A Simple Spin on Gravity

Abstract: **Euclidean interval-time coordinates reveal a surprisingly simple *explanation* of gravity. From this, gravitational mass, inertial mass and energy inextricably arise with inherent duality.**

What's the Matter?

Having modeled an alternative to massless particles,[1] those *with* mass are addressed here. Recent attempts, such as the Higgs mechanism[2], model inertial mass while ignoring equivalent gravitation and energy. The *description* of gravity has progressed remarkably from Newton's law to Einstein's field equations,[3] but *explanation* has been lacking.

Feynman asked: *"…what is gravity? Where does it come from? … although I have stated the mathematical law, I have given no clue about the mechanism."*[4]

"*There is currently no complete quantum theory of the remaining fundamental force, gravity."*[5]

"the primary role of mass is to mediate gravitational interaction between bodies, and no theory of gravitational interaction reconciles with the currently popular Standard Model"[6]

"What is gravity? …without a mechanism behind it…No one knows."[7]

"In these theories [e.g. Higgs field], as in the Standard Model itself, the gravitational interaction is either not involved or does not play a crucial role."[8]

Newton admitted, "*I feign no hypotheses."*[9] Wheeler described, "*Mass grips spacetime, telling it how to curve.*"[10] But physics fails to explain what a point mass is or how mass-energy manages to "grip", with indefinite reach, a decidedly slippery continuum. "*No machinery has ever been invented that 'explains' gravity."*[7] That is the task of this writing.

Put Space in Its Place

Less distortion means a better structural match between a map and the region it represents. Thus, a globe is the most accurate way to map earth's surface. Spacetime maps greatly distort the metric relations of our continuum so, interval-time coordinates were introduced as a Euclidean alternative.[1] With them, lightlike intervals are accurately portrayed as *direct contact* in 4D. Thus, light quanta are seen to transfer via pinhole (particle-interaction wormhole), bypassing space and time of indefinite (but equal) extent (Fig. 1).

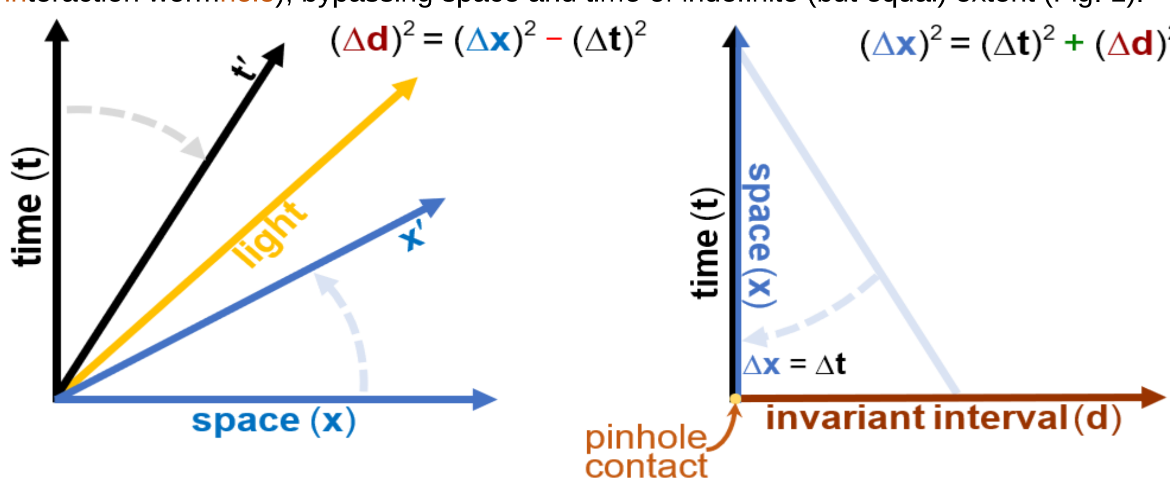


Fig. 1 Left: Minkowski coordinates collapse with increasing speed, denying light a rest frame in spacetime. Right: The particle aspect of light occurs by direct interval contact, remote in space and time, sans photons.

In 4D, *all contact is interval contact*. The vast majority are spatially remote, via pinhole ($\Delta\mathbf{t} = \Delta\mathbf{x} > 0$). Being lightlike, pinholes are velocity-dependent, accessible only to speed $\boldsymbol{c}$ phenomena, such as light and fields. Pinholes are not Einstein-Rosen bridges, instead being akin to Wheeler wormholes.

"Wheeler…has novel geometries…One such geometry consists of a space full of wormholes. Such holes are ultra-tiny."[11]

With the Euclidean lens, spin½ was then revealed as *chronaxial*, in an *interval 3-plane*.[12] More generally, it is spin about a fermion's worldline which, in its rest frame, is its *timeline*. Classical objects are prohibited from chronaxial spin by unbounded circumferential speeds. But a pinhole is a null vector[13] of zero size, effectively projecting contact. The progress of a projection is unrestricted by limit $\boldsymbol{c}$.[14]

A Principled Approach

"Someday, when physics is complete and we know all the laws, we may be able to start with some axioms, …no doubt somebody will figure out a particular way of doing it so that everything else can be deduced."[15]

Every model is founded axiomatically, upon its first principles. This model has only three:

1. The Continuum: from only ***one kind*** of dimension. Fundamentally-unidirectional time, emanates as a 4D radial temporal field from an absolute center, the Big Bang event (BB). Any enclosing 3-sphere is a spatial simultaneity in the rest frame of the BB (Fig. 2). In this curved-space, radial-time model, space expands non-linearly, approximately as the cube of cosmic age (i.e. radius^3).

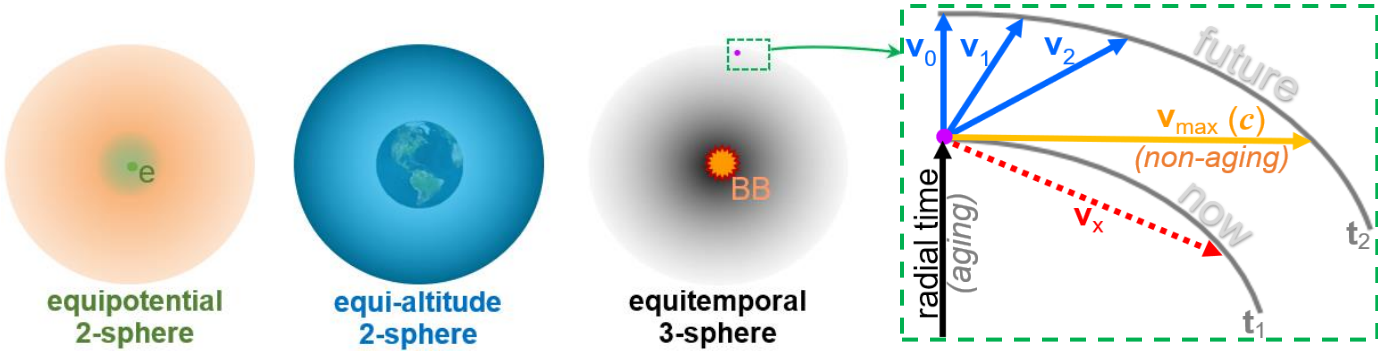


Fig. 2 Family resemblance? Spheres of equal field intensity enclose various charges (left trio), including the Big Bang (BB). Right: A 2D slice of a curved-space, radial-time cosmic structure has Euclidean interval-time coordinates available at every location, on radial and tangent directions (of $\mathbf{v}_0$ & $\mathbf{v}_{max}$) respectively.

2. Pinholes: Nothing is simpler than a hole, the ***one kind*** of fundamental object from which all others derive. Subsequent articles will develop their variety. *All contact is interval contact* (via pinhole). This is most often remote, understood as a *projection* of contact along a lightlike worldline in spacetime (Fig. 1).

Being lightlike, a pinhole is speed c dependent thus, it is exclusively an *energy conduit*. It may also be characterized as a fundamental *force object*, replacing massless force carriers. Seeing Newton's 3rd Law as "*Forces are always observed in pairs.*", it follows that *unpaired forces are unobserved*, since any force detector would represent half of a pair.

3. Spin: Pinholes exhibit this ***one kind*** of behavior, from which all other behaviors and all complexity arise. To fully characterize any spin, both its primary *axis* and its *plane* of rotation must be identified. The common description of spin½ as "intrinsic" admits that neither has been discovered. Here, it is modeled as solid-angular "chronaxial" spin about the non-classical axis (time), in an interval 3-plane.[12] Time is always excluded from the plane of rotation as fundamental unidirectionality denies the required oscillatory freedom.

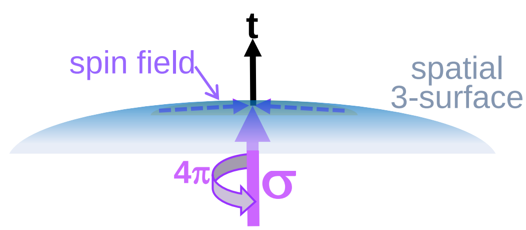


Fig. 3 Spin components (dashed) project onto curved space in a field from primary chronaxial spin vector, $\boldsymbol{\sigma}$.

Field Goal

Current convention relies extravagantly on numerous, all-pervasive, preexistent fields (e.g. the Higgs field) as first principles. The present model instead develops a field for each particle. Different field aspects provide the known interactions. Such fields are most easily understood by learning to make them.

Imagine spinning a rope so fast, there's only a blur. The rope, as a radial "field element", sweeps out a field over its angular distribution (Fig. 4). Instantaneous spin would yield a continuous field, for which density varies inversely with radius. However, field density clearly does not rise to infinity as the radius shrinks to zero. It instead "renormalizes"[16] to the rope's original density at the center.

Field morphology varies with different spin modes. For example, if a rope merely oscillates linearly, average field density would be constant along its distribution. By contrast, a rope spinning around a 4th dimensional axis would occupy a volume, and density would vary as the *inverse square* of radius. In any case, field intensity (i.e. density here) never exceeds that of the field element.

Of course, no ordinary object can spin instantaneously, as circumferential speeds would violate limit c. Yet, chronaxial spin is inherently instantaneous, being *around* a temporal axis.

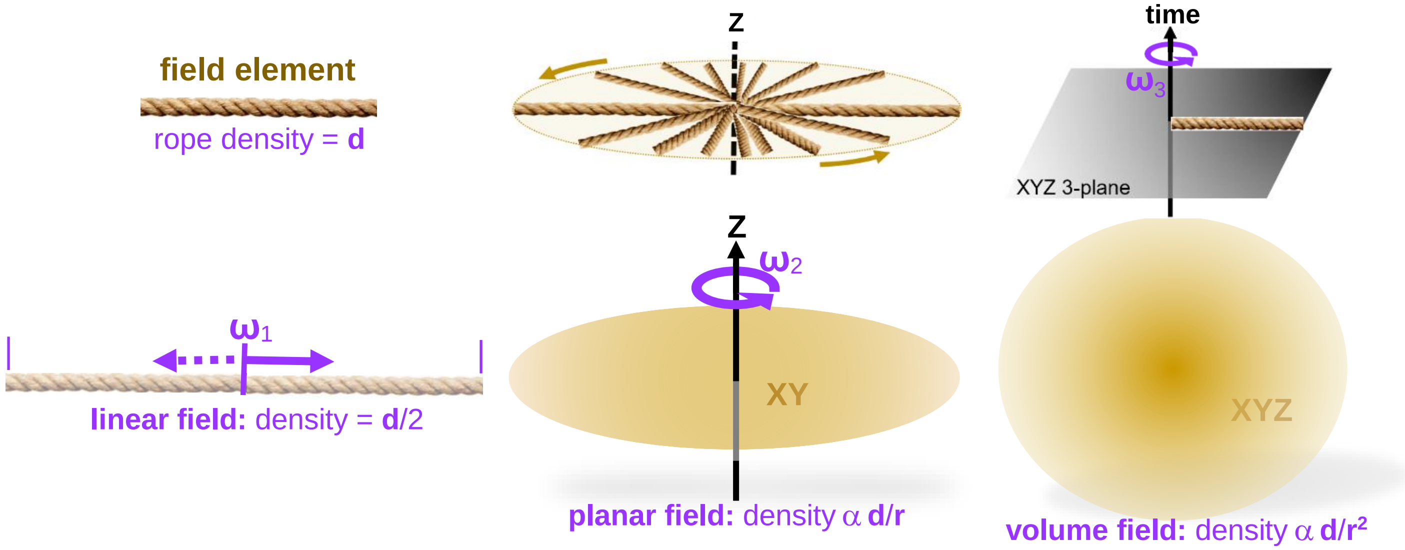


Fig. 4 A rope distributes its density over a field according to the dimensionality of its spin about one end. Left: rope still & in linear (1D) oscillation. Center: With increasing spin a rope becomes a planar (2D) field. Right: Solid-angular (4π) spin in a 3-plane generates a volume (3D) field exhibiting the inverse square law.

A rope is an *additive* field element, generating field intensity (e.g. avg. density) which exceeds ambient. A *subtractive field element* does the opposite. Consider a plastic disk representing ambient density. From it, a radial notch is cut. As the disk spins (Fig. 5), the notch distributes over a subtractive field. (One might also imagine an evacuated tube moving through a non-viscous fluid.) Average density now *falls to zero* at the center, with the subtractive element's field intensity.

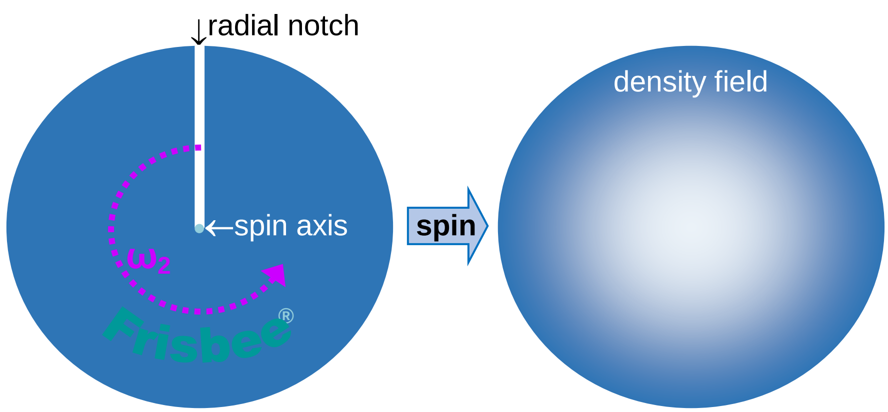


Fig. 5 Nothing Doing: A radial notch, filled with *nothing* but a vacuum, models a *subtractive* field element. Rapid spin simulates its movement through a medium, creating a planar density field that varies with radius. The notch itself has no inherent length. It simply projects "all the way", unmeasurable apart from its medium.

Imagined with chronaxial spin through a dense volume, average density will follow the *inverse square law*, falling to zero at the spin center. The "size" of a notch is ordinarily reported by the size of the medium it interrupts. But with no intrinsic size, a notch is better seen as a "null vector".

G-Wiz!

The quintessential feature of our continuum is that it provides the potential for separation, so much so that its separational capacity is taken for granted. But absent exquisitely balanced forces, the separation of any pair of objects is inherently unstable. Why? *Pinholes are subtractive field elements.*

Chronaxial spin puts a pinhole into a *superposition*. Its projected contact is instantaneously distributed in a radial 3-field (a volume) about its center. The term, "particle" indicates that center, while spin provides a wave character. The superposition creates *separational insufficiency*, a *mixed state* between *stable separation* and *full contact*, for which intensity varies with the inverse square of space (or time). With decreasing separational capacity, objects accelerate toward each other (Fig. 6). **That's gravity!**

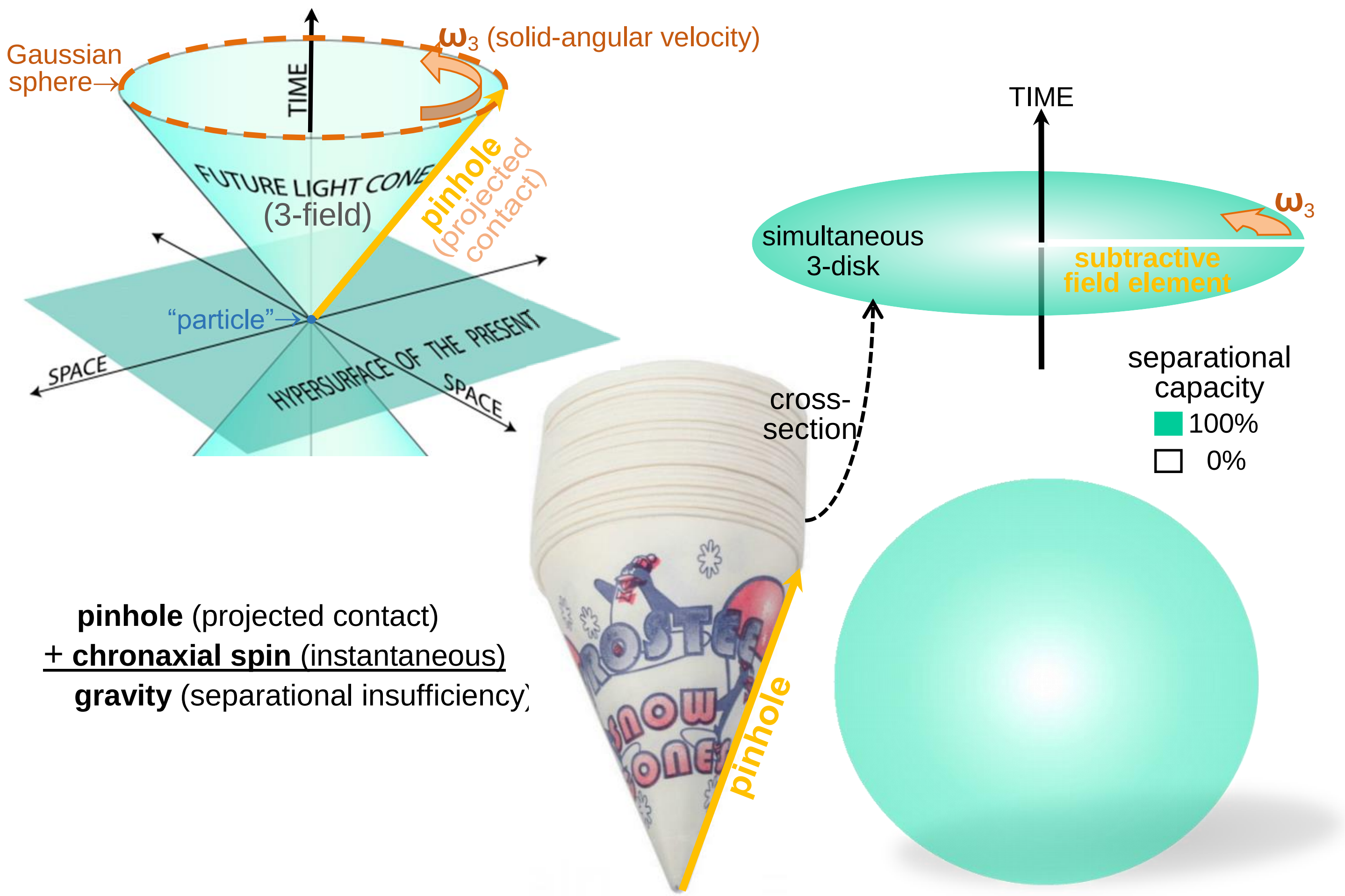


Fig. 6 Left: A light "cone" (3-field) in Minkowski spacetime, arising from a "*particular*" event is generated by a lightlike field element (pinhole) with chronaxial spin. Center: As spin persists, a stack of coaxial cone instances has a simultaneous cross-section (top right). Their collected pinholes act as a subtractive field element put in *superposition* by chronaxial spin. Separational capacity is compromised in proportion to field intensity. We experience the resulting radial acceleration 3-field (gravity) as Gaussian (bottom right).

Instant Energy

What causes a pinhole to spin? Does it require energy? Pinholes don't have mass or take up space. Gravitational mass arises *from* spin, not the reverse. Given that, so does energy! Here's how…

A gravitational field is continuous because chronaxial spin is essentially instantaneous. Yet, just as Cantor showed us different sizes of infinity,[17] there are different rates of "infinite" speed.

Imagine God's hand draws two horizontal lines in spacetime (Fig. 7). Both appear instantly (i.e. infinitely fast), yet one must have been drawn faster. Lacking a term for one infinite speed being *faster* than another, the measure distinguishing them is "length".

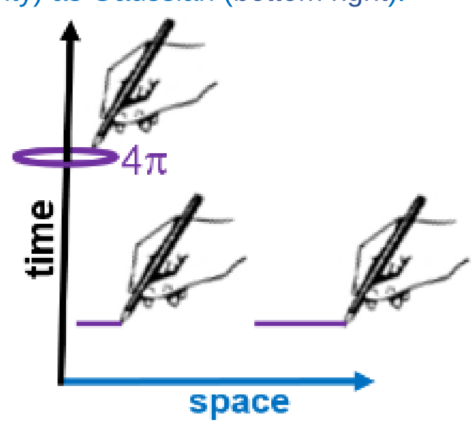


Fig. 7 Below: Two lines drawn with *"infinite"* speed but the "longer" one drawn *faster*. Above: Solid-angular loops (& spin) around time may also have *different* instantaneous rates.

Similarly, particles can have *different* "instantaneous" chronaxial spin rates. The term distinguishing them is, "mass-energy". Thus, gravity, mass-energy and chronaxial spin rate ($\boldsymbol{\omega}_3$) are inseparable. As ΔE relates to $\boldsymbol{\omega}_3$, the uncertainty expression: $\Delta \mathbf{E}\, \Delta \mathbf{t} \geq \boldsymbol{\hbar}/\mathbf{2}$ reveals that, for a single field instance, as $\Delta \mathbf{t}$ goes to zero, $\boldsymbol{\omega}_3$ must be infinite! And $\hbar/2$ realizes the Planck constant (h) reduced by the solid angle (4π sr) of chronaxial spin.

"…energy. … is it the source of a field? The answer is yes. Einstein understood gravitation as being generated by energy. Energy and mass are equivalent. …energy produces the gravity."[18]

A rope spinning instantaneously would no longer be a rope but a disk, a *continuous* radial superposition. *Instantaneous "motion" isn't really moving, it's "being".* Though spread out to vanishing at the edge, a long rope would still bump into itself on completing a turn because field density remains 100% centrally. The field is thus "particle-like" at the center and more "field-like" peripherally.

Ropes can't have chronaxial spin, but pinholes can. On completing a turn, a pinhole can't pass through itself because its center is a discontinuity in the continuum. It proceeds by advancing along its temporal axis, creating a new instance of the field. Seen in spacetime, light cone instances stack like cones (Fig. 8), establishing a "particle" worldline along their vertices.

This realizes Planck's quantum of action (h)[19] as a single chronaxial rotation, one field instance. So, solid-angular velocity is: $\boldsymbol{\omega_3 = 4\pi f}$, where **f** is relative field frequency (chronaxial cycles/sec.). Allowing Planck's **E = hf**: then $\boldsymbol{E = \omega_3 h/4\pi}$ relates energy to chronaxial spin rate ($\boldsymbol{\omega_3}$). Feynman wrote:

"The angular momentum does come in units. … which is very peculiar"[20]

"Now in quantum mechanics angular momentum must be quantized. In fact, one is only allowed to have angular momentum in multiples of (1/2)ħ, …so we have constructed ourselves a spin ½ object."[21]

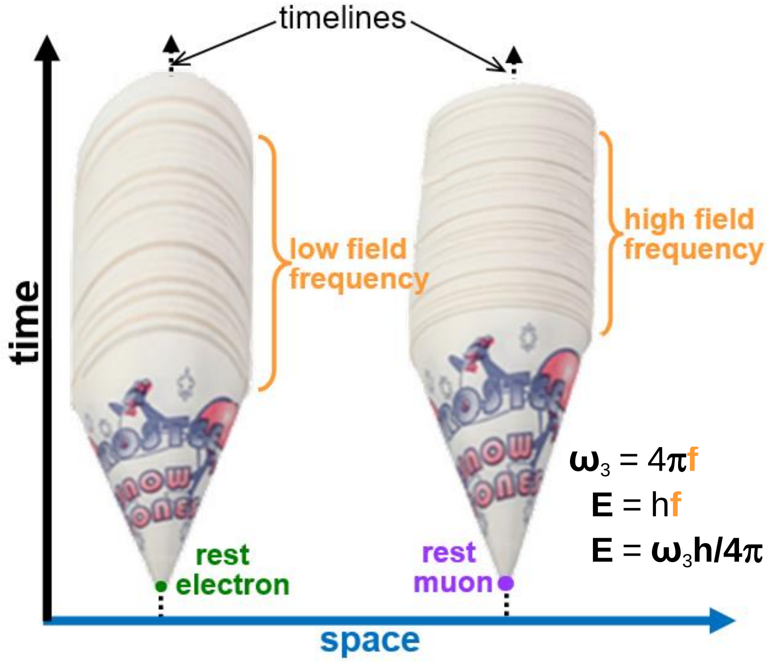


Fig. 8 A muon's greater spin rate ($\boldsymbol{\omega}_3$) stacks more field instances (light cones) per second (**f**), thus more energy (**E**) than an electron.

A higher chronaxial spin rate gives a resting muon more mass-energy than an electron by packing more fields/sec. (**f**) than an electron. This results in greater loss of separational capacity (i.e. more gravity) thus, greater implied mass.

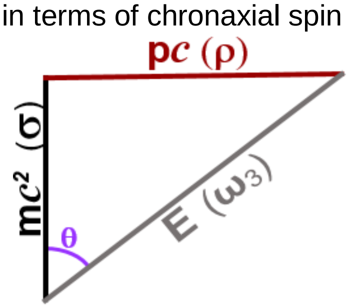
"Because the muon has a mass about 200 times higher than the electron, the 'stopwatch hand' [probability amplitude] for a muon turns 200 times more rapidly than that of an electron."[22]

Chronaxial spin is fundamental to all forms of energy. The rest mass-energy of a fundamental fermion appears as a classical form of potential energy (PE). Increasing PE in any way (such as with altitude) equates to greater chronaxial spin, thus gravitation.

Gaining Momentum

"…the energy associated with motion appears as an extra mass, so things get heavier [more massive] when they move."[23]

Kinetic energy (KE) also contributes to gravitation. But how, for example, does classical linear translation ($KE = \frac{1}{2}mv^2$) relate to chronaxial spin? The difference between PE and KE in terms of chronaxial spin is that PE ($\boldsymbol{\sigma}$) is $\boldsymbol{\omega}_3$ in the rest frame of the particle, having a vertical worldline and no momentum component. The axis of chronaxial *spin* for PE is a single timeline. By contrast, KE ($\boldsymbol{\rho}$) is analogous to *roll* that is, spin seen to be continuously changing timelines (i.e. moving). PE plus KE are total energy (E), or simply total chronaxial spin ($\boldsymbol{\omega}_3$), about a worldline.



$$E^2 = (pc)^2 + (mc^2)^2$$

Fig. 9 Einstein's energy triangle corresponds to total spin½ ($\boldsymbol{\omega}_3$), as the vector sum of rest ($\boldsymbol{\sigma}$) plus momentum ($\boldsymbol{\rho}$) components.

Classically, energy is a *scalar*. But $\boldsymbol{\omega}_3$ is the *vector* sum of rest ($\boldsymbol{\sigma}$) and momentum ($\boldsymbol{\rho}$) spin components (Fig. 9). These 4-vectors each entail a 3-plane of rotation. That distinguishes them from the spatial *projections* of spin½ (also often referred to as spin "components") which lose a dimension (to 2-plane of rotation), like a shadow does from its object.

Drawing stacks of light cones in spacetime is cumbersome and belies their accurate depiction as zero-size "null cones".[24] With interval-time coordinates, they are more accurately single points, so a stack of light cones reduces to a worldline. Relative cone frequency (**f**) may be indicated by hatch marks, always horizontal, corresponding to speed c (Fig. 10).

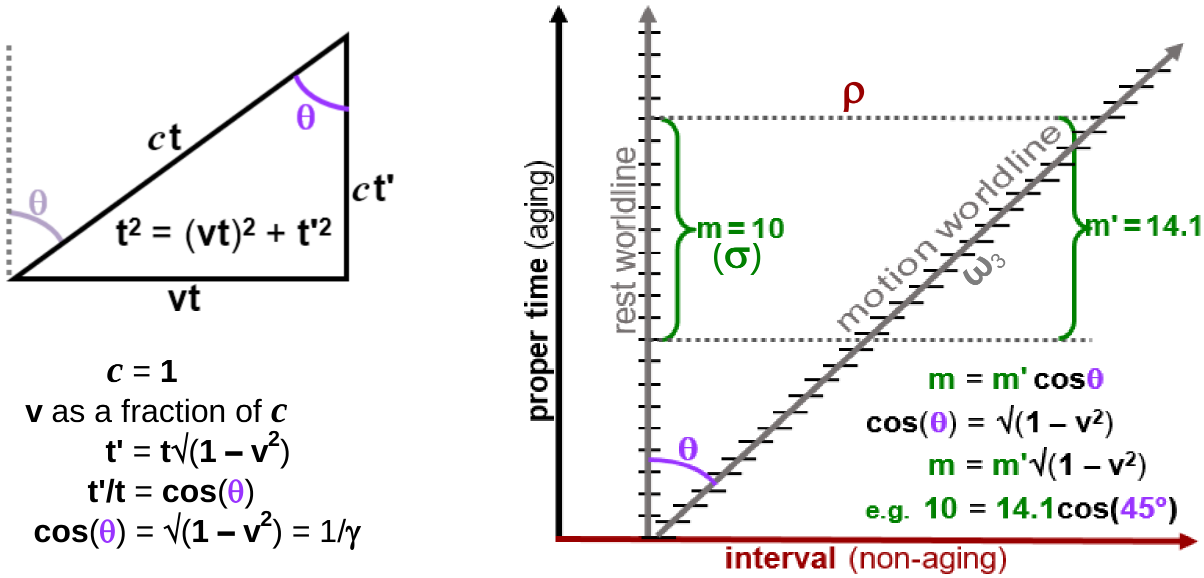


Fig. 10 Left: Einstein used Euclidean spatial coordinates for his light clock, so relative values may be expressed in terms or angle θ rather than γ. Right: Interval-time coordinates also relate speed to θ. Hatch marks/sec. indicate relative field frequency. So, a moving particle exhibits more gravitational mass (m') than an identical particle (m) at rest. This increases toward the non-aging speed limit c (at θ = 90°), where field frequency (and m') would be infinite.

Einstein's light clock utilizes Euclidean simplicity in spatial coordinates. But while time dilation and length contraction are beautifully derived from it (by factoring c), relative mass-energy is less apparent. Interval-time coordinates make that clear and intuitive.

Rest mass correlates to relative field frequency along a particle's world-line, indicated by hatch marks in Fig. 10. Identical particles have the same frequency at rest but with worldline inclination (i.e. relative speed), *hatch marks per vertical unit* increase. So, an observer at rest measures stronger gravity from particles seen in motion. This implies higher relative mass-energy. To change a particle's speed requires work, equal to the observed change in mass-energy. **That's inertia!**

Energy conveyed via pinhole (a fundamental force object) adds to the horizontal component (momentum) of a particle's worldline, as seen from its rest frame. In other words, force is lightlike, so application of a force makes a worldline more lightlike.

Maximal *aging* is observed at rest (vertical worldline), while speed limit c (horizontal) is *non-aging*. So, velocities (**v**) from 0 to c incline from 0°- 90° as described by: $\mathbf{v} = c\,\mathbf{sin}(\theta)$ or $\mathbf{v}/c = \mathbf{sin}(\theta)$. Giving **v** as fractional c, $\mathbf{v} = \mathbf{sin}(\theta)$. Since $\mathbf{sin}^2 + \mathbf{cos}^2 = \mathbf{1}$, then $\mathbf{cos} = \sqrt{(\mathbf{1} - \mathbf{sin}^2)} = \sqrt{(\mathbf{1} - \mathbf{v}^2)}$, which is $1/\gamma$.

For example, a 45° worldline corresponds to $\mathbf{v} = \mathbf{cos(45°)} = 0.707c$. Relativistic mass-energy is given by: $\mathbf{m'} = \mathbf{m}/\sqrt{(\mathbf{1} - \mathbf{v}^2)} = \gamma\mathbf{m} = \mathbf{m}/\mathbf{cos}(\theta)$, in agreement with Relativity and asymptotic with speed limit c (i.e. when θ = 90°). All real worldlines lead to the future but those in relative motion have a higher non-aging, interval component (are seen to age less). Since motion worldlines also exhibit higher mass-energy, *gravitation* is associated with *a lower aging* component (i.e. "time dilation").

Length contraction occurs only in the *direction* of motion, but time dilation and relativistic mass-energy (i.e. gravitational intensity) are independent of direction. Such spherical symmetry is consistent with a radial field, occupying the solid-angular range about a temporal axis. Spherical symmetry is chronaxial symmetry.

Massive Undertaking

From the dawn of Newtonian physics, there has been ambiguity about energy. Is it fundamentally an *object* or a *behavior*, "corpuscle" wave or both? Spin naturally sustains motion (a behavior) even with a stationary center (an object). Offering 4D of separation, the continuum must also provide 4D of spin freedom. Classical spin accounts for only three. Interval-time coordinates reveal time as a viable spin axis, from which chronaxial spin gives rise to a 3-field exhibiting the familiar inverse square law. Thus, chronaxial spin supplies the missing "intrinsic" spin axis of fermions.

Fig. 11 The Euclidean lens of interval-time coordinates allows us to *see* the possibility of chronaxial spin in a 3-plane about time.

The subtractive field element doing the spinning is the simplest possible object, a pinhole in the continuum. Direct physical contact is the only reasonable interpretation of "zero interval separation".

"Where light goes from a given point is always separated from it by a zero interval..."[25]

It should be unsurprising that fundamental first principles play multiple roles. Thus, a pinhole is also a null vector, projected contact, a field element and a fundamental force (i.e. energy conduit). More roles will come.

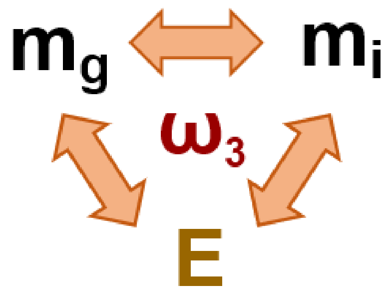


Fig. 12 Gravitational mass, inertial mass and energy are different aspects of the same fundamental behavior, chronaxial spin ($\boldsymbol{\omega}_3$).

Though bypassing space and time of indefinite extent, pinhole spin is unrestricted by speed limit c because it has zero interval span. Thus, chronaxial spin distributes a pinhole instantly as a radial field. To avoid pinhole self-collision, field instances stack futureward, reducing separational capacity of the continuum in proportion to field frequency. The resulting inward acceleration field is gravity, better considered a gradient of separational insufficiency than "warping" or "curving".

Chronaxial spin rate is instantaneous yet variable, the most fundamental expression of energy (Fig. 12). It is attributed to a "particle", implied at the center of spin (Fig. 13). Translational speed is chronaxial roll. This adds a momentum component to the total spin ($\boldsymbol{\omega}_3$) observed identically as increased mass-energy and gravitation.

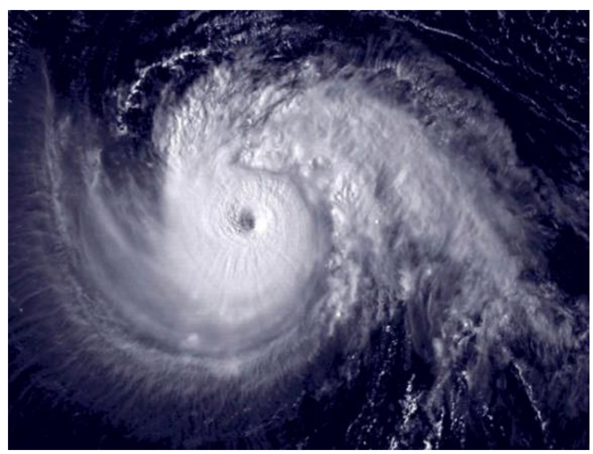


Fig. 13 Like the *eye* of a hurricane, a "particle" has no existence apart from spin.

"Anything which has energy has mass…in the sense that it is attracted gravitationally.[26]

"The conservation of energy…does not represent any particular thing."[27]

Conservation of mass-energy should now be seen as *identical* to *conservation of solid-angular momentum,* a *behavior* not a thing. Though science is unaccustomed to a temporal axis, there is hope in the fact that once before, it came to grips with a novel axis of rotation, proposed by Copernicus. Perhaps this time it won't take quite so long.

In Feynman's words:

*"…ultimately physics will **not** require a mathematical statement, …in the end the machinery will be revealed, and the laws will turn out to be simple"*[28]

"gravity is simple … the system beneath the whole thing is simple. …and therefore, it is beautiful."[29]

"…the truth always turns out to be simpler than you thought."[30]

1] D. Colasante, ALPHA: Applying a Light Touch? viXra 2019
2] Higgs Mechanism Wikipedia, 2019
3] Einstein Field Equations Wikipedia, 2019
4] R Feynman The Character of Physical Law ISBN-10: 0262533413, 1965 p33
5] Quantum Field Theory Wikipedia, 2019
6] Mass Generation Wikipedia, 2019
7] R. Feynman Six Easy Pieces ISBN-10: 9780465025275, 1963 pp107-9
8] Mass Generation (gravity-free models) Wikipedia, 2019
9] Newton's Law of Universal Gravitation Wikipedia, 2019
10] J. Wheeler (quotes) Good Reads, 2019
11] R. Feynman Perfectly Reasonable Deviations from the Beaten Track ISBN-10: 9780465023714, 2005 p432
12] D. Colasante Spin½ 'Plane' & Simple viXra 2019
13] Null Vector Wikipedia, 2019
14] Faster-Than-Light (spots & shadows) Wikipedia, 2019
15] R Feynman The Character of Physical Law ISBN-10: 0262533413,1965 pp49,50
16] Renormalization Wikipedia, 2019
17] Infinity Wikipedia, 2019
18] R Feynman The Character of Physical Law ISBN-10: 0262533413,1965 p77
19] Planck Constant Wikipedia, 2019
20] R Feynman The Character of Physical Law ISBN-10: 0262533413,1965 p80
21] R Feynman & S Weinberg Elementary Particles & the Laws of Physics ISBN-10: 0521658624, 1987 p50
22] R. Feynman QED: The Strange Theory of Light and Matter ISBN-10: 0691024170, 1988 p143
23] R Feynman The Character of Physical Law ISBN-10: 0262533413,1965 p76
24] Null Vector (null cone) Wikipedia, 2019
25] R. Feynman Six Not-So-Easy Pieces ISBN-10: 0465025269, 1963 p99
26] R Feynman Six Easy Pieces ISBN-10: 9780465025275, 1963 p112
27] R Feynman The Character of Physical Law ISBN-10: 0262533413,1965 p69
28] Ibid p58
29] Ibid p33
30] Ibid p171

Related Animations - by the author (as "Faradave"), in sequence

Getting Coordinated (the world via Euclidean Lens)
Contact Sport (*c*-ing the light)
The "Hole" Shebang (fishing for wormholes)
Applying a Light Touch (unmasking photons)
What Time Is It? (leaving Lorentz transforms)
3-Ring Circus (dark energy and speed c):
Spin½ "Plane" & Simple (classically modeled)
Riding a Bi-Cycle (720° rotation)
Probable Cause (probability amplitude)
A Noether Round (new symmetry)
Field Goal (making one)
Massive Undertaking (gravity mechanism)
Instant Energy (physically realized)
Gaining Momentum (relative mass-energy)
Native Uprising (simultaneous fields)