Appendix

Chapter 15. **Wheels Within Wheels: Some Notes on Rotational Dynamics**

A. Newton's Bucket Experiment Redux
B. Tops, Gyroscopes, and the "Quantum" Nature of Vectors
C. MOND and Observer Physics

A. Newton's Bucket Experiment Redux

Now that we have a theory of relativistic quantum gravity, we can understand how inertial motion behaves and explain why the surface of the water in Newton's bucket grows concave as the bucket spins faster. The Observer is the Prime Mover of the system.

Kinetic motion is the conjugate to gravity. The equal and opposite force to gravity is what we call kinetic motion. 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" but is "riding" on some component of the system that is in relative motion. In the latter situation 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. The whole thing is somewhat inside out. Newton's laws hold when you stay detached and can imagine the forces but can't feel them. When you get involved and can actually feel the forces, Newton's laws do not hold.

For example, when riding in a car, 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 -- though with respect to different frames. A centrifugal force is equal to a centripetal force. Newton's first law fails because you have no inertial frame, and his second law fails because you can't tell what is "really" accelerating. 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.) This inertial tendency is opposed by the center-oriented tension that forces the object to swing in a circular arc. So the outside observer sees the inertial momentum as a tendency to move tangent to the circular path, and he sees an acceleration that heads toward the center. The "inside" observer, who is riding on the rotating object, feels a centrifugal inertial push that is equal and **opposite** to the centripetal pull.

There is a **90-degree shift in the experience of kinetic motion** when we switch the observer from **outside** to **inside** an orbiting or rotating object. It is this shift of observer perspective that generates the kinetic complement to gravity. If the observer riding around the curve is unaware that he is in a curving trajectory, he may think this force is due to some kind of gravity. However, close observation shows that the centrifugal force is different from and conjugately opposite to gravity.

Newton' s bucket experiment clearly shows us the relation between gravity and kinetic motion. The two generate conjugate "forces". Newton' s bucket experiment is done in an Earth gravitational field. When the bucket is not spinning, the kinetic system is in equilibrium. If the bucket is not falling, it is also in gravitational equilibrium. The suspension cord' s pull equals the earth' s pull. Earth gravity also pulls the water downward, and the water has no cord attached to it, so there is only a virtual tendency for water particles to climb the walls of the bucket, and they tend toward the bottom of the bucket. The average kinetic motion of the water particles bumping around thus distributes them evenly in the bucket, with bias toward the bottom. 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 moving particles and the horizontal particles. Under earth' s gravity influence the upward moving particles have considerable density and bump into each other following zigzagging chaotic trajectories 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 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 strike the moving wall of the bucket are given "English" by the bucket' s motion. This English is gradually imparted to the rest of the water particles through mutual collisions, and the water catches up with the bucket. The two then spin together. They are now at rest relative to each other.

However, the surface becomes curved. It is slightly concave. The water starts to "crawl" up the sides of the bucket. 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. If the water is not too deep, and the rim of the bucket is recessed like a paint bucket, then you can reach a point of rotational speed where the water is evenly distributed along the bottom and along the walls. Increasing the speed even more, the kinetic force will almost completely overpower earth' s gravity, and the water' s surface will be oriented nearly vertically, parallel to the bucket wall.

On the microscopic level the individual water particles continue to bump around in their vaguely elliptical -- but now slightly 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 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 not so that they changed the bucket shape or intermixed 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 stepped in and started the bucket rotating. This changed the initial conditions. The Observer added 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 motion. Actually, even if there were nothing available to use as our external reference frame, the two systems would not move at the same speed relative to the prior set of initial conditions. The extra energy has changed the system' s whole energy structure. As the system moves toward equilibrium in its rotating state, the additional energy that started the spinning distributes itself throughout the system to reach a new equilibrium. The bucket slows down a little bit from the initial spin we gave it (assuming it is spinning without friction with any external apparatus), and the average velocities of the particles increases a little bit.

We can measure the slowing of the bucket if we have a reference frame. Lacking that, we can not measure it. But we **can** measure the change in average velocity of the water particles in the bucket. The shape of the bucket has NOT changed, since the molecular bonds holding it together are stronger than the forces associated with the rotation. 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 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.

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 kinetic particles gather at the wall, and 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. Since there are now more kinetic 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 the wall as compared to the bucket' 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.

The rising of the water near the bucket' s wall in apparent "defiance" of gravity is equivalent to antigravity -- if we are aware of the pull of earth' s gravity. In free space with no influence of earth' s gravity, and in the absence of rotation, the water forms a globular shape in the center of the bucket. The slightest rotation of Newton' s bucket pushes all the water to the wall -- if the water is also rotated. 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. This is the "rotating space station" phenomenon. Thus kinetic motion is the opposite conjugate to gravity. The wall of the bucket acts as a retainer 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 constant. The additional kinetic motion of 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.

The story of Newton' s bucket has nothing to do with Mach' s principle and the notion of 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.

<u>Principle of Observer Physics</u>: The Observer always 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.

B. Tops, Gyroscopes, and the "Quantum" Nature of Vectors

A gyroscopic top nicely displays the various components of a rotational system. The central axis of an upright top spinning on a flat supporting surface remains motionless while the remainder of the top' s structure rotates around the axis. In free space 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 such as we saw in the case of Newton' s bucket.

In a gravitational environment a base of some sort must support the central axis to prevent the 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 (t), we can find it by multiplying the distance from the pivot point at which the turning force is applied (r), times the force (f), times the sine of the angle (V) the direction of force takes with respect to the line between the point of application and the pivot point.

* *t* = r f (sin V).

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-->) is a vector describing how far from the pivot point the torque is applied with a certain force (f-->), then the torque is the vector cross product {x} of the "displacement" distance vector times the force vector.

* *t* = (r-->) {x} (f-->).

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 comes 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 types of vector multiplication are also defined. One is called the "scalar" or "dot" product {.}.

* (A-->) {.} (B-->) = A B (cos V) = (Ax Bx) + (Ay By) + (Az Bz).

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 "vector" or "cross" product {x}. The cross product {x} 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:

* C = A B (sin V).

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-->) {x} (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-->) 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 angle must be rotated to be parallel to the second angle. Then you extend your thumb. That is taken to be the direction of the cross product vector.

The "right-hand" rule turns out to be a ridiculous and arbitrary rigmarole that ends up confusing people when the mathematical procedure is applied to model certain physical situations.

For example, the vector cross product procedure is used to describe torque.

* *t* = r f (sin V) = (r-->) {x} (f-->).

The angular momentum description also uses this method, since momentum is vector in nature. Here (p) is momentum and (r) is a displacement from the origin of a rotation.

* *l* = p r (sin V) = (p-->) {x} (r-->).

The relation between torque and angular momentum (l-->) of a particle turns out to be the sum {S}:

* {S} *t* = d (l-->) / dt.

The sum of the torques for a whole system of particles extends this idea.

* {S} t_{ext} = d (L-->) / dt.

The torques in this expression are external, because the internal torques balance out.

Here (L-->) represents the angular momentum of the top as an ensemble of particles, and (t) is time.

Now we come to the question of why a top stands 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 and parallel to the plane that supports the top. The particles in the central axis are not moving. 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 CM of the top. This column corresponds to the cross product vector.

According to the vector product model, 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 correct description of the physical system. The upright axis is a vector all right, but it is not unidirectional. It goes half up and half down. This is a quantum mechanical result. If the physics of tops is taught in terms of the bidirectionality of the cross product vector, 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. 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. A symmetrical top could spin upside down just as well as upside right. 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 momenta balance in all directions parallel to the supporting 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 axis of spin, it has a rotation due to its tendency to fall over using its point of contact with the support plane as its pivot point. If the top is spinning very rapidly, the axial rotation torque is much stronger in comparison to the rotational torque from falling over. The direction of the angular momentum vector generated by the top' s rapid axial rotation is perpendicular (up and down) along the 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 "precessional" vector (*tp*).

* $tp = d\ Mt\ g$

Here (*tp*) represents the torque of precession, (d) is the distance the top' s CM is from the axis of falling rotation, (Mt) 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 precessional motion. The tilted top swings in a circle around the original axis of spin that is normal to the plane that supports the top.

If a top or gyro is spinning fast enough, it can hang outward from a pedestal at 90 degrees, anchored only by its bottom tip resting on the pedestal. This is a graphic demonstration of the "antigravitational" 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 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 to precess at its tilt angle as long as the primary spin momentum continues. The net precessional motion is just the tendency of the top to spread in the direction of the axis of its falling. Which way it precesses 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 are analogous to the laws of linear motion.

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 priorly established motion. Hence, tops precess in the direction of their spin.

Motion (energy) always is directionally "quantized" as various whole number multiples of Planck lengths (1.6x10^-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 (Ru). 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. This is your basic quantum top.

* e = Mp c / P Ru.

To the extent that relevant forces reach equilibrium, we can say that a gyroscope, or any object, is "floating". The directional "intelligence" of a spinning gyroscope makes it a natural guidance mechanism. Any attempt by an external force to twist the gyro out of the directional orientation of its rotational axis is just like a top tending to fall over under the influence of gravity. The fall causes the top to precess. This precessional 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.

Relative to itself, a gyroscope is always floating. Even its rotation ultimately is due to resistance on the part of the observer. 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 oriented palm downward, 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. 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.

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. 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 the momentum of the entire universe 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 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% forward and 50% backward. Newton' s third law describes this situation for linear forces. 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.

Furthermore, a single body can only have **two** simultaneous modes of spin with respect to its own mass, and these must be mutually orthogonal. Independent of its mass it may have any number of spin angles, since it is massless. In other words, an observer detached from a rotating system, regardless of its mass or spin orientation, can view it from anywhere in space. On the other hand, a top spinning clockwise in a gravitational field as you look down on it has a "left-handed" precessional drift relative to the top' s axis of falling, and a top spinning counterclockwise as you look down on it has a "right-handed" precessional drift relative to the top' s axis of falling. Primary rotation has no reference frame to determine bias, so the axial vector is two-headed. (Looking down at the tip of your thumb.)

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. 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 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 primary vector arrows are double-headed. 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 demonstrates the general principle of rotational dynamics on the quantum level. Electrons are charged tops, so when they are exposed to a magnetic field, they separate into spin up and spin down orientations, with an exact 50-50 distribution. The charge in the magnetic field acts as a secondary rotation, causing them to choose between "left-handedness" and "right-handedness" -- which appears in the experiment as up and down orientation.

C. MOND and Observer Physics

This third little article on rotational dynamics is devoted to a brief discussion of a recent proposal (initiated in 1983) to modify Newton' s laws of motion and its possible impact on observer physics. Known as Modified Newtonian Dynamics (MOND), the proposal is championed by Israeli physicist, Mordehai Milgrom, and aims to resolve the problem of the missing "dark" matter. This problem in large-scale physics and cosmology is related to the physics of rotational dynamics and remains one of the major unsolved difficulties in that field.

When astronomers total up the amount of matter they see in galaxies, galactic clusters and so forth, they find that there is not enough mass to account for the observed motions of the celestial bodies. Even assuming that there are dust particles and debris, and planets, and burned out stars, and so forth that can not be seen, there still does not seem to be enough matter to fit the dynamic behavior of the large-scale bodies such as galaxies, clusters, and supergalaxies.

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, so the acceleration effect gets correspondingly weaker. Yet the far flung bodies moving in galaxies or other large systems seem able to "keep up" as if there were a much stronger gravitational pull than appears warranted by the observed mass in the central region that governs them.

Milgrom proposes a constant (ao) with the dimensions of acceleration that modifies the dynamical equations of Newton and describes these motions when the Newtonian acceleration falls below a certain threshold. Milgrom modifies Newton' s gravitational equation as follows.

* $a = M G r^{-2}$. (Newton)
* $a^2 / ao = M G r^{-2}$. (Milgrom)

These two can be written together:

* $m (a / ao) a = M G r^{-2} = aN$.

Here (aN) represents the Newtonian acceleration. The expression m (x) satisfies $m(x) \approx 1$ when $x \gg 1$, and satisfies $m(x) \approx x$ when $x \ll 1$.

When the acceleration falls below the threshold ($a \ll ao$), Milgrom believes that his constant boosts the gravitational effect. When ($a \gg ao$), 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 (Tully-Fisher relation). Milgrom took the notion of asymptotic flatness of galactic rotational curves as axiomatic when framing his theory.

Milgrom estimates the value of (ao) to be

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

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. Here he believes, and reasonably so, that there must be additional dark matter to make up the difference.

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 harkens back to Mach' s principle, the idea that "local" inertial gravitational effects are influenced by the global totality of mass in the universe.

We discussed Mach' s principle in the body of our discourse (and briefly in our discussion of Newton' s bucket above), and we came to the conclusion that the intergalactic distances are too 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. Instead we proposed a simple explanation of inertial effects based on the role of the observer.

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 these two can not be separated, since they are conjugates of each other. Adjustment of inertia -- such as special relativity produced -- implies an adjustment to gravity, although not necessarily an adjustment of the gravitational constant.

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.

Here he is with a simple formula that fits the data, but no real coherent theory to back it up. In Chapter 14 we used principles of Observer Physics to show how the value of (G) changes for particles inside a cloud. This principle would hold for galaxies as well as nebulae, and even for the whole universe (shades of Mach?). It would tend to show that the G-force would be stronger far out in the wings of galaxies than closer to the center. This would tend to hold the structure together and allow the outer wings to keep up with the inner structure.

Milgrom' s estimate of 10 ^-10 m / s^2 for a(o) looks mighty close to the numerical value of (G). We could just say:

* Kx = (G) (ao) = 1 m^4 / s^4 kg.

Then we come back to Milgrom' s MOND formula:

* a^2 / ao = M G r^-2.
* a^2 = Kx M r^-2.

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) take place? Observer Physics suggests that a galaxy or other cluster has an <Ro> radius. This radius, rather than marking the far "edge" of the cluster, may actually represent the "midpoint". Half the mass resides in the <Ri> region, and half the mass resides in the <Re> region. Such an "edge" can be reasonably well defined. Thus we modify Milgrom's formula:

* Fg Fg__ = M1 M2 (Ri^2 / Re^2).

When (M2)'s radial distance from the CM of (M1) is greater than <Ro>, then <Ri> is fixed at <Ro> and <Re> varies. When the radial distance from CM is less than <Ro>, then <Re> is fixed at <Ro> and <Ri> varies. This approach swings us in the direction of modifying our treatment of (G), but inertia may follow suit, and there may be some Machian effects. These might not be noticeable on the scale of Newton's bucket, but only at the extremely large scale of the universe as a whole. Isolated massive bodies presumably would still follow Newton's law locally.

A physicist can work a problem from either his beliefs or his experiences. He can gather some data and then frame an equation to fit the data. Or he can frame a hypothesis, and then look for some data to support it. If he describes extant data with an equation, his next step is to justify his equation with a believable belief, a hypothesis that fits the equation that fits the data. We can ask: "What determines the value of <Ro>?"

Einstein started his exploration of relativity by asserting a belief. He theorized that the speed of light is constant for all observers. He did not explain why this might be so, but at least he framed his theory on a belief that he firmly held, a universalized general principle. The equations he developed from this principle also turned out to fit data in many varied and powerful directions. The equations of special relativity allowed physicists to discover and explore and understand many new types of data that could not be explained before. They also did not contradict the classical data that worked fine.

In quantum mechanics the principle that standing waveforms can only sustain whole numbers of oscillations (half wavelengths) matches observations and leads to an elaborate theory of quantized behavior. Although we can easily understand why standing waves generate whole numbers of impulses, we still have to develop a theory to explain why things like to oscillate as standing waves or as any kind of waves at all in the first place. There are numerous other puzzling aspects of quantum mechanics, some of which we have discussed in this work.

Observer physics provides a theoretical framework based on undefined awareness. This framework facilitates the derivation of first principles and core beliefs that can serve as the underpinnings of theories and either strengthen or modify the principles asserted by physicists to explain their theories.

For example, the fundamentally non-local nature of the observer forms a platform from which we can explain why electromagnetic exchanges always occur at a fixed velocity relative to all observers -- the belief that Einstein asserted as the basis of his theory of special relativity. Although the local viewpoint of the observer may change, his non-local status as an observer based in undefined awareness always remains constant. All perception of local events occurs via electromagnetic exchanges. Therefore any precise mathematical representation of electromagnetic exchanges must contain both a localized component and a non-localized component. A photon's variable wavelength (L) and frequency (f) constitute local components, and its constant velocity for all observers (c) constitutes its non-local component.

* c = L f.

The Einstein/de Broglie Velocity Equation is just an extension of this description of the photon that splits light speed into two component velocities, a group velocity and a phase velocity. Each of these velocities, in turn, has its particular wavelength and frequency.

* c^2 = (L1 f1) (L2 f2) = (Vg) (Vp).

An interesting feature of this extension of our description of the photon is that it introduces phenomena called phase waves that necessarily move faster than light speed and serve as the conjugates for the phenomena that Einstein asserted must move slower than light speed. A full understanding of phase waves has not yet been incorporated into physics due to a habitual tendency to put more attention on group waves and light-speed waves.

Einstein's assertion of the constancy of (c), supported by a reasonable argument from observer physics as to why (c) might be constant for all observers, leads us to accept a revision of Newton's laws of dynamics that further generalizes them to accommodate a theory of special relativity.

With regard to quantum mechanics, observer physics ascribes the oscillatory aspect of waves to resistance that is created by the observer toward his experiences and the notion that any creation must by definition exist and function within boundary limits. In a quantum world everything happens instantaneously. You define a creation, and it appears and happens as an experience, and then it disappears. The whole process is instantaneous. However, sometimes experiences approach the observer, and the observer resists them, pushing them away without experiencing them. The experiences move away and then return to the observer again for experiencing, and again are pushed away. This forms a repetitive pattern of aborted experience -- a persistent oscillation -- that generates the illusion of time. Only when an experience is absorbed and fully experienced does it dissipate and cease oscillating as a persistent creation. Thus, according to observer physics, oscillation originates from the tendency of an observer's belief to seek to be experienced. When the observer refuses to experience an experience, the underlying belief persists by oscillating in the observer's awareness until he relents and fully experiences his creation. The ball keeps bouncing automatically back into the observer' s court.

The success of the theory of quantum mechanics and vast experimental evidence supporting it justifies another revision of the laws of Newtonian mechanics to include the scale and/or conditions in which quantum processes dominate. Observer physics adds a deeper understanding of why apparently particulate phenomena also manifest wavelike qualities. It also reveals the mechanics by which the crossover occurs between wave dominance and particle dominance.

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 (ao) acceleration threshold? Without some principle to explain why Newton' s second law should suddenly shift gears halfway out the arm of 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.

On the other hand, MOND does give a description of what we see with the current data. We can also suppose that Newton is correct, and we have missed some extra matter, but then we have to tweak each individual case, because there is no reason why the "missing" matter should show up consistently in certain places. Also, the aberrations of acceleration occur far from the massive galactic centers. You don' t expect to find more mass there.

Observer physics suggests the "Transparent Belief" Exercise (# 23) in **ReSurfacing** as a tool to uncover what someone might believe in order to experience that matter moving at very slow accelerations and at great distances from a CM might appear to violate Newton' s laws of motion. Until there is a theory that reasonably supports the MOND approach, Milgrom' s idea remains an interesting patch, an alternate way of looking at a problem. The approach may eventually throw some light on the problem, and just may be an insight into dynamics that opens up a cosmological paradigm shift on the level of relativity and quantum mechanics.

The general supposition by most physicists is that there must be a lot of dark matter out there that has not yet been counted. This may not be the "right" answer, but I think there is a much larger than previously imagined number of medium-sized, large-sized, and super-massive (several million solar masses) black holes lurking in galactic structures, particularly in the cores of x-ray hot galactic clusters. Evidence is beginning to accumulate that supports the idea of clusters of several or even many black holes in galactic cores. The older the galaxy, the more holes there will be. These objects are only observable if they happen to be eating stars or other material. Otherwise they are quiescent and invisible except for their gravitational influence on surrounding objects. I suspect that in the next few years we will discover large enough numbers of these objects inside galaxies and globular clusters that we can form a better estimate of their distribution. We may also do some adjustment of the relationship between brightness and mass. These, plus other findings that may show up, will close the gap regarding the missing dark matter. There are also theories predicting exotic phenomena such as WIMPS, super-symmetric shadow particles, and cosmic strings. With the exception of a small mass for neutrinos, I do not put much faith in these ideas.

We have given some support to the notion of neutrino mass accounting for a portion of the dark matter. We can also imagine that the sQuarks, intermediate bosons, and (Bu) bosons we discussed may account for a notable portion of dark matter as shadow particles. Although these shadow particles are extremely transient in their massive forms and usually hide beneath the resultant protons and neutrons, a totaling of all the interactions occurring throughout the universe at any given moment in which such creatures poke their heads above the zero point of the vacuum -- for example as momentary intermediate bosons -- may play a role in the dark matter scenario.

Who knows? The vacuum activities of the shadow particles under the influence of very slow accelerations may turn out to produce inertial-gravitational ELF waves that support MOND!! We need to study zero-point effects with more attention.

Milgrom needs to come up with a rationale for his proposed threshold. In our initial discussion of neutrinos we proposed a charge threshold to account for the discrepancy that our initial theory seemed unable to explain why some leptons have charge and others do not. However, after deeper exploration we found that the neutrinos -- and the up quarks -- are not actually "separate" particles. They are components of the proton-neutron ensemble. The neutrinos can sometimes delocalize a portion of the baryon's mass-energy. The other leptons can also "delocalize" from the fundamental ensemble. The difference is that the charged leptons represent pointlike vortical foci, whereas the neutrinos are fuzzy blobs that can oscillate among three quantum values of mass-energy. Charge only builds around the electron and the positron vortex focal points. The muon and tauon are "fat" electrons with a momentary extra wave of energy clinging to them. ALL other particles are wavy impulses rather than tight vortices and thus do not support electrical charges except indirectly through the incorporation of electrons and positrons. The results of our research severely restricted the notion of charge and how and where it can occur, eliminating the apparent need for a threshold, while simultaneously resolving the question of why neutrinos do not have charge.

The experimental verification of the observer physics theory of quantum gravity will also justify some revisions in our understanding of the laws of Newtonian mechanics as interpreted through both relativity and quantum mechanics. This seems reasonable since observer physics aims to unify these two major scientific theories that so far have resisted unification. The only requirement is that any modifications should include the ability to describe the current successes of classical and quantum mechanics as special cases.

Below are some examples from the previous chapters of fundamental revisions to the theories and predictions of Newtonian, relativistic, and quantum mechanics proposed by observer physics that will both unify and generalize these systems as theories.

* The graviton propagates at an FTL velocity.
* FTL communication IS possible at the speed of the quantum wave function state reduction.
* FTL information transfer can occur without the causality violations predicted in current theory.
* Objects inherently have no mass or gravitational force.
* All mass and forces derive from resistance that originates in the observer.
* The observer is the prime mover in charge of all physical systems.
* Internally correlated quantum bubbles may be of any size and are managed by the observer.
* Gravity is bipolar, its physical opposite pole being kinetic energy (or "entropy").
* Gravity is generated by the observer's exercise of will to create bias in undefined awareness.
* Electromagnetic exchange is initiated by an observer's emission of attention particles.
* Palmer's theorem defines the relations among the observer, his beliefs, and his experiences.
* The Mental Space of ideas and the World Space of physics are mirror replicas of each other.
* Operations in either space modify the structure and function of the conjugate space.
* The entropy of any system is defined by the observer's choice of viewpoint.

<u>**Key Principle of Observer Physics**</u>: **When data exists that does not fit a theory, or when a theory lacks a general principle, or theories regarding the same data appear to contradict, a rigorous pursuit of "transparent beliefs" (hidden assumptions) and evidence that may support them is an effective remedy**. (Refer to **ReSurfacing** Exercise # 23.)