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INSTANTANEOUS GRAVITATIONAL AND INERTIAL ACTION-AT-A-DISTANCE

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Abstract

All physical systems balance. In energy and angular momentum terms, a galaxy is as balanced as a flywheel. The scandal in modern physics is that Einstein presented his theory of relativity in such a way that no balancing influence – indeed, no physical influence whatsoever – can pass between bodies faster than the speed of light. This makes it seem miraculous that the physical world holds together in the way it does without 'spooky superluminal actions-at-a-distance' being responsible for this holistic integrity. Some believe, therefore – as did Einstein – that relativity makes no provision for any such 'non-local' interaction; hence the steadily growing number of experimental evidences of such interaction seem to disprove relativity. We think this is a confusion created by Einstein's unnecessary interpretation of the constant *c* as the 'velocity of light *in vacuo*'. In relativity, proper-time instantaneity provides all that is necessary for balanced holistic interaction. We therefore support Relativity from the standpoint of modern philosophy, our only departure being to replace Einstein's 'velocity of light' with Bondi's more economical interpretation of *c* as a constant for converting observational distances in metres into times in seconds. Without affecting the value and dimensions of *c*, this profoundly alters the philosophical consequences of the theory, making it more conceptually economical and more compatible with the ideas of Einstein's philosophical mentor and critic, Mach, regarding the instantaneity of distant gravitational and inertial interaction. We also question, from this neo-Machian relativistic standpoint called Normal Realism, the conception of those various *in vacuo* 'forces' held accountable since Newton for orbital motion. We regard the conservation laws as sufficient in themselves to explain the motions of bodies in relation to one another without need of 'forces' acting between them, either at or faster than 'the speed of light'. This holistic balance of energy and angular momentum implies that all motions of all bodies are interlinked, instantaneously and reciprocally in direct quantum interaction. Motions such as the spins of bodies and the orbits of those bodies should therefore affect one another in a manner unaccountable in terms of classical 'force' theory. This presents an academic departure: a philosophical theory that is experimentally testable. That is, our theory predicts effects of additional angular momenta, such as spin, on the value of the gravitational constant *G* in Newtonian circular orbits. Evidences for and against such effects are evaluated.

This paper is part of an ongoing Maths/Philosophy project at Keele University, both the strength and weakness of which lie in the combining of Arts and Science in a way that is as difficult to place, academically, as to fund.

Key words: quantum relativity, gravitation, angular momentum, forces in a vacuum, intransitive simultaneity and instantaneity, Mach, Normal Realism, Positivism, light-speed, far action, coulomb force, orbital motion.

1. INTRODUCTION

The extent to which physics is a *philosophy* is seldom realized by working physicists. However, the only reason that physicists feel they can distance themselves from what philosophers do is that this particular philosophy we now call physics has not been revised for nigh on a century. So it is scarcely surprising that at its philosophical fringes, modern physics is becoming a little ragged.[1]

The very first thing of which philosophers are aware is that we can never be absolutely certain that the things we see around us really are, in themselves, as they appear to us in bare and/or instrumental sensation. This, of course, is because our knowledge of those things inevitably involves the *interpretation* of observational information. So any idea that in order to probe the reality of things we have only to build bigger and better microscopes, telescopes, 'atom smashers' and so on, is a philosophical non-starter. For, in the end, no matter how complete the observational information may be, there is still, always, the need to construct *theories* about what we observe, and no theory has any *a priori* guarantee of success. Ultimately, the efficacy of any theory is no more than a matter of sheer plausibility.

Even less generally realized among those who are caught up in this plausibility-assessment business called 'physics' is the extent to which their theories depend on the efficient employment of *language*. For instance, physicists continually talk about 'space' as though, in itself, it had physical dimensions and attributes. This is puzzling to a linguistic philosopher for, as Aristotle pointed out, space (*qua* void) literally means nothing (no thing). So the literal 'cash-value' of saying that things are separated by space is that they are separated by nothing, which is the same as saying they are not separated – a literal contradiction. Yet in modern physical theories that 'space' (sometimes referred to as 'the physical vacuum') has been given properties akin to those of fluids, gases and so on which makes those theories philosophically incomprehensible without some careful analysis and readjustment of the literal meanings of those terms. The same applies to physical theories in general, where the meanings of the central conceptions signified by our common uses of language may not be altogether clear, not even to the constructors of those theories.

Ideally, then, there needs to be a continual close contact between physicists and philosophers in the evolution of our understanding of nature. Indeed, such a liaison was once subsumed under the heading of 'Natural Philosophy'. However, the extent to which that title has now fallen out of fashion signifies the extent to which science and philosophy have since gone their different ways.

2. THE PROBLEM

However, there are signs of a revival of at least the spirit of Natural Philosophy in the increasing number of physics conferences and journals (such as this one) that are prepared to address, at the true philosophical level, problems posed by some extremely puzzling physical phenomena. For instance, we traditionally think of light as something

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[1] Television program, 'Big Science', BBC2, U.K., (Feb. 8th, 1984, 8.00 p.m.).

we can beam, by a torch or laser, say, from one place to another and whose ultimate quanta, the so-called 'photons', like bullets shot from a gun, can know nothing of their targets till they get there. Yet in interference-experiments with photons,[2] and even with other micro-particles such as electrons, kaons and so on,[3] there is evidence that those little 'bullets' (if that's how we think of them) choose paths in space that are designed to avoid landing in target-areas where they cannot be accommodated due to out-of-phase conditions between the emitting and absorbing atoms.[4] But how can that be if the photons, like bullets, have no foreknowledge of their destinations? By what miraculous means do their final distributions in that unknown territory end up fitting the holistic requirements of the overall energy-equation? As Tom Phipps once characteristically expressed it, 'those photons sure don't have a holding-pattern!'

It has therefore been clear for some time that there is need of a paradigm shift in traditional physical philosophy towards a more holistic, non-locality approach to the subject along the lines suggested by Mach. For instance, it has long been evident that the holistic laws of overall conservation of energy, action, angular momentum and so on, which determine the ways in which photons or light-waves fulfil their assignations, are at odds with the traditional interpretation of light as something whose direction of motion *in vacuo* depends solely on how it is aimed at the source. However, so recalcitrant have those 'localized, or 'source-directed'[5] interpretations of light become that some physicists prefer to see the evidences of holistic 'non-locality' as due to some sort of 'spooky superluminal' influence acting ahead of the 'particle/wave train' rather than contemplate any systematic revision of these traditional interpretations. Nor is it only photons, electrons and so on that distribute themselves in accordance with those holistic laws of conservation. So do bodies in general, even on an astronomical scale – for how can one body possibly balance another, in galactic angular momentum relations for example, if the balancing-act takes millennia to coordinate? [6] In view, therefore, of what has been said about the interpretational nature of physics, this holistic or whole-to-part (i.e., 'non-local') directiveness of physical action should be seen as calling into question that whole classical paradigm which is centred – even in Relativity – around traditional conceptions of locally-directed causality and motion.

3. APPROACH TO THE PROBLEM

Our response to this need is to demonstrate a viable logical alternative to the classical conception of natural rectilinear inertial motion in a self-extended vacuum. This alternative is to accept as it stands the empirical evidence of holistic or whole-to-part

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2 P. Davies, *Other Worlds* (Pelican, London, 1988)p.65.

3 D. Home, *Proc. 3rd Int. Symp. Found. of Quantum Mech.* (Tokyo, 1989) p.43.

4 N.V. Pope and A.D. Osborne, *Proc. Phys. Interp. of Rel. Theory,* (London, 1990) **2,** p. 460.

5 See, e.g., the 'ballistic' light-theory, in T.E. Phipps Jr., *Heretical Verities*: *Mathematical Themes in Physical Description* (Urbana IL., 1987) p.85.

6 Recent evidence shows that Einstein himself was worried about this: see A. Berry, 'Einstein was afraid of error in his theory' Daily Telegraph, U.K, (Thurs., Oct. 20th, 1994). Also R. Edwards, 'Einstein's second thoughts about relativity,' New Sci. (Oct. 1994) p.5.

directiveness of physical action (currently called 'action-at-a-distance') as simply revealing the natural tendency of objects to move and distribute themselves in instant conformity with the requirements of the various holistic conservation-laws. Our aim is then to revise our interpretations of the phenomena of physical separation and motion to fit those requirements. In this way we address the need which Phipps, Graneau and Assis,[7] have stressed, to rethink our ideas of space, time and motion along those more holistic, non-Newtonian lines proposed by the philosopher Ernst Mach.

This, of course, calls for an entirely different *philosophical* approach to physics, and the one we adopt is as described in a previous paper in this journal, entitled 'Instantaneous Action-at-a-Distance'.[8] Called Normal Realism,[9] this is an up-dated observer-centred approach to physics of the sort pioneered by Mach. Like the earlier offshoot of Machian philosophy which physicists call Logical Positivism, Normal Realism emphasizes the part played by *language* in the organizing of scientific experience. That, however, is where all similarity ends, because Normal Realism rejects the unwanted 'idealist' element in Positivist philosophy that continues to alienate most practically-minded physicists.

3.1 Positivism and Realism

Briefly, that idealist element in Positivism is an extreme form of empiricism which was encapsulated in the 18th Century Berkeleyan dictum *esse* is *percipi* ('to be is to be perceived').[10] This, in essence, is the view that only what is directly perceived at an instant can be real. At the opposite extreme is the reactionary, anti-Positivist view called 'Realism', which is that reality is never in what is perceived but only in underlying and unperceived causes of perception – 'hidden mechanisms' or 'hidden variables' as these are sometimes called.

3.2 G.E. Moore's Contribution

The fallacy of this whole dichotomy, hence of the positions taken by both factions, was revealed, in 1903, by the Cambridge philosopher, G.E. Moore.[11] The fallacy, as Moore pointed out, is simply that Berkeley's dictum, on which both Positivism and the reactionary 'Realism' rest, has no logical nor empirical justification. There is no more compulsion to choose between 'Positivism' and 'Realism' in our approach to physics than

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7 See argument for Machian gravitational holism in T.E Phipps Jr. Spec. in Sci. and Tech.,**1,** 5, 499 (1978); P. Graneau, "Electron". Wireless World **96,** 62 (Jan. 1990) and A.K.T. Assis, Found. Phys. Lett. **2,** 301 (1989).

8 N.V. Pope and A.D. Osborne, Phys. Ess. **5,** 3 (1992) 409.

9 Developments in this philosophy, leading to the present thesis, were prepared in the 1960s by N.V. Pope and G.A. Evans at the Department of Philosophy, U.C.N.W. Bangor, with A.M. Smart (British Telecom) and in correspondence with Gilbert Ryle (Oxford Univ.), under the eventual title of Normal Realism. [See *Phi* the Philosophical Viewspaper, *Phi* Philosophical Enterprises, Ltd., (July 1974-1976).]

10 G.E. Berkeley, *The Principles of Human Knowledge,* ed. G.J. Warnock, Collins, (London 1992) p.66.

11 G.E. Moore, 'The Refutation of Idealism', Mind, Vol. XII, (1903).

to answer yes or no to the well-known trick question, 'Have you stopped beating your wife?' [12]

Now far from being a purely academic philosophical issue which physicists can happily ignore, that question of 'Positivism or Realism' is posed by physics itself. That is, it arises from the physicists' notion of 'the void', the very same notion that, on linguistic grounds, we have called in question. For instance, if we suppose, as did Berkeley's predecessors, Descartes and Locke, that the objects of our perceptions and our perceptions of those objects are separated by 'the void', then that cuts us off from any direct knowledge of those objects. In that case, what certainty can we ever have that those objects are anything like we suppose, or even that they are there at all? Descartes, who introduced that schism into Western science, solved the problem to his own satisfaction by falling back on an implicit belief in the infallibility of those sense-organs with which a beneficent God had provided him. So, in effect, Descartes was saying 'What objects are in themselves, God knows!' This makes it seem that there is no recourse but to cancel those 'objects of faith' and reconstruct our ideas of the world, especially in science, on 'positive' or belief-less descriptions of the bare data of sense and instrumentation. This presents Modern Physics with the dilemma of whether to adopt that 'Positivist' view of physical reality as residing in those mental constructs themselves or to take the opposite, 'Realist' view of physical reality as lying beyond perception in an underworld of 'hidden variables'. This unsolved dilemma plays havoc with the language of modern physics, which is full of equivocation on questions of the reality or otherwise of theoretical objects such as 'black holes', 'virtual particles', the 'Big Bang' and so on.

The trouble is that language of that sort over-vividly suggests to the mind impressions of things and situations which, from the commonsense standpoint of Normal Realism, have no direct empirical meaning. A 'black hole', for instance,[13] in General Relativity, is a particular case of a space-time singularity surrounded by an event-horizon, the interior of which is effectively cut off from any sort of external observation. An observer can pass through the event-horizon but can never return or in any other way communicate his observations to the world outside. But an observer has to pass through the event-horizon in order to verify that the object is a true black hole in the sense of the definition. This leads to two *disjoint* domains of observation regarding the 'black hole' in only the one of which, so far as science is concerned, the effects are manifest. The interior effects are therefore no more than theoretical predictions of the 'metaphysical'[14] type which can never, even in principle, be physically, i.e., observationally, verified. So we have as much hope, of obtaining scientific information about the 'inside of a black hole' as of Conan Doyle's fulfilling his promise of reporting back from the dead.

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12 N.V. Pope, *Proc. Alt. Nat. Phil. Soc.*, (Cambridge, 1992) **14,** p. 125.

13 Some scientists would claim, of course, that a Laplacian 'black hole' has a special sense for them according to Popper's falsifiability criterion of the meaning of such concepts as something *indirectly* (i.e., mathematically) inferred, with theoretical implications which are observationally refutable.

14 The word 'metaphysical' is used here in the derogatory sense of Hume and the Logical Positivists as applied to speculative metaphysics, which is 'the construction of all-embracing systems which cannot be tested by observation.' See A.R. Lacey, *A Dictionary of Philosophy*, (Routledge, London, 1976) p.129.

No less metaphysical, in that mystical sense, is the theory, in accordance with General Relativity, of the initial singularity in cosmological space-time called the 'Big Bang'. This, from the Normal Realist point of view, is even more unreal than 'black holes' because in this case, cosmological pre-time or pre-existence is not even a disjoint domain into which an observer may theoretically penetrate – unless, of course that observer happens to be whatever we conceive to be 'God'.

This incipient idea that mathematical physics at the cosmological level is seeking, as Hawking puts it, to 'read the mind of God'[15] takes the lid off all normal constraints against what philosophers call misuse of language, allowing scientists to postulate 'black holes', 'virtual particles', *et cetera* with what they, the philosophers, may regard as a temerity comparable to that of the mediæval priests who talked about 'heavenly hosts' of 'angels and cherubim'.

The root of this confusion, philosophically speaking, is an inbuilt indecisiveness as to what constitutes physical reality. Does nothing exist beyond perception but ultimate bits of mindless matter and the spaces between them? If so, then without perception even the form of a thing or its relationship with other things (which necessarily involves cognizing more than one ultimate particular at a time) is an 'illusion', whose existence is physically inexplicable. Words referring to *phenomena*, that is, things consisting of groups of and relations between particulars, such as 'shape', 'order', 'colour', 'smell', 'will', 'justice' – in fact, that whole panoply of distinctions the common recognition of which is vital to human existence and consciousness, can thus refer to nothing that concerns those scientific 'Realists'. The fact that they can talk about anything at all is therefore, for them, an insoluble philosophical problem which they can deal with only by equivocation or else by ducking it altogether.

3.3 Gilbert Lewis's Contribution

The fact that relativity dispenses with that whole bogus issue of 'Positivism *versus* Realism' and all that it entails was simply and effectively demonstrated by Gilbert Lewis in 1926.[16] The mathematical basis for this demonstration had been there all along but Lewis emphasized a philosophical consequence which, until then, had been overlooked. That is, he showed that on the grounds of special relativity, at the ultimate quantum-level of sensory and/or instrumental observation there is *no intrinsic distance nor time*, far less any *'void'*, separating the emitter and absorber of quantum light-energy. This follows plainly from the familiar relativistic time-dilation formula:

$$t_p = t[1 - (v^2/c^2)]^{½} \qquad (1),$$

where t_p is the intrinsic, or proper, time registered by a travelling object at speed v in the time t of the observer of the motion and c is the so-called 'constant speed of light in vacuo'. So if we think of the ultimate light-quantum, the 'photon', in the classical way as a void-traversing object, then we have to think of its speed v as equal to c. At that speed the intrinsic (or proper) travelling-time, t_p of the photon, in (1), is zero, whence the intrinsic

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15 S. Hawking, *A Brief History of Time*, (Bantam Press, London, 1988) p.175.

16 G.N. Lewis, Nature, **117,** 2937,(1926) 236 .

'distance', s_p, which is said to be 'travelled' by the photon is nil. So the interpretation of the light-quantum as a travelling particle turns out to be just another linguistic contradiction like that of a self-extended void.

Nevertheless, despite what Lewis has demonstrated, distance, in that three dimensional form we call space, is definitely a *phenomenon*. From the Normal Realist standpoint, then, we need to review the whole traditional interpretation of what that space is and how things are placed in it, move in it and so on, for it seems a paradox that the ultimate elements of our perceptions of things which are distant from us and from each other have, in themselves, no such distance-separation. However, there are all sorts of examples of how the phenomenon of distance can be generated out of elements which in themselves have no such distance, in landscape painting and video or holographic projection, for instance. We may therefore, without contradiction, regard distance as a dimension (or, rather, a set of three dimensions) projected by the observer in the normal way out of *patterns* of co-occurring Lewisian distanceless and timeless light-quanta – that is, from optical measures such as magnitude and brightness comparisons, focus, perspective, parallax, ... and so on.[17] Observational time then consists simply of 'cinematographic' *sequences* of these instantaneous observational 'stills'.[18] Added to this is the fact, discovered by Roemer, that in unmediated observation, *changes* in those projected distances (in metres) divided by *c*, are *times* in seconds. This gives us the most logical and economical interpretation of the phenomenological data which, as Bondi has pointed out,[19] is simply that *c* is a conversion-factor, the same for all observers in the same way that the ratio of 39.37 inches to the metre is unproblematically the same for all observers, whether relatively moving or at rest.[20] All we need to do, says Bondi, is to measure distances in units of 3×10^8 metres as times in seconds, whence 'all the talk about the velocity of light dissolves into nothing.'

3.4 The 'Speed of Light' Conundrum.

There is, then, no contradiction in Lewis's discovery that according to special relativity there is *no distance nor time in the elements of our perceptions of distant objects*. However, it does mean that there *is* a contradiction in the way Einstein's theory is presented. For in maintaining that light 'travels at speed c' and that at that 'speed' it travels

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17 The full four-dimensional geometry of this extrapolation is conic. as described in N.V. Pope and A.D. Osborne, International Journal of Mathematical Education in Science and Technology, **18**, 2 (1987) 191-198

18 This 'cinematographic' model is developed in N.V. Pope, MENSA, (April 1987) 28 and in Philosophia. Mathematica., 2nd Series, **4,** 1 (1989) 23.

19 'A beautiful feature of using radar to determine distance is that all talk about the velocity of light dissolves into nothing. You then measure distance by time, and your unit of distance is the light-year or the light-second or the light millimicrosecond, whichever you like to choose. ... Any attempt to measure the velocity of light is therefore not an attempt to measure the velocity of light but an attempt at ascertaining the length of the standard metre in Paris in terms of light-units.' H. Bondi, *Assumption and Myth in Physical Theory* (C.U.P. 1965) p. 28.

20 Contrast this with the consternation created in physics by the Michelson-Morley experiment which showed that the constant *c* (conceived as the 'velocity of light') is the same for all observers in that same way.

no distance and takes no time, the theory creates a classic conundrum: 'When is a speed not a speed?' Answer: 'When it is the speed of light.'

Bondi's and Lewis's arguments therefore confirm each other, for how can light be said to 'travel' when, in Bondi's terms it is a constant for all observers and, in Lewis's terms, covers no distance in no time? Bondi, however, whilst concurring that on factual grounds all this traditional talk about the velocity of light is redundant and that dispensing with it greatly simplifies the teaching of special relativity,[21] expressly states that it is not within his brief as a scientist to follow-up the *philosophical* repercussions of dispensing altogether with the perplexing 'light-velocity' language. That is a task which he leaves to us, as he intimates, with his blessing.[22]

3.5 The Proper Use of Language.

The first thing to note, from the philosophical point of view, regarding Lewis's demonstration is that with no void to separate them *the photonic elements both of objects and of our perceptions of them are the same*. The language that organizes our perceptions is not, therefore, some subjective 'private language'[23] formed 'inside our heads' out of truncated 'sense data', as in Positivism. It is what post-Positivist philosophers such as Austin, Ryle and Wittgenstein refer to as *ordinary language.*[24] This is the sort of language that gives us our common everyday assurance that the world as we perceive it is no 'illusion' but is more or less as it appears to us, so long as we describe it 'correctly'; that is, without those over-elaborate 'metaphysical' usages, which describe 'black holes' and so on. The only departure that Normal Realism takes is to declare that this 'ordinary language' is not coextensive with the language of human tradition and convention, as those Linguistic philosophers would have us suppose, but a language which *includes* human language along with the languages of all other communicators of *information*, whether animal, vegetable or mineral. 'Language', in this widest sense answers to what the Greeks called 'logos', the original secular meaning of which is now lost but whose vestiges survive in the way in which the various '-ologies' stemming from that same root are still used in science to refer to a transcendent, error-less, language-like structure waiting to be discovered.[25] For it is plain that in science, no matter how grammatically correct some use of language may be, it may still, at any time, prove nonsensical in the face of nature. So the 'correctness' to which Normal Realism refers can never be established *a priori* but has to be discovered, ultimately, *in the nature of things*, by

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21 N.V. Pope, Schools Sci. Rev., **70,** 253, (1989) 86.

22 In correspondence with N. V. Pope, August 20th, 1985, Bondi writes:
'... my notions were primarily directed towards making the theory of relativity understandable without concentrating on possible philosophical implications. Clearly, I welcome their being investigated and with my sympathy for the ideas of Mach, I shall observe your endeavours with interest.'

23 See G. Ryle, *The Concept of Mind,* (Penguin, London, 1963) p.36; also R. Rhees, in *Wittgenstein: The Philosophical Investigations*, ed. Geo. Pitcher, (Macmillan, London, 1968) p. 267.

24 J.L. Austin, *Sense and Sensibilia* (O.U.P. 1962); G. Ryle. *op. cit.*; L. Wittgenstein, *Philosophical Investigations,* (Blackwell, Oxford, 1967).

25 N.V. Pope and A.D. Osborne, *Proc. Phys. Interp. of Rel. Theory,* (London, 1992) **3,** p. 281.

scientifically and philosophically revising, honing and paring our ordinary and theoretical descriptions of what we observe.

3.6 The Proper Space-Time Substratum

The essential difference, then, between Normal Realism and the reactionary Realism of the anti-Positivists is that whereas for those reactionaries everything is 'theoretical' (i.e., basically speculative) except the ultimate atomic particulars and space, for the Normal Realists *everything* is basically 'theoretical' in that way *including* atomic particulars and space. By dispensing with all nonsensical talk of light-velocity (*pace* Bondi) and of a self-sufficient void isolating objects from our perceptions of them (*pace* Lewis), Normal Realism seeks, by methods of linguistic analysis, to remove from science all traces of the schizophrenia occasioned by the traditional 'two worlds' view of matter and perception. In other words, in the ontological game of ascribing existence to things, in Normal Realism everything begins on a par, including our ideas of matter, space, time and light. The 'score' is then decided, as the game progresses, by a critical process of natural selection and elimination. This process, for the Normal Realist is essentially *logical and experiential*. That is to say, unlike what the Greeks conceived as *physis* which, for the likes of Democritus and Epicurus, consisted solely of 'atoms' and space', *logos,* for the Normal Realist, consists of all sorts of entities of a purely logical nature. Examples of such entities are the ratio, *pi*, of the circumference to the diameter of a circle, the theorem of Pythagoras, harmonics in music, justice in our dealings with one another ... in fact, all those things which, throughout the ages, have concerned students of logic, mathematics, music, ethics, geology, psychology, sociology, philosophy, religion – and, of course, physics and mechanics.

The stage, then, is now set, in Normal Realism, for referring quite unproblematically to *objects,* our *perceptions* or *ideas* of those objects, the *spaces* between them - even *voids* and *vacua* - all in the straightforward, ordinary-language sense that we have defined. Also, since perception is not self-supporting (except in cases of sheer hallucination or in theories of subjective idealism), we may sensibly refer to a residual class, or *substratum* of unperceived and perhaps unknown things, without falling into the anti-Positivist trap of 'Realism'. It is in that ordinary-language sense of dealing with things that are *relative* to perception without being *confined* to perception - far less alien to it, as in the 'hidden mechanisms' view of the Realists - that we now speak of *space, time, matter* and *motion*.

4. GRAVITATION AND INERTIA

In our Normal Realist aim of honing and paring over-elaborated conceptions, our first candidate for revision will be the classical idea that all force-free, or 'inertial', motion is rectilinear and that all non-rectilinear motion is evidence of the existence of unseen 'forces' propagating *in vacuo* – unseen in the sense that their existence is only an arbitrary inference from the observed motions of bodies and undetectable by any object supposedly under their influence. So our aim, thus far, is similar to that of General Relativity, in which the 'natural motion' of a freely moving particle is along a *geodesic* determined by the overall four-dimensional geometrical world-structure. On the

macroscale, the geometry of our system will therefore not differ significantly from that of General Relativity. However, that geometry is given a different philosophical interpretation, because the mathematical holism of General Relativity assumes a metaphysical God's-eye-view of a universe which is Euclidean when there is no matter present. From the Normal Realist standpoint this is just another example of false 'Realism', because in this limit of no mass the natural motion is supposed to be Euclidean, but in that limit *there is nothing to move.* What is supposed to 'move' is a mathematical point-source, not a physical object. So according to Normal Realism, the concept of rectilinear free motion, in both Newtonian and Einsteinian physics, is just another conundrum.

4.1 Newton's First Law Revisited

An alternative to this is Aristotle's interpretation of motion, which is that all force-free motion is basically cyclic. Much of Aristotle's original argument is undoubtedly lost in translation but the logical gist of it, we think, was as follows.

Free motion is, by definition, non-interrupted motion. But motion in a straight line, if it is not infinitely long (which was an absurdity to the empirically-minded Aristotle) has to begin somewhere and end somewhere. That is to say, it is *interrupted*, hence not free. So the only *free* motion for Aristotle, was in a closed cycle, which has no distinguishable initial nor final point. Moreover, since motion is always *relative* and since any real thing to which motion relates has mass, there are always at least two masses implicitly involved in any description of motion, the moving mass and the reference-mass, which makes motion, basically, a paired-body concept. In that case, all 'momentum' is implicitly *angular* momentum, in which bodies are automatically paired and *balanced*. It is only in the special case of a theoretically infinite angular momentum of a freely moving finite mass that the trajectory is straight in the way Newton and Einstein envisaged. Otherwise, for natural motion in general all bodies seek to move, if allowed, in closed orbits or trajectories with respect to one another (that is, geodesics) of the sort we observe in astronomical space.

If we accept this alternative, 'Aristotelian' interpretation, then we no longer have to think that bodies weigh what they do at the earth's surface due to being pulled towards the centre by some mysterious 'force of gravity'. We simply assume that at their distance from that centre they have insufficient angular momentum, even at the equator, to orbit freely ('weightlessly') at that point. The force they exert on a weighing-scale is thus, simply the force of their reaction against being prevented by the earth's surface from orbiting where they otherwise would, with the angular momentum they have, much closer to the earth's centre.

4.2 Varying 'G'

In Newtonian physics the angular momentum **J,** of a particle P of mass *m*, in an orbit about a point O is given by

$$\mathbf{J} = \mathbf{r} \times m\mathbf{v} \qquad (2),$$

where **r** is the position vector of *P* and **v** is the velocity of P relative to O*,* at any instant of time. The rate of any change in the angular momentum signifies the measure of an

externally applied torque. Otherwise, with the sum of all external torques reduced to zero, the angular momentum is constant in time and the trajectory lies in a plane. In general it follows, by Newton's third law (as an example of classical holism) that the total angular momentum of any number of particles in an isolated system is constant.

None of this, however, entails that the trajectories of freely moving particles should form Aristotelian closed orbits, which is why Newton had to introduce the notion of an *in vacuo* force of 'gravitational attraction' to explain the natural tendency of all masses to move around one another in closed trajectories (elliptical orbits) of constant angular momentum. However, if constant angular momentum does not entail that a trajectory should be closed, then neither does a closed orbit entail the existence of Newton's inverse-square 'attractive force'.

Moreover, Aristotle and Copernicus have been accused of being 'unempirical' in assuming that the free motion of bodies such as stars, planets and satellites is circular. Nowhere in nature, say the empiricists, are freely moving bodies found to travel in perfect circles. But if that is so, then how much more unempirical was Newton's assumption that natural, force-free motion takes place in perfectly straight lines!

Normal Realism eschews idealistic perfectionism on both counts and accepts, instead, the observational evidence as it stands, that all uninterrupted free motion is basically neither circular nor rectilinear but simply *orbital*.[26] The philosophical point we would make, therefore, regarding Newton's theory of gravitational motion is as follows.

In declaring inertial motion to be naturally rectilinear, Newton was implying that orbital motion is 'unnatural'. He therefore had to follow this first arbitrary assumption with two more. His second assumption, accordingly was that the observed tendency of all freely moving masses to orbit one another is due to an *in vacuo* force of 'gravitational attraction' between masses universally, the magnitude of which is directly proportional to the product of their masses and inversely proportional to the square of the distance between them. His third assumption, made necessary by these first two, was that orbiting bodies remain separate in the way they do due to the balance of equal but opposite 'gravitational' and 'centrifugal' forces. In general, for any closed orbit in a plane, this balance is expressed by

$$mr(d\theta/dt)^2 - md^2r/dt^2 = GmM/r^2 \qquad (3),$$

where m is the mass of the body moving with angular speed $d\theta/dt$ in an orbit around a mass M, r is the distance between m and M at an instant and G is the usual gravitational constant. For the sake of simplicity in developing our philosophical argument we confine our discussion to that of circular orbits, though our arguments are by no means confined to the same. In that case, this balance is expressed in Newtonian fashion as

$$mv^2/r = GmM/r^2 \qquad (4)$$

where v is the speed of the body.

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26 This, of course, includes not only elliptical motion as in Newtonian physics but also quasi-elliptical motion with perihelion shift as in General Relativity – and, indeed, any orbit that may occur in many-body situations.

This reasoning is as logically circuitous as it is unempirical. Yet Newton's system works. His laws can be implemented to a high degree of accuracy and that has generally (albeit fallaciously) been regarded as proof of the correctness of Newton's assumptions. Had he been more of an empiricist he might have begun instead with the empirical *fact* that there are no forces manifest in natural orbital motion. The minimal interpretation of this would then have been that all inertial motion is, as it everywhere appears, naturally orbital (*pace* Aristotle). His single 'gravitational' assumption might then have been expressed as

> All bodies in natural force-free motion tend to orbit one another with constant angular momentum, such that the force required to remove any one of those bodies from that orbit is directly proportional to the product of the masses of the two bodies and inversely proportional to the square of the distance between them.

In this alternative interpretation, the true (i.e., measurable) force is not concealed in the natural orbit of the particle but is *revealed* in the *difference* between that natural orbit and an 'unnatural' one – i.e., some state of motion or rest in which the particle is held by the use of a measurable force with magnitude F. Thus we have

$$F = (GmM/r^2) - (G'mM/r^2) = (mM/r^2)(G - G') \qquad (5)$$

where G' is now the 'unnatural G' for the 'unnatural' (i.e., constrained) orbit. Otherwise, for a natural force-free orbit we have $G' = G$ and $F = 0$.

The orbital centrifugal force for that same ('unnatural') orbit, if circular, is

$$F = (mv^2/r) - (mv'^2/r)) = m/r(v^2 - v'^2) \qquad (6)$$

where v is the speed of m in a natural orbit at that radius and v' is its speed in the 'unnatural' one.

The following is an example of how these formulæ work in practice. Let M be the mass of the earth (i.e., 5.976×10^{24} kg) and m a one-kilogram mass resting somewhere near the earth's equator. With the earth's equatorial speed $v' = 464.74$ metres/sec) and the earth's mean radius $r = 6.372828 \times 10^6$ metres,[27] the centripetal force with which the one kilogram mass m presses on the surface of the earth is, according to (6), 9.79 newtons. This compares with the value 9.80665 newtons given by BSI (April 5th, 1988) for the force required to act on a standard weighing-scale for that scale to register one kilogram.

Now since there is, *ex hypothesi*, no longer any real distinction between gravitational and centrifugal force, the force expressed in (6) is the same as expressed in (5), so that

$$[(GmM/r^2)-(G'mM/r^2)] = [(mv^2/r) - (mv'^2/r)] \qquad (7).$$

Also equivalent are the bracketed expressions containing the primed variables on both sides of this equation. So in the case of natural orbits (7) reverts to the standard Newtonian equation (4). From (2) and (4) it follows that the magnitude of the angular momentum J, of a freely moving particle in circular orbit is given by

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[27] These values are for an ideally spherical earth, whose oblateness and so on are neglected for reasons of simplicity.

$$J = mvr = GmM/v \qquad (8).$$

Here it can be seen that, for fixed G, m and M, as $J \to \infty$ $v \to 0$ and $r \to \infty$. This gives us our alternative interpretation of natural orbits according to which what keeps bodies where they are in free orbit is not the two classical 'equal and opposite forces' but simply the equivalence of the expressions for the magnitude of angular momentum in (8). This implies that if all the angular momentum between all the particles miraculously disappeared, everything would collapse together, not because of any special 'force of gravity', as in what cosmologists call 'gravitational collapse', but simply because of the lack of the *angular momentum* that normally separates them.

The natural orbit of any particle may therefore be thought of as the geodesic the particle describes when all restrictions on its motion are removed – that is, when the particle moves freely under the influence of nothing but its own (angular) momentum or inertia. In other words, the geodesic is the plot, in the angular momentum field of as many particles as are involved, of those points where the sum of all *real* forces acting upon the particle is zero.

Now the practical matter of actually plotting geodesics – the so-called 'many-body problem' – is notoriously difficult and it must not be supposed that our aim, here, is to offer any superior way of solving that practical problem. At this stage, therefore, our suggested philosophical departure from the standard, Newtonian account of orbital motion may, perhaps, seem trivial. However, as we shall see, that is not so. For a start, the metric of these plots of zero force, when corrected for the relativising of the measures involved, is precisely that of a 'world-line' in the Einsteinian 'space-time substratum'. However, that is only on the macrophysical level. In our new departure there is, ultimately, no spatial geometry or 'continuum' to be 'warped' or whatever in between one world-line and another in the way that was envisaged by Einstein and Minkowski. At the ultimate microphysical level the world-lines are as discrete as the particles forming them, and any idea of a self-extended metrical 'void' at that fundamental level, containing and separating them, is null and void.

Nor is there any *temporal* continuity in our world-lines, of the kind that characterizes the Einstein and Minkowski 'geometrical' approach. Since angular momentum is ultimately quantized in discrete action-events of $h/2\pi$ that unwanted *determinism* disappears and the usual clash between relativity and quantum physics on that score is thereby avoided.

Now the fact that the masses and velocities in (4) are *observational* measures makes that formula, in the Machian sense, *relativistic*. The formula is also, however, Newtonian insofar as the reciprocal influences of the masses on each other, in Normal Realism, are proper-time instantaneous (that is to say, there is no longer any 'Einstein-separation' to contend with – *vide* section **3.3**).

The fact that we are now dealing, holistically, with naturally balanced angular momentum (in quantum 'blips' like the 'photons' described in **3.3**), instead of time-retarded causal interaction as the reason why bodies influence one another at a distance in the way they do, commits us to predictions of a sort which are distinct from those of the 'gravitational' hypothesis. One of these concerns the necessity of including in the orbital

equation (8) the effect of additional forms of angular momentum, such as spin. This may be seen as follows.

Substituting for *mvr,* in (8), the dimensional equivalent $2Kr/v$ where K is the orbital kinetic energy, produces

$$J = mvr = 2Kr/v = GmM/v \quad (9).$$

Let us assume, then, to begin with, that (9) holds only for bodies like the earth, moon, and so on, which have no proportionally large auxiliary energies of a direction-coordinated kind, such as that of spin. For orbiting bodies which do have significant such energies the formula is then, by hypothesis,

$$J = mvr = 2(K + K_X)r^*/v^* = \mathcal{G}mM/v^* \quad (10),$$

where r^*, v^* and $\mathcal{G}$ are the (hypothetically) changed values of r, v and G, and $\mathcal{G}$ approaches G as K_X approaches zero.

4.3 The Redundancy of 'Field-Forces' and Geometrodynamical 'Substrata'.

If these arguments are correct, then there is no necessity for thinking of bodies being attracted and repelled by *any* sort of invisible *in vacuo* field-forces. From the Normal Realist point of view, these forces and force-fields are as fictitious as 'light *in vacuo*'. Nor is there need to postulate the existence of any Minkowskian substratum determining those geodesics, as in General Relativity. This is because, by the principle of conservation of angular momentum, on both the macro- and micro-physical scales, if the orbital interrelation of any pair of masses changes, then the effect must be felt *immediately* (in relativistic proper-time, *pace* Lewis) throughout the rest of the system, by Newton's third law – that is, by contiguity, without that influence having to be conveyed by 'æthers or 'fields' of any kind. There is thus no question of anything like an 'æther wind' resulting from motion. Nor is there even any 'Einstein separation', so there is no vexing question of 'locality versus non-locality', as in the notorious 'EPR' issue.

This Normal Realist approach therefore includes General Relativity to some extent. That is to say, in Normal Realism, as in General relativity, the natural orbits are produced by the holistic equilibrium of the geometric system – a consequence of Einstein's General Theory which is at odds with the 'Einstein separation' of his Special Theory. Also, since angular momentum is ultimately quantized, although the geodesics defined in our angular momentum terms are, geometrically speaking, not unlike those of General Relativity, they are not determinate, as in that theory, but fundamentally stochastic or *probabilistic* –which, of course, implies an information-theoretical approach to physics as opposed to the classical mechanistic approach. (Of course, on the macrophysical level it is a mathematical convenience to treat these geodesics as continuous curves in the usual way.)

We have also to consider the fact that any energy ascribed to a particle in the conventional form of a '*vis gravitas*', '*vis inertiae', 'vis electrica*', '*vis nuclea*' or whatever has to be ultimately cashable in the same energy-units, currently joules. So it seems a roundabout way of thinking (albeit understandable in view of the circumstances of history) to measure the motions of bodies in mechanical units of joules, ascribe strange

static powers to the objects concerned (in volts, farads, oersteds coulombs and so on) and then demonstrate those unseen powers by measuring their effects on the bodies in joules. To measure all those 'powers' directly in mechanical units of joules thus has the advantage of economizing on hypotheses. Every 'power', of attraction, repulsion or orientation of any object then becomes just an *energy,* either of the object as such or of the parts of that object, the parts of those parts and so on, as factors in the balance of the overall energy equation.

Here is an example of how such additional energies, in plain joules, may affect the orbital parameters of free-moving particles according to formula (10). It should now be clear that the usual conception of 'electrostatic force' can have no place in Normal Realism. On that understanding, let m and M in (9) have the values $m = 9.109534 \times 10^{-31}$ kg and $1.6726486 \times 10^{-27}$ kg, respectively, and let J in that same equation be the angular momentum quantum $h/2\pi = 1.054588721 \times 10^{-34}$ joule sec. The fact that these are the standard parameters of the circular orbit of the 'electron' around the 'proton' in the Bohr atom should not, therefore, inveigle us into thinking that the discussion, here, is about 'electrodynamics'. Our aim, it needs to be stressed, is to demonstrate philosophically how those orbits which Bohr calculated in terms of Newtonian dynamics laced with the electrodynamics of Faraday, Maxwell, Coulomb, *et al.*, could logically have been derived from Newtonian orbital dynamics alone, simply by altering the value of G. Nor should we be led into supposing that what is being proposed here is some new concept of the atom to compete, in terms of practical efficacy, with those current physics models which have superseded Bohr's. Our reason for choosing the Bohr model is simply because, as Sutton says,[28] "Bohr's theory of atomic structure, whatever its limitations, is a good example of the application of basic physics principles."

So it needs to be stressed and stressed again that this is not primarily an exercise in up-to-date physics but is essentially a logical demonstration of how our concepts of motion and distant interaction might have developed in direct observational terms without postulating invisible vacuum-spanning intermediaries such as 'gravitational force', 'coulomb force' and so on linking one atom or part of an atom with another.

On that clear understanding, with the values of m, M and J the same as in the Bohr model (ground-level orbit), let the smaller mass m move freely in a circular orbit around the larger mass M with that angular momentum J. The orbital speed of m, according to (9), would then be $v = GmM/J = GmM/(h/2\pi) = 9.64 \times 10^{-34}$ m/s at a distance $r = h/2\pi mv = 1.2 \times 10^{29}$ metres in a time $t = 2\pi r/v = 7.8 \times 10^{62}$ seconds. On that huge scale of distance and time, obviously, any practical difference between this natural orbital motion and Newton's imagined straight-line 'inertial' motion is insignificant.

However, without changing the value of the orbital angular momentum J let us now impart to those freely orbiting masses some extra, direction-coordinated, kinetic energy K_X. For the sake of simplicity we shall provisionally interpret that additional kinetic energy as a 'spin' on the part of the mass m in the same plane as the orbital

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28 R.M. Sutton, *Enc. Brit.* (1961) **17**.871c).

motion. Let that purely mechanical energy K_X be equivalent to hcR,[29] the kinetic energy, in joules, required to ionize the hydrogen atom (that is, $hcR = I_0 e$, where I_0 is the conventional ionization-potential in volts and e is the conventional electron-charge in coulombs. Since e is negative, then so is hcR, whence positive hcR is the kinetic energy of the 'electron' in the Bohr orbit a_0.[30]) Although that is not a large kinetic energy by ordinary standards it represents an enormous increase in the overall kinetic energy of *m in* (10) since m's orbital energy K in the above case was only 4.23×10^{-97} joule, whereas $K_X = 2.18 \times 10^{-18}$ joule.

Be that as it may, J is now given by (10), where $K + K_X \approx K_X$. So, for the same orbital angular momentum we now have, due to the added spin kinetic energy K_X of m, the following new values of orbital speed and radius:

$$v^* = [2(K + K_X)/m]^{½} \approx 2.19 \times 10^6 \text{ m/s}$$

and

$$r^* = J/mv^* \approx 5.3 \times 10^{-11} \text{ m.}$$

Easily recognizable as equivalent to the ground-level speed and radius in the Bohr atom,[31] these equivalents of the Bohr values have now been deduced in purely mechanical terms, simply from the mass and the maximum kinetic energy of the orbiting particle in the Bohr model but without involving 'electrostatic charge', 'coulomb force', the 'permittivity of free space' or any concept of that conventional kind. These classical measures have all been replaced by angular momentum and its internal parameters.[32] Knowing the value v^* of the new orbital speed for the spin-energized particle we simply calculate, according to (10), the value of $\mathcal{G}$ which, for those particular parameters is $\mathcal{G}_C = Jv^*/mM = 1.52 \times 10^{29}$ N m^2 kg^{-2}, where $\mathcal{G}_C$ may be referred to as the Coulombian (as opposed to the Newtonian) G.

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29 In this expression, R (= 1.097373177(85) × 10^7 m^{-1}) is the ideal Rydberg number, or wave-number coefficient for hydrogen, that is, for a theoretically infinite (i.e., relatively stationary) nuclear mass. Multiplying R by c expresses that limit in terms of frequency (*i.e.,* $cR = 3.289842024 \times 10^{15}$ s^{-1}) and multiplying that frequency by h expresses energy in joules.

30 H. Blanchard, C.R. Burnett, R.G. Stoner and R.L. Weber, *Introduction to Modern Physics,* (Pitman, London, 1969), 165, 487.

31 I.e., from the equivalence, in Bohr's theory, of electrostatic and centrifugal force, $e^2/(4\pi\varepsilon_0)r^2 = mv^2/r$ with $r = 5.29 \times 10^{-11}$ m (the standard Bohr radius) and $v = 2\pi r/t = [e^2/(4\pi\varepsilon_\theta)rm]^{½} = 2.19 \times 10^6$ m/s.(See Blanchard, et al. *op. cit.*, 161.)

32 We have, of course, not included, here, any discussion of quantized energy-levels, as in the Bohr atom, apart from that of the single quantum $h/2\pi$. which is the angular momentum of the orbiting particle at maximum (i.e., ground-level) kinetic energy hcR. This discretisation of the spectral levels of hydrogen, interpreted according to Normal Realism, is dealt with in N.V. Pope, 'Abstract: Is Relativity Quantised', Spec. in Sci. and Tech. **9** 4 (1986)242; also in N.V. Pope, Schools Sci. Rev. **71** 256 (March 1990) 105-107 and in N.V. Pope and A.D. Osborne, 'The Action-at-a-Distance Spectrum', *Proc. Phys. Interp, of Rel. Theory*, (London, 1992) p. 530.

It is easy to see, then, from these angular momentum equations, how ordinary bodies into which these mass- elements m and M are separated 'attract' one another with an inverse-square 'coulomb-force' $F = \mathcal{G}_C mM/r^2$. If the energy hcR were subtracted from, rather than added to the orbital energy K in (10), then the sign of $\mathcal{G}_C$ (and of v^*) would be negative and the masses, instead of being 'attracted' would be 'repelled'. Our Normal Realist mechanical paraphrase of that 'coulomb force', therefore, is simply the measured force required to keep apart, at a distance of one metre, opposite amounts of 6.24×10^{18} of these mechanically energetic (e.g., spinning) particles, m and M where that number of particles represents the conventional so-called 'charge' of one coulomb.

The reason, of course, for this huge increase in the 'constant' G is the relatively enormous amount of spin kinetic energy we have added to the micro-particle m. What we now need to ascertain is the extent to which, *ex hypothesi*, similar internal mechanical energies on a more moderate scale affect the orbital parameters of bodies in general. Whether such more moderate effects according to (10) are ordinarily detectable may be judged from what follows.

In section 4.2 we discussed the case of M being the mass of the earth and m a one-kilogram mass resting at the equator, so that its angular momentum in that state is the product of its mass, the equatorial speed (of 464.74 metres/sec) and earth's equatorial radius. Because some of the differences to be predicted are so minute (and because this is not an exercise in practical physics), we shall take these as ideally exact figures. Thus we take the earth's mean radius to be $r = 6.372828 \times 10^6$ metres, the earth's equatorial speed to be $v = 464.74$ m/s and the earth's mass to be $M = 5.976 \times 10^{24}$ kg. This gives us, for the one-kilogram mass, resting at the equator, an angular momentum $J = mvr = 2.96170808472 \times 10^9$ kg m^2/s. The velocity and radius of a natural orbit for this same angular momentum, according to (9) are: $v = GmM/J = 1.34644761939 \times 10^5$ m/s (about 290 times the earth's equatorial speed) and $r = J/mv = 2.199645973648 \times 10^4$ m (or about 1/290th of the earth's surface radius). The orbital kinetic energy, $K = \frac{1}{2}mv^2$ is then $9.064605958808 \times 10^9$ joules.

Let that one-kilogram mass, with the same angular momentum, J, now have a theoretical spin-energy K_X in (10) of, say, one kilojoule. Assuming that this spin is complementary to the orbital energy, we now have

$$J = 2(K + K_X)r/v^* = 2(9.064606958808 \times 10^9)r^*/v^*$$

whence $v^* = [2(K + K_X)/m]^{\frac{1}{2}} = 1.34644769366 \times 10^5$ m/s, which is 1.00000005516 times v). In that case, $\mathcal{G} = (v^*/v)G = 1.00000005516\ G$. As a result of that spin, therefore, our spinning mass should (*ex hypothesi*) weigh 0.055160 of a milligram more than a kilogram at the earth's equator.[33]

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33 These figures, of course, represent the maximum values predicted, which are for spins in the same plane as that of the earth's equator. In general, the magnitude of K_X will depend on the orientations with regard to one another of the various spin angular momenta.

Some recent attempts to detect such spin-effects were carried out by, for example, by Hayasaka and Takeuchi in experiments with spinning gyroscopes.[34] However, the change in weight reported by these experimenters is far too large to be feasible, being over 3000 times larger than our thesis predicts. We must therefore conclude, with A.A. Watson,[35] that those reported results lie too much within the margin of error. It is to be noted, also, that Jim Faller and his NIST team,[36] in repeated experiments, failed to observe any such anomalous reduction in weight of the spinning gyroscopes. That negative result, for the masses and spins used, is more in line with what we predict.

5 THE NON-LOCALITY of INERTIA

According to our theory, then, the reason that bodies respond to one another at a distance is not because they are possessed, individually, of 'powers' generated within them (i.e., 'locally') which shoot out and travel blindly on until they happen to hit something.[37] The interaction has to be immediate and reciprocal because for a mass on one end of a moment-arm to move without immediately affecting the other would be a miracle of non-conservation of the holistic angular momentum that both interrelates them and keeps them apart. Physically, these interrelations are of the Lewisian, proper-time-instantaneous sort we have already described and they take place in accordance with Newton's third law of motion. That is to say, in Lewisian terms the agent and reagent particles are physically *touching,* so there is no question of any 'vacuum' having to be bridged in that interaction. Nor is there any problem of *how* those particles interact in that instantaneous fashion at their distances apart because those distances, as already explained in section **3.3**, lie not in those quantum interactions themselves – which, being 'null-geodesics', are virtually punctiform – but in co-occurring sets or informational patterns of those punctiform interactions from which, in observation, distance is projected.

In Normal Realism, then, quantum interaction, is conveyed by the most easily understood sort of action-transfer, namely, *contiguity* which, as it transpires, is what 'action-at-a-distance' really is. What are customarily called 'electromagnetic waves' are no part of these Lewisian, discrete and contiguous interactions as such. Those 'waves', more suitably called 'probability-waves' – or 'probability wave-functions' – consist of informational *sequences* of these punctiform interactions, which propagate among objects in observer-projected or phenomenal space-time (not '*in vacuo*') in the geometrical phase-related way Schrödinger has described.[38] Normal Realism, of course, eschews the usual 'Realist' interpretation of these wave-functions as having some underlying or 'hidden' continuity, of which the actual quanta are observational 'surfacings' caused by some metaphysical sort of 'wave-functional collapse'. So far as Normal Realism is concerned, the observational or processes are sufficiently described in terms of probabilistic

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34 H. Hayasaka and S. Takeuchi, Phys. Rev. Lett. **63** 25 (1989) 2701.

35 A.A. Watson, Nature **344**, (1990) Letters.

36 M. MacCallum, New Scientist (Feb. 1990) 30.

37 T.E.Phipps Jr. vividly describes this as the 'Dick Whittington' model of light-propagation, *op. cit.,* p. 79.

38 C.H. Blanchard, *et al.*, *op. cit.,* p. 178.

sequences of discrete observational quanta, with no need whatsoever to postulate 'underlying mechanisms' or 'hidden variables' of this 'wave-dynamical' or any other kind.

5.1 Proper Inertia

This holistic requirement for angular momentum conservation is therefore, so far as we are concerned, what makes every freely moving bit of matter move in proper-time-instantaneous response to each and every other in accordance with Newton's third law, in the way that Phipps,[39] Graneau,[40] Assis[41] and others have suggested along the lines envisaged by Mach. This, with certain reservations to be explained in the following section, reinstates in relativistic terms the *absolute simultaneity* of Newtonian physics. By reason of the conservation of energy, angular momentum and so on it can therefore be said, without absurdity, that in rising from a chair one is simultaneously shifting the balance of the earth and all other objects throughout the solar system and beyond.[42] This, by Lewisian proper-time-instantaneous and reciprocal reaction, which we may call *quantum contiguity*, is what makes it such an effort to rise and prevents one's body from zipping about all over the place, as it undoubtedly would if the balance of angular momentum between one's own body and other bodies were not, in this 'Newtonian' manner, strictly and immediately conserved.

This proper-time-instantaneous angular momentum nexus therefore supports vision in giving us as much objective assurance that we are not alone as when we feel the crush of bodies against us in a crowded lift.[43] Moreover, the fact that the proper distance and proper time of a quantum interaction, be it dubbed 'photonic', 'gravitonic', or whatever, are zero in every observational reference frame makes those measures *invariant* in the sense of Einstein and Minkowski and provides, in quantum-contiguous terms, something like the 'universal simultaneity' of classical physics.[44]

5.2 The Relativistic *Intransitivity* of Proper-Time Simultaneity

This, however, is where all similarity with classical physics ends, because classical physics characteristic- ally assumes two things which can have no place in our thesis. One is that time ticks away everywhere in cosmic unison, not only in objects but also, absurdly, in the spaces between. The other is that if an event *A* is simultaneous with other

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39 T.E. Phipps Jr., Spec. in Sci. and Tech. *ibid.*

40 P. Graneau, *ibid*.

41 A.K.T. Assis, *ibid.*

42 Because these inertial interactions are uniformly immediate, it makes no difference whether the bodies concerned are near or far, as Assis has confirmed. (See Footnote 41)

43 The fact that this does not render us completely immobile in the way the Eleatic Greek philosophers, Parmenides and Zeno, envisaged entails either that the number of bodies with which we are in contact in this way is not infinite or that we are not in contact with everything simultaneously – or, of course, both.

44 This answers the puzzle, as stated by P. Graneau Spec. in Sci. and Tech. **13**, 3, (1990) 191: 'The universe we feel in having to overcome inertia is the present universe, while the universe we see with our eyes is, of course, very ancient'. As we now see, in quantum- contiguity terms these different sorts of quantum interaction are uniformly instantaneous.

events B, C, D, ... etc., in the quantum-contiguous manner described in the previous section, then B, C, D, ... etc. are also, necessarily, simultaneous (quantum-contiguous) with one another. Both of those classical assumptions are demolished by relativity. If you shine a light at a set of mirrors positioned at different distances from each other and from the source, then the 'kick' of your light-source and the jolt of each mirror is, in quantum-contiguous terms, one and the same.[45] However, for those mirrors to signify to one another that they are reacting in that way they have to become *secondary* sources and recipients with regard to one another. In each of these secondary interactions the secondary source and secondary recipient are in contact in the same way as in the first instance. However, 'secondary' signifies *sequence*; so in dealing with those secondary interactions we are dealing with *time-sequences* of quantum-contiguous interactions – that is, with the time-extrapolation of those patterns of co-occurring quantum-contiguous events we call space, as explained in section **3.3**. If everything is relatively stationary, then for any one of those recipients the source is at a distance s_S and a distance-time s_S/c and each of his fellows is separated from him by some other distance-time s_M/c. So the time at which he sees the reflection of the source in another mirror will be $(s_S/c)+(s_M/c)$ from a time-zero set by his own time of seeing the source minus its distance-time s/c relative to himself, as in the conventional 'speed of light'. Since all these distance-times are different, then it follows that although in each of those interactions the seeing (and feeling) are proper-time-instantaneous, those different, discrete instantaneities are not necessarily simultaneous with one another.[46] Add to this the fact that due to relative motion, time at these places progresses at different rates and we see that there is no transitivity whatsoever in the relation of simultaneity. That presents no paradox because time progressing everywhere at different rates is what relativity is all about, which makes it such a radical revolution in thought.

6. THE SPATIO-TEMPORAL NON-CONTINUUM

There is, then, no possibility of establishing an absolute or cosmic 'GMT' by means of proper simultaneity – which, of course, disposes of the classical physicists' 'universal' or 'God's-eye-view' of things that is as inimical to relativity as to quantum theory. The classical idea that time ticks away everywhere all at once is therefore an absurdity because even if a universal now could be established, the time-*flow* between one such now and the next will be different for all relatively moving things.

That is where the essential difference lies between the proper relativistic way of thinking and the classical way. Given that distance is time in the ratio of units c and that in moving, bodies consume that distance-time as well as time, it would be a geometrical miracle if there were any simultaneity of the classical kind. The geometry of our Normal Realist substratum is thus, as we have already said, similar to that of General Relativity insofar as it is the non-Euclidean four-dimensional geometry of our free angular momentum geodesics. Also, on the macro-level the same vector and scalar considerations

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45 N.V. Pope and A.D. Osborne, Phys. Ess. *op. cit.* See Fig. 3, 415.

46 These quantum instantaneities may, of course, be simultaneous in the sense of *co-occurring* at a single location (e.g., that of the observer, as explained in section **3.3**).

apply to those geodesics as in General Relativity. However, we see that there is now no meaningful way of referring to this meta-geometry in the predeterministic manner of the followers of Einstein and Minkowski. In other words, in our theory there is no geometrical space-time *continuum*, analogous to a blackboard or graph-paper, be it flat or 'warped', or of however many dimensions, on which those geodesics might be traced. So a microphysical particle in between one quantum transaction and another has no determinate or definable space-time trajectory. At the ultimate microphysical level there can be no sensible question of where that particle is, what it is doing, where it is going, what its 'world-line' is, or whatever, in between one quantum manifestation and another. Indeed, to think of there being a *particle* as such at that absolutely fundamental level is, from the Normalist point of view nonsense. All we have at that level are *events*. Only physical bodies *as wholes* have the temporal continuity we ascribe to matter, not their 'ultimate particles', far less the space or space-time between them.

It follows, then, that existential continuity, in our theory, cannot be anything but *statistical*. The metric of this phenomenal space, according to Normal Realism, is therefore quantized or discretised, not continuous. It is indeterminate, not determinate; information-theoretical, not mechanical. So the fact that these ultimate observational interactional events (photonic, gravitonic or whatever) are now common to both object and observer, while it reinstates in relativity the holism that is required by the classical conservation laws, does not predestine the motions of objects in the *Holistic* manner of classical physics and General Relativity. Our holism consists of overall-conserved, stochastic to-ings and fro-ings of proper-time- instantaneous quantum transactions between angular momentum systems – as in a coin-currency where, although bound by the holistic rules of the economy (a coin cannot come into or go out of circulation without affecting the values of all rest), people may spend or save as they please.

7. SUMMARY

Since the advent of Einstein's Theory of Relativity, the physics community has been split between two factions. On the one hand are those whom Graneau calls the London Group,[47] who follow Herbert Dingle in adhering to Newtonian physics with its absolutely simultaneous time-flow and universal action-at-a-distance. On the other hand there is the Einsteinian group who see physics as based on so-called 'retarded' action limited by the velocity of light. In our analysis this partisan divisiveness is unnecessary, because when the linguistic confusions are tidied-up these Newtonian and Einsteinian aspects of physics are seen to be two sides of the same relativistic coin.[48] To describe the motion of a body in the Einsteinian way is to express its velocity as the optical distance over which it travels divided by the time taken according to your observatory clock. To describe that same motion in the classical or Newtonian way is to express the velocity as that same distance divided by the time registered by the *body's* clock. Both observational

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47 P. Graneau, *ibid*. 193.

48 N.V. Pope and A.D. Osborne, *op cit.*, 414, Plate 2.

descriptions of that same motion are equally valid. In the one all velocities are asymptotic to *c*; in the other they may increase without limit, as in classical physics.

By the same token, the same distant interaction which in the Einsteinian quantum-*sequential* terms takes place at the 'finite speed *c*', in the Newtonian, quantum-*contiguous* terms takes place instantaneously. The fact, then, that in its Newtonian aspect the interaction is in perfect accordance with Newton's third law means that it is so, likewise, in its Einsteinian aspect. The contentious issue of *either* Einsteinian 'retarded' or Newtonian 'superluminal' interaction, of light, gravitation, inertia or anything else, is therefore spurious. For anyone who fully understands relativity (and for the philosopher Mach, that would have excluded Einstein) distant interaction takes place *both instantaneously and at the 'finite speed c'*. The so-called 'superluminal' nexus between distance-separated bodies is supplied by light itself.

The 'bottom line', then, in any study of physics, according to Normal Realism, is simply the direct observational (and philosophically unproblematic) study of bodies and their behaviour in relation to one another. The *space* in which these bodies are placed, move and so on, is the space of ordinary phenomenological projection. In that space the geodesics described by the angular momenta of bodies are as defined by a space-time metric of General Relativity, except that in our observational metric every 'freely moving particle' defines its own ultimately discrete and unique space-time world-line. These world-lines relate to one another, not in any continuous 'geometrical' way but only via those discrete and instantaneous quantum-transactions we have described, each of which is a rudimentary 'observation/ communication' (i.e., bit of cosmic *information*). To talk about the shape, direction or any other quality of the world-line of any microphysical particle in between one quantum manifestation and another makes no more sense than to talk about what a photon does 'in the void' between its emission and absorption. All we can sensibly talk about is the comparative proper-time length of a geodesic between one manifestation (i.e., interaction- event) and the next. Those proper-time lengths are therefore a relativistic function of the observational motions of bodies as wholes, not of those microphysical bits that are the observational irreducibles, the terminals of all physical analysis.

The situation we project therefore, as opposed to those of classical physics and Einsteinian relativity, is one of intrinsic *indeterminacy* of the sort described by Heisenberg. It thus entails, as we have said, a radical shift in approach to physics, away from traditional mechanist-determinist modes of explanation towards a stochastic, or *information*-based approach. In this new approach, as already stated, it makes no more sense to ask what mechanically, geometrically or mathematically determines the connection between one quantum-event and another than to ask what mechanically, geometrically or mathematically determines the sequence of characters in this sentence. To accept that intrinsic indeterminacy or stochasticity of things as the starting-point of physics, is to abandon, thereafter, all prospect of 'atomistic' explanation. The reason why the characters appeared in this sentence in the order they did was simply and unproblematically because the writer *intended* it that way. In the sort of theory we are prescribing, it is plain that wholes do not necessarily 'evolve' out of anything even analogous to mechanical collisions among 'fundamental particles'. It is no less plain that in many cases, causality goes as much from wholes to parts (i.e., cybernetically) as from parts to wholes (e.g., mechanically). Just one physics example of this is the sort of whole-

to-part direction of causality that takes place in 'interference' experiments of the sort conducted by Thomas Young; that is, in the way photonic events distribute themselves on the screen in strict accordance with the laws of overall energy-conservation. Another obvious example is the way in which the balance of the orbits of the planets, the stars, galaxies and so on, is automatically maintained in accordance with both the law of angular momentum conservation and Newton's third law. Yet another example is the way in which one's thoughts and ideas determine, albeit 'mechanically', via one's nerve-circuits and muscles and so on, where one's car goes or how the ink-atoms are distributed in a piece of writing. And if those wholes which commonsense calls 'intentions' seem to act from future to past, then that is only because by the nature and definition of stochasticity (guesswork) the probabilities of future physical events are presently calculable on a scale from nought to one and that there are organisms capable, to some greater or lesser extent, of making such calculations and acting accordingly (cybernetically). It by no means involves either mysteriously 'travelling into the future' or miraculously breaching the laws of mechanics'. Indeterminacy attests that there is no mysteriously preordained 'Future' to go to nor any absolute 'Mechanical Law' to be breached. So the way the world works is more or less as commonsense everywhere acknowledges. We physically *forge* our futures according to our intentions; and whether or not that future turns out as we would wish largely depends on the wisdom or otherwise of those intentions and the effectiveness or ineffectiveness of their execution.

A science which recognizes this therefore, as we have said, reinstates alongside physical measures in units like kilograms, joules, volts, amps and so on, those ordinary commonsense values such as 'wisdom', 'responsibility', 'morality' and 'virtue' which the custodians of pre-Scientific Western culture called 'spiritual' and which they feared would be destroyed by the rise of mechanistic science. And who is to say, nowadays, that the moral foundations of our Science-based society have not been undermined in precisely that way?

So what we need, undoubtedly, is to dissolve the now defunct division between the classical and mutually suppressive extremes of 'Religion' and mechanistic 'Science' and settle for a more liberal and amicable, commonsense middle-course. With the knowledge which Relativity and Quantum Theory have given us, and without the constraint of having to regard those two idea-systems as antithetical, we may contemplate re-embarking on the free dialectical course of discovery which was once called Natural Philosophy.

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