your head? The misconception comes from "feeling" a pull on your hand from the string. This is simply Newton's 3rd law in reaction to the inward force you are putting on the string to keep the object moving in a circle. **(Hand pulls inward on Ball & Ball pulls outward on Hand BUT there is no outward force on the ball.)** If you let go and there was a centrifugal FAKE force acting, then the object would fly straight ***OUTward*** from the center when the string was released. ***This does NOT happen***. The object flies off ***tangentially*** to the circular path.

The drawing of the swinging ball and comment about "fake" force are from http://www.quia.com/files/quia/users/nellr/Reg-Ch-7-8-RotationalMotion.pdf. **We agree on where the ball goes, but not that the force is a fake.** If you back up the rotation by a quarter turn, the ball's tangential momentum is exactly opposite the pull you feel on your hand. At every point in the circle there is that same opposing momentum but with a 90 degree "lag time". Imagine a wheel with a crank the length of the wheel's radius and a rope wound around its rim and tied to a hanging weight. As you turn the crank to raise the weight, the weight pulls down with a force almost equal to the force you apply to the crank. As you turn the crank in its cycle, the wheel rotates, but the weight always moves upward regardless of whether you push up, down, right, or left on the crank – as long as you turn the wheel in the proper direction.)

Experiment: Place a marble in a small rectangular box and hold the box so that the marble rolls to one end of the box. Gently place the box on a table top and then slide it along the table so that the marble stays at the back end of the box. Suddenly stop the forward motion of the box. What happens to the marble?

The marble that was not moving at the back of the box suddenly rolls rapidly to the "front" of the box. Harris Benson in **University Physic**s (1995, p 113) says, "An observer in the non-inertial frame must invent a fictitious "inertial force" to explain the acceleration of the body. This fictitious force is real enough to "throw" you forward when a bus suddenly stops. It is fictitious in the sense that it has no physical origin; that is, it is not caused by one of the basic interactions in nature. This "action" does not have the "reaction" required by the third law." **The above "explanation" is from a text on university level physics!** The "fictitious force" definitely has a physical origin in the force applied to suddenly stop the box (or the bus) that originally served as the marble's (or your body's) inertial frame. The box frame suddenly accelerates from its rest relation with the marble, so the marble accelerates in the opposite direction. The physicist has a problem switching frame viewpoints. From the inertial frame of the laboratory the box stops and the marble keeps going. From the inertial frame of the box, the box has an impulse of acceleration, and the marble has an equal and opposite impulse of acceleration. If the marble had been at the "front" of the box in the initial motion from the lab viewpoint, when the box stopped, it would seem from the box viewpoint that the box has a sudden acceleration backward and pushes on the marble. The marble suddenly pushes back against the front wall of the box. This is Newton's third law, just like you pushing your hand against a wall and feeling the wall push back against your hand. The force is simultaneous, mutual, and opposite.

When the box shifts to the lab frame **due to interference by an outside force that the "observer" applies directly or indirectly**, the marble stays in the frame of the moving box. As the box decelerates, the unattached marble leaves the box frame and accelerates with an equal and opposite reaction. Frames are relative, and all inertia is relative. When the observer accelerates the box, she forces the marble to stay in the box frame (at the back wall)and accelerate with it. When she applies force to decelerate the box, if she fails to hold the marble with the box frame, then when the box decelerates, the marble appears to accelerate "forward", but is really just retaining its inertial momentum relative to the table frame. It is not a fictitious force, it is an equal and opposite reaction to the application of a force to the entire local inertial frame. It is the same as pushing my hand against the table and feeling the table push back against my hand. The marble will stop when it hits the other end of the box, and the "observer" will see, hear, and feel that. The observer is responsible for all of this by her manipulation of the box and the marble. Teaching that "(non)inertial" frames are not physical structures or that "forces" that seem to materialize out of nowhere are "fictitious" is an irresponsible mode of teaching. Newton's third law is what ensures that the physical universe always remains in balance within itself and within the experience of the observer, even during dynamic transformations.

Newton's first law of inertia teaches that the observer is responsible for everything that happens. Nothing happens by itself. Any action is due to the observer resisting what already is. If the observer does nothing, then whatever is, remains as it is or keeps doing whatever it is doing (given the stability of the system). Whatever the observer does to his world keeps on going unless the observer modifies it with another action. An attempt to stop something that is already happening just adds another action and reaction to whatever is already happening.

Newton's second law states that any force involves the acceleration of a mass. A mass has inertia and therefore by definition resists change. Change is another word for acceleration. A force is a resistance to an inert condition that resists change/acceleration. The inert condition is the first law – resistance to change. Application of a resistance to something that resists produces acceleration and leads inevitably to the third law. **The force law does not apply to objects without mass.**

Physical objects by nature have no mass, because they consist only of pure light/awareness that an observer has defined as part of his reality. The boundaries that define these "objects" exist only as beliefs in the consciousness of the observer. Mass and force thus only arise when there is a resistance, and resistance is assertion of a belief with so much certainty that it becomes a solid mass that can be subject to force and thereby becomes "tangible" in various ways through sensory perception. The equilibrium of the universe requires that any exertion of force results in an equal and opposite reactive force. Physics is the systematic study of the shared physical reality we create through our belief systems with the aim of arriving at an explicit description of the fundamental beliefs by which we create, participate in, maintain, and enjoy our shared physical reality. Resistance may or may not be a part of a given shared reality, but if it is, then it follows Newton's laws.

Empirical proof of this principle is available through repeatable tests. When an observer merely observes phenomena in a detached manner with no resistance, the perception is a set of phase waves and does not involve mass or force. Motion and acceleration can occur at any speeds under those conditions. Force and mass are inseparable from an observer who participates in events by resisting them in some way. Thus, observer physics is the foundation of any physics that deals with masses and forces, but begins with motion and acceleration that may occur under conditions of pure detached observation.

The <u>challenge</u> to anyone disagreeing with this testable hypothesis is to discover the presence of mass and force without in some way physically interacting with something by means of some form of direct or indirect resistance.

Newton's third law says that any action (i.e., application of force) immediately involves an equal and opposite reaction. There is no lag time. This is usually written as $F_1 = -F_2$, but should really be $F_1 + F_2 = 0$. If $-F_2$ does not equal F_1, then some "mass" will "accelerate" to compensate for the missing reaction force (Newton's second law). The reaction is the complementary "other half" of the action and ensures that equilibrium is constantly maintained in the cosmos. Anyone contemplating action must be aware that the action contains the reaction and must accept that as part of the deal. Perpetration of violence against any sentient being or any aspect of the environment ensures the equal and opposite reaction has been set in motion against the perpetrator. Perpetrators of violence should take note and be prepared to take responsibility without complaint for their actions when they begin to experience the reaction components of their actions. The reactions are instantaneous, but may be somewhat delayed on the sensory level due to limited perception and deliberate or habitual numbing of the senses (i.e., ignorance).

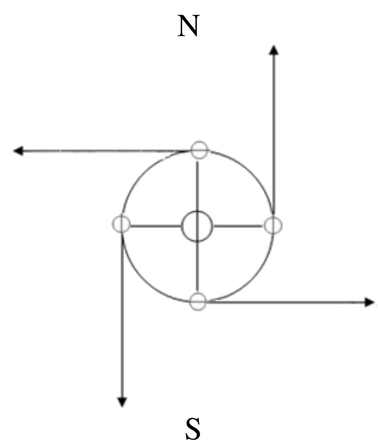
The key to Newton's laws is to understand about force. A pure detached observer is not involved with force. Only when an observer participates by performing action on something does force come into play. Pure observation occurs when an observer is detached from the objects of observation, so he can observe acceleration, but need not be involved in any force related to the acceleration. People who feel "fictitious" forces believe or have been indoctrinated to believe, that they are not responsible for the events that they feel happening to them. This is a denial of responsibility and is not scientific awareness. When the bus stops suddenly, you can say it is the bus driver's fault or the little kid's fault for running in front of the bus. But the jolt of whiplash you feel ultimately is your fault for deciding to ride the bus and to live where little children run out in front of traffic without realizing that such events can and will happen in such environments.

Secrets of Circular Motion

What is the idealized force and acceleration (disallowing gravity, wind drag, the string, and so on) involved with a particle moving circularly in a plane? Circular motion is the degenerate case of an elliptical orbit in our conic sections analysis. In turn it is a wave guide reduction of a converging/diverging interaction. We know that an object in orbit necessarily has what Newton called an "innate motion", that is the initial velocity (and momentum) it had when it entered the orbit. By conservation of momentum (Newton's first law of inertia), the innate momentum (constant mass times constant velocity) never changes unless the mass somehow changes or the orbit is disrupted by an external influence. Furthermore the curving acceleration and the linear momentum are orthogonal, so it is hard to imagine the linear velocity affecting the acceleration or vice versa, since momentum is unidirectional, and not orthogonal. However, an object in an elliptical orbit is changing velocities all the time and an object in a circular orbit is also changing direction all the time, but at a constant angle per u nit of time. The reason for this change must be due to the centripetal acceleration, since **the tangential velocity is innate in speed and constant in direction**. Furthermore, the object in an elliptical orbit moves much faster at perigee than at apogee, which means that the trajectory's curvature should be very different at these two places, and thus a symmetrical elliptical orbit would seem to be impossible. The gravity well is at one focus and a "ghost" is at the other focus. Perhaps something at the "empty" secondary focus must influence the acceleration to balance the kinematics into a stable and symmetrical elliptical orbit.

Miles Mathis does not argue with the orbital shape and other observational data. He believes that there must be another mechanical force at work generating an effect that opposes gravity and balances the acceleration. He believes it is due to a Coulomb force. He may be right, and our study of the electro-gravitational equilibrium dynamics suggests this as a possibility with our string-rock and bucket-water experiments. (Mathis knows that electro-gravitational dynamics is involved in the equilibrium, but has not discovered the mass at the balance point.) In the case of the ball on the string the "pull" of gravity becomes the pull of the electrochemical bonds in the string and pouch.

Here is an idea to consider. To see the acceleration and force in the ball and string example, we can just back up the rotation by 90 degrees. Then the tangential momentum of the orbiting ball in the "East" quadrant of its circulation is parallel to the "North-oriented" radius 90 degrees "before" the orbiting particle reaches that "North-oriented" radius. Also, opposite that momentum is another momentum 90 degrees "after" (in the West) and that heads in the opposite direction (South). In each quarter turn, the momentum will be directed 90 degrees in a different direction and will have no affect on the string at that moment. So the pull of the ball or rock on the string is a "lag momentum" from when the ball was moving away from the direction of the swinger 90 degrees earlier. (Perhaps it is a space-time lagged tug of war.) Each moment there is a lag momentum from 90 degrees earlier in the trajectory that pulls on the string, and an opposite momentum 90 degrees later. The angle keeps changing at a constant speed, so the angular momentum is constant and the pull is always the same at every angle for a circular path.



The planar omni-directional momentum of an object in constant circular motion.

The velocity of the ball is $2\pi r / T$, where T is the period of one complete rotation. This is a linear velocity, since the circular path of the ball could just be a point on a wheel rim rolling along a flat surface. HOWEVER, it is a net velocity (speed) including the acceleration due to the force that curves the motion into a circular path and not just the innate tangential velocity.

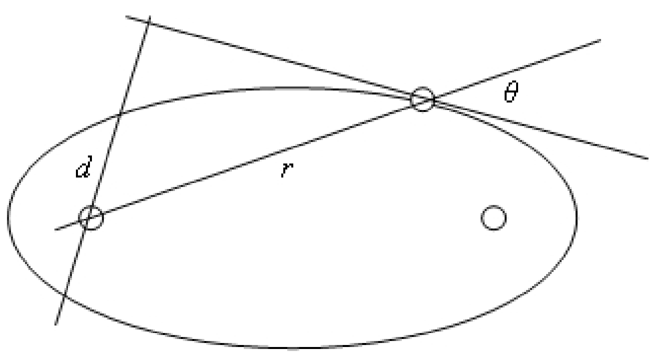
The acceleration is usually given as the velocity squared divided by the radius: $a = v^2 / r$. As far as the ball is concerned, it might as well be moving in a straight line, except that it feels a force normal to its tangential momentum that makes it think it has to accelerate toward the center of the circle. We know this because we can feel it as the pull that we put on the string. The problem is how to calculate the force and the acceleration that cause the trajectory to curve. Presumably v represents $2\pi r / T$. But why square it?

* $a = 4\pi^2 r / T^2$.

This equation tells us where the $4\pi^2$ comes from in the gravitational constant G, which for our solar system comes to $G = (4\pi^2)(3.36\times10^{18}\ \mathrm{m^3/s^2}) / (1.99\times10^{30}\ \mathrm{kg})$, the second factor being Kepler's constant for our system and the third factor being the sun's mass. The problem is that I look at many sources and fail to find a strong **argument** supporting the notion that the centripetal acceleration that is normal to the linear velocity is related by $a = v^2 / r$. For example, when you let go of the rock you are swinging in a circle, why does it go off along the tangent rather than fly toward you (centripetally) or away from you (centrifugally)? There's more to the story. The constant speed for a circle is $s_{cir} = 2\pi r / T$, and for an ellipse s_{ell} is as follows:

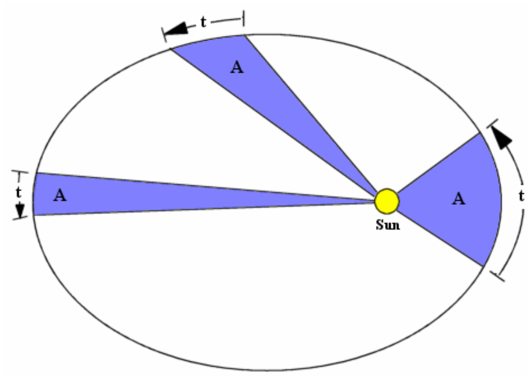
* $s_{ell} = 2\pi ab / Tr \operatorname{Sin} \theta$, (where a is semi-major axis, b is semi-minor axis)

The ratio of the area of the ellipse (πab) to the orbit period (T) gives the speed of a complete sweep by r, the distance between the gravity well and the orbiting planet. The relation ($s_{ell}\, r \operatorname{Sin} \theta /2$) is also equal to half the angular momentum divided by the mass ($L / 2m$), which is the sweep at any particular interval. The length of r and the speed of the orbiter vary as the object moves, but the "wheels" of the relation maintain conservation of angular momentum and equal sweeps for equal time intervals as Kepler discovered.



$d = r \operatorname{Sin} \theta$

The linear velocity s_{ell} is the tangent line that forms a leg of the right triangle. The other leg is d and the hypotenuse is r. The area of the triangle is then half the base times the height ($s_{ell}\, d / 2$) = ($s_{ell}\, r \operatorname{Sin} \theta / 2$), which is then equated with ($\pi ab / T$) for Kepler's constant. The speed at any interval is the ratio of the distance moved to the time elapsed. So the relation tells us that at any segment of the orbit, regardless of how the (net) velocity or "radius" may change, the sweep ratio per given time interval is constant.



A Planet Sweeps Equal Areas (A) in Equal Time Intervals
http://en.wikibooks.org/wiki/General_Astronomy/Kepler's_Laws#mediaviewer/File:Kepler2.gif

For an ellipse we need to know the radius of curvature to calculate the acceleration:

* $a = v^2$ / R, where R is the radius of curvature.
* R = b^2 / a $\text{Sin}^3\ \varphi$, (where φ is the angle between tangent at P and PF.)
* $a = 4\pi^2 a^2 b^2$ a $\text{Sin}^3\ \varphi / T^2\ r^2\ b^2\ \text{Sin}^2\ \varphi$. (Plugging in for R and v)
* $a = 4\pi^2 a^3\ \text{Sin}\ \varphi / T^2\ r^2$ (Simplifying).

This final simplified equation gives us Kepler's constant for a solar system around a common star, and for a circle simplifies further to:

* $a = 4\pi^2\ r / T^2$ (Since a = b = r and Sin φ = Sin 90° = 1).

Note how b in the generalized elliptic format corresponds to the 90 degree "lag radius", but cancels out when we simplify. The problem is that v^2 / R for the radius of curvature is just a generalized form of the usual conflation of line and arc that we saw with a circle, so the fact that it shows up in the circle derives from what was assumed before but not really explained.

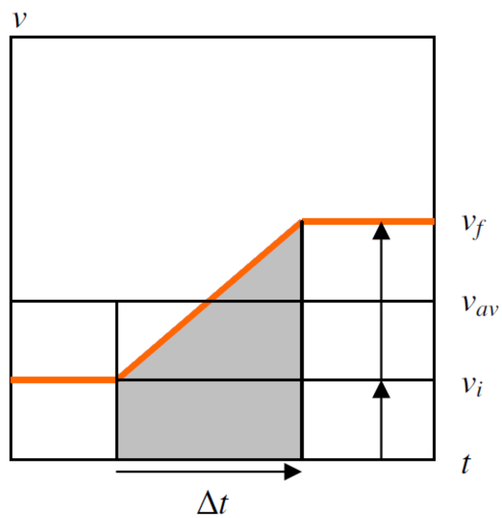
If we work from Newton's version, we have $GmM/r^2 = mv^2/r$. This simplifies to:

* $GM/r^2 = v^2/r$.
* $v^2 = GM/r$, but $v_{cir} = 2\pi r / T$.
* $GM = 4\pi^2\ r^3 / T^2$. (We see here the appearance of the $4\pi^2$ in G.)

But once again $a = v^2/r$ has been assumed. On the other hand, this equation shows the reciprocal relation that as the orbiting object nears the gravity well, r gets smaller and the centripetal acceleration along r gets bigger. As the object moves away from the gravity well, r gets larger and a gets smaller. . . . all assuming that v (the supposed "innate tangential motion" is constant, which is **not true** if r changes. So we really have three or even four variables (including initial velocity v_i and final velocity v_f) and only know the radius, which also changes in an ellipse. We know that v_i has to be greater than 0 and less than the escape velocity for the system or the orbit would not last.

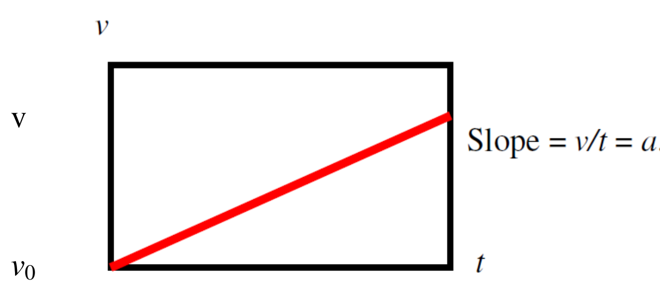
Miles Mathis notices that when we look at the equations for the kinematics of constant acceleration in magnitude and direction **along a given axis (e.g., *x*)**, that is, in a straight line, we find the following result.

Suppose we have an object that moves at a constant velocity v, but then accelerates at a constant pace for a while Δt, and then reverts to a new faster constant velocity. We can graph this in terms of v and t.



The velocity increases steadily over the period Δt. The area in the trapezoid during that period equals the area of the two rectangles, since the two little triangles are equal in size.

* $(v_i\ \Delta t) + ½\,(v_f - v_i)\ \Delta t = ½\,(v_i + v_f)\ \Delta t = (v_{av}\ \Delta t) = \Delta x.$



Constant Acceleration has a Straight Line Slope in Terms of v/t.

* $a = (v - v_0) / t.$
* $v = v_0 + at.$ (Straight line graph v by t, slope = a.)
* $\Delta x = (x - x_0).$
* $x = x_0 + ½\,(v_0 + v)t.$ (See $½\,(v_i + v_f)\ \Delta t$ above.)
* $x = x_0 + v_0 t + ½\,at^2.$ (Substitute $v = v_0 + at$ into the previous equation.)
* $t = (v - v_0) / a.$ (Substitute out t this way in above and simplify.)
* $v^2 = v_0^2 + 2ar$, where $\Delta x = r = (x - x_o)$.
* $2ar = v^2 - v_0^2.$
* $a = v^2 / 2r$, where $v_0^2 = 0$.

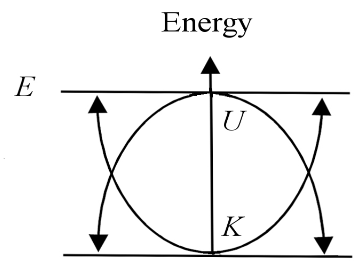
That also makes sense if we think in terms of kinetic energy:

* $GmM / r = ½\, mv^2$
* $GM / r = v^2 / 2$
* $GM / r^2 = v^2 / 2\, r.$

For a gravity system $U = GmM / r$ represents the potential energy, and $K = ½\, mv^2$ represents the kinetic energy and is based on the net linear velocity, **not** the innate tangential velocity. A stable orbit is in equilibrium energetically, so no work is done. $E = K + U$.

Here is what the energy diagram looks like for a bouncing ball.

* $E = U + K$. (Total energy is potential plus kinetic.)
* $mgh = ½\, mv^2$
* $g = v^2 / 2h$



When the ball bounces to its highest point, its potential energy U is highest and kinetic energy K is lowest. When the ball falls approaching the ground, its kinetic motion is greatest and its potential is the lowest. The rebound of the ball reflects the kinetic motion back up from the ground. As it rises, the ball again loses speed and gains in potential energy. When the ball loses all its kinetic speed, then it stops rising. Its potential is greatest, but it then loses potential as it falls. The sum of the kinetic and potential energies is always constant. The ball's trajectory is a parabola.

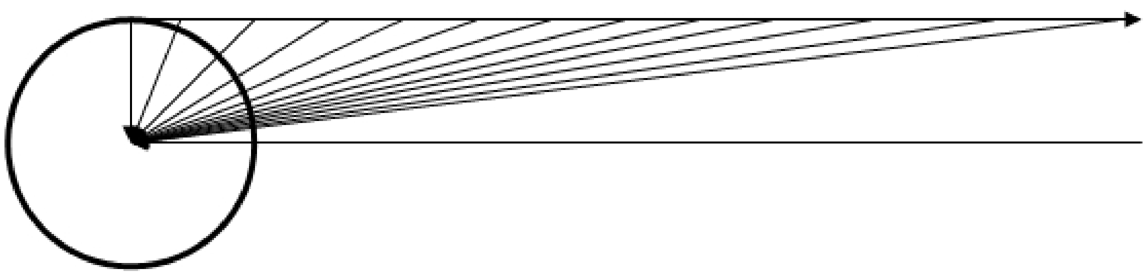
Based on this we might suppose that the formula for the acceleration in constant circular motion is $v^2 / 2r$. But this is not the whole story.

Very often angular momentum and other rotational phenomena are discussed in terms of a unit called a **radian**. The symbol ω conventionally is used to measure an angle in terms of its associated arc. We may select any arbitrary point as a center or origin and then the complete set of coplanar points equidistant from that point defines a circle. A radius is any [straight] line from the center point that intersects a point on the circle. Any two such radii form a pair of angles at the center and also define a pair of arcs on the circle. Any segment of a circle, including the whole circle, can be defined by an angle (from the center) or an arc (along the circle). "An angle's measurement in radians is numerically equal to the length of a corresponding arc of a unit circle, so one radian is just under 57.3 degrees" (**Wikipedia**, "Radian"). The length of the arc of a complete circle is usually given as $2\,\pi$, because that is the constant ratio between the circumference (complete set of points in a circle) and the radius of the circle.

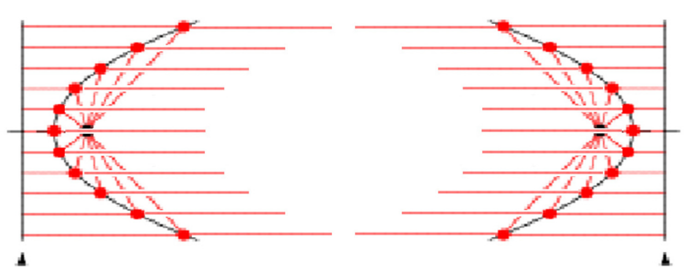
A radian is scale independent and has no particular length, since an arbitrary center point may define any number of circles with various radius lengths. So to associate a specific length with a radian we must specify a particular radius length. Since the speed is constant, and the direction changes in a constant manner, the "slope" of the tangent is meaningless as far as velocity and acceleration are concerned.

Mathis rightly notes that no matter how small the angle is, the arc is still an arc, not a straight line. He also knows that you can not calculate a derivative of a speed, because at the limit there is no speed. The derivative is the rate of change. A constant linear velocity has no rate of change. A change in velocity is acceleration. The derivative of acceleration is really an average velocity over a given very small interval of time. The derivative of a velocity (i.e., a straight line, a simple ratio) is nothing. The important thing to remember is that radians have nothing to do with speed, because they have no scale.

Interestingly, for solid discs $a = \omega r$, and the acceleration increases as the radius grows. For gravity systems, the relation is more like $a = \omega^2/2r$, so that the acceleration drops off as the radius increases.



In the above drawing we see the tangential velocity as it manifests from various different initial velocities relative to a given radius. If the initial tangential velocity is 0, then the body simply stays put in a rigid system or falls to the center if nothing holds it at bay. The greater the initial tangential velocity, the longer the tangent will be and the greater the angle will be that its "end point" makes with the center relative to the normal at the tangent point. If the angle reaches 90 degrees, the body has reached escape velocity and continues on away from the center. This is an idealization, because we know that an object with escape velocity can fall toward a gravity well, swing around it, and then swing back away, never to return. It follows a parabolic path. So let's go back to our drawing of the "force lines" for a parabolic trajectory.

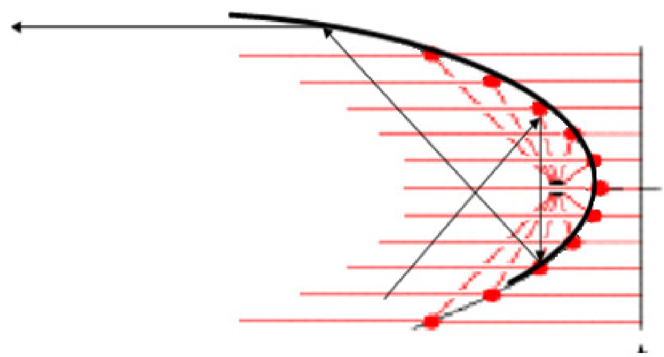


The red dot is the moving body, and the black dot is the gravity well focus. If the body heads straight for the focus, there is a collision. In the second version of the diagram I have squeezed the parabola until it becomes very thin and it is clear how much it begins to resemble an ellipse. We know that the trajectory, when extended, gradually approaches a tangent to the parallel lines, but never is allowed to become tangent or else the trajectory becomes an ellipse bracketed by two finite directrices. **In the case of a circle, the two foci merge into a single center point, and the directrices move off to infinity.** Whenever parallel "force lines" from infinity encounter the circle, they either reflect off with the angle of reflection equaling the angle of incidence – ranging from 0 degrees at the center to 90 degrees at the tangent or rays that enter the circle reflect in the same way, but are trapped inside the circle forming endless polygons. A quantum element enters here, because those rays that do not form regular polygons destructively interfere. So the circle is filled with an infinite number of regular polygons, and the circle itself is an infinite sided regular polygon (from an idealized mathematical perspective).

When a rigid body reaches its disintegration point due to inertial stress during rotation, the pieces fly off tangentially. So this is not a parabolic trajectory. It is like our drawing of the tangential velocity. (Pitchers pitching, discus hurlers hurling, gauchos tossing bolas, and so on.) So the release from a circular orbit is just like the capture – when done in a rigid manner. With gravity, however, the force is not rigid, but varies as the inverse square of the distance, which is why the trajectory is distorted.

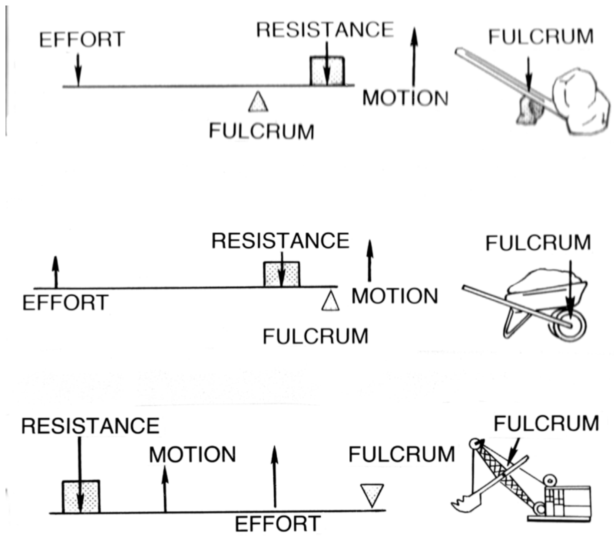
With solid-body rotation, the key factor is the EM bonds that hold the structure together and keep the object in a circular rotation. The EM "bonds" cancel the spaces between molecular components and hold the structure together. The further a component of a "solid structure" is from the center of rotation, the faster it goes. In a gravitational system the structural bond is elastic and due to relaxation rather than cancellation. The velocity of components is opposite that of an EM system. The closer a component is to the center of the system, the faster it goes, and the further it is from the center, the slower it goes (the Kepler decline). (An exception is a body such as a neutron star that is held together as a solid mass by gravitation.)

In the parabola you can see how the "force lines" are always parallel when they enter or leave the parabola. When they encounter the trajectory, they reflect through the focus to the other side of the trajectory and then back out parallel to the direction of entry. Even force lines that enter at random angles tend to get redirected into alignment after reflection. An eccentricity of 1 is the secret to conic section gravitational systems, and the parabola has that unity built into it. So, in a gravitational system, the initial velocity can range from 0 (pure centripetal acceleration) to escape velocity. Anything in the range from orbital velocity up to a parabolic escape velocity will form an elliptical (or circular) orbit.



In the case of a system in which the “orbiting” body is physically attached to its center of rotation by some sort of rigid bond (a strong EM bond), then there is no initial tangential velocity. There is only the linear velocity relative to the radius. As the radius grows, the linear velocity grows. Because the body rotating at the edge of the circular path has mass, the faster it goes, the larger its momentum becomes. The acceleration required to curve that mass with the given momentum into the circular path logically is measured by the length of the vector from the end of the tangential velocity vector (indicator of the speed relative to radius) to the edge of the circular path in the direction of the center of the circle. The faster the linear velocity relative to the radius, the longer the velocity vector tangent to the circle will extend. The ideal limit is infinitely fast so that the velocity vector goes to infinity, but in the real world the limit is the strength of the EM bond that holds the system together.

When we turn it around and turn a crank in a rigid system, we are applying force to the “orbiting” object to rotate it around a barycenter fulcrum point. This is how all levers work. Then we see how simple the rotating system is. The fulcrum acts as the barycenter of the system. In a first class lever the mass on one side times its displacement from the fulcrum equals the mass on the other side times its displacement from the fulcrum. **Time and motion are not even relevant once we find equilibrium. The radial arcs will also be proportional, since the displacements from barycenter fulcrum are the radii.** We have concentric circles that all turn at the same rate (revolution per second), but have speeds that vary according to radius length and involve forces that are relative to the masses and displacements.



- **Class 1**: Fulcrum in the middle: the effort is applied on one side of the fulcrum and the resistance (or load) on the other side, for example, a seesaw, a crowbar or a pair of scissors. Mechanical advantage may be greater than, less than, or equal to 1.

- **Class 2**: Resistance (or load) in the middle: the effort is applied on one side of the resistance and the fulcrum is located on the other side, for example, a wheelbarrow, a nutcracker, a bottle opener or the brake pedal of a car. Mechanical advantage is always greater than 1.

- **Class 3**: Effort in the middle: the resistance (or load) is on one side of the effort and the fulcrum is located on the other side, for example, a pair of tweezers or the human mandible. Mechanical advantage is always less than 1.

These cases are described by the mnemonic *fre 123* where the *f*ulcrum is in the middle for the 1st class lever, the *r*esistance is in the middle for the 2nd class lever, and the *e*ffort is in the middle for the 3rd class lever.

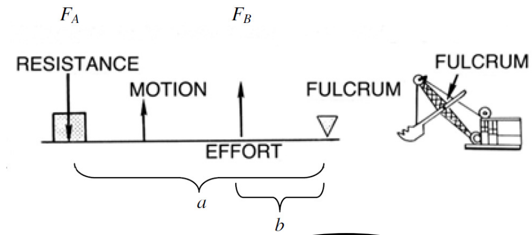
….

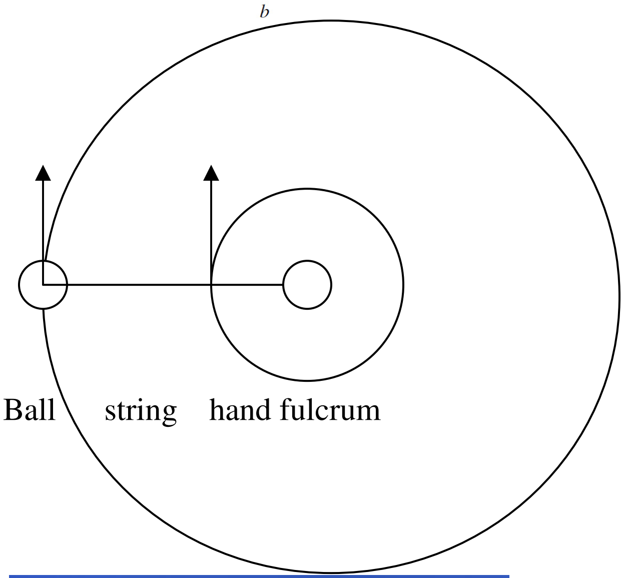
Assuming the lever does not dissipate or store energy, the power into the lever must equal the power out of the lever. As the lever rotates around the fulcrum, points farther from this pivot move faster than points closer to the pivot. Therefore, a force applied to a point farther from the pivot must be less than the force located at a point closer in, because power is the product of force and velocity.

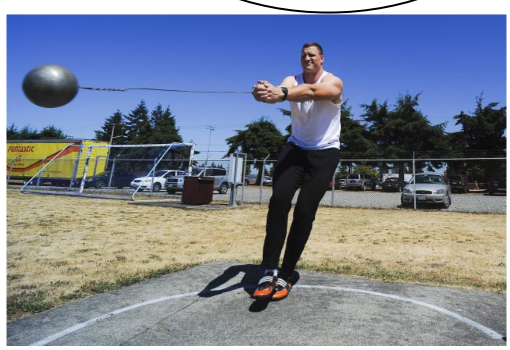
If a and b are distances from the fulcrum to points A and B and the force F_A applied to A is the input and the force F_B applied at B is the output, the ratio of the velocities of points A and B is given by a/b, so we have the ratio of the output force to the input force, or mechanical advantage, is given by $MA = F_B / F_A = a / b$.

Three Classes of Lever
(**Wikipedia**, "Lever")

Third Class Lever







Hammer Throw

Whether we have a rigid disc rotating or a rock moving circularly on the end of a string, or any mechanical lever, the period is always the same at any distance from the center (except 0) but the angular speed becomes greater in a linear relation as the radius increases. **It is simply all about levers. Swinging a rock in a circle on a string is really a variation on a third class lever.** Where you grasp the string is where you apply effort. Your shoulder-spine is the fulcrum. Because the string is flexible, you have to first impart innate linear momentum to the rock. When the string is stretched tight, then you exert effort on the lever with your hand that grasps the string. The rock resists, but your effort swings the rock around in a circle pivoting on the fulcrum of your shoulder and the continuous pressure of your hand's grasp. You are actually applying force in a linear direction tangential to the smaller circle described by your hand at the short radial distance from your shoulder fulcrum. **Because the forces have to be transmitted via the string, it seems like the force of your hand pulls the rock toward**

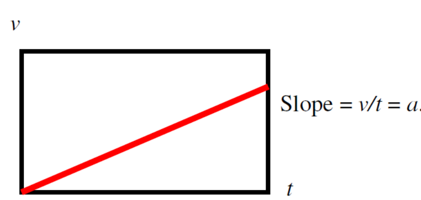
you on the string and the rock also pulls in the opposite direction on the string. The two forces are equal. The period of your hand and the period of the rock are also equal, so the acceleration seems to be found from the ratio of the outer radius (rock-fulcrum) to the inner radius (hand-fulcrum). It tells us the mechanical advantage, discovered by Archimedes, which is the same formula for all classes of levers.

* $MA = F_B / F_A = a / b$.
* $K = F_A\, a = F_B\, b$. (The kinetic energy is the force through a distance.)
* $\mathrm{a} = F_A / M_A$

The force is the mass times the acceleration, so we can divide the mass out from the force to find the acceleration. The force times the distance is the kinetic energy. The energy of the input effort equals the energy applied as output on the resistance. **The true acceleration is not directed toward the central fulcrum. It is always tangential, but it constantly changes direction as the effort of the guiding hand pivots around the fulcrum, and this keeps the energy transmitted along the string. The speed is the ratio of the circumference ($2\pi r$) to the period (T). The kinetic energy is ½ mv^2.** We know from our lever analysis that the actual force of the circulating rock is tangential, so the v must be linear. We know also that a in $F_A\, a$ is the radius. So to calculate the acceleration we say,

* $\mathbf{a} = F_A\, a / M_A\, a = ½\, mv^2 / mr = v^2 / 2r = 4\, \pi^2 r^2 / 2rT^2 = 2\, \pi^2 r / T^2$.

Push a shovel under a rock and then lift. You anchor the shovel handle with one hand, and you pull upward with your other hand, pivoting the rock up into the air. This is the same third class lever. The curious thing is that this calculation also agrees with Miles Mathis, who in his own fashion also finds that $\mathbf{a} = v^2 / 2r$.



Constant Acceleration has a Straight Line Slope in Terms of v/t.

A change in motion involves some force acting on a mass to produce acceleration. **The change in kinetic energy has to be <u>averaged over time</u>, and that is where the ½ comes in. With constant circular motion we have a constant acceleration over time. However, because the average is of <u>direction only rather than involving speed</u> (which is constant), there is no need to find an average speed, only an average direction. <u>On average the direction is also constant, as you can easily see when you let a wheel roll along a flat plane.</u> If the direction is constant, there is no change, and thus the average is the full constant value. Therefore, the ½ falls out of the equation in this special case, and we end up with the traditional equation: a = v^2 / r.** This is my current understanding of the simple but subtle mechanics of constant circular rotation. The textbooks all say that the acceleration in constant circular motion is centripetal, but it turns out that the centripetal acceleration is as fictitious as the centrifugal acceleration, and with the mass included they are both fictitious forces, because the "force" turns out to be "tangential", but restricted by the radial guide that keeps changing the direction. The change in speed is 0, and the sum of all the changes in direction is also 0, so there is nothing to average when the system is completely constant on average over time in spite of all its dynamic motion. The angular acceleration $\boldsymbol{v^2 / r}$ is just twice the linear acceleration $\boldsymbol{v^2 / 2r}$.

Next we will consider tops, gyroscopes, and gravitational systems such as solar systems and galaxies.

A celestial gravitational system, although planar, is not attached to a rigid "disc". A solar system experiences a "Keplerian decline" in the speed of bodies according to the inverse square of the radial distance from the barycenter of the system. The rotational curves of galaxies are yet another problem. We will discuss these issues later in the chapter. But first, a few words about solid spinning objects such as tops and gyroscopes, where torque becomes an issue.

Spinning Tops and Gyroscopes

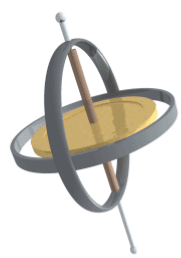


Image: **Wikipedia,** "Gyroscope"

Why does a top stand up when it spins and resists falling over? The momenta of the various particles in a top that is spinning upright are directed tangentially to the circular paths that they follow. The particles in the central axis are only rotating in place. All the moving particles circulating around that axis balance each other moving in different directions so as to generate a column that is perpendicular to the plane on which the top spins and running through the center of mass of the top. This column corresponds to the cross product vector.

If the top spins fast enough in a counterclockwise direction, it generates a strong vector force with an upward tendency. The top should lift off its base and float into the sky. Why doesn't it do that? The answer is that the "right-hand" rule is not a complete description of the physical system. The upright axis is a vector all right, but it is not unidirectional. It is a pseudo-vector that goes half up and half down (based on observer viewpoint), thus balancing out the tendencies so that the top spins right where it is. This is also a macroscopic quantum mechanical result. If the physics of tops is taught in terms of the bi-directionality of the cross product vector for rotating systems (the order of multiplication is bi-directional and arbitrary), students can more easily understand tops and some puzzling features of quantum mechanics. It is very confusing for a student to learn that a counterclockwise spinning top has an "upward" pointing axial vector, especially when it is a kinematic vector. That answer is only 50% true. The upward direction is exactly balanced by a downward direction, so the top just stays put, maintains its weight, and spins on the plane surface that supports it. In free space it would just spin on its axis and not go anywhere. Electrons spin this way, and can be oriented spin up or spin down, although they definitely do not spin the way macroscopic tops spin. A symmetrical top could spin upside down just as well as upside up. No matter how fast a top spins, it will not lift off into the air. Its "antigravity" potential is only in the direction away from its spin axis, which is normal to the earth, and has no effect on earth's “pull” except to keep the top upright because the momentum of spin balances in all directions parallel to the spin plane.

Nevertheless, earth's gravitational pull is constantly affecting the top. A non-spinning top falls over immediately. A spinning top not only has torque related to the rotation around its primary axis of spin, it has a secondary rotation due to its tendency to fall over using its point of contact with the support plane as its pivot point. This means it is dynamic in three dimensions. Relative to a horizontal surface it has an upright primary axis of spin. The second dimension is the tipping over of the top as it falls pivoting on the point where its spin axis is supported and provides a torque that twists the primary spin axis around a secondary axis along the horizontal support plane. The third dimension is the precession twist that causes the top of the primary axis (opposite the base) to swing around in circles.

If the top is spinning very rapidly, the axial rotation torque is much stronger in comparison to the rotational torque caused by falling over. The direction of the angular momentum vector generated by the top's rapid axial rotation is perpendicular (up and down) along the primary rotational axis. That is why the top does not fall over, even though it does start to tip under gravity's influence. When its rotational axis starts to tip at an angle, an additional torque is created by the rotation of the top as it tips over. This rotation generates a secondary axis orthogonal to the primary axis and parallel to the supporting plane. The orthogonal torque vector created in this case is called a "precession" vector (τ_p).

* $\tau_p = d\, m_\tau\, g$

Here τ_p represents the torque of precession, d is the distance the top's center of mass is from the axis of falling rotation, m_τ is the top's mass, and g is the acceleration due to gravity. This extra torque generates a vector that points along the axis created by the falling rotation, which is orthogonal to the vertical direction and lies in the plane that supports the top. This vector converts the falling energy of the tilted top into a sideways swing in the direction the top is rotating. At each moment the axis of falling rotation changes as the top swings to the side. This results in a precession motion. The tilted top swings in a circle around the primary axis of spin that is normal to the plane that supports the top.

$$\boldsymbol{\tau} = \frac{D\mathbf{L}}{Dt} = \frac{d\mathbf{L}}{dt} + \boldsymbol{\omega} \times \mathbf{L} = \frac{d(I\boldsymbol{\omega})}{dt} + \omega \times I\boldsymbol{\omega} = I\boldsymbol{\alpha} + \omega \times I\boldsymbol{\omega}$$

"where the pseudo-vectors $\boldsymbol{\tau}$ and $\mathbf{L}$ are, respectively, the torque on the gyroscope and its angular momentum, the scalar I is its moment of inertia, the vector $\boldsymbol{\omega}$ is its angular velocity, the vector $\boldsymbol{\alpha}$ is its angular acceleration, D is the differential in an inertial reference frame and d is the differential in a relative reference frame fixed with the gyroscope." (**Wikipedia**, "Gyroscope")

If a top or gyro is spinning fast enough, it can hang outward from a pedestal at as much as 90 degrees, anchored only by its bottom tip resting on the pedestal. This is a graphic demonstration of the "anti-gravitational" force that can be generated by kinetic energy. Instead of falling off the pedestal, the fall of the gyro will convert into precession around the pedestal in an orbit parallel to the plane that supports the gyro.

Careful observation reveals that a spinning top has an additional motion called "nutation" that is generated by the wobbling of the falling axis as it overshoots its momentum equilibrium and then overcompensates as it falls and then converts falling into precession. Nutation produces a wobbly trajectory along the path of precession. If you release the top to move on its own while tilted at a 90-degree angle, it will tilt over a little bit more than 90 degrees and then pull up. The nutation bounce will gradually damp down to a tiny wobble, and the average angle of suspension from the pedestal will be slightly over 90 degrees.

If a gyroscope can balance at right angles without falling, why can't we find a way to make the whole system levitate? Couldn't we put another gyroscope on the other "end" and have the whole thing float? Unfortunately that will not work. The torque has to rotate pivoting on something in order for the precession to work. We explained earlier that there is no net upward force in any of the vectors other than the nutation bounce, which is temporary like a bouncing ball and counterbalanced by a falling nutation. So if you remove the pedestal, the gyro just drops. The "levitation" produced by rotational torque only comes at most to half a levitation nicely balanced by half a falling. Still, it's remarkable.

When the gyro is tilted at 90 degrees, half the momentum is going up, and half is going down, so the gyro continues the precession at its tilt angle as long as the primary spin momentum continues with strength. The net precession motion is just the tendency of the top to spread in the direction of the axis of its falling. Which way the precession goes is determined by the clockwise or counterclockwise direction of its primary spin.

In any case **force is relative and can only occur in three ways. It can be applied from one point directly onto another point, directly away from the other point, or as a torque pivoting in some way around that point. The laws of rotational motion with torque are analogous to the laws of linear motion and are <u>basically just pivoting levers</u>. The solid rotating body is a bit more complex (since we have to consider all the particles that distribute the mass) but follows the same principles.**

We find then that there is either a 90-degree or 180-degree resistance involved in any motion. Rotation of a particle around another particle defines one as moving and the other as still. This is an arbitrary definition unless you jump in and take a ride on one particle or the other. However, when a particle ensemble rotates, it forms an axial vector normal to the direction of the motions of the particles. This axial vector is equally bi-directional, but if prior motion exists in another direction, the vector will favor the direction of the prior established motion. Hence, tops precess in the direction of their spin.

Quantum Spin

Motion is an expression of energy that always is directionally "quantized" as various whole number multiples of Planck lengths (1.6×10^{-35} m) of observer-defined unit vectors or polar vectors oriented at 90 degrees or 180 degrees to each other. All matter at "rest" is quantized in terms of mass (resistance), charge, the speed of light, the *pi* ratio, and the observer's gauge -- the radial unit (*R*). The fundamental quantum ensemble is the proton. A proton mass equivalency of energy cycling at light speed around half a circular orbit with a 1-meter radius generates a single quantum unit of charge. Charge is an indication of the creation or destruction of space between charged particles. A proto-antiproton pair emerge

* $e = m_n c / \pi R$.
* $e = 2 m_n c / 2 \pi R$.
* $2 m_n = (2 \pi R) (e / c)$.

We can see here that ($2 \pi R$) sets up a space around which a neutron particle pair emerges from the vacuum state like a binary star. The charge forms a ratio of space warp with the speed of light that appears to be two neutron masses or becomes a proton-antiproton pair that mutually annihilates. If they each lose an electron, which is common, they can stabilize as two protons to form hydrogen gas. Light speed and quantized mass generate a constant momentum. For some reason the cycle of this space-defining momentum has a radial displacement of about 1 meter (*R*).

To the extent that relevant forces reach equilibrium, we can say that any object, is "floating". It floats just above any material that is slightly denser. The directional "intelligence" of a spinning gyroscope's angular momentum makes it a natural guidance mechanism. Any attempt by an external force to twist the gyro out of the directional orientation of its primary rotational axis in its self-generated reference frame is just like a top tending to fall over under the influence of gravity. The fall causes the top to precess. This precession twist can be measured. If the gyro is anchored to a moving device, the twist tells exactly the angle of change in the trajectory of the device's motion. This is very useful as a navigational guidance system for submarines, rockets, and spaceships – and even the screens on cell phones.

Relative to itself, a gyroscope, like any object, is always floating. Even its rotation ultimately is due to resistance on the part of the observer. However, a spinning object creates a distortion of space-time relative to the whole cosmos. The rotational axis forms a self-defined absolute reference frame. To understand firsthand the way a gyroscope works, become one.

Exercise: Find a clear and unobstructed space and deliberately spin like a Sufi dervish. If you like you can use some Sufi music as a background, but that is not necessary. It helps to extend your arms as you rotate. Keep one arm -- your left if you rotate counterclockwise, your right if you spin clockwise -- slightly in front of you, hand extended, and let your eyes focus on the tip of the thumb on that extended hand. The other hand can be held palm upward if you like and slightly behind you. Do not try to focus your vision on the surroundings. This will help prevent dizziness. Placing attention on the hand or thumb extended in front of you also helps. When you wish to stop, decelerate slowly and bring your palms together outstretched in front of you. Focus on your thumbs. Once you stop turning, gradually bring your thumbs inward to an inch or so in front of your eyes. It makes you cross your eyes for a moment, but helps prevent dizziness and falling over. After a few moments you can lower your arms and sit down or resume normal activity. With a little practice you can get quite good at this exercise.

While you are whirling, notice the kinetic effects in your body. Also note how you have reversed the normal procedure of motion in the world as experienced by most humans. Usually the world stays still, and you run around doing things. On the other hand, if you gently whirl, you expend very little effort, your central axis is motionless, and the whole universe swings around **you**. Since motion is relative, are you not spinning the countless galaxies of the universe about you as effortlessly as if you were twirling a scarf?

As you get used to the whirling motion, spin in an effortless and relaxed manner and feel how slight the momentum of the entire universe is as it rotates beneath your feet. You may also be able to feel the "skater's" effect. When a skater starts spinning, her arms are fully extended. Then she draws them in, and this concentration of her relatively constant angular momentum into a tighter circle causes her to spin faster.

Contemplate the dervish experiment carefully from direct experience if possible for a deeper understanding of the observer's role in the physics of relative motion.

<u>Key Principle of Observer Physics</u>: **The vector that describes a primary axis of rotation is a double-headed vector arrow with no bias toward either direction. A secondary axis of rotation forms a bias with respect to its prior primary axis. This results in precession.**

In general, a primary vector **of any kind** in physics is quantum mechanically 50% "up" and 50% "down", or 50% clockwise and 50% counterclockwise. Newton's third law describes this situation for linear forces. (50% forward, 50% backward . . . .) A secondary (non-collinear) vector of any kind "chooses" to be "left-handed" or "right-handed", depending on its relative orientation to a preexisting primary vector.

A given system can only rotate its whole structure in two directions at once without causing turbulence, although gimbals outside the rotating system may allow movement in any rotational direction. If the primary rotating system maintains sufficient speed, it will resist any change to its orientation. This suggests that a rapidly spinning primary rotation establishes an absolute inertial frame. The primary and secondary rotations are mutually orthogonal and define a three dimensional space. The primary rotation forms an axis, and the secondary rotation generates a precession. Nutation is a wavelike bouncing or wiggling of the precession rotation. Independent of its mass a rotating object may have any number of spin angles, since that aspect is massless. In other words, frictionless gimbals, or an observer detached from a rotating system, regardless of its mass or spin orientation, can view the spinning object from anywhere in space, at rest or in motion. On the other hand, a top spinning clockwise in a gravitational field as you look down on it has a clockwise precession, and a top spinning counterclockwise as you look down on it has a counterclockwise precession. Primary rotation has no reference frame to determine bias, so the axial vector has direction, but is two-headed.

Two-Headed and Omni-Directional Dynamic Linear Vectors

This principle of rotational dynamics is also true for linear dynamics, and gives birth to Newton's Third Law. For example, when a bullet is fired from a gun, the momentum resulting from the event has no directional bias. The bullet's vector points forward, and the gun's vector points backward due to wave guide effects. The two together form a single vector with two arrow points. The resultant momentum produced by the powder explosion is actually evenly distributed in **all** directions when we take into consideration all the components of heat, light, sound, powder fragments, etc., and forms an expanding event bubble just like the release of light from a point source. In a binary action-reaction expansion event, where there is no rotation, the vector arrows are actually omni-directional. This generates the fundamental conjugate nature of phenomena. "Handedness" is a secondary result that always requires a primary reference frame from which symmetry is "broken" in half. This bifurcation can continue until the system appears chaotic and randomly organized. Chaos and randomness are conjugate to order and symmetry.

The Stern-Gerlach Experiment

The Stern-Gerlach experiment demonstrates the general principle of rotational dynamics on the quantum level. Electrons are charged tops due to photons forming whirlpools. There is not really any solid body spinning. What is important is having a two-dimensional subspace of a larger space. The charge comes from the effort of the observer to be able to see something. By convention we label charge as positive or negative. When charged electrons are exposed to a magnetic field, they separate into spin up and spin down orientations, with an exact 50-50 distribution, corresponding to magnetic charge. This is a secondary “precession” rotation in a further effort to “see” something. The charge in the magnetic field acts as a secondary rotation, causing the electrons to choose between "left-handedness" and "right-handedness" -- which appears in the experiment as up and down axis orientation. An interesting aspect of the Stern-Gerlach experiment is that, after a group of electrons have been sent through the magnetic device and sorted into up and down orientations in the Z axis, you can filter out the down electrons and send only up electrons through the apparatus again, but from X axis orientation, and again filter out the spin down electrons leaving only up electrons; then, when you again send them through the Z axis orientation, you find you are back to 50% up and 50% down distribution and the prior filtering is lost. This makes sense from our analysis of spins, since up spins when viewed tipped over at 90 degrees have no preference for up or down and will sort 50-50 when passed through the magnetic field. This experiment works not only for electron spins in a Stern-Gerlach device, but also for horizontal-vertical polarization of photons, hyper-fine energy levels, flux in superconductor loops, and is a general quantum mechanical phenomenon. The binary contrast is known as a quantum bit (q-bit), and some forms of this phenomenon form the physical basis for the evolution of quantum computers.

Experiment: Find a toy gyroscope. Have a friend start the gyro spinning. When your friend holds the gyro by its frame with the spin axis upright in the "Z" axis as it spins, suppose you see that it goes counterclockwise. We'll say the end of the axis facing up represents spin up. Have him turn it upside down while still spinning. The gyro now appears to go clockwise, so by our prior convention we say that we now have a spin down gyro. Next have your friend hold the gyro so that its axis is horizontal in the "X" axis. Which way is it now, up or down? You can tilt your head and look from both ends to see which goes counterclockwise and call that up, but you have to do a new determination. Relative to the Z axis, up and down spin just depends on how the gyro is oriented in the XY plane, and Z axis can't distinguish X from Y, especially if the gyro top is spinning very fast and there is precession that scrambles the tilting from Z to X, reversing the orientation, twisting it to Y or any angle between. If you tilt the X-axis up end of the primary gyro spin axis back into the Z dimension, then it becomes ambiguous with regard to the ZY plane. So each time you switch dimensions for the primary spin axis, the other two dimensions become ambiguous, and the primary spin axis loses its specificity with regard to up and down. Any quantum binary contrast has this property. For a spinning top, earth's gravity is like a Stern-Gerlach device. It pulls the top over sideways from its upright Z axis by 90 degrees, and the precession scrambles its new XY orientation.

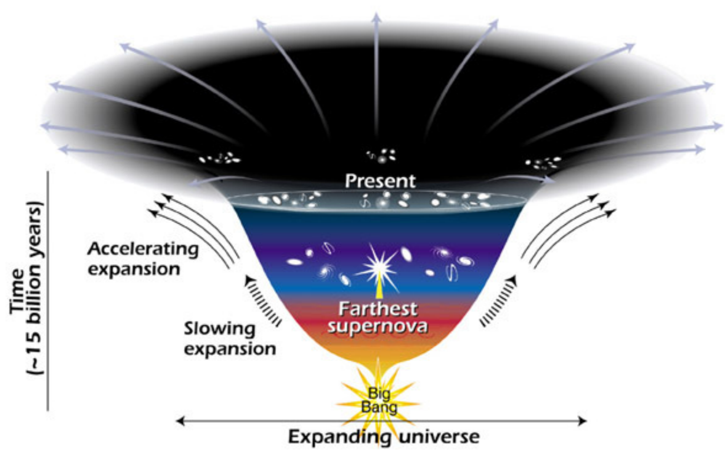
Does this belie what we said about memory never being lost? Not really. Once the principle is understood, you know how the system works. The statistics are always there. You know that the total probability of all the top angles is 1 and always has been. The moment-to-moment details no longer are that important.

Dark Energy and Cosmic Inflation

There is a popular theory developed in the 1980s by Alan Guth and Andrei Linde that during the early part of the first second of the Big Bang the universe expanded at an astounding rate much faster than light before settling into its "usual" expanding momentum. "The inflationary epoch lasted from 10^{-36} seconds after the Big Bang to sometime between 10^{-33} and 10^{-32} seconds." (**Wikipedia**, "Inflation (cosmology)") There is no physical mechanism in standard physics to explain why this might have happened, but it does explain how matter came to be distributed in the universe.

Wikipedia continues: "Inflation explains the origin of the large-scale structure of the cosmos. Quantum fluctuations in the microscopic inflationary region, magnified to cosmic size, become the seeds for the growth of structure in the universe (see galaxy formation and evolution and structure formation). Many physicists also believe that inflation explains why the Universe appears to be the same in all directions (isotropic), why the cosmic microwave background radiation is distributed evenly, why the universe is flat, and why no magnetic monopoles have been observed. While the detailed particle physics mechanism responsible for inflation is not known, the basic picture makes a number of predictions that have been confirmed by observation. The hypothetical field thought to be responsible for inflation is called the inflaton." ….

"The universe expanded by a factor of at least 10^{26} during inflation. Inflation is a period of supercooled expansion, when the temperature drops by a factor of 100,000 or so. (The exact drop is model dependent, but in the first models it was typically from 10^{27} K down to 10^{22} K.) This relatively low temperature is maintained during the inflationary phase. When inflation ends the temperature returns to the pre-inflationary temperature; this is called *reheating* or thermalization because the large potential energy of the inflaton field decays into particles and fills the universe with Standard Model particles, including electromagnetic radiation, starting the radiation dominated phase of the Universe. Because the nature of the inflation is not known, this process is still poorly understood, although it is believed to take place through a parametric resonance."



This diagram reveals changes in the rate of expansion since the universe's birth 15 billion years ago. The more shallow the curve, the faster the rate of expansion. The curve changes noticeably about 7.5 billion years ago, when objects in the universe began flying apart at a faster rate. Astronomers theorize that the faster expansion rate is due to a mysterious, dark force that is pushing galaxies apart.

The Observer Physics viewpoint is that exponential superluminal inflation is a critical phase in the birth of a universe cycle. The primary outcome of inflation is that a single photon becomes innumerably many photons and all the fundamental constant relationships appear, most important being the complementary relationship between matter and antimatter. This is the birth of the great romance of the proton and the electron. In between lots of loyal quarks hover as best men and brides' maids. The Z bosons play an important role in the proliferation of massive simultaneous pair creation throughout the cosmos.

The source of Dark Energy is the observer's powerful resistance to the frustrating boredom of unity. That is the "nature of the inflation". Dark Energy is "dark" only because it has been suppressed deep into the subconscious of every conscious being. The rediscovery of Dark Energy is a good sign that humanity is finally beginning to wake up and recover an important component of our long abandoned motivation for creation – a fundamental transparent belief – that has always been right there in front of us all without being recognized. As mankind grows in terms of responsibility, Dark Energy will become more and more illuminated. When it is finally "Game Over", then the Dark side of the Force will no longer be "Dark" and sentient beings will begin to play freely and deliberately in the universes of their creation.

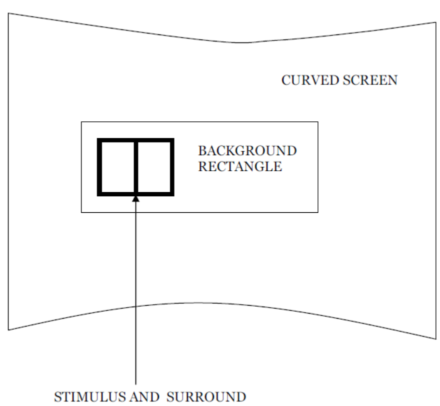
Many scientists also see evidence that for some as yet unknown reason about 7.5 billion years ago the universe once again began to expand at an accelerated rate. It may be that during that epoch conscious intelligence appeared in the universe and rapidly expanded, but then the consciousness began to shrink in intelligence and harden into ever more isolated individualities. At present we simply do not know enough about that period of cosmological history to say what happened, and for now it remains a mysterious "dark energy" that favors anti-gravity over gravity.

The Observer, Quantized Perception, and a Hidden-in-View Subliminal Reality
I recall that back in the late 1950s and early 1960s for a short while there was a tiny little discussion about subliminal advertising in movies and television. Then it disappeared from the media and all public discussion. The scientific reality however did not disappear, because laws of nature have a tendency to hang around. Near the turn of the century a friend of mine sent me a copy of the May, 1959, doctoral dissertation by Leo J. Baranski at Princeton University. One of the advisors for Baranski's research was Albert Einstein, who at that time was at Princeton's Institute for Advanced Studies. The title of Baranski's research paper was "Temporal Characteristics of Dynamic Contour Perception". Baranski defines dynamic contour perception as the ability to perceive the sharp edges or borders of any object moving in the visual field. The laboratory work for this project involved testing the ability of subjects to recognize objects with various contours under different dynamic conditions such as moving at various speeds with or without prior opportunity to view the contour at rest. Baranski wanted to determine when the object became lost to the observer. Here is the abstract statement summarizing his thesis. The full document is posted on my website at http://www.dpedtech.com/OPpapers.htm. For direct download: http://www.dpedtech.com/barphd1.pdf and http://www.dpedtech.com/barphd2.pdf.

Abstract to Dr. Baranski's Thesis
"This study is presented in two parts, the first being an experimental study of the temporal characteristics of contour formation of a moving stimulus under several conditions of illumination and three stimulus sizes. Contour perception here is taken to mean the formation and subsequent maintenance of sharp edges during the entire movement phase of a small (a few degrees in visual angle) stimulus. Such contour is

usually not maintained at speeds exceeding about 15°/sec.; however, if the stimulus is first presented in a fixed position, contour may be maintained at speeds up to 30°/sec. This study then investigated the relation between the velocity (V) of the moving stimulus and the duration of the exposure (T) of the stationary phase before movement under several conditions of illumination and stimulus size.

"The criterion of maintaining contour was that the stimulus should be seen as sharp and clear during the entire extent of movement. **Thus, an interesting feature of the data is that dynamic contour is never perceived under any condition, even at the slowest speed, unless there is at least a very short duration of T.** It was found that, within the limits of this experiment, when contour formation is hampered by the stimulus speed, an increase in T facilitates contour formation of the subsequent moving phase. An increase in illumination level facilitates the perception of dynamic contour at speeds above 10-15°/sec. The ease with which dynamic contour can be seen at slow speeds, and the fact that there seems to be a minimum excitation level to be overcome, combine to eliminate differences between the various conditions at speeds under 10-15 °/sec. For similar reasons, an increase of stimulus size facilitates dynamic contour formation particularly at speeds above 10-15°/sec. and at low illumination levels. A change in the contrast ratio (between screen background and stimulus brightness) has no consistent effect upon dynamic contour formation.



Drawing of Test Apparatus from p. 9
Baranski presents stimuli as images moving past on a curved screen.

"In the second part of this study is forwarded the hypothesis that the nervous system involves a central quantum field structuring process which is quantal in nature. This proposed theory of sensory processes is based upon the quantum field theory of physics and, while of necessity many ramifications are omitted, a brief background of both quantal theory in psychology and quantum field theory is given. A new position of the quantum field and particle concepts of physics is presented. It is postulated that the basic substratum of the universe is a structured quantum field whose intrinsic properties and formative tendencies are responsible for all processes and structural organizations. Reasons are given for the belief that a comprehensive and adequate explanation [of] sensory processes, indeed all psychological phenomena, must be based upon a central nervous process and that the underlying parameter must be one (here held to be the quantum field structure) which runs throughout natural phenomena in whatever field.

"This view leads to an expectation of step-wise functions in sensory discrimination. Individual plots of the data gathered in this study, although not at all conclusive, are used as an indication that dynamic contour discrimination is far from being continuous."
(**Boldface** emphasis added by me. DAW)

It appears that the observer perceives his world through the senses that are physiologically limited to the range of stimuli that the perceptive faculties are capable of sensing. For conscious perception of visual stimuli this is not merely limited to colors and shapes, but requires a certain minimum period T of duration. There is also the question of what portion of a given perception is due to the mechanical function of the sense organs such as the rods and cones in the eye, and what is due to psychological process, higher cognitive functions, and perhaps many other factors. However, in terms of pure awareness that is not subject to conditioning, there may be subconscious ranges of perception, cognition, non-deliberate and deliberate habits, decisions, and actions of which most people are simply not consciously aware. These may include perception of a continuous "big bang" and various other stages of manifestation that are far beyond conscious perception and thinking, but nevertheless present from moment to moment much like the frames in a motion picture film.

Dark Matter, Spiral Galaxies, and Observer Physics

The rotational curves of spiral galaxies present another major problem in the physics of large scale gravitational systems. When Kepler and Newton framed the theory of gravity, they had no knowledge, much less any observational data, concerning galaxies and only considered what they knew of our solar system. According to current standard theory a large body of "Dark Matter" is required to bring the rotational dynamics of galaxies in line with Newton's theory, but unfortunately the hypothetical dark matter has not been clearly observed. Dark matter is considered to make up about 80% of the matter in our universe and includes a very large amount that is not explained as unobservable neutrinos, dust, gas, burnt out stars, planets, moons, quiescent black holes and so on. Dark matter is thought to consist of a type of matter that is not visible and may only react with known matter types gravitationally. To me this notion sounds like matter that has been cooked up by active imaginations just to make the gravity equations come out right.

The justification for the theory of vast amounts of dark matter in rotating galaxies derives from an analysis of the motions of the stars in such galaxies. Using various tools such as the red and blue shifts of the star light astrophysicists calculate the average momenta of the component stars and match it to the "virial theorem" that says that if the time averages of the total kinetic energy and the total potential energy are well defined and the positions and velocities of the component stars are bounded for all time (or at least are roughly in equilibrium for a very long period of time), then the time average of the total kinetic energy $\langle T \rangle$ equals minus one half of the time average of the total potential energy $\langle V \rangle$.

* $\langle T \rangle = - \langle V \rangle / 2$.

Physicist John Baez describes the virial theorem in a simple way by beginning with just one large particle and one small particle in a gravitational relation with a radius of R, and then he expands it to consider the average for a large collection of particles. He starts with the gravitational potential energy as described by Newton:

$V = -GmM/R$ (1)

where G is Newton's constant. To figure out the kinetic energy, remember that the gravitational force is

$F_{grav} = -GmM/R^2$

while the centrifugal force is

$F_{centrif} = mv^2/R$

In a circular orbit these counteract each other perfectly, so we must have

$mv^2/R = GmM/R^2$

Thus the kinetic energy of the light particle is

$T = mv^2/2 = GmM/2R$ (2)

while the kinetic energy of the heavy one is negligible. Comparing (1) and (2), we see that

$T = -V/2$

just as the virial theorem says!

(John Baez [mathematical physicist], "The Virial Theorem Made Easy", http://math.ucr.edu/home/baez/virial.html)

When we cancel out the mass in $mv^2/R = GmM/R^2$, we have the acceleration:

* $a = v^2/R = GM/R^2$.

This is all fine in theory. The problem is that when the astrophysicists calculate the rotational curves for these galaxies the data does not match the theory. Not only that, it is way off – so far off that something is seriously wrong. Is the data wrong, is Newton wrong, is the virial wrong, or is there a huge amount of invisible matter lurking out there somewhere and skewing all the data. Not wanting to admit that the problem could be with the measurements, Newton, or the virial, since they all work fine elsewhere, the physicists opt for the "dark matter" hypothesis to provide as much as 80% of the additional mystery mass that is needed to pull the kinematics of such galaxies in line with the virial and Newton.

In 1983 Israeli physicist, Mordehai Milgrom, proposed a Modified Newtonian Dynamics (MOND) formula that is able to match fairly well the observed rotational curve data for many spiral galaxies, but he lacked a coherent theory to explain why his basically ad hoc formula works the way it does. From the Observer Physics viewpoint I propose an alternative approach that takes into account observer viewpoint without arbitrary changes to Newton's mathematical model or any need to invent huge amounts of new and exotic invisible matter. In this preliminary discussion of the dark matter problem I only consider in detail spiral galaxies, but this seems to handle most of the problem.

Many astrophysicists believe that galaxies must have huge halos of "dark matter" (MACHOs = "MAssive Compact Halo Objects") that our instruments can not detect, but which influence the dynamics of these galaxies in the manner that we observe.

Some believe that exotic forms of matter such as WIMPs (Weakly Interacting Massive Particles) may be hiding in the galactic core, but none so far have been "captured". Milgrom's formula fits the data fairly well but has no theoretical justification. The problem in the rotational dynamics of large-scale physical systems remains one of the major difficulties in astrophysics and cosmology.

Invisible Evidence?

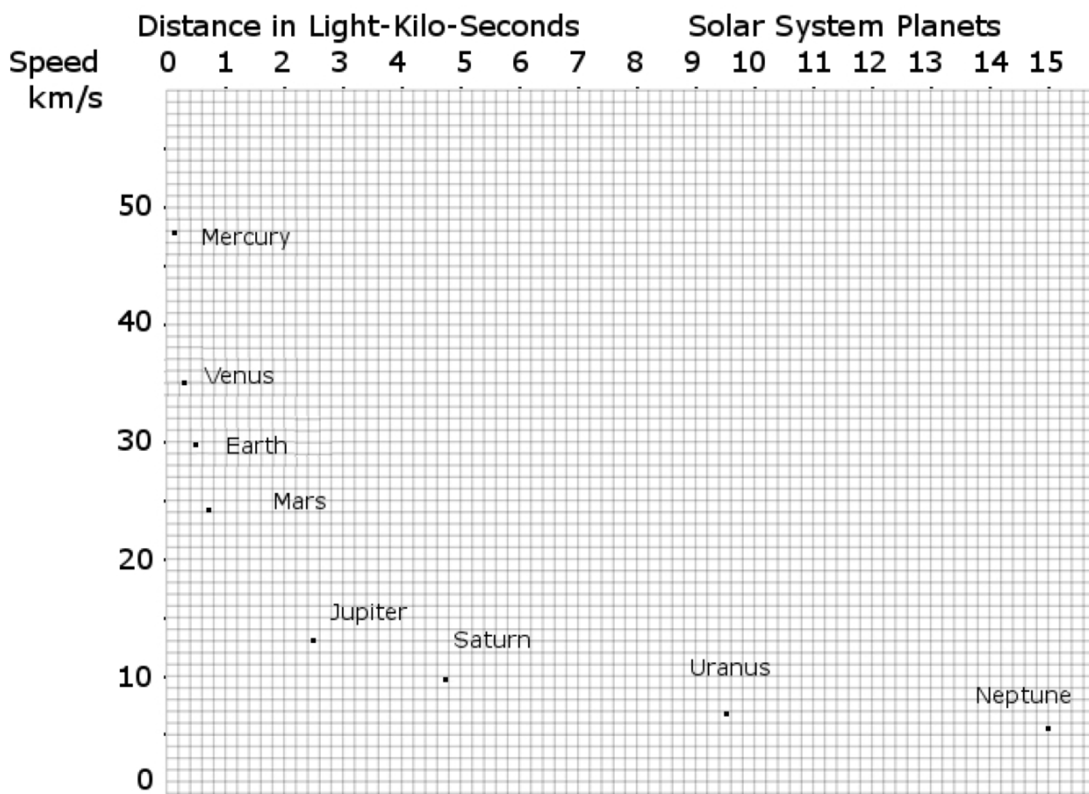
Data from NASA's Fermi Gamma-ray Space Telescope indicates greater than expected gamma rays emanating from the center of our galaxy. Some scientists suspect that this excess may be some evidence of dark matter annihilating and releasing gamma rays. A massive galaxy cluster collision in Abell 520 may show signs of dark matter's gravitational influence, but the colliding galaxies are running away from the supposed dark matter rather than being held or attracted by it. Another area under study is Abell 383 where the supposed dark matter seems distributed like a football rather than a sphere – based on studying the gravitational movements of galaxies participating in the cluster. "Dwarf spheroidal galaxies" (as distinguished from "globular clusters") are thought to contain large amounts of dark matter based on the study of the movements of their constituent stars, but they apparently do **not** emit the gamma rays that others think are symptoms of dark matter WIMPs annihilating. What goes on here is not at all clear yet. Astronomers using the Chandra X-ray telescope have discovered a huge galactic collision (called "El Gordo") 7 billion light years away – the earliest known such super event. Observations suggest that the hot gas involved in the event was slowed down, but somehow not the "dark matter". Scientists using the Hubble space telescope have recently discovered the earliest so far seen formation of a galactic cluster over 13 billion light years away and only about 600 million years after the Big Bang. This find reveals an early stage in the construction of galaxy clusters. Scientists believe clumps of dark matter serve as a kind of invisible scaffolding on which galaxies form, so this may be a good place to find evidence of dark matter. The theory of hierarchical merging starts with dark matter and gas forming into primordial galaxies (dwarf ellipticals?). These then accumulate into ever larger clusters. The problem with these preliminary investigations is that there is no clear indication of what the dark matter is made of and what to look for as symptoms of large-scale dark matter footprints. So the observational stage of investigation is still too early to make any clear cosmological judgments. (Source: http://science.nasa.gov/astrophysics/focus-areas/what-is-dark-energy/)

In this discussion I will focus on the rotational curves of spiral galaxies, an area of cosmic dynamics that is more thoroughly studied, with lots of detailed data available.

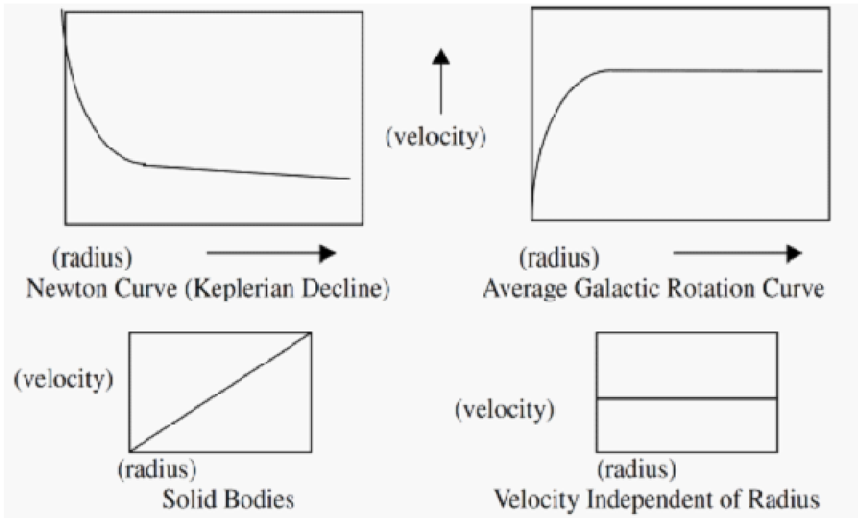
Whether the conclusions of this discussion can be extended to the broader cosmological arena where people suspect other dark matter may lurk remains to be seen – and, of course, it helps if the ideas expressed here become more widely recognized and evaluated with the growing body of observational data.

Galactic Rotation Curves

Let us understand more clearly what is wrong with the galactic rotation curves. The velocities of particles out in the "arms" of a large rotating system such as a galaxy or galactic cluster tend to be nearly independent of the radius. Velocities are also for the most part independent of the number of particles or the density unless the density becomes so low that the system no longer can function as a single entity or gets so high that black holes form. Below is a sketch of the Keplerian decline for our solar system.



Below I compare a sketch of an average galactic rotation curve (upper right) to a Keplerian curve (upper left). For further comparison I show the rotational velocity curve for a solid body (lower left). It has a linear relation to the radius. Another possibility is that the rotational velocity is constant and is independent of the radius (lower right). In that case bodies with larger radial distances from the CM will lag behind those with shorter radii, because the distance traveled per revolution is much greater. This diagram looks about the same as the outer portion of a galactic rotation curve, and indeed spiral galaxies tend to have arms whose outer portions trail behind in a spiral shape. Only when the average local density is below the "cluster" density or when a particle is outside the cluster in "open space" does the relation between that particle and the cluster take on the normal two-body behavior described by Kepler and Newton and show velocity decline.



The Keplerian Decline and Milgrom's Patch Job

According to Newton's gravitational law as matter rotates in large celestial bodies at greater and greater distances from the gravitational center of mass of the system, the gravitational force gets weaker as the inverse square of the distance, so the centripetal acceleration effect gets correspondingly weaker. This is known as the Keplerian decline. Yet the far-flung bodies in galaxies or other large systems move as if there were present a much stronger gravitational influence than appears warranted by the observed mass in the central region that governs them. The most popular theory to explain this is that there is a great deal of invisible dark matter in galactic cores or as galactic halos. In his MOND theory Milgrom proposes a constant a_o, with the dimensions of acceleration that modifies the dynamical equations of Newton and describes the observed motions when the Newtonian acceleration falls below a certain threshold. Milgrom modifies Newton's gravitational equation by boosting the acceleration effects for distantly separated objects as follows.

* $a = M\,G / r^2$. (Newton)
* $a^2 / a_o = M\,G / r^2$. (Milgrom)

These two relations can be written together:

* $(a / a_o)\, a = M\,G / r^2 = aN$.

Here aN represents the Newtonian acceleration. The expression $[m\,(x)]$ satisfies $[m\,(x)] \approx 1$ when $x >> 1$, and satisfies $[m\,(x)] \approx x$ when $x << 1$. When the acceleration falls below the threshold ($a << a_o$), Milgrom uses his constant to boost the gravitational effect. When ($a >> a_o$), then systems follow Newton's law.

One key result is that bodies far from the mass center of a galaxy attain an orbital speed that is independent of the radius and proportional only to the fourth root of the total baryonic mass of the galaxy (the Tully-Fisher relation). Milgrom took the notion of asymptotic flatness of galactic rotational curves as axiomatic when framing his theory. Note that the Tully-Fisher relation does not involve the hypothetical presence of dark matter.

"In astronomy, the **Tully–Fisher relation** is an empirical relationship between the intrinsic luminosity (proportional to the stellar mass) of a spiral galaxy and its velocity width (the amplitude of its rotation curve). It was first published in 1977 by astronomers R. Brent Tully and J. Richard Fisher. The luminosity is the amount of light energy emitted by the galaxy per unit time; it can be measured using the galaxy's apparent brightness when the distance to the galaxy is known. The velocity width is measured via the width or shift of spectral lines using long-slit spectroscopy.

"The term **Baryonic Tully–Fisher relation** is used when the mass being considered is the baryonic mass of the galaxy, as opposed to the mass value inferred from luminosity alone.

"The quantitative relationship between luminosity and velocity width is a function of the wavelength at which the luminosity is measured, but roughly speaking, luminosity is proportional to velocity to the fourth power.

"The relation enables the difficult-to-observe intrinsic luminosity to be calculated from the relatively easily observable velocity. Use of the observed apparent brightness and the inverse square law enables the distance to the object to be estimated. In astronomical parlance this distance measurement is known as a "secondary standard candle".

"Internal dynamics of stars in galaxies are driven by gravity. For this reason, the amplitude of the galaxy rotation curve is related to the galaxy's mass; the Tully–Fisher relation is a direct observation of a close relationship between galaxy stellar mass (which sets the luminosity) and total gravitational mass (which sets the amplitude of the rotation curve)." (**Wikipedia,** "Tully-Fisher relation".)

Milgrom estimates the value of (a_o) to be

* $a_o = 10^{-10}$ m / s^2.

The MOND constant relation appears to fit the data in most cases, especially fitting the well-studied disc galaxies. The main exceptions seem to be the cores of rich X-ray galactic clusters, where there is still a considerable discrepancy from his formula. In such cases Milgrom believes, and reasonably so, that there must be additional dark matter to make up the difference. There may be active X-ray emitting black holes involved.

Milgrom's procedure deals with low acceleration conditions. It does not integrate with relativity or quantum mechanics, breaks down entirely in the presence of black holes, and has not been integrated with the cosmology of the entire universe and its evolution, although there are some correlations emerging with the cosmic background radiation data. Milgrom admits that his hypothesis is weak in that it lacks a theoretical foundation and does not work in the extreme ranges of physics. He sees it as a patch to get the observations to fit the equations. He can not say for sure why there should be a constant, or why it should have the value it has.

One suggestion is that the MOND approach harks back to Mach's principle, the idea that "local" inertial gravitational effects are influenced by the global totality of mass in the universe. The intergalactic distances are so great and the rate of falling off for the gravitational force so great that Mach's principle seems improbable as a factor governing inertial effects at the cosmic level (but not necessarily at the level of internal galactic dynamics.) Milgrom suspects that, if his constant is correct, it more likely requires an adjustment to inertia rather than to gravity. In observer physics we find that we can not separate inertia and gravity, since they are conjugates of each other. Adjustment of inertia -- such as special relativity produced -- implies an adjustment to gravity. Milgrom also speculates about possible influence from the vacuum state. The vacuum is Lorentz invariant with regard to constant speed, but may not be so with respect to acceleration. He even speculates on a possible macroscopic connection to the Casimir effect and the vacuum zero point. In sum, Milgrom has a simple formula that fits the data, but as yet no real coherent theory to back it up.

A Fresh Perspective

The key to galactic dynamics is the realization that the apparent value of the gravitational "mass" changes for particles inside a cloud, -- and a galaxy is a cloud of stars. This dynamic principle holds for galaxies as well as nebulae, and possibly, in an attenuated manner, even for the whole universe. It would tend to show that the *G*-force between galactic participants would be strongest out in the wings of galaxies rather than close to the center. Milgrom's estimate of 10^{-10} m/s^2 for a_o looks mighty close to the numerical value of (G) and leads right to the Tully-Fisher relation (which is where he got it).

* $Kx = (G)\,(a_o) = 1$ m^4 s^{-4} kg^{-1}. $= V^4 / M_{tot}$, (where M_{tot} is the total galactic mass.)
* $a^2 / a_o = M\,G / r^2$.
* $a^2\,r^2 = M\,(G\,a_o) = Kx\,M$.
* $a^2\,r^2 = V^4 = Kx\,M$.

The problem with Milgrom's approach is that both his formula and the value of a_o look arbitrary. Why should this shift from a to a^2 suddenly take place at his a_o threshold? What causes the Tully-Fisher relation? Why should matter at one distance from a center of mass (*CM*) behave in a fundamentally different way than matter at another distance? If it turns out that the "missing" dark matter doesn't really exist, what happens at Milgrom's a_o acceleration threshold? Without some principle to explain why Newton's second law should suddenly shift gears in a galaxy, the idea sounds arbitrary. Adding such a rule when it may not be necessary complicates Newton's simple dynamics and may even threaten to modify our notions of geometry, given that general relativity is based on space/time geometry. We must justify such a complication. Newton predicts for the big circular orbits of stars in galaxies that:

* $A R^2 = G M$.
* $R V^2 = G M$.

Enter the Dark Matter Hypothesis
This means the acceleration drops off as the inverse square of the distance and the velocity changes as the inverse square root of the radius. To keep the velocity from dropping way down as we get far from the center we have to amplify the velocity somehow. Physicists figure they need around ten times the visible mass of a galaxy to hang around outside the galaxy as a "dark matter" halo in order to keep the galaxy holding together as it turns. That much normal non-radiant matter should render the galaxy invisible, and luminous matter would make the whole thing glow like a bubble unless dark matter is somehow stable but transparent. Alternatively there must be lots of dark matter hidden in the core of a rotating spiral galaxy or else the halo is somehow transparent and invisible. In any case something must be preventing the Keplerian decline.

Because of the strong belief in Newton's correctness -- even though Newton had no idea of the existence of galaxies and other large cosmic formations when he made up his handy gravity law -- physicists strain at inventing all kinds of exotic hypothetical materials to account for the supposedly missing mass. Our analysis suggests that the problem is not that there is extra mass outside, but instead that there is cancellation of "mass" on the inside. Just like a powerful static charge can appear on a sphere's surface but there is no charge inside, so a galaxy that shows a strong gravitational influence from its outside, has diminishing net values of gravity on the inside due to relative equilibrium.

My analysis shows that a large cluster of particles with sufficient density (such as a galaxy) behaves internally as if the mass increases as the radius increases. However, deep in a cluster the mutual "attractions" of the various component particles tend to cancel out in a state of gravitational equilibrium, and this reduces the effective gravitational mass near the center and appears to increase it toward the periphery. A particle inside the cluster therefore tends to eventually behave as a member of the cluster and synchronizes its movements with the group so as to produce a trailing spiral in a coherently rotating galaxy. These dynamics do NOT follow Newton's law for freely falling bodies. Particles in a cluster behave as if they are under the influence of "antigravity".

It Is All Done with Mirrors
The rotation curves for galaxies look very much like flipped-over mirror images of the usual Newtonian rotation curve that shows the "Keplerian Decline". Newton's relation is a hyperbolic equation. It describes the behavior of satellites that move in a highly diluted space outside and at some distance from the dense mass of a large gravity well. This is not the case for galaxies. They contain millions and billions of stars all interacting like a huge swirling gas cloud. The "internal" dynamics of galaxies are the **mirror image** of Newton's "external" dynamics. We do not have to find huge amounts of invisible dark

matter, nor do we need to do any major surgery on Newton's law. We simply generalize it into an "internal" and "external" form. The difference is obtained by simply reversing the sign of any arbitrary component's "internal velocity" and reversing the sign of the total galactic mass. The sign on the total mass reverses because the mass tends to pull "out" rather than "in" relative to component particles deep inside the cluster. The outward “pull” increases as an object nears the center of the galaxy. The sign on the "internal velocity" reverses because we set the outer edge of the cluster as the "zero point" boundary line for velocity -- that is, the asymptote for maximum "internal" velocity. The "external" law (for solar systems) describes two objects moving externally relative to each other, so both velocities are positive. The two objects have equal relative speeds in opposite directions. The "internal" law deals with the case where the "satellite" component is "inside" the whole cluster, so the cluster's relative velocity is positive. But the internal component's relative velocity is negative. (Which is positive and which is negative is conventional so long as we are consistent in our relative viewpoints.)

Thus the speed of an isolated satellite outside, but close to a cluster of particles will be greatest near the cluster's edge and then will drop off quickly as radial distance increases. It then fades off toward zero at greater radial distances. This is the Keplerian Decline. On the other hand, a star near the central core of a galaxy consisting of many gravitationally interacting stars will have almost zero velocity. The velocity will pick up rapidly as the radial distance from the galaxy center grows. Then it will level off as it nears an asymptotic velocity. Toward the outer regions of the galaxy the velocity will seem independent of the radius and more likely influenced by other factors in the cluster's makeup. This velocity is relative to an observer who is outside the galaxy. Unlike a planet that is some distance away from the star it orbits, a star in a galaxy is **inside** the system of a large rotating star cluster.

Based on these observations we simply make a viewpoint shift and a tiny modification to Newton's usual law to get the proper shape to the rotation curve and discover that the invisible "dark matter" is an optical illusion brought on by the observer's relative viewpoint and the physical structure of galaxies.

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*** *Mcore G = Vsat Vcore R*. (Newton's "External" Gravitation Law).**
*** - *Mtot G = -Vcomp Vtot R*. (Newton's "Internal" Anti-Gravitation Law).**

The first expression is Newton's traditional relation. *Mcore* is the mass of the gravity well that anchors a satellite system. It may be a solar system or a planet with moons. *Vcore* is the velocity of the gravity well relative to an observer on the satellite. *Vsat* is the velocity of the satellite relative to an observer on the gravity well. (By relativity the two velocities appear to be equal.) In each case the "orbiting" object is "outside" the object it orbits. *R* represents the radial separation of the CMs of the two bodies. Newton's relation expresses the Keplerian Decline that characterizes such systems. The second expression is our modified version of Newton's law for large scale gravitationally structured clusters of objects. *Mtot* is the total mass of a large cluster formation such as a galaxy that has significant internal gravitational dynamics. We give it a negative sign because we are treating objects inside the cluster rather than outside as in the case of

Newton's traditional relation. *Vtot* is the velocity of the cluster (e.g., an arm of the galaxy) at the position of the component object (e.g. star) as seen by an observer **outside the cluster**. *Vcomp* is the velocity of a given component (e.g. star) **inside** the cluster as seen by an observer **outside the cluster**. In the satellite case the velocities are equal and opposite in direction. In the component case the velocities are equal and identical in direction, because the star is a component of the galactic arm and they rotate together. Thus, if we keep the two velocity signs the same for the satellite case, then the two velocity signs must be opposite for the galaxy case. The sun’s rotation in our solar system is not linked gravitationally in any strong way to the orbit of the earth, but a star’s motion in a galaxy is very much linked gravitationally to the axial rotational motion of the galaxy as a whole.

The position of the observer relative to the system and the structure of the system are both vital to determining the shape of the rotation curve. In our solar system observers see the sun and a planet as "outside" each other. However, in the galaxy system observers see the component star as "inside" the galaxy, and the galaxy contains the component. Thus by **arbitrary convention** we set both velocities positive in the first case (solar system). But the component velocity is negative in the second case (galaxy). The mass is positive in the first case (solar system) because the net attraction to particles outside the gravity well is always inward toward the center of the gravity well. The mass is negative in the second case (galaxy) because the net "attraction" of the total mass of a spread out galaxy is to draw **central components** outward away from the center of the gravity well.

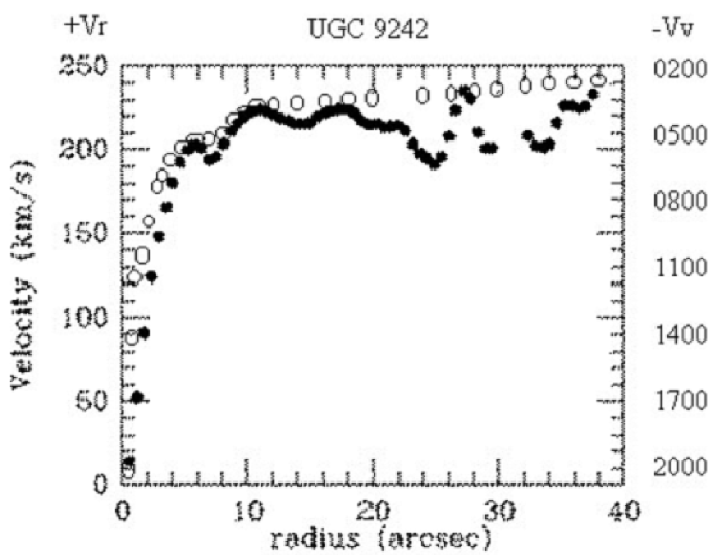
Let's summarize our logical argument. **The density of material in a galaxy or other cluster causes the interacting gravitational effects of the various component masses to tend to cancel, depending on the radial distance from the center. A component in the core of the cluster is surrounded by objects pulling it outward. The result is an “antigravity” effect inside large clusters of gravitationally interacting matter such as galaxies and galactic clusters. Newton's Law is hyperbolic, and the rotation curves astronomers draw look hyperbolic and look very much like mirror images of the Keplerian Declines we see in Newtonian satellite systems. In a velocity-to-radius map of a galactic system we get a mirror image of such a relation by simply reversing a sign.**

The model will show a leveling off toward an asymptote as the radius increases. What happens as the radius decreases? The "negative" velocity value grows very quickly (i.e., drops off quickly toward a real world "zero" velocity.) But it moves into relativistic "negative" velocities as it approaches -10^7 m/s or higher. At smaller radial distances the relativistic shift goes up very rapidly. It doesn't matter whether the velocities are positive or negative when it comes to the relativistic effects. The mass also does not matter. The only thing that matters here is the value of ($-v$).

* [$m_1 (1 - v^2 / c^2)^{1/2} = m_o$.] (Einstein's relativistic shift of mass.)

This tells us roughly where the velocity cutoff is. Below a certain radial distance from the galactic center the relativistic inertial resistance of a body to further negative acceleration will rapidly increase until it reaches an equilibrium point and stabilizes. This corresponds to "zero" velocity inside the galactic bulge core area. A black hole core would show orbital velocity degenerating into a core rotational velocity. Clearly the region $R <= 10^{16}$ m will correspond to approximately zero effective velocity for any component. Depending on actual observed maximum velocities, we will know where along the relativistic curve the cutoff point lies. Velocity data from near the core of a galaxy tends to have a large **smear factor** due to measurement limitations. Speeds are getting quite slow, and density is higher. But we know for sure it will never reach -3×10^8 m/s, and will fall somewhere between -10^6 m/s and -3×10^8 m/s. This tells us the range of velocity for the system's internal dynamics. Running our velocities backwards from the cutoff at zero to the periphery velocity that is known, we see a range. With this simple theoretical framework we should now be able to work out the details of large-scale dynamics, filling in the variations based on individual cases. We thus settle one of the major headaches in modern cosmology. At least this aspect of the universe is OK after all, and we can stop fretting about the huge mass of missing Dark Matter there.

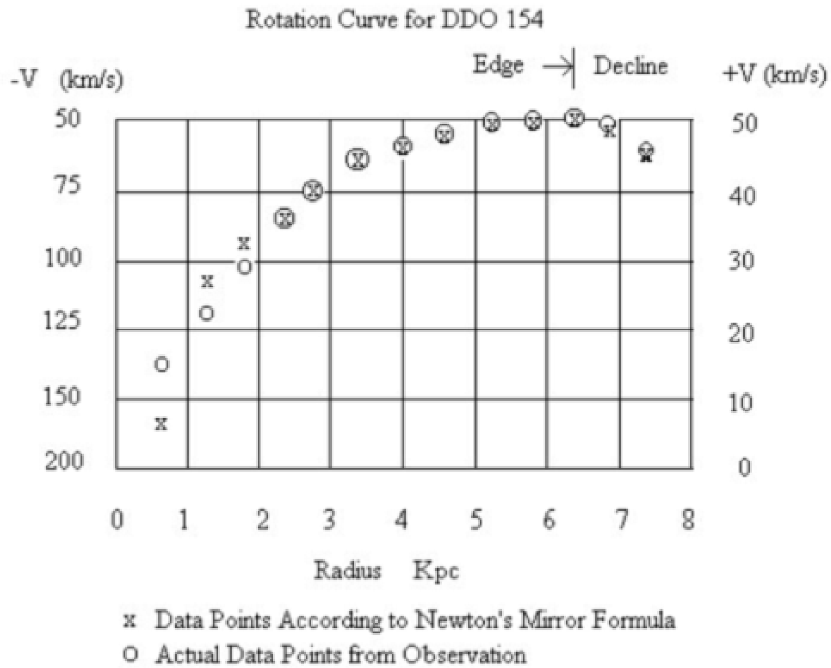
Now let's look at some examples of data taken from the observation of real galaxies. Our first example is the thin galaxy, UGC 9242.



The above chart shows rotation curve data from galaxy UGC 9242 with an average peripheral velocity in the neighborhood of 230 km/s. The radius is measured on the chart in arcsecs from 0 to 40. Let's see how well this data relates to our Newtonian formula. We'll use for the galaxy rim the values R = 38" and $-Vv$ = -230 km/s. This gives us approximately ($-Vv$) ($+Vv$) R = ($- 2\times10^6$ m^2/s^2) ("). The Newtonian Mirror Formula smoothes out the curve ignoring local idiosyncrasies. This gives the smoother "negative" curve. Also, the negative curve (in hollow dots) is calibrated slightly higher so the two curves don't overwrite each other. We label the negative curve's velocities "virtual" (*Vv*). We will call the real velocity that we observe (+*Vr*). The following is a table of approximate values. Black dots represent the observed data. Hollow dots show Newton's ideal curve. (The chart and data were based on the Cornell University "Astronomy 201: Our Home in the Universe" web site example of a rotation curve by Martha Haynes and Stirling Churchman.)

*	R	+Vr	-Vv	(Velocity is in km/s.)
	38	230	230	
	36	225	235.7	
	35	225	239	
	32	210	250	
	30	200	258	
	29	210	262.6	
	28	230	267.26	
	27	235	272.16	
	26	220	277.35	
	25	180	282.84	
	24	190	288.6	
	20	215	316.2	
	18	225	333.33	
	16	225	353.55	
	14	215	377.96	
	12	220	408.25	
	11	225	426.4	
	10	220	447.2	
	09	215	471	
	08	210	500	
	07	190	534	
	06	200	577	
	05.5	205	603	
	05	200	632.45	
	04	190	707	
	03.5	180	755.93	
	03	165	816.5	
	02.5	150	894.43	
	02	125	1000	
	01.5	050	1154.7	
	01	050	1414	
	00.5	015	2000	
	(00	000	3×10^8) (asymptotic values)	

The next example we'll look at is DDO 154, a test case with a very slow rotation. I estimated the data from a rotation curve plotted by Milgrom and Braun in "The Rotation Curve of DDO 154: A Particularly Acute Test of the Modified Dynamics." (Astrophysics Journal 334: 130-134, 1988 Nov. 1). Milgrom draws the curve showing the data compared with the curve his calculation generates and the curve predicted by Newton's standard formula. Let's see what our modified Newtonian Mirror Formula gives. The rotation curve, plotted in kiloparsecs vs km/s, shows a maximum peripheral velocity stable at around 50 km/s. Then it tapers off a bit at the very edge. This is due to material that is already drifting outside the "edge" and is starting to follow the Keplerian Decline. We saw a similar raggedness appear near the rim in our first example. If we take 6.4 kpc as the edge, then we get $G\ Mtot$ = 16000 kpc (km/s)^2. We simply flip the sign of *Mtot* to find that Newton's Mirror law is a nice description of the rotation curve.

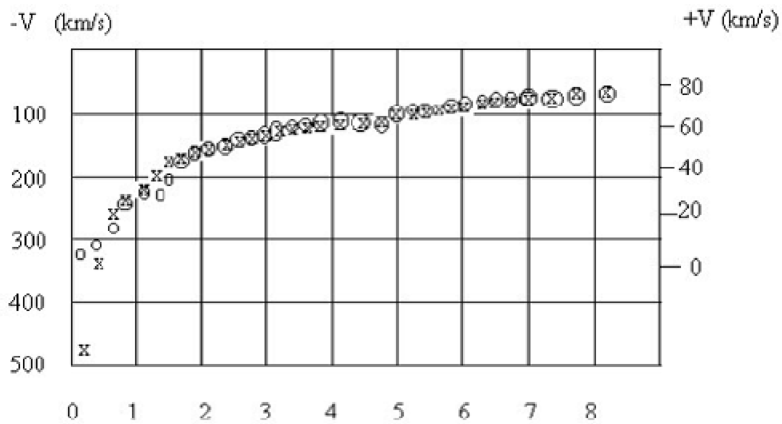


R (kpc)	V (km/s)	- V (km/s)	
0.00001	00	40000	
0.001	~0	4000	
0.1	~0	400	
0.6	15	163.3	
1.2	22	115.47	
1.8	29	94.28	
2.4	36	81.65	
2.8	40	75.59	
3.4	43	68.6	
4.0	46	63.245	
4.6	48	58.98	
5.2	50	55.47	
5.8	50	52.5	
6.4	50	50	(Outer Edge of Galaxy)

6.9	49	+48.15	(Keplerian Decline begins.)
7.4	47	+46.5	(Velocity becomes positive.)

Next we look at a Rotation Curve plotted for NGC 1560, a dwarf spiral. The data is based on A.H. Broeils, "The mass distribution of the dwarf spiral NGC 1560", Astron. Astrophys., 256, 19-32 (1992).

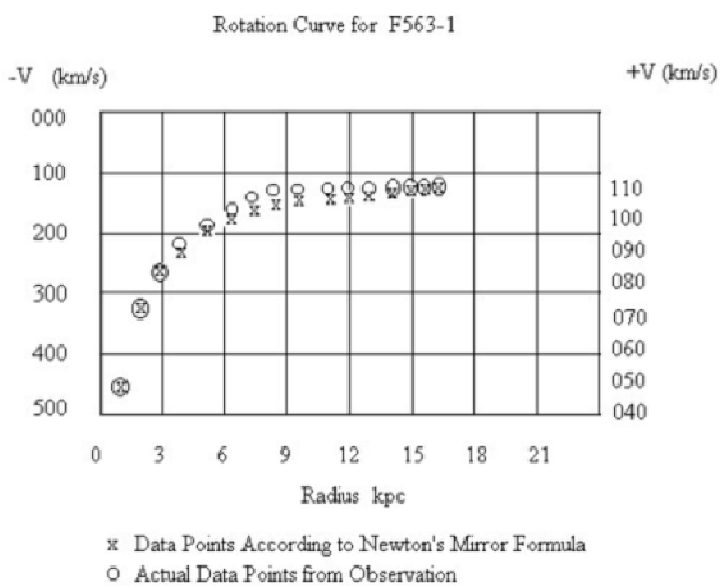
Rotation Curve for NGC 1560



R (kpc)	- V	+V	+/- Errors by least squares algorithm
0.22	485	05.0	7.5
0.4365	343	08.9	9.9
0.65475	280	14.5	6.3
0.873	242.57	26.4	5.6
1.09	216.96	28.9	5.7
1.3	198	27.8	2.3
1.53	183.365	31.8	3.2
1.746	171.522	42.8	2.1
1.96	161.7	48.2	1.6
2.18	153.4	48.4	1.3
2.4	146.3	50.6	1.0
2.619	140	53.5	1.0
2.837	134.55	57.2	1.3
3.055	129.658	59.1	1.5
3.274	125.26	59.8	1.6
3.492	121.28	60.3	1.6
3.71	117.667	60.7	1.6
3.9285	114.35	62.1	1.9
4.14675	111.298	63.6	1.6
4.365	108.48	62.0	1.6
4.583	105.866	60.5	1.4
4.8	103.4	60.3	1.5
5.019	101.158	63.8	1.3
5.238	99	66.1	1.3
5.456	97	67.7	1.2
5.6745	95.14	70.4	1.1
5.89	93.365	73.0	1.2
6.111	91.68	74.2	1.2
6.329	90	75.1	1.3
6.5475	88.574	75.2	1.2
6.76575	87.1336	76.3	1.3
6.984	85.76	77.2	1.4
7.42	83.2	76.9	1.5
7.857	80.856	77.5	2.0
8.2935	78.7	78.7	2.3

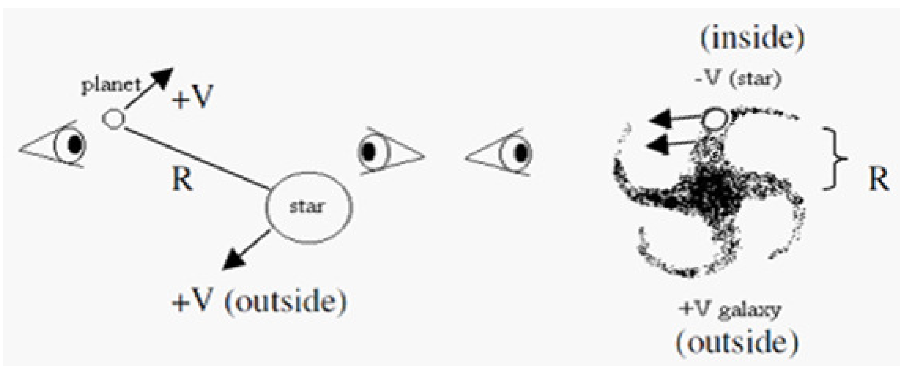
When we re-calibrate the negative plot into positive velocities there is a distortion at the low velocity range. This is partly due to greater smear factor in the data itself that occurs as measurements are taken closer to the core, -- as you can see from the data. The radial distances are in kiloparsecs, and I used Broeils' circular velocities corrected for asymmetric drift. The negative velocities are calculated from the product of the largest radius and the squared velocity at that radius (which is also maximum): 51,367.368 (kpc) km^2 / s^2.

Our next example is F563-1. This data is from McGaugh and de Blok, "Testing the Hypothesis of Modified Dynamics with LSB Galaxies and Other Evidence," (Astrophys. J., 499: 66-81, 1998, May 20,) p. 73.



R (kpc)	+Vr (km/s)	-Vv (km/s)
01	049	460.16
02	070	325.38
03	080	265.67
04	090	230
05.4	095	198
06.5	100	180.5
07.5	105	168
08.5	110	157.8
09.7	110	147.75
11	110	138.7
12	110	132.8
13	110	127.6
14	110	122
15	110	118.8
16.2	110	114.3
17.5	110	110

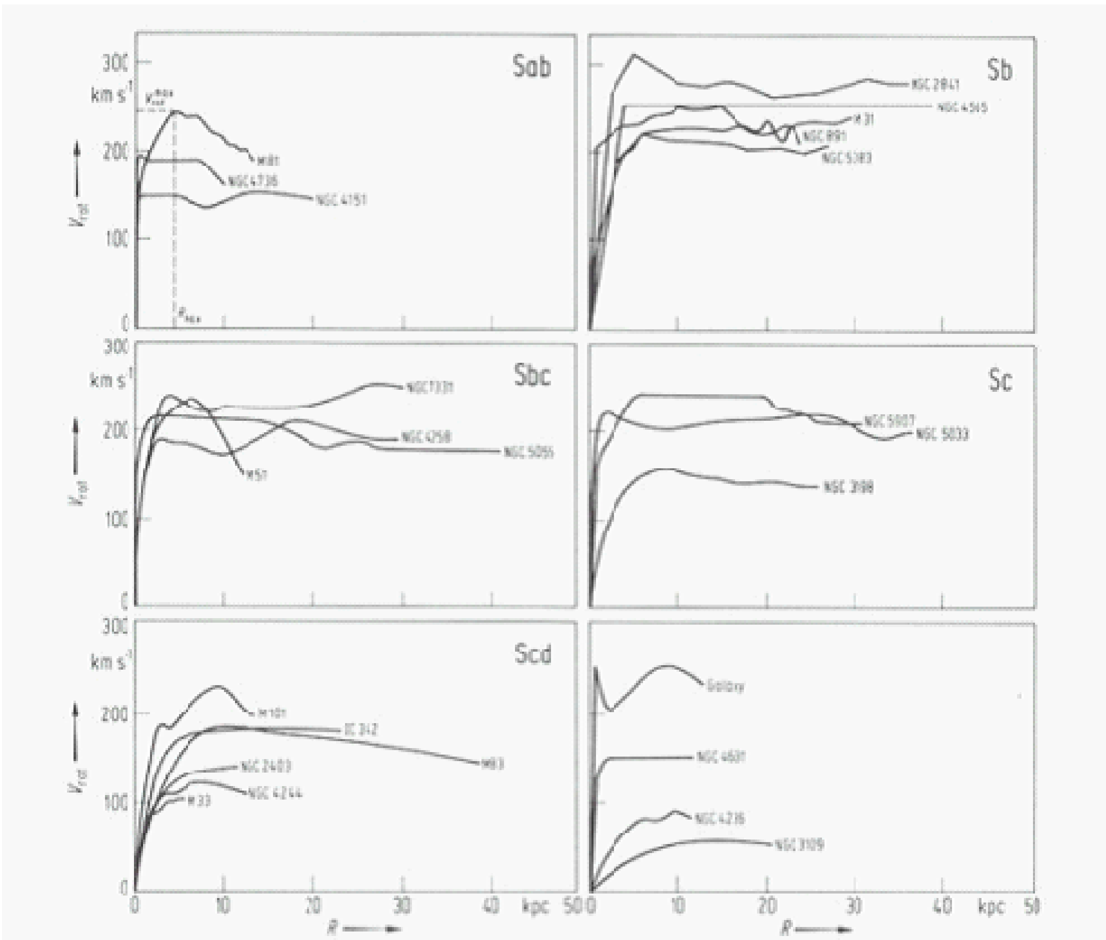
What I call Newton's Mirror Formula correctly gives the commonly observed rotation curve for galaxies in close agreement with observations. The procedure to flip the Keplerian Decline into its mirror image is simple and straightforward. Usually we have some data from observations that can be interpreted in terms of radial distances and velocities. So first we plot out the rotation curve from that data and then calculate from the rim inwards to see how well Newton's Mirror Formula predicts that data. We calculate (*Mtot G*) by multiplying the rim velocity squared times the rim radius. Then we divide (*Mtot G*) by each radius value we wish to calculate the velocity for and take the square root of that to get the negative velocity. We plot downwards from the rim velocity as we move in along the radius. Then we adjust the scale according to the cutoff velocity, comparing the curve to the velocity data points gathered from red/blue shift measurements. We map the two rim velocities and the two inner velocities and calibrate the two scales between those two limits. If this simple theoretical framework describes the general rotation curves of spiral galaxies and other large-scale systems, we may be able to settle one of the major headaches in modern cosmology and astrophysics with a generalized Newtonian formula.



Resources
There is an excellent list of articles by and about Milgrom and his MOND hypothesis accessible on the Internet at Stacy McGaugh's "The MOND Pages". I based my sketches of general types of rotation curves on the nice ones done up by Martha Haynes and Stirling Churchman for the Cornell University "Astronomy 201: Our Home in the Universe" website. That site also contains a lot of good photos and data summaries. That also was my source for the UGC 9242 data. The sources for the other examples are listed in the article by each example. This article November 5, 2003, marks the first publication of a theoretical treatment of my Newtonian gravity adapted to rotating galaxies. My preliminary discussion without a final theoretical resolution appeared in chapter 15 of **Observer Physics** (Taipei: Delta Point, 2002, 2003). The revised edition has been updated to include the latest drafts of these recent rapid research developments.

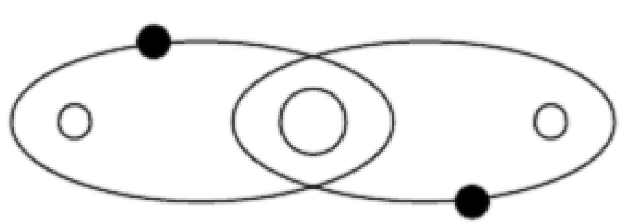
To look at lots of rotation curves, see "The Data Base of Spiral Galaxies by Courteau" (1996, 1997). This data is available on the Internet as "Rotation Curves and Surface Brightness Profiles of 304 Bright Spirals" in **An Atlas For Structural Studies of Spiral**

Galaxies, in the knowledge base Level 5 section of **NED** (NASA/IPAC Extragalactic Database.)
* Courteau, S. 1996, Ap JS, 103, 363 (photometrics).
* Courteau, S. 1997, A J, 114, 2402 (rotation curves).



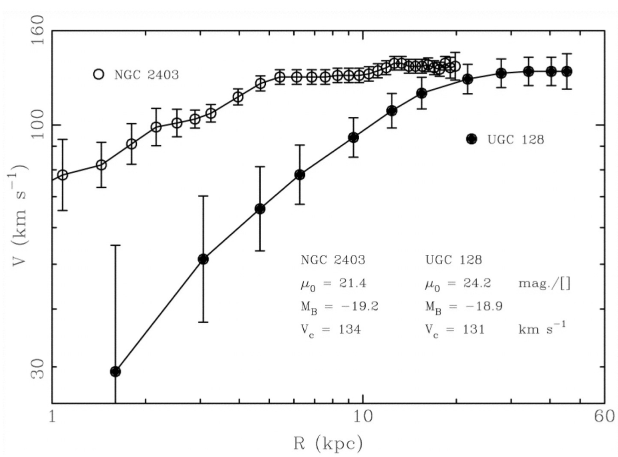
25 Rotation Curves Showing Typical Variations in Size, Speed, and Curve Shape

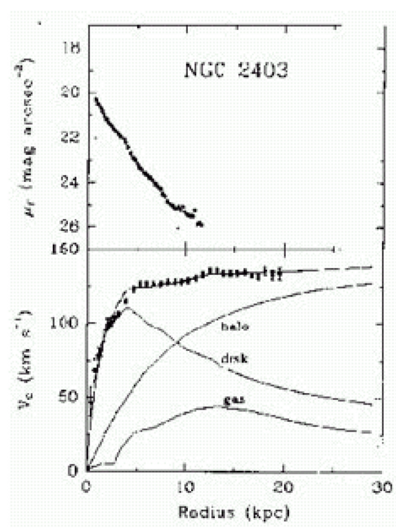
The above sample of rotation curves is based on A. Bosma, Ph.D. Thesis, University of Groningen (1978). It is available in the section on "Rotation, Kinematics, and Dynamics" of "Internal Structure and Dynamics of Galaxies", Basic Data, Level 5 of the **NED** Knowledge base.



Additional Examples and Methods
Here's another way to plot a Flipped Newtonian Rotation Curve that may feel more comfortable. Let's say that the current resolution of your telescope and Doppler equipment is around 1 kpc and 20 km/s. Doing Doppler measurements of such small velocities using hydrogen we must resolve wavelength differences of around .035 nanometer. The margin of error can be quite large, and I would consider 20 km/s is a pretty reasonable margin. Distance measurements are also often being revised. The distance affects the size.

We plot a galactic rotation curve using Newton's Flipped Formula and our limits of resolution. Let's say that we look out at NGC 2403 and find that it runs at its asymptote rim velocity with a radius of around 15 kpc. So we set that as our closest instrument reading to "zero" negative velocity -- that is our error margin of 20 km/s -- translating from our Doppler equipment. This gives us -6000 (kpc) (km^2/s^2) as our "minimum" negative constant for the rim asymptote. We then use our Flipped Newton Formula to plot off "negative" velocities at various kpc distances along the radius to see our theoretical rotation curve. (Divide by the desired radius and then take the square root.) If our Doppler actually measures the positive asymptote rim velocity at 134 km/s, then our last (innermost) plot will be at [(6000) / $(154)^2$ = .253 kpc. (-154 - (-154) = 000.) This is the smallest radial distance we can get meaningful data from. Anything from there on in can be going on average anywhere from zero to 20 km/s, but it all gets mushed. That's our cutoff radius and cutoff velocity. (The negative velocities go “relativistic” inside that radius.) We call this cutoff (-*Vlo*) and use that as our asymptote velocity and convert all our negative velocities to positive velocities simply by subtracting the lowest readable negative velocity (-*Vlo*) calculated at our low limit radial distance (.253 kpc) from each negative velocity (-*V*). This gives us our theoretical rotation curve for NGC 2403.





$R\ V^2$ = (15)(20)(-20) = -6000 (kpc)(km/s)^2. [-*V* - (-*Vlo*)] (km/s)]

R (kpc)	+V (data)	-V	+V (Theoretical Curve Using Newton)	
15	134	20	134	[-20 - (-154) = 134]
14	133	20.7	133.3	[-20.7 - (154) = 133.3]
12	133	22.4	131.6	[and so on]
10	131	24.5	129.5	
08	131	27.4	126.6	
06	130	31.6	122.4	
04	124	38.7	115.3	
02	095	54.8	099.2	
01	077	77.5	076.5	
00.253	"000"	154		

I estimated the data from McGaugh's plot in "Testing the Dark Matter Hypothesis."... The theoretical curve fits the data curve pretty closely, always staying within 10 km/s.

Here is UGC 128. We need to raise our velocity resolution range to around 27 km/s. (For example, see the error margins in McGaugh's plot, also given in "Testing..." .)

$R\ V^2 = (45)\ (27)(-27) = -32805\ (\text{kpc})(\text{km/s})^2$

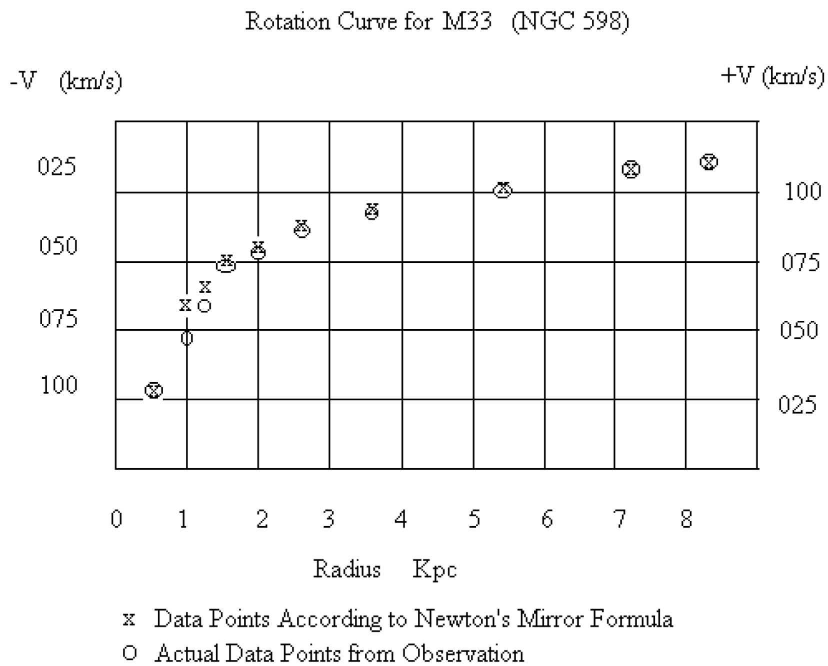
R (kpc)	+V (data)	-V	+V (Theoretical Curve Using Newton)	
45	130	27	130	[-27 - (-157) = 130.]
39	129	29	128	
28	128	34.2	122.8	
20	125	40.5	116.5	
15	118	46.8	110.2	
12	107	52.3	104.7	
09.5	090	58.8	098.2	
06	079	73.9	083.1	
04.5	065	85.4	071.6	
03.5	052	96.8	060.2	
02	030	128	029	

.

I used as a source data by Chris Mihos (see his Applet program on RotCurves. See also the chart in McGaugh and de Blok.) The minimum error range shown on the McGaugh plot for data is at least -27 km/s. By using this margin as our negative asymptote we get a very close fit to the data that stays within 10 km/s throughout the curve.

Here's another example: M33 (NGC 598). I estimated the data from Chris Mihos' site.

Setting -*V* at -25 km/s we get $R\ V^2 = -5250\ (\text{kpc})(\text{km/s})^2$.



R	-V	+V	+V (data)
8.4	25	108	108
7.2	27	106	106
5.4	31.2	101.8	100
3.6	38.2	094.8	093
2.6	44.9	088.1	085
2	51.2	081.8	078
1.6	57.3	075.7	072
1.2	66.1	066.9	055
1	72.5	060.5	047
.5	102.5	030.5	030

When we take a velocity resolution cutoff margin of around -25 km/s, we get a curve that fits the data very closely. Only two points are more than 10 km/s off from my estimations of the Mihos plot. It would help if I had the exact numbers, but these curves are amazingly close considering that the only thing I did was flip Newton over to allow for the observer viewpoint difference and then allow for an instrument resolution cutoff. Please take a good look at this material. All the curves go in this direction. Messing around with huge invisible halos or globs of dark matter is just a messy way of fixing things, since we don't see any such substantial halos or globs and end up searching vainly for exotic unproven particles such as WIMPS. MOND means we have to change Newton's law for some unknown reason. Why not simply take note of the fact that the observer's relative viewpoint is different when he looks at a galaxy compared to when he looks at a solar system. Also galactic structure is fundamentally different from solar systems, and our instruments have resolution limitations. This is the simple truth. All the rotation curves from galaxies support this basic dynamic shape. We do not need to reinvent the universe. The relativistic argument I gave in the earlier notes still holds, but people may feel more comfortable thinking of "measurement uncertainty" as the key factor in the cutoff, because that is what the "relativistic" onset of "negative velocity" looks like to an observer making the measurements. It's just good old Heisenberg quantum uncertainty due to the subtlety of the measurements. I see plots of the same galaxy that differ by many kpc's regarding size, often simply because it's hard to measure the distance accurately. This also throws the velocities off.

The one thing we all agree on is the general shape of the galactic rotation curve. It is clearly a mirror image of Newton's mathematical description of the Keplerian Decline. If the establishment wishes to keep giving galaxies invisible halos or adding arbitrary factors to Newton's law, I suppose these are imaginative ways of doing astronomy. There are many ways to write equations that "fit" the data. I just think it's nice to know that the physics we already have and the data that we already have are all quite adequate to do the job -- at least as far as the troublesome case of spiral galaxies. I have not yet studied in detail the alleged anomalies in the cosmic background radiation and other purported symptoms of dark matter, but suspect that simpler explanations may also lurk in those domains. Once we agree that everything is generally OK, we can then focus on the details of what happens in specific cases that modify the general pattern.

Revised, June- September, 2014 and July-August, 2016.