

Re-evaluating the Local Equivalence Principle

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The parameters within which science operates rarely reveal the philosophical assumptions which underpin them and which are taken for granted. Consequently, the ideas they give rise to can begin to suffer from a rigidity that assumes they must extend and hold over vast expanses, even though their formulations are derived from local measurement and experiment. In fact, when data is provided concerning large scale structures, the concepts that are then used to mould them into models of reality are rarely questioned and examined, and one must wonder therefore how we are to distinguish between a true model of reality, or simply a reification that has no real existence. Since the implications are significant, this cannot be deemed a merely philosophical enterprise. The ramifications and implications for science can be extremely serious and intellectually damaging. This is particularly so today when so many ideas have become part of the common domain with little, if any, evidence in support of them, and which are consequently made believable by consensus or by an active PR campaign by the parties presenting or defending them.

In order to show how the consequences of false projection actually operate, a well-known example has been selected as a test case, in order to show how flaws can be concealed even when they are visible in plain sight, but made invisible by the lack of proper critical appraisal. A lengthy philosophical discussion might be appropriate at this point, but it may be more effective to cut to the chase, so to speak, and analyse a case in point, letting the philosophical dimension reveal itself in the process.

The general theory of relativity is selected since it the most accepted theory of gravitation to date, and has now enjoyed at least 80 years of unchallenged supremacy in its field. But instead of looking at it through purely scientific or mathematical eyes, the aim is to dig beneath these perspectives to the metaphysical underpinnings from which they arise which are unchallenged and uncriticised beneath their more familiar scientific expression.

The most appropriate way to do this is to look at Einstein's own formulation from his book 'Relativity'. As is well known, the theory revolves around the local equivalence principle, but before this is considered in detail, one should first recognise the ideas and assumptions which precede it and are carried into its formulation.

In chapter 19 of this book, it is clear that the concept of the gravitational field is entirely dependent for its existence upon an isomorphic relation akin to a leap of faith. Just as science is generally uncomfortable with subjective language, so also Einstein attempts to free his concepts of any likely subjective elements in his language like 'attraction', and he speaks of electromagnetism in this way:

We are constrained to imagine – after the manner of Faraday – that the magnet always calls into being something physically real in the space around it, that something being what we call a ‘magnetic field’.

The aim here is not to discuss electromagnetism but gravity. The force of gravity, however, is connected to it in that its form is inspired by this statement about electromagnetism, so it is important to consider what is being stated here. As just mentioned, given the predilection for non- emotive language, which a word like ‘attraction’ might suggest, matter (in this case, a magnet) ‘calls into being’ a field. But what exactly does this ‘calling into being’ mean or entail? In some ways, this is closer to subjectivity than what is normally associated with it, a kind of ontological naturalism which is ‘physically real’. But in general, this kind of metaphysical definition is overlooked since the ensuing existent ‘the field’ lends itself to measurement, and it is that quality that is the reality for science, as though the ‘calling into being’ can be safely ignored. In fact it is ignored, and Einstein put it this way:

This magnetic field operates on the piece of iron, so that the latter strives to move towards the magnet. We shall not discuss here the justification for this incidental concept, which is indeed a somewhat arbitrary one. We shall only mention that with its aid electromagnetic phenomena can be theoretically represented much more satisfactorily than without it.

Of course, there is no justification, but this does not matter, for the incidental conception provides a framework of measurement, even though what it measures is somehow ‘striving’. We should be alerted by this habit of operation, however, for it leads to the eventual presence of reification that grows directly out of such incidentals. It should be stressed that this is not a serious consideration with respect to electromagnetism, though it should be borne in mind. But it becomes a problem when the successes in one area of field theory become an analogue or extension into areas that do not comply in the same way.

This becomes a problem once the discussion on gravity gets under way, and Einstein immediately sets this habit of thought to work:

The effects of gravitation also are regarded in an analogous manner.

Straightaway analogy is invoked, only this time an idea becomes reified for no more reason than this, that it had produced results before with respect to electromagnetism. That is to say, yet another field is ‘called into being’, only this one does so as it was useful in a completely different domain, that of electromagnetism:

The earth produces in its vicinity a gravitational field...

But does it? It is like a field and at the same time it is not like a field. That is, it is given characteristics that are not field characteristics which present us with a conception that is mass-dependent and at the same time mass-free. How can it be both at the same time? ‘The earth produces a field’. But then, the field suddenly becomes mass-less and purely geometric, in order to operate with an inverse square law that is impervious to the presence

of mass which comes in two forms, inertial and gravitational, which conveniently cancel each other out to provide such a geometric framework.

Just to emphasise this, the first successes of science were driven by the application of the inverse square law, but no prescriptive data has ever been produced that justifies the notion of a gravitational field, nor gravitons nor gravity waves, and this after many years of effort to find them. This equivalence underpins and precedes the local equivalence principle, even though it is known that while mass plays a role in the deliberations of gravity on the quantum level, like every phenomenon that grows from the microscopic to the macroscopic, the apparent geometric form is a statistical matter on the large scale, and not the result of a conception of mass that is inertial cancelling the same mass in a gravitational form. (In some respects, this should have been obvious. A mass of 100 kilograms and one of 5 kilograms, may well hit the ground at the same time when dropped from a height to the earth. But if one were to speculate on a universe containing only these two masses, their different weights would have a more dramatic effect with respect to the relation between them, since their masses in such an isolated conception would be much like those found only in an initial state such as might emerge in the early stages following the alleged Big Bang. That is to say, 105 kilograms would be a great deal more in such conditions, and the relation of the two masses would be 20:1. In the presence of the earth, however, those differences as fractions of the total earth, or indeed of the whole universe, become irrelevant, since each is a miniscule fraction of a different whole as the trillions of tons of the earth overpower them. [Again, this has not been recognised since the inertial view has been given so much weight over time. Max Planck came closest to identifying this problem, except he would have been more accurate if he had spoken of universal gravitation instead of universal inertia.]) But these are mentioned as ideas for consideration elsewhere since they cloud the emphasis here. In many respects, it is unavoidable since they represent just a few of the assumptions taken for granted as part of the prequel to general relativity.

Of course, science has done very well despite the difficulties with its basic concepts. It is for this reason that even now, these will seem to be no more than a philosophical discussion-of-terms that has little to say about the nature of reality. The problem is, however, that most of the concepts used in science were developed in a context which saw light as instantaneous. Einstein goes some way to redress this since his ideas begin to loosen them up so to speak, but only part way, and this has more to do with his indebtedness to the past, as one can see in this principle of equivalence between inertial mass and gravitational mass which he retains. It is inevitable that this will create serious problems when they begin to be applied specifically, for then reifications will begin to appear just about everywhere. They will not be immediately apparent until there is a closer inspection of some of the finer details – in this instance, those present in the local equivalence principle. Those finer details are partly mathematical but essentially conceptual, and it is the conceptual form that is of interest here.

Einstein's conception of gravitation had to be coupled in some way to geometry, since it is this that results from the exclusion of mass. The essence of the local equivalence principle is simply that the effects of gravitation are identical to the effects of acceleration. It is these two effects that he attempts to unite in this principle, which he demonstrates through the use of a thought experiment involving a lift. Virtually every popular science book and every text book cites this lift experiment in order to demonstrate what is meant by

this principle. It goes something like this: a lift or box is being accelerated by a rocket engine, say, producing a thrust that pushes its occupants to the floor. The acceleration is just enough to create the sensation of weight that is experienced by actually standing on the earth. The equivalence stems from the fact that it is impossible to perform an experiment inside the lift that would allow the occupants to distinguish between the accelerated state and proximity to the earth, and hence the gravitational state. This is more or less universally accepted as the essence of local equivalence, and local equivalence then becomes the basis for the conception of space-time as the actual geometry of reality. The problem is that this is not the way the thought experiment is set up by Einstein. It is as if, in the very process of accepting this as gospel, no-one seems to have noticed what Einstein actually said. Again, it is as if we have been made blind to the one detail which rigs the experiment in such a way that its conclusion is guaranteed. So here is Einstein's own depiction of this experiment, from chapter 20:

We imagine a large portion of empty space, so far removed from stars and other appreciable masses that we have before us approximately the conditions required by the fundamental law of Galilei. It is then possible to choose a Galileian reference-body for this part of space (world), relative to which points at rest remain at rest and points in motion continue permanently in uniform rectilinear motion.

So begins the discussion, by invoking the first law of motion which only actually holds in the arena described, since there is no arena in existence that can actually be described by it, except in the most ideal, though limited way. Even so, we should note here a kind of predilection for ideal states that describe nothing at all with respect to masses, but which already provide a possible canvas of operation as though it were a real thing. Even so, this is not the problem that is the point of focus, although it eventually becomes one. This begins to emerge with the construction of the ideal candidate that is placed in the arena:

As reference-body let us imagine a spacious chest resembling a room with an observer inside equipped with apparatus. Gravitation naturally does not exist for this observer. He must fasten himself with strings to the floor, otherwise the slightest impact against the floor will cause him to rise slowly towards the ceiling of the room.

Here, then, are the two conditions which are posited for this thought experiment, a region of space so far removed from anything else that the whole universe can be deemed non-existent, and therefore without fields to influence it. The second condition is the room, a particular but unspecified mass floating in it, containing equipment and occupant who clearly shape no field by their presence. It is effectively a situation that may have existed just after an alleged Big Bang perhaps, but this is doctored in such a way to conform to Newtonianism, that is, with the laws of motion which assume the principle of inertia as a starting point, and which are assumed to hold in such remote conditions when they clearly cannot.

But now it is necessary to make it possible, and it is here that Einstein inserts a condition which is overlooked, and has been overlooked, since the inception of general relativity:

To the middle of the lid of the chest is fixed externally a hook with rope attached, and now a 'being' (what kind of a being is immaterial to us) begins pulling at this with a constant force. The chest, together with the observer then begin to move 'upwards' with a uniformly accelerated motion. In course of time, their velocity will reach unheard-of values – provided that we are viewing all this from another reference-body which is not being pulled with a rope.

This other 'reference-body' is suddenly inserted as an objective watching post that does not affect the experiment that is to take place. In some respects, this too has become habitual practice when considering certain fundamental questions as though such a position actually exists somewhere. However, this is not the problem, and is stated here to show how easily we can be distracted from what is being said. Here is the problem: the experiment cannot possibly work in these conditions because whatever causes the acceleration is absolutely impervious to any changes that occur in the mass being accelerated.

Basic Newtonianism tells us that an acceleration of any particular magnitude is dependent upon both the mass of the object being accelerated and the force acting on it. In effect, Einstein puts a regulator in place to be impervious to any changes, and it is this that requires the being causing the acceleration to be 'immaterial to us'. The equivalent of this 'being' is a governor that can be found in any lift system, so that its speed can be the same for one person or several persons. It is this special type of accelerated system that is created in this thought experiment so that its experimental conclusions are guaranteed. That is to say, we are made to ignore the role of the accelerator in order to focus entirely upon what is happening in the lift without reference to it. Is it any wonder, therefore, that Einstein should come to this conclusion:

But how does the man in the chest regard the process? The acceleration of the chest will be transmitted to him by the reaction of the floor of the chest. He must therefore take up this pressure by means of his legs if he does not wish to be laid out full length on the floor. He is then standing in the chest in exactly the same way as anyone stands in a room of a house on the earth.

So far, so good. But now, since he has brought equipment, he performs an experiment:

If he release a body which he previously had in his hand, the acceleration of the chest will no longer be transmitted to this body, and for this reason the body will approach the floor of the chest with an accelerated relative motion.

Is this the case? The answer is yes in only a very small number of experiments where the weight dropped is very small. However, perform the experiment with an appreciable weight and the outcome is very different. Suppose the weight of the lift and contents is given. Then the force applied to accelerate it and simulate gravity is a fixed one. That is to say, the force acting on the mass produces a clear acceleration, or :

$$F \longrightarrow M = A$$

Now imagine that the experimenter is standing on scales which show his weight under this acceleration. He may conclude, since it is a constant acceleration, that the weight reading is identical to someone on the earth. He now pulls a lever which releases a heavy weight from the ceiling which is half the weight of the whole system of lift, equipment and occupant. He will now notice that his weight on the scales doubles as the weight is in relative motion according to this formula:

$$F \longrightarrow M - M/2 = 2A$$

This clearly falsifies the equivalence principle, since he can now conclude with some confidence that he is not standing on the earth, but accelerating upwards. This is forbidden by the equivalence principle, and explains why the accelerator is ignored in the reaction, since it is only true where the lift is governed, so that the accelerator is superfluous, or it is extremely local, where the falling weights are tiny fractions of the whole that are virtually immeasurable. But this is not what Einstein is saying. He is so convinced of the equality of inertial and gravitational mass that he is hardly aware of this problem and actually universalises it beyond the local level where it could possibly be relevant:

The observer will further convince himself that the acceleration of the body towards the floor of the chest is always of the same magnitude, whatever kind of body he may happen to use for the experiment.

Consider, therefore, how this entirely restrictive conclusion with respect to acceleration is forced into equivalence with gravitation. (It should be stated that by 'restrictive', the limited range of application is meant. That is to say, there is a range of application, but it is limited to the Newtonian scale):

Relying on his knowledge of the gravitational field (as it was discussed in the preceding section)...

That knowledge, of course, is not so much established fact but belief, that gravitation is made into a real thing by analogy alone to the electromagnetic field. Belief suddenly becomes 'knowledge' and ultimately in this discussion into a 'law'. No evidence of any kind other than descriptive observation is relied on, as though the description was in itself prescriptive, and it is this habit and nothing more that has reified it. Consequently:

...the man in the chest will thus come to the conclusion that he and the chest are in a gravitational field which is constant with regard to time.

But is this a realistic conclusion? Recall that this lift is placed in its own particular contextual framework (the Galileian reference field) that begins by having nothing in it. Consequently, how is one to understand this kind of statement with respect to equivalence? Einstein continues:

Just then, however, he discovers the hook in the middle of the lid of the chest and the rope which is attached to it, and he consequently comes to the conclusion that the chest is suspended at rest in the gravitational field.

Here is the problem – How is one to come to such a conclusion, when the equivalence is established from a closed system? That is to say, how does he come to the conclusion that there is a hook with rope attached outside the closed system, from experiments inside it, as though suddenly he can have a peek outside? If, in peeking, he sees a large, earth-like mass near the lift, he might be justified in assuming an alleged gravitational field emanating from it. But no such mass is given. It is as if Einstein has forgotten this context and suddenly adds another body to the example ad hoc, for in order to remain logically consistent, he then states:

We have thus good grounds for extending the principle of relativity to include bodies of reference which are accelerated with respect to each other, and as a result we have gained a powerful argument for a generalised postulate of relativity.

What precisely is it that has made this a powerful argument? We should not underestimate its power since, as will be seen, this view of relativity has been the accepted concept of gravity for nearly 100 years, and has not been open to critical appraisal as other theories are. Indeed, because of the manner in which it is presented, it is clear that it is a view based more on the philosophical predispositions in science than any kind of scientific warrant based on evidence. We should note carefully, therefore, how this theory moves forward; two problems exist here which are rendered invisible by the notion that geometric equivalence must be a true conception of reality - the belief that inertial and gravitational mass are expressions describing real properties, and that they cancel out, thus creating the geometric view that is constructed. Thus, these problems become eclipsed by a kind of intellectual sleight-of-hand in order to keep the attention focused on this equivalence. The first problem is ignoring the role of the accelerator in any acceleration, and this helps to keep one's attention focused on what is going on inside the lift, and the second is to add masses to the thought experiment as and when they are required in order to give this kind of equivalence a greater degree of realism. Once this kind of attention-fixing is achieved, Einstein can then express the following with some confidence:

We must note carefully that the possibility of this mode of interpretation rests on the fundamental property of the gravitational field of giving all bodies the same acceleration, or what comes to the same thing, on the law of the equality of inertial and gravitational mass.

The description from analogy becomes knowledge, and now that knowledge becomes a law. That law in turn gives substance to the geometry that comes out of it, so that ultimately we arrive at a unification of space and time, such that two tools of measurement are somehow given an independent, real existence by being united. This unification, called the fabric of space-time, becomes the synonym for the gravitational field. In effect, gravity is considered to be the curvature of the geometric space-time field, and it is this curvature that directs the motion of matter. Is this really so different from Newtonianism which states that matter is essentially inert and driven by forces that are separate from the matter? This in

turn gives an overwhelming supremacy to impact technology as the fundamental shaper of the universe. Worse still, because this continuum is considered to be a 'real thing' matter has virtually disappeared out of reality as a whole army of strange creatures begin to emerge from the geometry. Space-time curves in on itself to form 10 dimensional realities in string theory at a sub-quantum level, strings being effectively 'space-time atoms'. Black holes appear just about everywhere, in different forms and sizes as real entities, yet space-time creations where dimensions seem to be dimensionless can nonetheless exert an influence on matter even though nothing emerges from them to effect such influence. Gravity waves are virtually space-time ripples which, despite every effort, remain undetected. And this lack of detection of such things has become their hallmark. Maybe it is because of this feature that no attention whatsoever is directed towards the assumptions that spawned these reifications of darkness since the assumption itself is ironclad as a rule of law, and so beyond the scope of scientific enquiry, since that enquiry has a very definite form. In any other field, particularly if funded by private investment, the suspicion would arise that continual failure points to the lack of existence of the 'thing' sought, and research would be halted. But where gravity research is concerned, there seems to be no end of funding, no limits to time for experimentation; in fact, the assumptions appear to be strengthened as the reports reviewing failure often begin 'we assume that gravity waves exist', and reasoning put forward to increase expenditure in favour of their search indefinitely.

It hardly seems possible to think that such objects are nothing more than reifications that suggest a correspondence in reality with mathematical models that require them, but nothing more. And yet there is a sense in which such reification is built into scientific procedure. In chapter 21 of 'Relativity', Einstein makes clear the difference between the mechanics that pertain to inertial systems and the need to find a different form of mechanics for non-uniform systems. He uses an example to illustrate this point; a bluish something is seen beneath a pot of water that is boiling and no such 'something' is found beneath another which is not. He writes:

...I can only say that this bluish something will cause the emission of the steam, or at least possibly it may do so.

This is reasonably standard causal logic, but it is what he says next that is interesting:

If, however, I notice this bluish something in neither case, and if I observe that the one continuously emits steam while the other does not, then I shall remain astonished and dissatisfied until I have discovered some circumstance to which I can attribute the different behaviour of the two pans.

In the first instance, it may look as if the case of the 'bluish something' is a reference to inertial systems. But such systems are rare since changes of state are the rule rather than the exception in reality. It is these that are the things that require explanation. However, not remaining satisfied until mechanics is placed on a new footing will clearly be open to reification since no bluish something appears anywhere. But because the local equivalence principle is essentially Newtonian, it will inevitably be reflected in a mechanics that makes real the curvature of a space-time in order to maintain the grip of inertia. As John Wheeler

put it famously, space commands and matter acts. In this way, Einstein (and science generally) becomes predisposed to reification.

In fact, Lee Smolin in his book 'The trouble with Physics' hones in on just this unified space-time manifold as the real problem area confronting modern science:

Whatever else one says about string theory, loop quantum gravity, and other approaches, they have not delivered on that front. The standard excuse has been that experiments on this scale are impossible to perform – but as we've seen, such is not the case. So there must be another reason. I believe there is something basic we are all missing, some wrong assumption we are all making. If this is so, then we need to isolate the wrong assumption and replace it with a new idea.

Most of the book to this point has been an exploration of the research done over the last thirty years to throw light on some of the major concerns in physics. He himself has been at the forefront of many such investigations. But he suddenly reaches this point where one feels he is right on the money as he continues:

What could that wrong assumption be? My guess is that it involves two things: the foundations of quantum mechanics and the nature of time...But I strongly suspect that the key is time. More and more I have the feeling that quantum theory and general relativity are both deeply wrong about the nature of time. It is not enough to combine them. There is a deeper problem, perhaps going back to the origin of physics.

WE should not underestimate this conclusion. Questioning assumptions is not the usual business of science. Rather, assumptions give rise to concepts and the concepts to mathematical models. It is very rarely the case that science will work back to the assumptions to review them. This is partly because so much may have been built up already on the assumptions that it is preferable to tweak the models rather than make such a drastic change that could undermine an edifice that is already in the service of a world dependent on them. Furthermore, and to put it bluntly, questioning assumptions is not their business. As a result, we find that whatever new idea comes along, it comes complete with references to a space-time context. It is never seen that the concept itself drops out of a seriously flawed thought experiment (trivialising the flaw by making its presence 'immaterial to us'). Consequently the unification of space and time into a reified structure dons the mantle of realism for no better reason than the perception that all advances in science are represented by unifications. In this case, however, it has been a disaster. The fact that Lee Smolin is at last raising this issue offers a glimpse of hope, if for no better reason than this: it is a problem situation that originally stems from something simple. This is how he put it:

Around the beginning of the seventeenth century, Descartes and Galileo both made a most wonderful discovery. You could draw a graph, with one axis being space and the other being time. A motion through space then becomes a curve on the graph. In this way, time is represented as if it were another dimension of space. Motion is frozen, and a whole history of constant motion and change is presented to us as something static and unchanging. If I had to guess (and guessing is what I do for a living) this is the scene of the crime....We have to find a way to unfreeze time – to represent time without turning it into space.

If we now read this in the light of the current analysis, it is inevitable that time becomes a feature of a static view since stasis is the natural condition of a world apparently enfolded within the Newtonian notion of inertia. Consequently, there are a whole range of questions that arise from this: what do we understand by motion? What is meant by space? Indeed, all the basic concepts of science revolve and draw their meaning from inertia, which in turn become enfolded in the local equivalence principle, so yes, Lee Smolin has identified the problem very precisely. There is just one problem with unfreezing time and it is this:

I have no idea how to do this. I can't conceive of a mathematics that doesn't represent a world as if it were frozen in eternity. It's terribly hard to represent time, and that's why there's a good chance that this representation is the missing piece.

We should not imagine that this is a personal problem for Lee Smolin. There is a sense in which he is speaking for the scientific mind generally, for no one has risen to the challenge. So consider the problem with respect to space-time curvature. It has already been said that matter curves space-time and space-time in turn motivates matter. To repeat John Wheeler, space-time commands and matter acts. But it is the time component that does the work here. The problem then is not simply to produce a different mathematical model. It is to unweld what has been wedded together and produce an entirely different order of unification. How is this to be done?

Actually, there is a sense in which the answer lies before us. There is a very good reason why Einstein's thought experiment has received little critical attention in itself, and therefore why this appraisal may seem to be trivial. In a less tidy illustration of equivalence, we find that there is indeed a connection between acceleration and gravitation; from the perspective of a passenger in a train experiencing a change of state such that he is propelled forwards or pushed backwards in his seat, Einstein writes:

...he is compelled by nobody to refer this jerk to a real acceleration (retardation) of the carriage. He might also interpret his experience thus: 'My body of reference (the carriage) remains permanently at rest. With reference to it, however, there exists (during the period of application of the brakes) a gravitational field which is directed forwards and which is variable with respect to time. Under the influence of this field, the embankment together with the earth moves non-uniformly in such a manner that their original velocity in the backwards direction is continuously reduced.'

This is true, and for this reason there seems to be something fundamentally correct about such an equivalence. Gravitation and acceleration have the same effect, irrespective of the fact that the lift thought-experiment is accelerator-independent. The criticism, however, is not aimed at the equivalence itself directly. What has been shown is that general relativity couches itself in a framework that assumes Newtonianism is fundamentally correct, and this colours the equivalence in such a way that it leaves space and time essentially absolute, as they are in Newtonianism, but connected enough to suggest that the conjunction itself is a real thing, when it cannot be so. Even in this example concerning the train carriage, we should note the assumption of naturalism granted to inertia, and it is this quality of Newtonianism we find lurking in the curvature of space-time, since matter itself is still pushed around. But if the problem is, as Lee Smolin suggests, that we need to free up time,

then it follows that the thought experiment should be replayed, only this time with a non-trivialised accelerator, in order to see whether this has anything to offer with regard to this project.

Unlike Einstein's experiment, looking to set the lift in an inertial reference frame, imagine a lift suspended by a spring above a planet. Imagine another lift, identical in every way, accelerating at a rate that mimics gravitation and far enough away from a planet. Neither occupant is therefore in the initial condition set by Einstein which has them floating in a freefall state. The occupant in the first lift drops a substantial weight and immediately feels a thrust towards the floor. As the weight descends, he notices that the scale he is standing on measuring his own weight alters, and that he weighs a few kilos more, say. But as the weight hits the floor, he himself returns to his original weight. He repeats this operation several times, and the effect is the same in each case. Can he conclude from this that he is accelerating rather than gravitating? At first glance it would appear so, in which case the principle of equivalence is destroyed.

But wait a moment. Remember that the lift on the planet is suspended above it on a spring. The spring is stretched to the point where his weight is also constant. He also drops a substantial weight in his lift. As he does so, the spring retracts and he sees that the reading of his weight on the scales that he is standing on also shows a similar increase to that of the person in the accelerating lift. But then the weight hits the floor and he also returns to his normal weight. Can he conclude that he is gravitating? Clearly not. Notice, therefore, that whether the lift is accelerator-dependent or independent, the result in both cases clearly demonstrates an equivalence concerning the effects of acceleration and gravitation. No experiment performed in either lift, in either context, is able to choose between acceleration and gravitation.

If this were the case, and there was no more to add, these criticisms would indeed be trivial. But there is an important difference, one whose implications cannot be ignored as it impinges upon the scope and limits of classical science which are embedded in relativity theory generally, despite certain overt differences. In fact, it is only by adopting a different perspective that those limits can be overcome, and this requires taking a more radical philosophical position.

With respect to philosophy and as an aside to the discussion, it should be stressed that the true work of philosophy had always been the questioning of assumptions in order to prevent the onset of intellectual ossification (which is a quality of fundamentalism). In recent years, however, in the shadow of the apparent successes of science, and the treatment of reifications as real entities, it has sadly lost its way and has in fact colluded in the scientific enterprise. (After all, in the true tradition of science, that which is deemed to exist without any evidence cannot really be called scientific.) Both fields of thought have suffered as a result, and this essay is an attempt to return science to its own tradition instead of cloaking metaphysics with realism, and to bend philosophy back to its critical function in order to aid in this enterprise. One thing should be noticed, however; it is the fundamental way in which different branches of thought have been artificially separated, and this is most probably one of the reasons why the partial successes of one enterprise have come to

represent whole views instead of partial ones. Hence unified field theory, grand unified theories etc...

To return to the subject, let the accelerator-free lift be called experiment A, and the accelerator-dependent lift experiment B. The use of the word 'experiment', whether real or in thought is embedded in the scientific consciousness as a vital and definitive praxis in the seeking of knowledge, something that raises it above guesswork. It is this perspective that has been responsible for the raising of the status of the mathematical model since precise measurement makes it possible to observe and manipulate reality in many ways. The successes of such application, however, have had an intellectually seductive effect, leading many to proclaim that mathematics is the true language of the universe. What this means is never really clear, and has the effect of creating a mystique around those expert in such applications, and leaves them free to fill reality with any reifications their models may suggest without fear of redress. So much so, in fact, that the translation of this 'language' into things that supposedly correspond in the everyday world (black holes, multiverse, worm holes etc.) has become part of common consciousness as though these were actually real things. It is inevitable, therefore, that both experiment A and B are couched in terms suggesting that measurable changes from within are clues to the nature of the 'without', in this case the equivalence of accelerated systems under gravity or rocket power.

The point is that in both cases, the experiment from inside the closed system implies a kind of Plato's cave from which no one can exit to see the reality of context, and it is this imposition of limitation that has prevented a different insight from emerging. The approach to this different insight is to imagine that the occupants of these lifts, especially in experiment B, do not have any experimental equipment, no weights to release, and no scales to stand on. No experiment from within the different lifts can therefore be carried out. This in itself was causal in experiment B in that experiments themselves actually created the very states of change that were being examined. In experiment A, these were incidental and therefore unnecessary. But now, the occupants of these lifts in experiment B feel a sudden change of state, one that is not the result of anything happening in the lifts. Their knees begin to buckle and they feel somewhat heavier. What can they conclude from this? A great deal. In fact, they go far beyond the mere generalisation of accelerative/gravitational equivalence, to something more specific. The lifts can only be in one of two states. Either an extra rocket has been fired to give the accelerating lift an extra boost, or, (and this is the relevant perception) a great deal of mass has been added to the planet above which the gravitating lift has been suspended.

Note carefully what is implied by this more specific type of equivalence: a small amount of acceleration in one lift is equivalent to the addition of much mass in the proximity of the other. That is to say, a small change in one is equivalent to a large change in the other. In this case, there is no need to equate mass with a gravitational field, since it cannot be invoked in the first place, as we find it invoked in experiment A through nothing more than analogy. In any event, to speak of an intensification of an alleged gravitational field would amount to saying the same thing as 'an addition of mass', and since these would in themselves be saying the same thing, it is not necessary to invoke a field at this point, if at all.

But one should also consider another crucial difference. Experiment A begins with the assumption of an inertial reference frame and the principle of inertia that arouses no curiosity, since no changes imply no state requisite of explanation. Let this therefore represent a type A mode of thought, or mind-set. It has proved a useful principle on a restricted local level, but we should not allow ourselves to be seduced into thinking that it can be applied to any level whatsoever. Be that as it may, we should note that given the type of set-up of experiment A, there is no experiment that can be performed within its specified reference frame that can actually distinguish different types of states of change since the experiment has no participative accelerator, and is therefore indifferent to different weights. Whatever the weight that is dropped, be it a kilo or a ton, it can make no difference to the outcome since the result will be the same in every case, since the only type of equivalence it can actually describe is one in which a gravitational field is indifferent to mass. And needless to say, such a set up owes its form to the base assumptions concerning inertia.

What, then, is a type A mind-set? Speaking metaphorically, it is the state of being asleep, or unconscious, until awoken by a disturbance. This corresponds to the notion of uniformity or rest. The disturbance in that event (causing the sleeper to awake) becomes defined as an external agency or 'force' acting on the inert state to produce a change or awakening (like the sound of an alarm clock or a prod). It is this type of mind that remains 'astonished and dissatisfied' until some circumstance is discovered which returns the mind to its normal state of quiescence, or inertia. And it is this kind of mind-state that characterises a very specific type of objectivity, defining real things in terms that do not disturb the sleeper. Reifications are then bound to appear like the shadows on the wall of Plato's cave that are also deemed real to its occupants.

Experiment B, however, does not recognise inertia as a fundamental state. But this raises many problems. From the outset, it is clear that the definitions of all conceptual terms derive their meanings from a circularity of reference which finally come to rest in the concept of inertia. Since this concept is not recognised in experiment B, then what can it mean to say that a little bit of change in one lift is equivalent to a lot of change in another, especially since the equivalence itself cannot be discussed in terms of fields, but in terms of mass. What is meant by 'mass', far from being a simple thing, becomes seriously problematic.

The distinction between these two experiment forms, A and B, highlights that a bare fact cannot exist except in a context of concepts that can accommodate it, and it is for this reason that time and space need to be uncoupled since space-time itself acts in favour of a type of mind in which mass is effectively frozen out. In other words, what must a non-inertial base be like to reflect a type B mind operating in a state of constant wakefulness, where changes of state are the norm rather than the exception?

Reference has been made to the fact that relativity is embedded in classical physics, but with some overt differences. The one, major difference is the inclusion of the speed of light as a fundamental operative determining the nature of the behaviour of real things possessing mass. That is to say, we find there the usual concepts of mass, time, energy, space, momentum etc., but while their meanings were coined in a mode that was indifferent

to the speed of light, these are now to be seen as being more 'elastic' in its presence. A key equation in relativity is this:

$$\sqrt{1 - v^2/c^2}$$

The aim here is not to discuss mathematical matters, but to consider the meaning and implications to mass and time of this equation, particularly v/c . A problem arises immediately in that 'c' as it is found here is considered only with respect to the fact that it is comparable to 'v'. In both cases, the interest is focused upon speed alone. Put another way, the only feature of the nature of light that is relevant is its velocity, as though both 'v' and 'c' share the same quality of motion. Consequently, we can measure the speed of light by the use of a clock that signals the arrival of a photon from a point A at point B. In this way, light speed is not seen as anything especially different from anything else that is moving. This is a problem.

In the absence of formal structure, the only way this can be illuminated is through a thought-metaphor as opposed to a thought experiment. Imagine a ruler, such as a king or emperor, holding a staff three metres in length that symbolises his power. Such authority then delegates the responsibilities of power to subordinates in the form of shorter staffs, and different degrees of responsibility are represented by fractions of length of the emperor's staff. In that respect, the ruler's staff acts as a bench mark, and so cannot be called 'three metres' since it is the standard against which other lengths are determined. It represents a means for determining measurement, and therefore should be called '1', and all others fractions of '1'.

After a revolution, and the death of the emperor, democracy takes over and the plethora of fractions begin to redefine themselves in the absence of '1', using independent measurements with well-defined names such as 'inches' or 'metres' and lose the sense of subordination or 'fractions'. In such a context, inertial frames take over, and no particular frame acts as a benchmark. If after some ages have passed, an archaeologist finds the bones of the ruler and his staff is discovered, it is at that point that it will be 'measured' by whatever standard happens to be in vogue, and in this event it becomes nothing more than a long stick. That 'long stick' is the speed of light, but redefined to be nothing especially different to anything else, and therefore subject to the same principles of quantifiability.

The 'staff' sense, however, is very different, and should be called the internal sense, since it is concerned with the essential nature of light as power-giver. This latter sense is clearly immune to the kind of representation made in a quantifiable model in which the act of measurement itself reduces everything to a common, external form. Consequently, there is a very real sense in which light should not be thought of as 'speed of -', but as a standard against which that which is not light can be compared. Light in effect is not-moving. (The hyphenated form 'not-moving' is intended to try to move the mind away from 'unmoving' or 'static'.)

How is this to be understood in a practical way? Since the effects of measurement remove all internal structure, and this effect is only made possible with highly defined

words like 'motion', the answer is to jettison the concept of motion itself in its standard form and replace it with an internal definition. In that internal form, v^2/c^2 is not so much a comparison of velocities but a relation of states expressing a degree of participation between that which is the staff (light nature) and everything else that is not-light, i.e. mass. In that event, the use of the word 'velocity' appears accidental in that in some ways, on an internal level, it had always meant participation in a measured state. This may still sound somewhat metaphysical, but it can be translated in two ways that are found in the external form: The faster the motion of any mass, 1) the slower the time experienced by it, and 2) the greater the mass becomes. That is the same as saying this: since there is no experience of time in light nature, there is an effective slowing of time as this nature is approached in a moving state (called participative), and since there is no mass associated with light nature, there is an increase in mass in the participative state (increased motion) until the point of parity is reached and it becomes as light, and massless.

This internal route, being unfamiliar, is not easy to digest because it is unfamiliar (rather than difficult). In such a context, what is difficult is the unfamiliarity itself, since it does not fit neatly within the assumptions of the familiar, but rather it reveals the limited scope of the familiar that has grown from those assumptions. Of course, these may appear to be philosophical issues, but nonetheless they clearly have a direct bearing on the particular issues here with regard to the unification of space and time, and with what we consider to be the ultimate nature of reality. This becomes apparent even in the separate treatments of concepts as though it is understood that they are entirely different kinds of 'thing'. So there is more to be added here that is relevant to the question of equivalence, and this may help in expanding the internal sense.

Chapter 12 of Einstein's book is entitled 'The behaviour of measuring-rods and clocks in motion'. The point of interest here is the notion of time in motion, and here, with the appropriate use of the Lorentz equations, part of which was shown above, Einstein states:

As a consequence of its motion the clock goes more slowly than when at rest. Here also the velocity 'c' plays the part of an unattainable velocity.

It is in a later chapter, significantly, that Einstein then discusses mass as a separate issue. In chapter 15, 'General Results of the Theory' he writes:

If a body takes up an amount of energy E_0 , then its inertial mass increases by an amount E_0/c^2 ...

Just before this, and using the same Lorentz equation ($\sqrt{1 - v^2/c^2}$), Einstein also shows how the kinetic energy of a material point increases and approaches infinity as 'v' reaches parity with 'c'. Now while it may appear that time and mass are treated separately here, we should notice that whether the focal point is time or mass, the same equation is used to determine that an alteration occurs in both. But because the point of interest in Einstein is velocity alone, he is unable to see that velocity as an abstract term may well be expressible as a number, but in reality, velocity is actually always attached to a thing that is in a state of

change. What this means is that every time the velocity is referred to as 'v', what is really meant is the velocity of a 'thing' which is $v(m.t)$ where 'm' and 't' are the apparent component forms of the 'thing' that is moving. In this internal sense, therefore, neither mass nor time can be thought of separately, and it is only the convention in mathematical practice that has actually separated them. Whatever and however time and mass are conceived in their external form, in their internal form they are intrinsically linked. After all, we should note that the application of the Lorentz equations to both time and mass shows that both are altered, at the same time and in the same place. It is only in the external form that time is regarded as a measuring device, yet it is the mass measured that slows in time, and not a watch that measures it that is relevant, and this slowing in time is actually a synonym for an increase in mass. In other words, all mass is temporal. Time really is mass, and mass really is time. It is the predisposition in the inert state of consciousness that separated them in the first place, even though so much of relativity theory points to this internal sense. So in thinking of the more famous equation, $E = mc^2$, what can be seen here is the actuality of mass as a temporal existent that is the actuality of electromagnetism as potential within it, an actuality that is the expression of an enfoldment of potential which is altered by the participative state as masstime 'moves', which is the participation of temporality in the atemporal. But this requires the perception of light as a standard or benchmark, and altogether disappears from view when it becomes no more than a 'long stick' as discussed earlier. It is this 'long stick' approach that is thoroughly Newtonian and which pervades relativity theory. Turning space-time into masstime reveals the limit of application of the Newtonian view, since it only truly applies at a practical level where light can be thought of as instant, and where no harm is done to the nature of reality with the use of clocks and other measuring devices, where participative states are slight. ('Space-time' is hyphenated here to emphasise the nature of the conjunction as reified, while masstime is not hyphenated because it is not two things that are actually separable, but one thing that is seen in two aspects.)

This effectively provides the kind of framework for thought suggested by Lee Smolin when he stated the necessity of freeing up the static universe. Since masstime describes a real thing, then clearly space-time becomes uncoupled or more accurately de-reified. Given the amount of science that is devoted to space-time, this can be no mere philosophical oddity, nor a trivial conclusion. But the implications should be pushed a little further here before returning to the local equivalence principle. By decoupling space-time, it should not be imagined that one is left with space and masstime, since the notion of space itself as some kind of emptiness that is filled with things is unhelpful, and in fact is like a mental form of ether as it was understood in the 19th and early 20th century. There is in its place a masstime state of all things temporal (or not-light), which in turn is in a context of electromagnetism or atemporality which is dynamically separate from it, and it is the dynamic between these two states that generates all of reality. Furthermore, as stated earlier, since the time component was seen as the activating principle, the alliance with mass changes this Newtonianism completely and transfers activation to mass, and this activation is entirely due to its nature as receptor or container of light that lies all about it. That is to say, light or electromagnetism can be thought of as information, but masstime as its container is in-formed. Nor can these be regarded as the same thing essentially, but rather the separate existence of masstime and

electromagnetism as modes of existence (and through the dynamic between them) generate reality through their participation, which is externally referred to as motion.

This should be pushed even further for the sake of clarity. It was stated earlier that the Newtonian form of relativity which Einstein presents us with led to the notion that space-time commands and matter acts (that space-time is curved and matter is directed by the curvature), which are little more than new ways of presenting the laws of motion in which matter is inert and pushed around by forces. The latter view is easily seen as the result of the logical consequences that grow out of the principle of inertia, but space-time presents us with a more subtle idea: time is the element in the space-time manifold that activates the curvature. The question here then reverses this and places the activating element in mass, and this leads to the following: what does it mean to say that mass is activated?

Here is a kind of question that is real and relevant, but up till now science has not been able to answer it or even to conceive of it. Yet it is a fundamental question about the nature of reality that we experience since as beings of masstime, we are subject to its nature as activated entities in ways that are impossible to conceive within the old Newtonian framework. Yet clearly, by uncoupling space and time, this is one of a number of questions that arise as a result of a reconceived equivalence principle. Consider the question, therefore, purely from the point of view of the psychology mentioned earlier. Newtonianism, in which reality is always reduced to the principles of inertia and the laws of motion that grew out of it, reflects a sense of mental unconsciousness or sleep. To be awoken from that mental state is the equivalent of being disturbed by forces that are not part of the sleep state. But this use of the word 'reflected' should not be assumed. It is inevitable that whatever we think, do or say, there is a sense in which the very projection of thought always reflects in actions and symbols what is going on within the human psyche. Consequently, in stating that time and mass are unified, it is inevitable that the kind of questions that will evolve from it are of the type 'Why are we here? What does it mean to be alive?' And so on. These questions are not part of the usual scientific arena, and so very speculative. But the different form in which it presents itself initially in experiment B raises a question that leans towards them and it is this: what does it mean to say that masstime is activated?

First of all, it is necessary to see why this question cannot arise in traditional or mainstream science. Bearing in mind that the point of reference is time, and that time in this internal sense is actually mass seen in a particular mode, we should note that until now the tendency has been to reify it as a measure no different from a ruler or meter rod. This is exactly how Einstein employs it throughout his thesis on relativity, whether the special or general theory. In chapter 28, 'General Principle of Relativity' we should note carefully how time as an abstract concept turns into a real 'something' as he turns it into a 'mollusc' in his thought:

For this reason non-rigid reference bodies are used, which are as a whole not only moving in any way whatsoever, but which also suffer alterations in form ad lib during their motion. Clocks, for which the law of motion is of any kind, however irregular, serve for the definition of time. We have to imagine each of these clocks fixed at a point on the non-rigid reference-body. These clocks satisfy only

the one condition, that the 'readings' which are observed simultaneously on adjacent clocks (in space) differ from each other by an indefinitely small amount. This non-rigid reference-body, which might appropriately be termed a 'reference-mollusc' is in the main equivalent to a Gaussian four-dimensional co-ordinate system chosen arbitrarily. That which gives the 'mollusc' a certain comprehensibility as compared with the Gauss co-ordinate system is the (really unjustified) formal retention of the separate existence of the space co-ordinates as opposed to the time co-ordinate. Every point on the mollusc is treated as a space point, and every material point which is at rest relatively to it as at rest, so long as the mollusc is considered as reference-body. The general principle of relativity requires that all these molluscs can be used as reference-bodies with equal right and with equal success in the formulation of the general laws of nature; the laws themselves must be quite independent of the choice of mollusc.

What should be noted here is that this treatment of time as a mollusc is designed to give space-time itself a tangibility as a continuum. How this emerges is also significant, since what we find in relativity is not so much a sea-change of thought, but a translation of Euclidean reference-frames into non-Euclidean geometry, where the only real difference is that the rigidity of measuring rods, including clocks, is made more elastic in order to serve the reified form of space-time, which appears at the beginning of this chapter:

'All bodies of reference K, K^1 , etc., are equivalent for the description of natural phenomena (formulation of the general laws of nature), whatever may be their state of motion,' cannot be maintained because the use of rigid reference-bodies, in the sense of the method followed in the special theory of relativity, is in general not possible in space-time description. The Gauss co-ordinate system has to take the place of the body of reference. The following statement corresponds to the fundamental idea of the general principle of relativity: All Gaussian co-ordinate systems are essentially equivalent for the formulation of the general laws of nature.

It seems here as if a change has occurred, yet the word more commonly used by Einstein is 'translation'. Such translation does not reflect fundamental change but apparent change since clocks are still required in exactly the same manner, and not in an internal sense where they are synonymous with mass but separate from it as they are in Newtonianism. Generally speaking, the idea of a radical change is usually associated with a movement away from absolutism to relativism, but in both cases time is essentially quite separate from mass and in relativity, it is given its own reified existence (as mollusc) in the warp and weft of space-time. The reality, needless to say, is that change in mass always coincides with change in time since the real mollusc is mass. Einstein's 'mollusc' is quite clearly intended to don space with a mantle of realism, since ultimately he presents us with geometry, and this geometry then becomes a net or web that captivates and defines mass, as well as directs it.

But it should never have been a surprise that, from the perspective of experiment B, a feeling of greater weight is automatically associated with a slowing of time. Both are experienced simultaneously, but seen in relativity as quite distinct, even though a test mass like a clock is in itself a mass, as Einstein reports, again in the same chapter:

In gravitational fields there are no such things as rigid bodies with Euclidean properties; thus the fictitious rigid body of reference is of no avail in the general theory of relativity. The motion of clocks is also influenced by gravitational fields, and in such a way that a physical definition of time which is made directly with the aid of clocks has by no means the same plausibility as in the special theory of relativity.

Quite so, but the reason for this is its intimate attachment to mass, and not a space-mollusc becoming a space-time atom, or string.

From the perspective of experiment B, having replaced accelerated motion with participation, it should be emphasised that participation itself is an expression intended as constant comparison of a temporal state with a non-temporal state. It is a relation of masstime with electromagnetism. In contrast, the external form is, in many ways, a superficial comparison of velocities in which that of light, being very high, is nonetheless a velocity. It seems to be accidental that this high velocity and atemporality go hand in hand, and so the latter tends to be ignored. In this way electromagnetism is turned into an aspect of phenomenology subject to the usual rules of measurement within the given parameters of space, time and motion.

However, despite this restriction, participation as an infrastructure is only one of two ways in which masstime is altered. The other has already been alluded to with reference to Einstein's gravitational fields where clocks are seen to alter. But this drops out of experiment B as a matter of course: it is clear as a result of equivalence the alteration experienced by masstime is the result of the addition of further masses, and it is clear from this that this process of addition is exactly the same in effect as participation. In fact, while the effect is the same, the source of the effect is not participative, and should be more accurately called 'accumulative'. But it should be emphasised again that unlike Einstein's local equivalence principle, where the effects of acceleration and gravitation are treated geometrically and so experience a direct equivalence, the effects seen in experiment B suggests something more radical and also more fruitful: it is not local equivalence but inverse equivalence. There it was seen that a small change (suggesting the quantum level) is equivalent to a large change (suggesting the relativistic level). It should be noted here that such a principle would be of significant importance in current theories of quantum gravity. Indeed, what has been said so far actually satisfies all the conditions laid down by professors Jeremy Butterfield and Chris Isham in their paper, 'Space-time and the Philosophical Challenge of Quantum Gravity:

. . . philosophers of physics do in fact tend to endorse realist accounts of reference and truth. We suspect that the main cause of this is the powerful psychological tendency to take there to be real physical objects, corresponding to their properties and relations to the mathematical objects in mathematical models, especially when those models are very successful . . . The main example of this psychological urge will be the tendency to reify spacetime points . . .

Challenging that process of reification has been the main aim here, since a lack of philosophical input makes this process inevitable. But this is followed by a more succinct comment:

Start ab initio with a radically new theory. The idea here is that both classical general relativity and standard quantum theory emerge from a theory that looks very different from both.

Such a theory would indeed be radically new...very little is known about potential schemes of this type, let alone whether it is necessary to adopt such an iconoclastic position in order to solve the problem of quantum gravity . . . For the moment, we want just to emphasise the philosophical interest of this type of approach. For it is often motivated by the view that the basic ideas behind general relativity and quantum theory are so fundamentally incompatible that any complete reconciliation will necessitate a total rethinking of the central categories of space, time and matter. And as mentioned . . . we like to think that philosophy could have a role in that enterprise.

Refiguring these concepts has been a side issue here, next to the equivalence principle, but has to be undertaken if an inverted form of equivalence is to make sense. However, such a re-evaluation reveals more problems than any solutions it may have on a purely physics level and why this is the case needs to be stated. Physics and psychology are not comfortable bed-fellows. The reference earlier to the sleeping mind as the natural correspondent for the laws of motion and the principle of inertia was deliberately made, since the notion of an objective reality ultimately boils down to a non-peopled universe. Since relativity is merely one step up from Newtonianism, the same state of mind applies, where reified objects do little to actually present a true wake-up call. But the outlines of a reformed equivalence principle, apart from altering the conceptions of space, time and matter, require a language of participation/accumulation of processes that only make any real sense in a peopled universe. Why this should be so is now the question.

Begin with the principle of inertia, a state in no need of explanation, for being unforced it is regarded as a natural state. In this form, the word 'natural' is being used to mean 'in no need of further explanation'. Consequently, gravitation as a force rises out of it as a logical consequence (complete with associated fields and particles) because an accelerated state is in need of explanation. However, because the principle of equivalence in experiment B invokes no fields, one is forced to look at the situation differently. And yet, paradoxically, what is 'seen' is little different from what was recognised by Einstein when forced to use language rather than mathematical description. Here we find ourselves back at the start, and what was said there was of more fundamental significance than the apparent equality of inertial and gravitational mass, although it is this that lies behind the shape of relativity theory. Matter, he wrote, 'calls into being' a field. A stone is 'attracted' by the earth. Iron 'strives' to move towards a magnet. Indeed, in chapter 29, Einstein writes that gravitational field and matter together must satisfy the law of the conservation of energy, but in brackets writes 'and of impulse'. What he might have meant by this is unclear, but we should not that the language of the quantum realm is itself one that expresses changes in terms of tendencies, dispositions and inclinations, all of which, like the equality of inertial and gravitational mass, dissolve away as reality becomes statistical at a macroscopic scale. But where mindset A dominates, such language is turned into an 'incidental' since nothing of it is required in mathematical description. But just as equivalence is inverted here, so also is the mindset, in which it is mathematical description that becomes incidental, and such descriptions of supreme importance.

A different form of logic inevitably forms around experiment B, since the conceptual forms that emerge are quite different; masstime is essentially a state of the 'become', embedding in dynamic form a temporality originally derived from the atemporal nature of electromagnetism. Space-time as a concept is seriously flawed from the outset as it welds together the temporal and the atemporal (conceived as space) as an essential conjunction in a cavalier fashion. Metaphorically speaking, oil and water have been forced into a blender, and reality frozen in a way that conforms with the expectations of an inert view that built the blender. It is this that has had the effect (in mindset A) of keeping reality both essentially and dynamically dead. But in the considerations being proposed here (given the previous statement in which it was shown that the activating principle in space-time was the time component), it is mass that is activated, and that means that it will always 'strive' towards the point where its experience of time is slowest, and this striving is seen to exist in both the states of participation and accumulation. That is to say, matter is 'driven' by time always to

seek out the point of slowest time. But because it lies between two points, this will be experienced as a tension such that there is no immediate collapse as is suggested by a universe created from some kind of series of impacts, particularly where electromagnetic effects are large, but a gradual slowing of time in matter as it becomes organised through circular motions, and as we see in the universe generally and particularly, orbital structures are evident on both the atomic scale and the large scale, as masstime becomes adept at 'sniffing out' atemporal locations, or locations of less time. It does not require an 'extra' such as a force of gravity, since all matter gravitates naturally, and as seen with inertia in mindset A, what is natural requires no explanation.

Secondly, notice that experiment B did not require an actual experiment to be made in order to arrive at these conclusions, at least, no experiment such as the dropping of weights as in experiment A. In actual fact, an experiment did take place, and it required merely the presence of a person in the lift of experiment B to note a change of state as a 'felt' state. He 'felt' heavier. What can be meant by this word 'felt'? It is the natural correspondence in the meaning of the temporal as 'activated' which gives this word 'feeling' a new level of meaning. When we are falling, we do not feel anything happening, but we feel the resistance that prevents it.

We should not imagine that this use of the word 'feeling' implies an element of subjectivity in its normal sense. Instead, we should recognise a prejudicial aversion purely in mindset A that prefers to treat such alive states as anthropomorphic interpretations, since the predisposition there is essentially a 'dead' state, revealing an allegiance and predilection for inertia. Quite the contrary, an inverted equivalence principle also stands this attitude of mind on its head since a type B mindset provides a more human perspective, in which a greater range of human experience is necessarily involved in conceiving of reality, recognising simultaneously that a type A mind is necessarily restricted to its own 'dehumanised' sense of reality. It is this contrast of views which virtually guarantees that these words 'accumulation' and 'participation' will not be greeted as advances in thought. Even though they describe very specific states of reality that relate to an atemporal state, nonetheless they echo in themselves something pertaining to a felt state, and this naturally involves human experience that has successfully been kept at bay for the past 300 years or so. But this is to be expected. Philosophy, it was stated earlier, is concerned with the questioning of assumptions, but assumptions themselves, once accepted, provide a framework of familiarity over time, such that questioning creates discomfort. The more the assumptions are retained and adhered to, the greater the discomfort as they are challenged. Besides, one cannot simply despatialise time and expect what results to conform to the prevailing concept forms of science which created the problem in the first place. Frankly, the notion of a mindset that does little more than measure reality is hardly a comprehensive mental framework. 'Activated' time as masstime was always bound to reflect a different mindset, one with a wider field of perception in the human psyche. Should this lead to feeling states and counter a dehumanised universe, it should not be excluded simply because it does not fit or suit the prevailing zeitgeist.

The aim here has been to provide a critical appraisal of Einstein's general theory of relativity through the local equivalence principle which is effectively the seed from which it grows. That it has been found to be seriously flawed has repercussions for how the large scale universe is thought to be structured. It is not the aim, however, to look in detail at these

larger structures since this is beyond the scope of this essay. But a few general remarks by way of exploring the implications of a revised equivalence principle may be in order.

It is generally assumed that the large scale structure is adequately defined by the influence of the force of gravity. But when considering the laws of motion which spawned it, one should bear in mind that they were designed for improving the trajectory of missiles. It is an intellectual arrogance indeed to assume that they can be applied on the grander scale to the whole universe to explain how it came into being. But since it is known that they do not possess the means to explain the high degrees of order within it, an invention of the mind called the multiverse is forced into existence, a structure of millions of possible universes, so that one as highly ordered as ours drops out of them as a statistical necessity. This kind of thinking creates a firewall around itself through which the kind of equivalence being proposed here can be ignored. It is astonishing that such an idea, as illogical and irrational as it is, ever took root when the proposal is, frankly, intellectually ridiculous and restrictive. It is incredible to imagine that serious scientists even contemplate getting in touch with these other worlds, and even try to explain the nature of light through it. It is a make-believe structure, and it is amazing that so many have come to believe it.

Even when considering ideas like the alleged Big Bang, there seems to be a growing consensus that we now 'know' about the nature of the universe in the first second of its existence and can talk 'straight-faced' (as Sir Martin Rees, the astronomer royal put it) about it. It is overlooked that the concept of a second itself is being applied backwards here from our own definition of it to a state of things to which it cannot possibly apply. The solar system that defines it did not exist then, and one need only ask one simple question to understand why this idea collapses: how long was the first second? Indeed, how was such a moment altered by the second second, if such a concept of time were to have meaning then? And to hear that such a moment has actually been photographed beggars belief, but that is another story. Given that mass and time are one and the same, this talk of an initial time as though a separate thing from mass becomes meaningless.

If we think now of the Higgs boson, the question that this is apparently answering is this: what is it that gives mass its massiness? Answer: another mass, presumably existing at higher energies. The problem is that this kind of question is raised by a form of thought forever in search of a building block, like the Greek conception of an indivisible atom, from which everything is made. In actual fact, the revised equivalence forces a different kind of question: what is it that gives mass its temporality, or what is it that is manifest as temporality in mass? This kind of question has implications beyond the scope of current science, but it clearly makes the former question concerning the mass that gives mass its mass defunct. Its concerns, too, savour of reification. Indeed, a clear case is made about this redundant programme by Professor Alexander Unzicker, and more can be seen and heard about this by him on the following site: <http://www.youtube.com/watch?v=0NOaYu-AxsI>

Perhaps the best known reification is the black hole since in most people's minds it is a real thing. This testifies to the influence of science which persuades through many forms – through articles on the subject in science texts, magazines and popularising science books for the layperson, as well as settings in many stories in the science fiction genre which make

it real. In reality, it is a product of a reified space that has disastrously attached itself to time and made a real thing of itself. This cannot be in reality, as shown here, and can have an instrumental use only at a local level. But rather than present lengthy argument here, mention should be made of Stephen Crothers whose analysis and work on general relativity (as well as other areas like black body radiation and cosmic microwave background radiation) has taken these issues much further and in greater detail, revealing that the bulk of ideas in relativity are even more Newtonian than outlined here. Indeed, in a communication with regards to reification and the metaphysical nature of current thinking, he made these comments:

Reification is mysticism. The current state of affairs is appalling. Science is now a string of fantasies each ever bigger than that before...both Special and General Relativity are fallacious. Both are riddled with illogical arguments, false mathematics, and conflict with reality. Some theory other than Relativity is necessary if Newton is to be superseded. Newtonian mechanics is still as strong as it ever was...contemporary physics is very poor quality metaphysics at best. In fact, I feel that it is not even metaphysics because it is replete with outright fantasies produced by irrational imagination all trussed up in meaningless mathematical symbols that lend it the façade only of scientific profundity.

(Again, for more information concerning his analyses, these can be found on the internet in many places by following this link:

<http://www.youtube.com/watch?v=nXF098w48fo&list=PLTelNRf8MIXXIw-fAiNHlJQpcUeDe1TAH&index=5>

But one should also consider that searching for gravity waves is an expensive business. It has cost hundreds of millions to build and service the LIGOs around the world, and to keep them running since at least the beginning of this century. One wonders how it is possible to dupe the public purse so effectively in the pursuit of something that has no reality. Add this to the billions spent at CERN to look for the Higgs boson, not to mention the sheer number of hours spent exploring these issues, one must wonder why it is so easy for such programmes of investigation to continue unabated while producing no results or at best, questionable ones. To produce no results for such a huge investment, a programme set to continue for the foreseeable future, clearly something deeply wrong is going on, and this has much to do with retaining Newtonianism even while appearing to have superseded it. Why is this?

Consider that the key terms introduced here are accumulation and participation, and that these terms replace the use of acceleration and gravitation in the local equivalence principle. However, it is quite obvious that these words have connotations that extend beyond the borders of mainstream science, and are in fact excluded by them. It is as if their meaning is already known, a meaning which galvanises a natural aversion since they oppose Newtonianism by their very nature. Be that as it may, it is of interest to note that something of their meaning dwells below the surface of virtually every distinct form of thought.

This may be the place, therefore, to explore something of the meaning of the 'isomorphic relation' that was mentioned early in this paper. Since this relation is responsible for turning gravitation into a field (having been given a gloss of similitude with electromagnetism) it should be realised that the bulk of learning that takes place psychologically has much to do with pattern recognition on an intellectual level, but with imitation on an emotive one. Consequently, while one form of thought may copy the methods of another, it will inevitably and automatically inherit the behaviours that stem from it. What this means in practice and how it operates is not easy to analyse here, since that too is beyond the scope of this paper, but an example may suffice to show this.

Having identified that somehow time needed to be freed from its spatial ties, Lee Smolin subsequently wrote a book entitled 'Time Reborn'. There is no intention here to discuss this, but in a broadcast given at the RSA, Lee Smolin made the following comments, after criticising the old paradigm of a timeless universe:

This idea that time is unreal...is an overinterpretation of a method that is suited to studying small parts of the universe...Where we differ and where we impose a wedge is in taking this method and this characterisation of nature and extending it from small parts to the universe as a whole...if you have a method which is well suited to studying individuals, to studying small parts of the system... it is incorrect to take the same ideas and apply them to the full closed system they are part of. (<http://www.youtube.com/watch?v=6Hi4VbERDyI>)

This is precisely the problem that is indirectly confronted by this re-evaluation, since it is now clear that Einstein's theory of the large scale, as reflected in the local equivalence principle, is dominated by Newtonian influences which are inevitably carried into the concepts of space-time and produce reifications. But now, the problem because more serious, for we should consider how this influences other kinds of thought. After his speech at the RSA, the next speaker was Dr Gillian Tett who spoke from an entirely different perspective, that of economics:

In some ways I was wrong to be criticising economics for borrowing so heavily from physics because the fact is that the issue wasn't the fact that economics was borrowing from physics or mathematics, but rather it was borrowing the wrong type of physics or mathematics. They were borrowing this idea of the universe being full of eternal timeless truths that essentially could be uncovered and applied to the way that money worked in a rather crude, rudimentary fashion. And so in many ways I think his work really does challenge us to think not just about the import of quantitative techniques into the world of money and policymaking, but also to reflect on what we can perhaps learn from his vision of physics and this new appreciation for time.

Any system that borrows or copies the methodology of another entirely different system is doing so to improve its own methods of operation. But just as mass and time cannot be truly separated in the manner accomplished by Einstein, so it is not possible to cherry-pick what one wants, since the hidden intentions buried in the assumptions that give rise to the models borrowed come with them entirely. We have seen here that science has generally sold itself on an objective philosophy as though its concerns were dispassionate, and seen how this tendency actually leaves it prone to the impulses it discounts on the way

because it cannot recognise them as inbuilt activations but as externalised reifications. This now returns us to the feeling state mentioned earlier. However, it should not be thought that what is meant by 'feeling state' is a merely emotive expression, but that it is a philosophical expression used dispassionately as a 'lure for feeling' or 'subjective aim' which informs all of reality and not simply its mental pole. This is, in fact, how Alfred North Whitehead defined this, and how it is meant here. What can this subjective aim be? It has already been stated; it is time. But this activation has also been described as the search by matter for the point of slowest time, and this is attained through accumulation and participation, words that replace the limited scope of gravitation and acceleration. The word 'participation' has been discussed briefly, but the interest here will be the word 'accumulation', meaning specifically the addition of mass, but resonating at the same time with many cross-border applications.

Considered specifically, the process of accumulation as a temporal expression in mass is an internal perspective, whereas an external form that imagines itself entire and requiring no internal dimension would subject this to its own method of definition. Recall the staff of '1' and how this is measured by a different standard in which the '1' is subsumed, and one is close to understanding this difference. In any event, that subjection is one that results in a reification called a black hole which is entirely accumulative in its conception. Its gravity is so strong that nothing gets out, nor does anything escape its grip once trapped in its vicinity. In such a form, it has also been described as a cosmological eating machine whose appetite is insatiable.

While physics generally has become adept at concealing such descriptions, it is this end-state that carries over into any system that borrows from this tradition built on inertia, and this is nowhere more telling than in economics. The reason for this is that economics is already tuned into accumulation. While the general definition of economics also seems dispassionate, (the study of the production and distribution of commodities) it is in practice a science of the study of scarcity while in the presence of plenty, the aim of which is to maximise what can be accumulated. Dr Gillian Tett speaks of economics as borrowing from physics, but cannot see that such borrowing entails the adoption of the black hole/accumulative state being reified in both. The recent collapse of the banks worldwide is an ironic example of false value accumulating towards itself a large addition of mass-equivalent circling junk bond seas containing nothing at all; is this not the effect that black holes are reputedly demonstrating. But we can also see how the principle of inertia in one sphere becomes the principle of maximum return for minimum effort in the other. Given that it soon becomes apparent that the central concept of work is one that removes the necessity of itself, coupled with the fact that human endeavour and involvement adds a burden of cost, the end-state of the current economic models is one in which, as in physics, human inclusion becomes superfluous to requirement. Such attitudes and perspectives have indeed spilled over into the political arena. At one time, high unemployment was high on the political agenda, but in more recent times the aims have lowered somewhat as the aims are to have lower unemployment than nearby competitors or nations. It is already understood that unemployment is not a problem, but a natural conclusion to a system of thought that has it inbuilt from the beginning. In any event, one can see in this oversimplified perspective of economics that the imitative spirit, drawing from science, will inevitably adopt the spirit of exclusion of all things human, and this will filter through the

culture into every form of thought that shapes our ends. The question then arises: what kind of economic model could grow out of a revised scientific model that puts the emphasis on tension and resistance rather than freefall?

But to explore this influence further, one could mention the *proprium*. This is a word that is no longer in current usage, and generally means something like selfhood. Actually, it is more fundamental than this, for its true origin is a recognition that mankind, indeed all living things, are driven by the spirit of appropriation, and appropriation itself is another word for accumulation. In effect, it is desire, or a sense of want, or a sense of lack, and that itself is what can also be seen as the idea of time seeking its slowest form in order to attain to atemporality. This has more aspects than can possibly be covered here. Even eating has this symbolic substructure since we feel hunger and seek for ways to allay it, or arrive at completion. Consequently, we should see something fundamental to all aspects of human life as it is lived being mirrored in the larger picture when we recognise the centrality of the temporal/atemporal nature of reality, and that this is entirely removed from our perspective by the reified models presented to us by science in its current form.

So it would appear that Lee Smolin is correct to note that the spatialisation of time is the problem, and it would also appear that, as Professors Isham and Butterfield surmise, a radical and 'total rethinking of the central categories of space, time and matter' are required if the problems which are an inherent feature of current relativity, as revealed in the local equivalence principle, are to be addressed. Clearly, it is not possible simply to patch it up. The irony of this is actually a sense of echo derived from a spiritual origin, for you cannot patch an old garment with new material since both are ruined in the process. This sense of echoes across the usual borders of forms of thought is inevitable.

Before ending, it should be clear that while such a revision must meet with a great deal of opposition, the picture emerging from this discussion is one that greatly simplifies reality. It is not faced with the complexities of trying to artificially marry a force of gravity to a standard model, but presents a picture in which electromagnetism as areal, testable atemporal phenomenon has more to offer our understanding than an artificial space-time in which it supposedly rests.

It is for this reason that the last word is left to Dr Michael Clarage who, in studying the Van Allen belts, came to conclusions in terms quite uncharacteristic of a pure science perspective, opening up the whole exploration of reality by the inclusion of a moral perspective that leads back to a holistic spirit, and expanding the scope available to a new science :

Perhaps the arguments are really about two things. One set of fights is about whether or not there is any purpose to it all. Another set of fights is about whether or not we humans are the most important thing in the picture. Purpose is a very practical word. We do not need to get into religious fights about it. Purpose is related to function. Inside your stomach there are cells whose function it is to manufacture and excrete acids for the practical purpose of digesting your food. Inside each plant there are many chlorophyll molecules whose function it is to begin the multi-step process of locking energy of sunlight into organic matter of fruits and vegetables, in part for the practical purpose of

keeping animals like you and me alive. These are functions and purposes that are visible to our eyes. So why, looking at connections between the earth and the sun do we have such a difficult time seeing practical, purposeful function? This leads to the second problem: our tendency is to think that we are the most important thing in the universe. If I am the most important thing, then how can there be a purpose that is bigger than me? It is similar to the difficulty of accepting that the earth is not the centre of the universe. We are OK thinking that everything revolves around us, but we get upset if someone tells us that we are orbiting around something. So if someone suggests that between the sun and the earth there are large scale processes of transformation, in which we humans appear to play only a very small part, well, that is insulting to our exalted opinion of ourselves. Studying these larger connections, studying how the earth digests and transforms solar energies might be insulting to me because these are functions that I serve. Those functions do not serve me. But if we can overcome our self-importance, we are poised now to understand the earth's electrical environment in a way that will relate the part to the whole, and seeing the part in relation to the whole is one definition of the word 'meaning'. So, we are exploring a world of new meaning, and that is very exciting.

<http://www.youtube.com/watch?v=z2W5jaxKlgU&list=PLwOAYhBuU3UfkIHQ8Rb1sOzkSAw50fCfc&index=1>