On Counter-Intuitive Science
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November 13, 2001

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Modern science abounds with assertions, supposedly based on careful observation or deduction, that appear to fly in the face of simple commonsense. Counter-intuitive propositions are of course present in many fields, religion, politics, economics, and psychology to name a few, although it is less surprising to find such paradoxes in the human sciences than in what have been traditionally called the hard sciences. That this comes to us as such a surprise is because hard science claims to be derived from simple perceptions and primitive notions, indeed that it is only a form of heightened, common-sense, self-critical and systematized. Even the most abstruse scientific theory is built on ideas so elementary that no sane person would bother to dispute them.

Through examining the collection of counter-intuitive statements that are most characteristic of modern science, one comes to realize that , in every case, a decision has been made as to what set A of opinions is going to be treated as *more self-evident* than another set B , which, being (perhaps arbitrarily) designated as *less self-evident* is to be replaced by a number of counter-intuitive statements based on carefully reasoned arguments on the set of premises contained in A.

We have become accustomed to seeing such things since the Renaissance. It was then that the commonly held belief of a fixed or stationary Earth around which the rest of the universe revolved was replaced by the counter-intuitive picture of a compact roughly spherical

object spinning around both its axis and a far more massive Sun. The famous names associated with this paradigm shift are Copernicus, Kepler, Galileo and Newton. Doubts continued to persist until the transit of Venus across the face of the sun was mapped in the mid-18th century.

In this case it is most unlikely that the world scientific community is prepared to revert to the flat, stationary Earth theory. After Isaac Newton developed the theory of gravitation it became possible to relate most of the observed movements, and many of the shapes, of material bodies from the fall of an apple, to the tides, to the shape of the orbits of the solar system, to the deviation of the shape of the Earth from a perfect sphere to a single all-embracing concept of gravitational force.

Once this was done, anyone who stubbornly clung to the dogma of a fixed Earth would thereby have to surrender the advantages of a homogeneous universe whose phenomena, either observed or in thought experiments, are invariant under time translation, spatial translation and spatial rotations. To make predictions from his world system he would have to postulate force fields operating at different places and times in different ways.

Ultimately the problem of having to use a different set of equations for the tides, for the interaction of Mars and Jupiter, for the motion of a pendulum, for the arc of a projectile shot from a cannon, for the changes in the orbits of the fixed stars throughout the year (***particularly since it could be shown that his enormous catalogue of equations could be reduced to a single equation through a transformation based on the strange counter-intuitive fiction that our world spins around its axis and around the Sun*** **), proved beyond the resources of most astronomers, not all of whom are calculating prodigies. The Copernican viewpoint has ruled the day ever since .**

General Relativity has succeeded in placing both paradigms on their respective heads. Both extremes, that of a fixed, and that of a moving Earth, have been abolished. NASA continues to make its calculations in a Newtonian framework. Cosmologists however treat all local fields as legitimate within their own reference frames, inter-transmutable through covariant transformations. Only the global curvature constant is allegedly the same for every self-referential system.

Two recent findings now obfuscate even General Relativity's higher enlightenment.

(1) The universal hum of the background microwave radiation, believed to be the echo of the Big Bang, re-instates the concept of a background Ether. In its own day, this was itself a highly counter-intuitive construction based on the commonsense observation that a wave phenomenon such as light needed a medium for its propagation.

(2) The Cosmological Constant, Λ , first proposed, then rejected by Einstein as his 'biggest blunder' , has re-entered cosmology as a possible explanation for the inability to detect the dark matter that, for other reasons, is believed to be ubiquitous.

In the cases (drawn from physics and the foundations of mathematics) we will be looking at, our curiosity has prompted us to reverse the direction of the standard syllogism, if only to see where this takes us. That is to say, if both *assumption A* , and *assumption B* , are taken to be self-evident , and if , by giving its verdict to A , modern science has demonstrated that B is no longer tenable, we propose that one examine the consequences of giving greater validity to assumption B, then investigate what set of counter-intuitive conclusions might replace A.

This leads to an alternative science, one might call it the *dual image* of contemporary science. It is speculated that, at least in certain cases, the pairing of *Image/Dual-Image* may be a more effective vision of reality than a narrow adherence to either side of the debate.

7 Counter-Intuitive Assertions of Modern Science

Logic

$S_1 = [B_1, A_1]$:

B_1, the "counter-intuitive notion" of a hierarchy of levels of infinity K_0, K_1, K_2, ... is based on A_1, the "commonsense notion" that no set Q can be put into 1-1 correspondence with its power set P(Q). (*Cantor Diagonalization*) Otherwise stated, the computational procedure of 1-1 correspondence as a way of determining numerical equality, is deemed more fundamental than a monistic, indecomposable Infinity .

$S_2 = [B_2 , A_2]$:

B_2 , the "counter-intuitive notion" that there exist well-defined propositional functions that have no class extensions, is based on A_2, the "common-sense notion" that an entity k , known as "the set of all sets that don't contain themselves" is not well-defined . (*Russell's Paradox*)

RELATIVITY

$S_3 = [B_3 , A_3]$:

B_3 , the "counter-intuitive notion" that there is no *universal present* (non- simultaneity) , is justified by A_3 , the "commonsense assertion" that the behavior of a closed dynamic system in isolation is invariant under time and space translations (that is to say, that a clock at rest in my reference frame on November 5, 2001 will

behave in exactly the same way as the same clock on October 8, 1017 at rest in a rocket ship moving away at a fixed velocity) .

$S_4 = [B_4 , A_4]$:

B_4 , the "counter-intuitive notion" that matter warps space is based on A_4 , the "common-sense" experimental observation that inertial and gravitational mass are equivalent. (*Eötvös Experiment*)

$S_5 = [B_5 , A_5]$:

B_5, the "counter-intuitive notion" of an absolute limit c to velocities, while all other velocities are relative, is based on A_5 , the "commonsense experimentally deduced fact" that the speed of light has been measured to be independent of reference frame. The measuring process has been deemed more fundamental that the epistemologically self-evident notion, virtually a truism, that time is an autonomous , non-spatial dimension. (*Relativistic Addition Law for Velocities*)

Quantum Theory

$S_6 = [B_6 , A_6]$:

B_6, the "counter-intuitive notion" that an electron "is" both a wave and a particle, is based on A_6 , the "common-sense notion " that a proper interpretation of the evidence from a 1-slit and the evidence from a 2-slit experiment, results in contradictory images. Richard Feynman has stated that all of quantum theory derives from this observation .

The interpretation of a pair of experiments is deemed more fundamental than a non-contradictory Gestalt of the electron.

It is as if we have decided to prefer the notion of a "round square" rather than accept the impossibility of squaring the circle with ruler and compass!

Thermodynamics

$S_7 = [B_7 , A_7]$:

B_7 , the "counter-intuitive notion" that the Second Law of Thermodynamics is statistical , (hence both exact and probable) , is based on A_7 , the "common-sense assumption" that the collisions of individual molecules are governed by the Galilean law of conservation of momentum. Otherwise stated, time asnd space averaged aggregate observables, E , T, Q, P, V, are deemed more fundamental than local observables (position, momentum, energy) .

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For each of the propositions on the above list, we propose a reversal of premise and conclusion along the following lines:

The basic syllogism at work in each of them may be pictographed as follows:

[1] $B_i \vee \neg B_i$
[2] $A_i \rightarrow \neg B_i$
[3] A_i
[4] $\therefore \neg B_i$

Both { A_i } and { B_i } are taken to be sets elementary propositions derived from simple perceptions, correctly performed measured, or logically unimpeachable deductions. For each i , A_i and B_i are incompatible. We recast the above syllogism as :

[1] $A_i \vee \neg A_i$
[2] $B_i \rightarrow \neg A_i$
[3] B_i
[4] $\therefore \neg A_i$

A List Of Alternative Intuitive/Counter-Intuitive Paradigms

Dual Logic

R_1 , reversing S_1 (Dual Cantor):

Assuming a monistic infinity without either a total or partial ordering of levels is equivalent to the denial of the existence of transfinite numbers. Depending on one's initial assumptions this can be used as a basis for several non-intuitive consequences:

(i) that 1-1 correspondence is not a valid procedure for establishing numerical equality for infinite sets; or

(ii) that there is a way of putting the power set of a countably infinite set S, into 1-1 correspondence with S itself .

Option (i) leads to a Constructivist procedure for mathematics. Two ways of setting up this alternative interpretation suggest themselves:

(a) Any 1-1 correspondence $\phi : U <--> V$, involves taking an infinite number of steps. Many people might consider this methodology counter-intuitive.

(b) One of the two sets in the 1-1 correspondence , say U , *must already be ordered* before its order can be imposed on V . This leads to an infinite descent, because since one can argue that U must have been previously ordered by yet another set W, etc.

This is true even if the original set U is the positive integers. Imagine that U is some representation of Z^+ , containing elements $\{ u_j \}$. In order to set up the "successor" function @ , which will order U, one must find the element u_0 . However, one cannot know if what one has found is in fact u_0 until one has gone through the entire inductive

procedure and discovered that some members of U are missing in the final result.

The following argument is even stronger. If all we know is that U has only countably many elements, with no further information about their succession, there is no way that we can be assured that the process of selecting elements and labeling them as u_1 , u_2 ,etc. will exhaust U. If *you* order U, tell me that it is countable, and *I* begin to remove elements at random one at a time, it cannot be stated in advance, what countable ordinal I will arrive at when U has be emptied of all its contents.

One must invoke an axiom to the effect that such a process on any 'arbitrary' countable set, must always lead to some countable ordinal γ , that exhausts it . **This axiom is very far from self-evident.**

We now look at option (ii) :

There are a number of ways in which $P(Z^+)$ might in fact be set into 1-1 correspondence with Z^+ . First map $P(Z^+)$ onto the collection of binary decimal representations of the elements in the half-open interval

I= [0,1) . Under the proviso that there are no infinite sequences of 1's (0.0111111111.... is identified with 0.1000000000.....) the elements of $P(Z^+)$ will now be indexed by infinite sequences of 0's and 1's.

Some of these real numbers are computable, most are uncomputable. One can now argue that non-computable numbers are non-intuitive, that is to say that they aren't *really* real numbers! This means *defining* a real number as one that can be generated by some algorithm based on the integers. Most human beings, even scientists who are not mathematicians, would accept this.

Indeed, the very notion that the "real" line is closed in the Dedekind sense is very counter-intuitive and can be discarded without

causing a ripple of protest in any science other than the foundations of mathematics. The only use that non-computable numbers have is to give Roger Penrose an excuse for saying that the mind is not a computer. If one eliminates the class of representations of non-computable numbers as mere arbitrary sequences of 0's and 1's without meaning, then $P(Z^+)$ can be put into 1-1 correspondence with Z^+ .

Some might go further, arguing that the very notion that there are *distinguishable* points on the real line is questionable. The inaccurate way of speaking of a certain length ,L , as being "two inches long" , should be replaced by the more accurate statement " L is less than 2 + ε inches , and greater than 2 - ε inches " , where ε itself is defined *as any length in the set of all possible or potentially identifiable lengths* . These two statements differ significantly in so far as the latter allows L to be an open set, or a set with some pathological configuration at its boundary, (such as a set of measure zero extending outward from its end-points) .

One can even argue that closed sets in general aren't well-defined, because the existence of a limit point *presupposes* the possibility of a definite location, whereas common every-day experience shows that every location in the real world is actually a tiny little segment of some sort. Else why would we be speaking about 'continuous' phenomena in the first place?

Conclusion:

If one were to put the matter to a vote, there would be a near consensus in favor the view that there is only one "infinite" number rather than a hierarchy of transfinite numbers. I doubt that many persons would be upset by the knowledge that this obliges them to give up the possibility of 1-1 correspondence for infinite sets.

R_2 , reversing S_2 (Dual Russell) :

The stipulation that an object S not contain itself is a *necessary condition only, and not sufficient* for identifying S as a set. The object one calls "S" might be excluded from the extension of the proposition "*S is a set and S doesn't contain itself* " for all sorts of reasons having nothing to do with non-self-containment.

In a sense, all such statements resemble questions of the form " *What is this question saying?"* or " *What is the content of a container?"* [1]

The collection of all sets not containing themselves can be considered a set, though not a well-defined set, in the same way that one can argue that the formal Erotetic proposition : "Is this a question?" has an affirmative answer, whereas " Is this a well-formed question?" has an emphatically negative answer.

It isn't all that easy, in fact, to state all the conditions that a set must satisfy to be well-defined. In particular, the notion that a set H, all of whose elements are well-defined sets , must automatically be a well-defined set, requires another axiom , one that is far from self-evident.

Let the "object" defined by the Russell set construction be designated as K. Let Λ be the set of all well-defined sets. Then in particular, the members of Λ don't contain themselves. Λ itself is also not a member of itself because Λ is not well-defined, the notion of not being well-defined having been extended beyond mere non-self-containment. The paradox is avoided and one must instead deal with the notion that there are well-defined mathematical objects containing well-defined elements , which are not themselves well-defined sets. Lets, for the moment, call these things "formal sets".

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[1] I refer the reader to my essay, "Logical and Psychological Question Theory", available from Ferment Press for $10 .

Other examples of formal sets come readily to mind. There are, for example, the "particles " of an electron gas, or any plasma of elementary particles governing by Fermi-Dirac statistics. One cannot select out the individual particles, yet by weighing the gas and using the experimentally established figure for the weight of an electron, one can compute " how many" particles it contains!

There are also well-defined sets which become improper when the quantifier "All" (∀) is applied to them:

(i) To the extent that one grants the existence of Free Will, the set of all the acts of a certain human being on a certain day is not well-defined until that day is past; at which point one is free to conclude that, in a certain sense, the set no longer exists.

(ii) An even simpler notion, such as the "set of all chairs" may also be undefinable. Its specification requires foreknowledge of the free decisions of all carpenters and owners of factories that manufacture chairs, until the end of time.

Then there is the question of whether things intrinsically unknowable to us can still make up a well-defined set. Let S be a set consisting of two elements, the position and the momentum of an electron at a certain place at a certain moment. Whether or not S is well-formed set depends upon

(x) One's private formulation of set theory and

(y) One's private formulation of quantum theory!

Dual Relativity

R_3 , reversing S_3 :

There aren't many people alive and well on our planet who would agree that velocities don't add in a linear fashion. It seems to be inherent in the conception of a physical quantity, that disjoint amounts of it should add linearly.

Let O be at the origin of a (spatially) 1-dimensional rest frame. Consider two systems S_1 and S_2 moving away from the origin at velocities v_1 and v_2 . After a time T has elapsed, S_1 will have moved a distance $x_1 = Tv_1$, while S_2 will have moved a distance $x_2 = Tv_2$. The total distance traversed is $x_3 = x1 + x2 = T(v_1+v_2)$. Therefore, in time T , the combined system will have covered the distance x_3 with velocity $v_3 = (v_1+v_2)$ For example , the distances x_1 , x_2 could be the lengths of two autonomous grass plots being mowed by lawn-mowers moving at the respective velocities of v_1 and v_2 . The fact that the entire lawn was mowed in time T is equivalent to saying that there was a single lawn-mower moving at velocity v_3 , (which could well be greater than the speed of light!)

In this situation, therefore, velocity does function as an additive physical magnitude: the whole is equal to the sum of its parts. This is because the component velocities are "uncoupled", as the physicists say.

It is only when the velocities are "coupled", that is, when S_1 moves relative to O at a speed v_1 , and S_2 moves relative to S_1 at a speed v_2 , that the speed v_3 of S_2 relative to O is measured as

$$\boxed{v_3 = \frac{v_1 + v_2}{1 + (v_1 v_2 / c^2)}}$$

Conclusion:

Velocity is *not* the measurable quantity,(or magnitude), that is being combined in this situation, but a *pseudo-magnitude* in the same way that "phlogiston" was not the physical substance entering into the production of fire, but oxygen. The true magnitude is

$$\theta = \operatorname{arctanh}(v/c)$$

, the relativistic angle, or ,let's say, the "rangle". Rangles *do* add properly when the measure the amount of change in moving from one reference frame to another. The correct "magnitudes" are therefore:

$$\boxed{\begin{aligned} s &= \sqrt{c^2t^2 - x^2} \\ \theta &= \arctan h(x/(tc)) \end{aligned}}$$

These magnitudes, proper time and relativistic angle, are the real quantities which, because of our artificial situation with respect to the universe we do not immediately grasp. Let us rather say that we have confused 'uncoupled' with 'coupled' change, and wrongly measured both of them as 'velocity'. The relationship between these two sets of quantities is given by

$$\boxed{\begin{aligned} x &= s\sinh\theta \\ ct &= s\cosh\theta \end{aligned}}$$

Both s and θ are additive. Note that by switching to (θ , s) coordinates we have rediscovered time as a dimension of free action. s is no longer linked to θ by a pseudo-Euclidean metric, but functions autonomously, free from all geometric bondage to the spatial dimension θ . Free Will, Kinetic Theory, Quantum Theory and other undeterministic entities can operate freely along the s-direction.

R_4, reversing S_4: (Dual Equivalence)

Space and matter appear to be autonomous quantities, so let's assume they are. One is thereby led to the "counter-intuitive" conclusion that gravitational and inertial mass are different . In fact, this is the proof that they are different. That is to say, that the very ingenious General Relativity experiments that have been done to date are in fact measurements of the deviation of inertial from gravitational mass!

Consider the two basic equations of Newtonian mechanics:

$$[1]\ F = M\alpha = M\frac{d^2\vec{r}}{dt^2}$$

$$[2]\ F_{Grav.} = \gamma\frac{M_1 M_2}{r^3}\vec{r}$$

The "M" in the first equation is inertial mass. If there is such a thing as gravitational mass, it must appear somehow in the second equation. However there doesn't seem to be any good reason for thinking that the individual magnitudes M_1 and M_2 are any different from the masses that enters into a collision. The difference is clearly in the following fact: in collisions, the masses, or their equivalent momenta, *add* ; in the gravitational force equation, they *multiply* .

Although any reasonable definition of a magnitude should assume its additivity, there is no reason to assume that they should also "multiply" in some simple fashion. For one thing , the dimension changes. Otherwise stated: Gravitational mass, arising from the interaction of masses moving freely in space, *is an interaction phenomenon* , and should be modeled by a bivariate *function* $\Omega(M_1, M_2)$ of the inertial masses.

One sees how one could argue that Eötvös and Einstein were mistaken when they assumed from experimental observation, that gravitational mass and inertial mass were identical. "Gravitational Mass" is not mass at all, but an interaction magnitude Ω with the dimension mass-squared , with the following properties:

(1) The function $\Omega(M_1, M_2)$ is equal, up to the limits of experimental error, to M_1M_2 for "small" masses.

(2) It deviates from the simple product for either large M_1 or large M_2 by exactly the amount needed to explain the deviation of the perihelion of Mercury, the bending of light in the Sun's gravitational field, etc. Let M_χ and M_Θ respectively stand for the mass of Mercury and of the Sun. Combining equations [1] and [2], one gets:

$$[3]\; M_\chi \alpha = \gamma \frac{\Omega(M_\chi M_\Theta)}{r^3}\vec{r}$$
$$\therefore \alpha = \gamma\,(\Omega(M_\chi M_\Theta)/M\chi)\frac{\vec{r}}{r^3} = M^* \gamma \frac{\vec{r}}{r^3};$$
$$\Omega(M_\chi M_\Theta)/M\chi = M^*$$

The function Ω that enters into the expression for the modified mass M* is constructed to obtain the exact value of the deviation from the Newtonian picture one finds in the perihelion of Mercury. The formula from the basic Keplerian model for the eccentricity of the elliptical orbit is:

$$\varepsilon^2 = 1 + \frac{2\mu^2\lambda}{\gamma^2}$$ **,where**

μ is the angular momentum, proportional to M_Θ .

λ is the total energy , proportional to M_Θ .

γ is the universal gravitational constant.

Replacing by M* , to compute a modified eccentricity ε ' , a simple calculation shows that $\frac{1-\varepsilon}{1-\varepsilon'} = \left(\frac{M_\Theta}{M^*}\right)^3$ **. It is but a step from this to plug in the "gravitational mass" deviation needed for the correction to Mercury's perihelion.**

R_5 , reversing S_5 : (Dual Time Paradox)

There are many thoughtful and informed persons who will never accept the conclusion of Special Relativity that there is no moment designated as "Now" applicable to the entire universe. The obviousness of simultaneity appears to be so well grounded in experience that many of us would gladly sacrifice some other 'intuitive' notion in order to save it .

One can actually cheat a bit on this one, and argue that Time *measured from the instant of the Big Bang* , is the same everywhere. The opinion general (though not universal) to the community of cosmologists is that the Big Bang occured about $14x10^9$ years ago. Since there is no preferred or absolute character to the motion of our own reference frame, this duration, calculated from the Hubble expansion and other evidences. must be the same everywhere. The Universal Now Moment (UNM) is therefore $14x10^9$ (plus whatever) years from the instant of the Big Bang. Hawking and Penrose have shown that an irreducible singularity is embedded in the field equations of General Relativity. Thus this definition of the UNM is supported by General Relativity itself. It does appear to be a strange feature of the theory that tells us, on the one hand, that all time-reckoning is relative to reference frames and , on the other hand, everything that everything all began in the same split second, and at a 'place' we all continue to occupy!

It is not clear that one can have a universe in which Special Relativity holds but General Relativity does not: one can assert GR=> SR but not the converse. The abolition of simultaneity is a feature of Special Relativity; therefore one ought to look at ways of rescuing simultaneity under the assumption of the Postulate of Relativity alone.

My proposed strategy will not be deemed credible by everyone I fear, and I understand their misgivings. However, a UNM (without which many systems of philosophy are untenable, even unthinkable) can easily be identified once the world of science accepts the convention that the clocks ticking in my room right now are the only correct ones. All clocks that , relative to mine, are slower, are either incorrect or malfunctioning. Granting this convention, events are simultaneous if and only if they appear so in my reference frame.

Disputes between reference frames can be resolved by calling me up on the telephone.

This can be reformulated as a modification of the Light Principle. An observer traveling in a rocket ship with velocity v relative to me will see a length which is L when measured at rest in my frame but which, as a foreshortened length, is:

$$L' = \sqrt{1 - v^2/c^2}\, L = \beta L.$$

In a duration T which, by my clock, is given by L/c , his clock will measure T '= βL/c . However he's agreed to use my clock. It is one of the paradoxes of relativity that my clock will also appear to him to be moving more slowly in the proportion β . Using my clock and his measurements, he will conclude that the speed of light is:

$$c' = \frac{\beta L}{\beta(\beta T)} = \frac{L}{\beta T} = c/\beta.$$

This new Postulate of Relativity states: In all systems moving relative to mine with a velocity v, it will appear that the light speeds up in the ration β .

Dual Quantum Theory

R_6 , reversing S_6 : (Dual Wave/Particle Duality)

Alternative Interpretation I :

There is a clear mistake involved in supposing that one can lay down a strict chain of deductions that lead to the conclusion that the evidence of the 1-slit experiment for an electron beam shows that the electron must be a particle, or another such chain showing that the evidence from the 2-slit experiment proves that the electron must be a wave. The whole matter of the "thinginess of the wavicle" is akin to the nature of the elephant as ascertained by the 6 blind men in the Hindu

legend: is it a wall, a tree, a rope, etc. As the story indicates, it depends above all on the observer's position relative to the animal, combined with his inability to move away from that position, either through inhibition or lack of some sense organ.

One might therefore postulate that what we human beings lack is some sense or intellectual faculty akin to the blindness of the wise men. Possession of that sense would allow us to construct a coherent Gestalt for the electron.

In fact it's an easy matter to state just what this missing faculty ought to be. To begin with, our inability to remove ourselves from the world in which the electron is being observed is often cited as the origin of the Uncertainty Principle and all the quantum dilemmas. Still , we do see, hear and touch a great many things without feeling that we need to distance ourselves from the objects we're observing in order to understand them.

The following proposal seems more reasonable to us: namely, that our universe, call it U , is a closed and proper subspace of another universe, say W, *in which the quantity measured by the Schrödinger wave function* ψ *, is directly perceptible as a physical magnitude.*

In the larger universe , what we consider to be 'imaginary' numbers of the form x+ *i* y , *i* = √-1 , are accepted by the intellect as perfectly ordinary, or real numbers. Perhaps this is a world in which matrices of the form $\begin{pmatrix} 0 & -1 \\ 1 & 0 \end{pmatrix}$**, are used for counting!**

What human beings see is only the projection of Ψ **onto its radius vector. It is more than reasonable, therefore that the 2-dimensional continuum in which our 1-dimensional "Schrödinger" space is embedded, should utilize 2-matrices as integers.**

Conclusion:

Our notion that the 1-slit and 2-slit experiments lead to contradictory pictures of the elementary particles is incorrect. We simply lack a certain sense organ that can see the Schrödinger wave function.

Alternative Interpretation II:

One might take the position that *either* the picture obtained from the 1-slit experiment, *or* the picture obtained from the 2-slit, but not both, is the correct one. Then there are 3 options:

(i) Obviously the electron and the photon are particles

(ii) Obviously the electron and the photon are waves

(iii) It's more than obvious that the electron is a particle and the photon is a wave.

Since (iii) accords with "commonsense experience" we will adopt this as our fundamental notion. Assuming that the electron is a particle means that the conflicting evidence of the 1- and 2- slit experiments must be reconciled through Quantum Electrodynamics.

Assuming that the photon is a wave means that the conflicting evidence of the 1- and 2- slit experiments must be reconciled through DeBroglie wave mechanics.

The interactions of electrons and photons can therefore be lifted to the abstract level of the study of the interactions of QED with wave mechanics.

This is not unrelated to Alternative Interpretation I, gievn that the Schrödinger wave equation was designed to do just that .

Dual Thermodynamics

R_7 , reversing S_7 :

Placing the 2nd Law of Thermodynamics on a statistical foundation makes everyone uncomfortable. Why not postulate it as an absolute law and take if from there?

Law : *Entropy Always Increases* . There are no exceptions. The passage of heat from warmer to colder bodies is therefore irreversible, without fluctuations. What fluctuations we do encounter once in awhile are due to a statistical phenomenon inherent to the scattering of individual molecules in collision.

We therefore need a new law, approximating Galilean mechanics for individual molecules. Classical mechanics already breaks down at the atomic level, so this may not be so radical a step as might appear at first sight.

Such a modification of natural law requires that one modify some conservation principle. Lets see what happens when we try to modify the conservation of momentum. Our "alternative molecular mechanics" , would then assert that all individual collisions result in a net loss of momentum in exact correlation with the phenomenon of heat dissipation and the limitation on efficiency of machines and Carnot cycles.

By Nöther's Theorem we know that the conservation of momentum is a consequence of a more fundamental symmetry principle, invariance under spatial translation. One can show why this is so through the following thought experiment. Let us say that we have three reference frames, K_0 , K_1 , K_2 . Relative to K_0 , K_1 is moving at velocity V. Relative to K_0 , K_2 is moving at velocity -V.

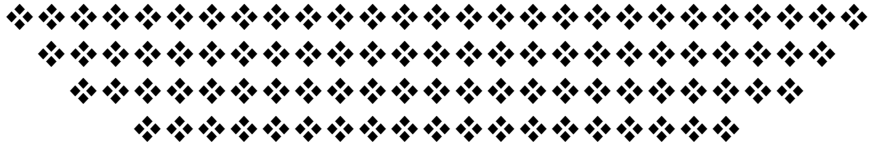
Now imagine two massive objects with identical weight M: O_1 and O_2 , at rest in frames K_1 and K_2 respectively and moving on a collision course. By virtues of the symmetries involved , and under the assumption of a linear addition of velocities, O_1 and O_2 will recoil symmetrically, , picking up new velocities -U and U relative to K_0 . Likewise the situation seen with respect to K_1 must be *anti-symmetric* to that seen by K_2 . That is, if K_2 sees O_1 recoil with velocity P , and O_2

with velocity Q , then K_1 must see them recoil with velocities -P and -Q respectively. This is only possible if P and Q are identically 0 . The further assumption that mass and momentum are additive leads to the conservation of momentum.

Therefore, if we want the 2nd Law of Thermodynamics to be exact and not statistical, one must modify one or more of the 3 addition laws, that for velocity, for mass, or for momentum. If we abandon momentum we abandon Galilean relativity.

Perhaps we have been mistaken all along to imagine that mass and (non-relativistic) velocity compound in a linear fashion! If we assert that

p = mv be conserved, then changes in m are compensated for by changes in v. The change in the combination $1/2mv^2$, that is to say, kinetic energy, can then be adjusted to agree with the 2nd Law of Thermodynamics.



	Commonsense Notion	*Counter-Intuitive Notio*
Cantor S_1	**1-to-1 correspondance**	**Hierarchy of Transfinite**
Cantor R_1	**A single "infinity"**	**(i) 1-1 correspondance i valid procedure for esta numerical equality for sets. Two alternatives: (a) An infinite num steps is prohibited. (b) Ordered sets m 'presented', that is to sa pre-counted. This requi new axiom. (ii) There is a way of p power set of a countab infinite set S into 1-1 correspondance with S One postulates that non-computable 'numb aren't real numbers, the binary representation a meaningless string of d**
Russell S_2	**All sets are well-defined**	**Unextendable Proposit**

Russell R_2	**All propositions define sets**	**"The sets of all sets not containing themselves" but not well-defined; "[illegible] all well-defined sets no containing themselves" a paradox . 'Formal sets have their own objectiv existence , without bei well-defined as sets**
Minkowski S_3	**Velocity is measured by clocks and rulers**	**Upper limit to velocity speed of light**
Minkowski R_3	**Linear addition law for velocity**	**"velocity" and "time" b pseudo-magnitudes un change of reference fra The correct magnitudes proper time and relativistic angle. Thes uncoupled,and an auto time-like direction for 'free action' is recov**
Equivalence S_4	**Equivalence of Inertial and Gravitational Mass**	**Matter warps space-tim**

Equivalence R_4	**Matter doesn't warp space-time**	**Gravitational Mass is r inherent in material bo in their interaction. The "multiplication" of in Newton's equation i by a function Ω , of tw masses.**
Postulate of Relativity S_5	**All clocks "at rest" are equivalent**	**No simultaneity**
Postulate of Relativity R_5	**Simultaneity**	**(1) Universal time measured from Big Ba (General Relativity) (2) Only one reference f correct (Special Relativity)**
Heisenberg S_6	**1- and 2-slit experiments give conflicting pictures**	**Electron and Photon ar wave/ particles**
Heisenberg R_6	**No contradiction in evidence, only in interpretation**	**(1) The sense organ for the quantity measured Schrödinger wave func missing. (2) Electrons follow QE Photons follow DeBrog Wave Mechanics.**
Boltzmann S_7	**Molecules collide by the laws of Galilean mechanics**	**2nd Law of Thermodynamics is statistical**

Boltzmann R7	**2nd Law of Thermodynamics is exact**	**Mass and velocity fluct Momentum conserved; Energy conservation modified.**

#26...

#27...