The Time Flow Manifesto

Chapter 5.
Time Flow Physics.

DRAFT ONLY

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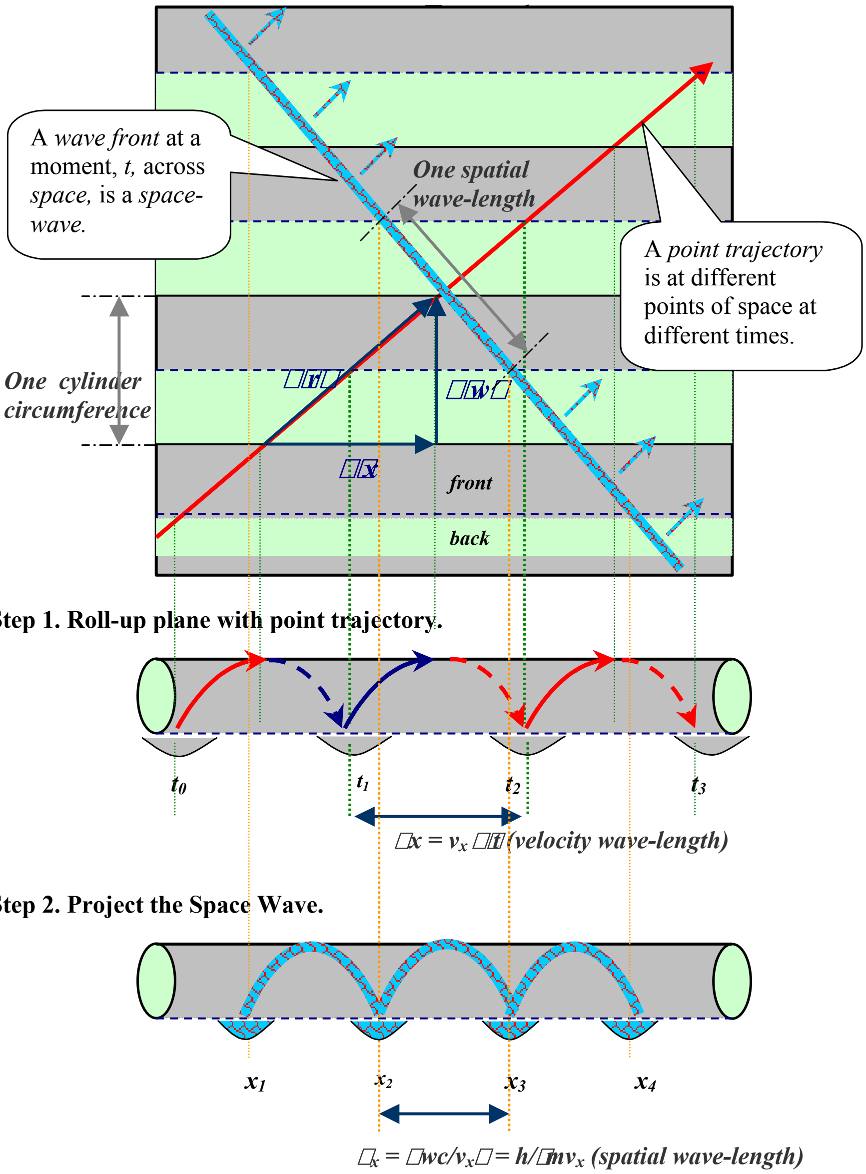
CHAPTER 5. TIME FLOW PHYSICS.

In this chapter, we see one way that *time flow* may force us to develop our physical theory *if we add it back into physics proper.* Now of course this is speculative in this context, and should be thought of as a model. The two following extracts are from introductions a more complete *unified* theory. They explain the basic mathematical models that are required to illustrate the point that *such models may be plausible.* The second extract, 'the parable of the ants', introduces us to the ideological-philosophical conflict that prevents such a development being considered in the present generation, which we will go on to next.

EXTRACT 1. THE PHYSICS OF TAU.

STR from extra circular dimensions.

The next two sections explain the first step of the particle-STR model in some detail. The model is based on a *mathematical equivalence*, which is worth understanding if you want a clear visualisation of the particle-level physics.



This simple geometry on the surface of a *classical cylinder* generates the STR metric in one dimension, with relativistic quantum wave and spin properties.

STR from simple maths.

Take a flat piece of paper (plane), mark one direction as Δx, *and the perpendicular direction as* Δw. Δx *and* Δw *are unit vectors of the same length.*

Mark the plane with horizontal strips, Δw *high.*

Then draw a straight line (red) across the plane, in a random direction.

This represents the path of a particle moving at a universal speed, *c*.

We assume it moves a total distance Δr *in a period* Δt.

Now work out the components of motion in the two directions.

(1) $\Delta r^2 = \Delta x^2 + \Delta w^2$ *[Pythagoras' theorem]*

(2) $\Delta r/\Delta t = c$ *[Universal wave-particle speed c]*

(3) $v_x = \Delta x/\Delta t$ *[Define speed in the x-direction]*

(4) $v_w = \Delta w/\Delta t$ *[Define speed in the w-direction]*

(5) $c^2 = v_x^2 + v_w^2$ *[The velocity components]*

We now roll the sheet of paper up into a cylinder, parallel to *x*, with circumference Δw. *The straight line trajectory we drew is now a spiral around the cylinder. It completes a revolution of the cylinder when it travels* Δw *in the w direction. This* circular motion gives it properties of having a *frequency* and a *period* and a *wave-length in the x-direction.*

(6) $T = \Delta w/v_w$ *[Time to move* Δw *at speed* v_w*]*

(7) $f = 1/T = v_w/\Delta w$ *[Revolutions per unit time]*

(8) $\lambda = v_x T = \Delta w\, v_x/v_w$ *[Distance in x each revolution]*

We now think of this motion as representing a *physical clock,* having a periodic process. We will call it a *process clock.* We will define the quantity of *time* it measures, called *process time (or proper time),* with a variable usually written as the Greek *Tau*, or τ. *We will define* τ *as periodic motion in w, by the definition:*

(9) $\Delta\tau = \Delta w/c$ *[Define* $\Delta\tau$ *from* Δw *and c]*

So far, this is a simple piece of *preliminary classical physics (or geometry)* – but we will now see that it represents the special relativistic metric and Lorentz transformations and relativistic QM particle properties all in one go. We don't add anything to it, we just look at it in a slightly different way. First, use (9) to replace Δw with $c\ \Delta\tau$ and (2) to replace Δr with $c\Delta t$ in (1) and we have:

(10) $c^2 \Delta t^2 \quad = \quad \Delta x^2 + c^2\Delta\tau^2$ *[Rearrange equations 1, 2, 9]*
[speed] [time] [space]

This is the metric equation of Special Relativity (Minkowski) space-time, where it is rearranged with *process time* on the left:

(11) $c^2 \Delta\tau^2 \quad = \quad c^2\Delta t^2 - \Delta x^2$ *[STR Metric Rearrange equation 10]*
[speed] [proper-time] [space-time]

The R.H.S: $c^2\Delta t^2 - \Delta x^2$ *is sometimes referred to as the STR metric. It is interpreted as* a *length (or interval) in space-time.* This rearrangement of (10) to (11) corresponds to the *tensorial interpretation,* with *invariant quantities.* In the physical situation, the measurement of $\Delta\tau$ *is invariant or absolute, like the count of rotations around the* cylinder, so the metric is fixed at every point.

However, physics has *moving observers* in space, who set up *moving coordinate systems for space* relative to us. What the form (11) shows is that if a moving observer sets up a new set of space-time variables, call them: (x', t'), it must leave: $\tau' = \tau$ *invariant, so:* $c^2\Delta t'^2 - \Delta x'^2$ *has to be invariant:*

(12) $c^2\Delta t^2 - \Delta x^2 = c^2\Delta t'^2 - \Delta x'^2$ *[STR relation between variable systems]*

The *Lorentz transformations* are the set of (linear) transformation functions from: (x,t) → (x',t'), that preserve this quantity, the *'space-time interval',* when we transform from one coordinate system to another. They can be interpreted 'epistemically', like Einstein, as the coordinate transformations that represent a uniformly moving *(x',t')*-

coordinate system, and retain the form of (2), the universal speed postulate, in the new coordinate system. But Einstein and Minkowski took the *metric as expressed in (11)* as a fundamental and unanalysable property of 'space-time'. This metaphysical substance became (after generalisation to GTR) the key substance in C20th physics, the new 'box' that holds the 'particles'. But they left proper time, $\Delta\tau$, *physically uninterpreted in detail.* Its interpretation in STR is by the (second-order) 'Principle of Relativity', that *any laws that determine proper-time,* τ*, must conform to the metric (11),* meaning they must be invariant w.r.t. the Lorentz transformations too. In our 'rolled-up-space' model, the STR metric (11) is derived from the *speed equation,* (10), and interpreted and explained by the simple Euclidean geometry. We see next that *this forces us to interpret* τ*, but first I add the definition of energy.*

To complete the basic STR relations for mass-energy, assuming we are modelling a fundamental particle with rest-mass m_0, and total mass m, we define *total energy* for motion in the original plane as *kinetic energy*:

(13) $E = mc^2$ [Define Energy]

This has two components, in x and w:

(14) $E \;=\; mv_x^2 \;+\; mv_w^2$

Kinetic energy + *Rest-mass energy*

From the definition of v_w it is useful to define the quantity γ:

(15) $\gamma = c/v_w$ *[Define Speed Ratio]*

Note this is identical to the conventional *Lorentz Factor*: $\gamma = 1/\sqrt{(1-v_x^2/c^2)}$*, by* substitution. If we take a *stationary particle in x* to have rest-mass m_0, we can write:

(16) $E_0 \;=\; m_0c^2$ [Define Rest Energy]

Then for Lorentz invariance we must define energy generally as:

(17) $E = \gamma E_0 \;=\; \gamma m_0 c^2$ *[Define Energy]*

And with (13), this entails mass dilation:

(18) $m \;=\; \gamma m_0$ *[Define Rest Energy]*

QM from extra circular dimensions.

The *proper time, Δτ, physically uninterpreted in STR, could only be interpreted in* detail when QM particle physics was discovered. We now see how the *cylinder model forces the interpretation of Δτ, and gives rise to quantum particle-wave properties,* just as simply and naturally as it gives rise to the STR metric. If we can imagine that each point in 3-D space *actually has a circular dimension attached,* we can use this as a physical model to generate a particle theory.

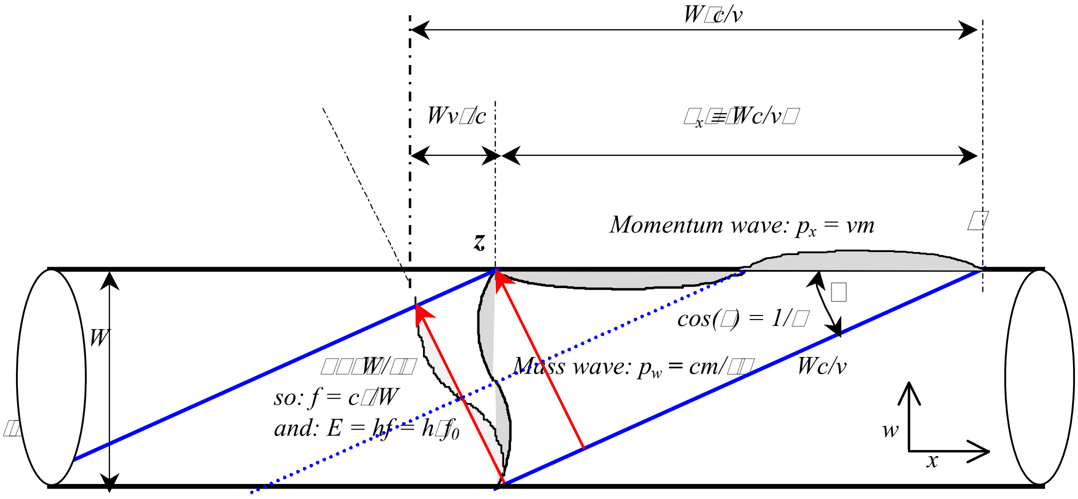


Figure 9.

Geometry of the plane-wave motion across the cylinder.

The following mathematical derivation is illustrated in this diagram. It means that this simple model does two things at once: it *reproduces the relativistic STR metric,* and simultaneously *generates wave-like motion with quantum mechanical properties of real particles*. This is all from a manifold without any intrinsic relativistic space-time properties or quantum properties.

QM from simple maths.

In this model, radiation and mass waves are both wave perturbations travelling at the local speed *c,*, light is simply perpendicular to the *W-directions,* rest-mass is parallel to the *W-directions*. We postulate that the *mass energy equals the wave energy.*

(19) $E = \gamma m_0c^2 = hf$ *[Equivalence Postulate, energy law for light]*

Since: $f = c/\Delta w$ *for a stationary particle, this means:*

(20) $m_0c^2 = hc/\Delta w$

This determines the new *circumference,* Δw, *for a particle with rest-mass* m_0.

(21) $\Delta w = h/m_0c$ *[Postulate of* Δw *for particle* m_0*]*

The *spatial wavelength* is the apparent wave-length around the cylinder of a *plane wave-front,* perpendicular to the direction of motion. From the geometry, because the *wave front is perpendicular to the motion in the plane:*

(22) $\lambda_x/\Delta w = (\Delta r/\Delta x)(\Delta w/\Delta r)$ *[Geometry: similar triangles, rotated 90 degrees]*

Using: $\Delta x = v_x\Delta t$ *and:* $\Delta r/\Delta t = c$ *and and:* $\Delta r/\Delta w = \gamma$ *and rearranging:*

(23) $\lambda_x = \Delta w\Delta r/\gamma\, v_x\, \Delta t = \Delta w\, c/\gamma\, v_x$

Using (21) for Δw:

(24) $\lambda_x = (h/m_0c)(c/\gamma\, v_x) = h/\gamma m_0v_x = h/mv_x$

This is the *de Broglie* wave-length for a 'matter wave'. This 'mass-wave' is also spinning in a *circle,* so it should have an 'intrinsic' angular momentum of *V x M x R,* which turns out to be an invariant quantity (w.r.t. *mass*), the QM intrinsic spin:

(25) $\mathbf{L} = c\, m\, (\Delta w/2\pi) = h/2\pi$ *[Intrinsic angular momentum predicted]*

The Torus

We can't go around introducing a new spatial dimension for every mass. The Aethereal Universe uses a *torus,* to model two fundamental mass-particles, the *proton* and *electron,* and derives other particles as complex wave-modes. This means adding *three dimensions of space*, giving six in total. The *particle waves* are distortions or perturbations of a 5-dimensional surface.

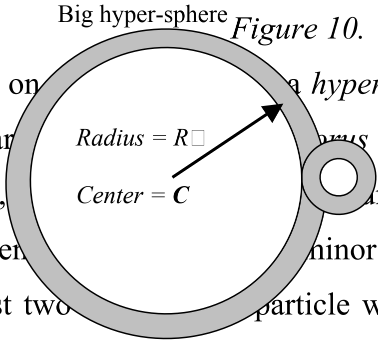


Figure 10.

This shows TAU on ... a *hyper-sphere* (our normal *x, y, z* space, but curved into the lar... ...*rus* embedded at each point. The *torus* has three dimensions, ...rface, and it defines two *circles.* It is defined by two len... ...minor radii or circumferences of its circles. These circles host two ... particle waves, for the *electron and the proton.* Note light particles or *photons* are surface waves, with only a circular polarisation.

This choice of the torus is needed to identify the correct form of the *cosmological volume equation,* the fundamental property of TAU. This says that *the total 6-D aether volume is constant.* The volume of the torus, as shown, is: $2\pi^2 R_p^2 R_e$, where R_e and R_p are the radii for the *electron* and *proton* 'circles', respectively. This determines *the combination of particle masses* in the relation required to predict:

(26) $T^* = h^2/2\pi^2 m_e m_p^2 Gc = 13.823$ *b.y. [99.9% accurate against empirical 'age']*

T^* predicts the conventionally measured age of the universe. Note that $h^2/2\pi^2 m_e m_p^2 G$ is purely *local constants*, but predicts the '*cosmological age'* of the universe.

EXTRACT 2. INTRINSIC VERSUS EXTRINSIC CURVATURE: PARABLE OF THE ANTS.

The theory of the ‘realist ants’ sketched in this parable refers to a real unified theory proposed in “A Geometric Model of the Universe”. The parable is about the metaphysical controversy faced in trying to introduce such a theory. The conventional positivist philosophy of ‘space-time physics’ holds that an intrinsically curved space-time manifold, governed by GTR and represented by a tensor calculus, is the only scientifically legitimate possibility in light of ‘the known facts of modern physics’, while the realist view supported here is that an alternative type of theory using an extrinsically curved space manifold, within a higher-dimensional Euclidean manifold, with time flow and real physical simultaneity relations, remains empirically realistic and conceptually preferable. This raises the question whether the science establishment has checked if this type of theory is possible. The proposed model is only the simplest of a class of models. Because it is incompatible with the ideological prescriptions of modern physics, enforced through the modern interpretation of space-time, this type of theory has been placed scientifically out of bounds.

Curved space.

Introductions to the General Theory of Relativity and the concept of curved space-time typically start with attempts to visualise *curved spaces*. We are asked to imagine 'ants' living on the surface of a 'balloon', with only two dimensions of freedom to move or observe. They make geometric measurements to check the rules of Euclidean geometry. Euclidean geometry is characterised by the Euclidean metric or distance function, which we know as Pythagoras' theorem: $a^2 = b^2 + c^2$, where a is the hypotenuse of a right-angle triangle. For small triangles on the balloon surface this law seems to hold.

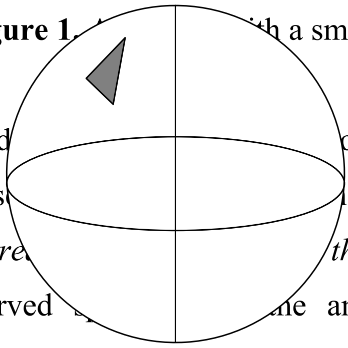


Figure 1. [illegible] a small, almost 'flat' triangle.

However the ants d[illegible]ometry is invalid when they make large-scale or global obs[illegible] of this thought experiment is of course that the balloon is *re*[illegible] *three dimensions*. This underlying realist model of the curved [illegible] ants will discover their apparent two-dimensional space is curved. The moral is then drawn however that if the ants are clever enough, they should be able to infer that *their world has more than 2 dimensions* – that they really live an extrinsically curved two-dimensional surface, embedded in a three-dimensional world.

The example then moves to our real space or space-time, as studied in physics. We are able to make measurements that confirm that three-dimensional space acts like it is really curved – both on a local scale through gravity, and on a cosmic scale, reflecting global topology. However the moral drawn in this case is very different to the moral for the ants. We are told that we must interpret the curvature of our own space as *intrinsic curvature.* Why don't we infer that we live in an extrinsically curved three-dimension space, set in a larger 'empty' Euclidean space of higher dimension? The reason given is that there is nothing observable 'outside' our physical universe, and the existence of a higher-dimensional Euclidean space would be unobservable or meaningless.

The laws of physics – the equations of General Relativity - are then developed in a tensor calculus for intrinsically curved four dimensional space-time. Alternative models, with extrinsic curvature in higher dimension Euclidean space, are not considered. The reasoning is positivistic. An 'empty Euclidean space' might as well not exist, it is just an abstract mathematical space, not physical. We can only be interested in the *physical contents of the material universe,* and even if this was embedded in an 'empty' geometric space, we may as well ignore any idea of the higher-order space, and stick purely to describing an intrinsically curved physical manifold.

This reflects the anti-realist, positivist approach to scientific modelling that dominates modern physics and philosophy of physics. It starts with the assumption that *our observations define the boundaries of reality, and are at the centre of all models.* Physical observation that is directly accessible to us is the ground of all scientific models in this view. But an alternative, realist approach is illustrated here. This allows us to propose models quite independently of assumptions about our observational abilities. We subsequently *model ourselves as physical observers within the model, and derive our expected observations from within the model.* Epistemology is not assumed *a priori:* it is a part of the model. This allows a much larger class of theories to be considered than in positivist approaches.

The enhanced ant world.

Let us consider how this works with the ants on their balloon. We first enhance the model of the balloon to allow micro-physical features, as follows. We take the surface to have an average thickness, call it ΔW, *and to contain energy in the form of localised* waves, which can either travel along the surface, or can bounce back and forwards between the inside and outside surfaces. We add some simple micro-physical principles to model these waves: these are *classical mechanical laws for a continuum,* with conservation of energy and momentum.

(A) all waves travel at the same basic speed, *c,* whether on the surface or through the material. The universal speed *c* reflects the surface tension.

(B) all waves have an energy *hf,* where *h* is a universal constant that reflects the material properties of the balloon.

(C) all energetic waves ‘stretch’ the surface slightly – this is how their energy is stored in the balloon material.

(D) in places where the balloon is stretched, the wave properties (*speed, c, and energy constant, h*) are distorted slightly, and the distances are distorted slightly as well.

To make things even tricker for the ants, we will postulate later that the balloon itself is slowly expanding (slow from the ant’s point of view anyway), and the values ΔW, *c* and *h* are slowly changing too. But to start with, the ants begin by examining their local physics on a small local region of space, with negligible global curvature, and negligible change in ΔW, *c and h. We can picture some waves like this:*

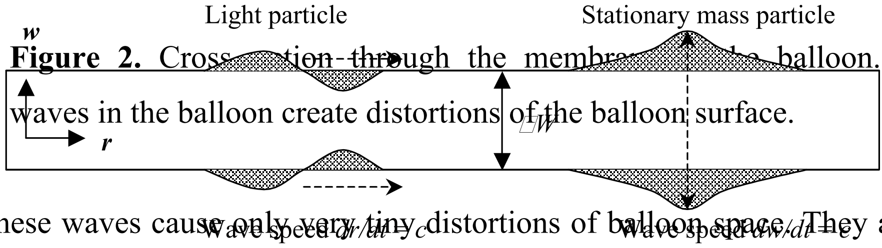


Figure 2. Cross-section through the membrane of the balloon. Energetic waves in the balloon create distortions of the balloon surface.

Now these waves cause only very tiny distortions of balloon space. They appear like ‘mass particles’ and ‘light particles’. The ants living on the balloon can see that these waves exist (because they form large clumps, and their effects add together), but they cannot observe the fine structure of individual waves, or their fine effects on space directly. In fact the ants don't realise that these are 'waves' - they appear like 'energetic particles' - waves on the surface travel like 'light', waves through the manifold appear like 'mass particles' impinging on the surface.

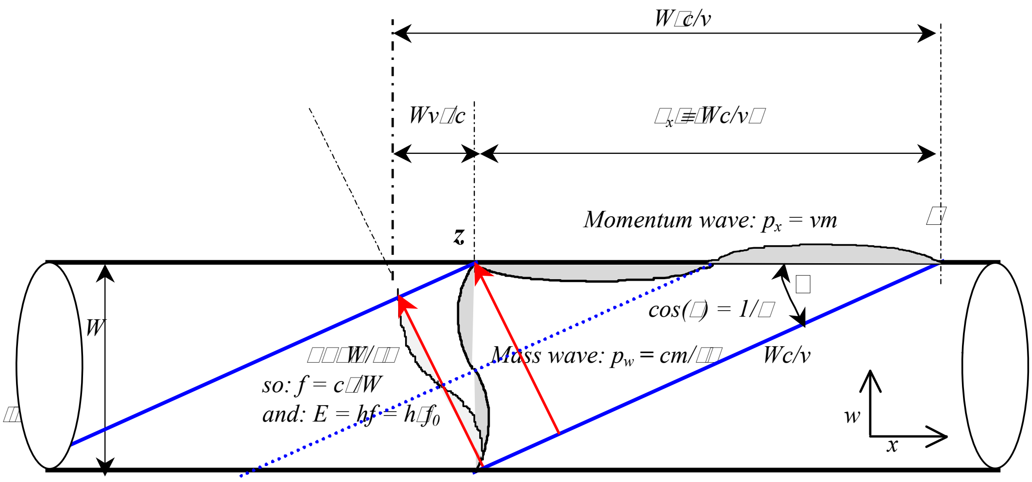


Figure 3. This illustrates variables for a 2-dimensional version (with continuous circular waves in a pipe, rather than bouncing waves in a slab), but the relationships are very similar.

But there are two different schools of geometers among the ants, a *positivist school* and a *realist school.* The positivists hold that their world is simply two dimensional, and has a constant intrinsic spatial curvature on a global scale. They write all the laws of geometry in the form of a two dimensional Riemannian geometry, and hold that these are simply *the fundamental laws of space*, with no deeper explanation or model. Since only events on the surface are observable, there is no question for them that any 'external reality' is possible. This is the end of *geometry* for them.

The realists, however, raise the question of whether there might be a deeper mechanical model for their world. They consider the possibility that they might be living on an extrinsically curved three-dimensional material manifold. They conceive a model for this, inferring that the manifold should have a finite thickness (rather than being a pure two-dimensional surface), and that there should be fine-grained effects of stretching of space, intrinsic frequencies of ordinary particles from their wave motion as they impinge the surface, and so on.

Ant local equations.

The ants refine their particle experiments, and confirm the wave-nature of 'light' from inference effects, and confirm the wave-properties of 'particles', and confirm fine-grained alterations in propagation speed and energy. They even confirm that the local deformities of space caused by waves causes an attractive force they call gravity. They express their results in a theory that starts with three fundamental equations, which define the model:

$dr^2 + dw^2 = c^2dt^2$	*Law of universal speed of propagation*
$E = hf$	*Law of energy*
$f_o = c/\Delta W$	*Law of frequency for particle stationary in r*

These laws apply to elementary particle and light waves alike. The quantity *dr* measures distance on the two-dimensional surface, *dw* measures distance in the third dimension though the continuum. They can separate the equations for the two distinct dimensions of motion (light and matter) by defining quantities like:

$V_r = dr/dt$	*definition of ordinary velocity on the surface*
$V_w = dr/dt$	*definition of ordinary velocity through the manifold*
$V_r{}^2 + V_w{}^2 = c^2$	*definition of components of speed*
$m = E/c^2 = hf/c^2$	*definition of mass from energy*
$m_o = E_0/c^2 = hf_o/c^2$	*definition of rest mass for a particle stationary in r*
$p = mc$	*definition of total momentum*
$p_r = mV_r$	*definition of momentum in r*
$p_w = mV_w$	*definition of momentum in r*

They can convert the quantities ΔW *and* f *into quantities defined from* m_o*,* c *and* h*.*

$f_o = m_o c^2/h$ *frequency for a particle stationary in r*

$\Delta W = c/f_o = h/m_o c$ *extension of the hidden dimension w.*

$d\tau = dw/c$ *definition of proper time*

These already embody *a Lorentz metric* and basic *quantum mechanical properties.*

Complex wave function solutions.

As an extra detail for mathematicians, the realist ants can derive a more general complex solution for wave motion in one dimension, *x,* that looks like:

$$\Psi(x,w;t) = A\,Exp(i/\hbar)(p_x x + p_w w - (E_x + E_w)t)$$

$$= A\,Exp(i/\hbar)(p_x x + p_w w - (E_x + m_0 c^2)t)$$

Defining: $\gamma^2 = 1/(1-v^2/c^2)$ *and:* $\hbar = h/2\pi$*. This is a kind of Klein-Gordon wave* function for a free particle, i.e. the simplest variety of *relativistic Schrodinger wave*, as shown by differentiating.

$$\frac{\partial\Psi}{\partial x} = \left(\frac{i v_x \gamma m_0}{\hbar}\right)\Psi = \frac{i}{\hbar} v_x m\Psi = \frac{i}{\hbar} p_x \Psi$$

Hence this solution satisfies the usual momentum eigenvalue equation:

$$p_x \Psi = -i\hbar\frac{\partial\Psi}{\partial x}$$

For the second spatial differential:

$$\frac{\partial^2\Psi}{\partial x^2} = \left(\frac{-v_x^{2} m}{\hbar^2}\right)\Psi$$

$$\approx \frac{-2m}{\hbar^2} E_x \Psi \quad \textit{for low velocities.}$$

Similarly for the spatial differentials w.r.t. *w:*

$$\frac{\partial \psi}{\partial w} = \frac{icm_0}{\hbar} \psi$$

$$\frac{\partial^2 \psi}{\partial w^2} = -\frac{m_0{}^2 c^2}{\hbar^2} \psi$$

So the total second spatial derivative is:

$$\nabla^2 \psi = \frac{\partial^2 \psi}{\partial x^2} + \frac{\partial^2 \psi}{\partial w^2} = -\frac{m^2 c^2}{\hbar^2} \psi = -\frac{mE_{Total}}{\hbar^2} \psi$$

The time differential is:

$$\frac{\partial \psi}{\partial t} = -\frac{i}{\hbar} \left(\frac{m_0 c^2}{\gamma} + m_0 v_x{}^2 \gamma \right) \psi = -\frac{i}{\hbar} mc^2 \psi = -\frac{i}{\hbar} E_{Total} \psi$$

This is a relativistic version of the time-dependant Schrodinger equation for a free particle (without spin components).

The positivists model and special relativity.

The realists ants confirm that particles really do have these kinds of properties, and start feeling confident about their new model. The positivist ants have been busy too, however. They don't like the realist's postulate of an extra dimension of space. They prefer their own *two-dimensional spatial ontology,* with intrinsic curvature, and separate *mass, momentum* and *energy laws* for particles. They reinterpret the realist ant's equations. They rewrite the *universal speed* equation in what they call a tensor form:

STR-metric $\quad c^2 d\tau^2 = c^2 dt^2 - dr^2 \quad$ *metric tensor law*

They interpret $d\tau$ *(or proper-time interval) as a fundamental observable, directly* measured by counting *particle events* ('clock time'), and converting them to a time scale. They observe that when written in this form, this law has a powerful symmetry, viz. Lorentz symmetry. In the underlying model for the ant world, of course, by assumption there is a unique frame of reference for the balloon – defined by its underlying matter. But *if the ants in the balloon world can only observe local waves in the balloon,* and cannot observe its underlying material composition directly, then to the ants, the classical laws of wave and particle motion have a symmetry that appears exactly like Lorentz symmetry.

In the true, classical theory of the model, we can take a moving coordinate system for *r,* call it *r'*. We cannot take a moving coordinate system w.r.t. *w,* because there are two surfaces of *w* that define where the waves bounce. Measurement of *w* or τ *is* unique or invariant. But so far we have not specified anything in the model that the ants in the world can locally observe to fix the coordinate frame for *r.* To preserve the form of the 'metric law', we have to transform the coordinate frame for both *r* and *t* appropriately. I.e. we map: $r \rightarrow r'(r;t)$ *and* $t \rightarrow t'(r;t)$. *It is well known how to deduce* that this coordinate transformation is the Lorentz transformation.

So the positivist ants argue as follows. First, they insist that *it is impossible to detect any true frame of reference for space, r, or time, t, and hence no such frame is physically real,* using a principle that 'only physically observable quantities are real'. Second, they insist that *physics must be split into two parts: the theory of space-time, which is simply defined by the metric equation;* and *the additional theory of particles, which is defined by additional equations governing measurable quantities.* These are mathematically equivalent to the 'quantum equations' the realists derived above, but interpret mass, energy and momentum as fundamental physical quantities. They reject the realists' idea of an extra dimension, *w,* as just an 'intervening variable'. Their 2+1-dimensional space-time theory becomes the foundation for all other theories. They stipulate that additional theories of particles or forces must use space-time coordinate frames that preserve the fundamental metric equation - or more generally, covariant tensor formulations.

The realist model and cosmology.

The realist ants still have a very good empiricist reply to this, however (we have defined the real model in this case to make sure they have!) The laws proposed above are Lorentz invariant, but they are only *approximate laws.* They do not take into account the fine detail of the distortions of space, or the modifications to constants *c* and *h* caused by the energy-waves. These will become evident in a theory of *gravity,* which is caused by local distortions of space – through the stretching of *ΔW. The laws* proposed above also assume that space is globally flat, but on a global scale the balloon is really curved. These two features both make the positivist interpretation of Lorentz invariance inapplicable.

By the assumption of the model, the realists are right. There is indeed only one valid global frame of reference. A locally moving frame is really *rotating,* and hence *accelerating,* and acceleration is detectible. In fact they only need to send two beams of light at right angles, and wait until the beams have circled the balloon. The balloons will cross again at a definite point. That point will be the same spatial point they were sent from.

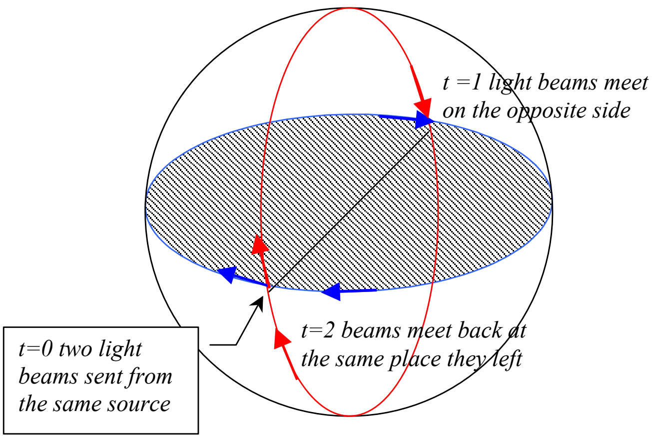


Figure 4. Two beams of light are simultaneously sent from point-event *A*. They circle the balloon and return to cross at point-event *A'*. Their paths are independent of the local velocity of their source.

On a global scale, in a closed curved space, a unique absolute frame of reference is required, despite the local Lorentz metric. This means we can define observations that force us to identify events *A* and *A'* as being at *the same point of physical space, at two distinct times, t = 0 and time t=2, respectively.* Spatial points therefore have identities through time. The *unique stationary frame of reference* is the inertial frame that connects *A* at *t=0* with *A* at *t=1.*

This contradicts the common assumption that a Lorentz metric on the local scale implies that there is no absolute frame for space and time required when we consider the cosmos on a global scale.

However it does not rule out the development of a *covariant theory of physics and gravity.* The key point here is that the *realists* and *positivist ants* will develop distinctly different empirical theories of gravity, because of their assumptions respectively that curvature is *extrinsic* and *intrinsic*.

Realist gravity from extrinsic curvature.

On a local scale, the realist ants propose a theory of 'gravity' in the balloon. This happens to match the real model. This starts with a *strain equation* that determines the distortion of the surface by a small central mass *M*, like*:*

$$W(x) = W_0 \exp\left(\frac{MG}{c_0{}^2 \sqrt{\left(\frac{W(x)}{2\pi} \right)^2 + x^2}} \right)$$

and gives rise to a central mass law that looks like:

$$\mathrm{d}\tau^2 = \frac{dt^2}{K^2} - \frac{dr^2 K^2}{c^2} - \frac{r^2 d\theta^2}{c^2} - \frac{(r\sin\theta\, d\phi)^2}{c^2}$$

where K is defined to a very close approximation by:

$$K = \exp\left(\frac{MG}{c^2 r}\right)$$

It is not possible to maintain this solution in a covariant theory, or describe it by intrinsic curvature of the two-dimensional surface space. It needs to be described by an extrinsic curvature of the true three-dimensional space of the underlying balloon model. This is where the underlying classical model distinctly departs from the 'special relativistic' approximation.

Positivist gravity from intrinsic curvature.

However the positivist ants have also been busy, and worked out a method to describe locally curved space, and provide *a fully covariant theory based purely on the intrinsic curvature of the two-dimensional surface space*, which they call General Relativity. They derive a central mass solution like:

$$\mathrm{d}\tau^2 = \frac{dt^2}{k^2} - \frac{dr^2 k^2}{c^2} - \frac{r^2 d\theta^2}{c^2} - \frac{(r\sin\theta\, d\phi)^2}{c^2}$$

where:

$$k = \left(1 - \frac{2MG}{c^2 r}\right)^{-1/2}$$

They call this the Schwarzchild solution to the General Theory of Relativity. This is the only *possible* solution for the positivists, because of their insistence on representing the solution in a certain form, viz. through a covariant theory of intrinsic curvature. The two solutions differ by a very small amount, seen by the difference between the factor in the positivists equation:

$$\frac{1}{k^2} = 1 - \frac{2MG}{c^2 r}$$

compared to the factor in the realist's equation:

$$\frac{1}{K^2} = 1 - \frac{2MG}{c^2 r} + \frac{1}{2!}\left(\frac{2MG}{c^2 r}\right)^2 - \frac{1}{3!}\left(\frac{2MG}{c^2 r}\right)^3 + \ldots$$

Ant experiment results.

At this point it is perfectly clear that the ants have two different theories. The theories have very similar empirical predictions, in normal conditions, but diverge radically in extreme situations, and have quite different ontologies and explanatory mechanisms and metaphysical implications. By the assumption of the model, the realists ants are actually right, and the positivist ants are wrong: for the Balloon model has been defined to require three-dimensional extrinsic curvature. But only close attention to detailed observation will confirm this empirically.

In a scientific world, both theories would be investigated, and their relative merits compared. But to complete the Parable of the Ants, as it happens, politics takes precedence over science. While the realist ants have been busy working out their theory they have neglected their politics. The positivist ants have dedicated their time to becoming professors, saturating the ant literature with their views, popularising their philosophy, and have successfully established themselves as the academic authorities. By the time the realists complete their theory, they are confronted by a hostile audience, their views been attacked, and they can't publish their findings. Ant physics is now in the iron grip of positivist philosophy. Only positivist ants can get jobs teaching or researching the subject. The realists find themselves ridiculed for their cranky theories and metaphysical speculation. Unable to find employment as scientists or publish their work, they go back to working as drones, collecting food for the aristocratic ants. They die penniless, and their strange notebooks filled with mysterious scrawls and symbols are thrown in the rubbish. Positivist ants proudly reign over Ant Science for the next thousand years. Then the guy in external three-dimensional space who created their balloon world in the first place sprays it with insecticide. He writes a scientific paper showing that ants do not have the ability to conceive the true realist theory of their world. The paper is refused publication. He rewrites it as a study of the efficacy of his insecticide, and ultimately has success writing advertisements for poison manufacturers. "Kills bugs fastest!", that kind of thing. After he dies, he is reincarnated as an ant for his trouble.
