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A New Theory on the Behaviour of Light

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A New Theory on the Behaviour of Light

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Abstract. A number of experiments into the behaviour of light gave results which have no satisfactory explanation. These tests proved that light signals, sent in opposite directions around various rotating circuits, including the Earth at any latitude, do not return at the same instant. A new explanation is proposed for these test results. From this, it follows that time and distance are absolute, not relative. A new theory on the behaviour of light is developed; this postulates that light, generated upon the Earth, travels with the Earth on its orbital path around the Sun, but does not follow the motion of the Earth as it spins upon its axis. The speed of light is thence shown not to be, in all circumstances, independent of the speed of its source. This is substantiated by a very accurate Michelson & Morley test, which yielded a difference between the East-West and the North-South directions. It is postulated that light, generated upon the Earth, travels with the Earth's gravitational field. The behaviour of neutrons and electrons is shown to be similar to that of light.

1. Introduction

This paper describes the further development of a new theory on the behaviour of light. An earlier paper (Kelly, 1995) brought that theory to the point where it was shown that time and distance were absolute, not relative. It posed the question as to how light behaved, but did not answer that problem. This paper will show that light, generated upon the Earth, travels with the Earth, as it describes its orbital path around the Sun, but does not adapt to the daily spin of the Earth upon its axis.

Sagnac, a French scientist, (1914) mounted a light source, a set of mirrors and an interferometer on a spinning disc. He showed that the time for a light signal to traverse a closed path, in a plane perpendicular to the axis of rotation of the disc, differed according to whether the signal travelled with or against the direction of spin. That test is discussed in detail in Kelly (1995).

Macek & Davis (1963) confirmed the Sagnac effect to great accuracy, by repeating the experiment using ring lasers.

The Michelson & Gale test (1925) measured the effect of the rotation of the Earth on the behaviour of light. That test will be shown to conform with the Sagnac test, where the cross- section of the Earth, at the latitude of the tests, is considered to be a spinning disc.

Recent ring-laser tests on a stationary circuit by Bilger *et al* (1995), have also confirmed the Michelson and Gale results to great accuracy.

Saburi *et al* (1976) sent electromagnetic signals between standard clock stations on Earth and showed that these signals went around the Earth slower Eastward than Westward, by an amount that conforms with the Sagnac effect.

As shown in Kelly (1995) light emitted on a moving object in the laboratory does not travel at constant speed relative to an observer aboard that object. A consequence of this is that it must be concluded that time and distance are the same in the laboratory as on a moving object. It is thence postulated that time and space are absolute. Anomalies, such as the "twin paradox", that derive from the Special Theory, are dispelled.

The Theories of Special and General Relativity do not explain, and are not relevant to, the behaviour of the light in these Sagnac-type tests. In any case, they predict results that are infinitesimal compared with the actual test results.

In this paper, a theory is put forward that conforms with all of these tests. This theory states that light, generated upon the

Earth, adapts to the orbital movement of the Earth, but not to the daily spin upon its axis. This distinction shows that the speed of light is not, in all circumstances, independent of the speed of its source.

It is postulated that light, emanating upon the Earth, travels with the Earth's gravitational field.

Neutrons and electrons give identical results to light on a Sagnac-type test. This gives rise to an interesting speculation on the behaviour of electricity.

2. Sagnac Test

Sagnac recorded a fringe shift on an interferometer, when measuring the time taken by opposing light signals to traverse a spinning disc. An illustration of the test is shown in Figure 1.

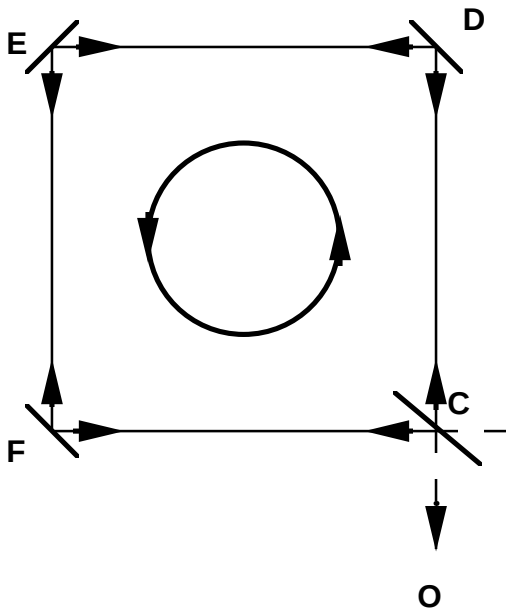

Fig. 1. Sagnac Test

A light source at S emits light to a composite beam splitter cum interferometer at C. Some of the light traverses the path SCDEFC and is reflected at the interferometer to a photographic plate at O. Some of the light goes the other way, around SCFEDCO. The whole apparatus can rotate with an angular velocity ω. The light source S, the photographic plate at O and the interferometer at C are fixed to the rotating apparatus. When stationary, the interferometer at C produces fringes (dark and bright bands). When the disc is set in motion, the fringes shift, indicating that the two light signals do not return to the point C at the same instant.

Sagnac derived the difference in time, dt, as:-

$$dt = 4A\omega / c^2 \qquad (1)$$

where A is the area enclosed by the light path, ω is the angular velocity, and c is the speed of light. The derivation of this formula for a circular path may be found in Kelly (1995). Sagnac showed that the formula applied to any shape. To obtain a fringe shift of one fringe, using a disc of 1m radius, the required velocity of the interferometer relative to the laboratory is but 13 m/s. Sagnac recorded a fringe shift of 0.07 of a fringe. Pogany, in 1928, achieved a shift of 1.8 fringes. Many explanations have been proposed (see Hasselbach and Nicklaus, 1993, where various unsatisfactory explanations are listed).

3. Michelson & Morley Test

In 1881, Michelson performed the first test showing that the speed of light as measured on Earth was not affected by the travel of the Earth on its orbit around the Sun.

The accuracy of this test was but 1:2 (i.e. 50%) and was not taken as positive proof. In 1887, Michelson & Morley (M & M hereafter) repeated the test to greater accuracy (1:40) and proved that light travels at the same speed when sent in the direction of travel of the Earth on its orbit around the Sun, as when sent at right angles to that direction.

This test has been repeated to greater accuracy down the years; Shankland *et al* (1955) list thirteen tests, culminating in a test done in 1930 where the accuracy was 1:375. In 1964, Jaseja *et al* carried out a test using infrared masers to an accuracy of 1:1000. Any theory

proposed on the behaviour of light must conform with the M & M result to this accuracy. At an accuracy of 1:1000, a velocity of the surface of the Earth of $900ms^{-1}$ should show up in an M & M-type test. The orbital velocity of the Earth around the Sun (and consequently the resulting surface speed of the Earth) is $30,000ms^{-1}$, so there is no question of that orbital movement having an effect on the speed of the light on Earth.

Following the M & M test, Fitzgerald (1889), an Irish scientist, proposed that objects contracted in the direction of their travel as an explanation that would concur with the M & M test results. Fitzgerald was unaware that his letter to Science was published, because that Journal had temporarily ceased production after he had sent his letter in 1888. Later, in 1892, Lorentz proposed the same theory, but he ascertained that Fitzgerald had been lecturing on that theory for some time and graciously acknowledged that earlier proposal. It became known as the Fitzgerald-Lorentz contraction.

4. Michelson & Gale Test

In 1925 Michelson and Gale (M & G hereafter) conducted an experiment, at a latitude of $41^{0}46'$ N, on the effect of the rotation of the Earth on the behaviour of light. They used an evacuated closed rectilinear 12 inch piping system, which was fixed to the Earth, and measured 2010ft (East-West) by 1113ft (North-South). They recorded the difference in time taken by light signals to go around clockwise and anticlockwise. The difference was measured as 0.23 fringes on an interferometer.

The M & G theoretical result was 0.26 fringes, which was very close to the actual result. This result has been largely ignored in physics texts; like the Sagnac effect it has had no satisfactory explanation. There may have been a reasonable doubt concerning the M & G test because the individual readings varied from -0.04 fringe to +0.55 fringe, with the bulk of the 269 test runs between 0.17 and 0.36 fringe. Michelson had previously attempted, in 1923, to get results in the open air over a circuit of one mile and, while fringe shifts were present, they were so unsteady most of the time that the results could not be used; the clearest fringes were to be seen for a half-hour before and after sunset.

Michelson, in 1904, had derived the same formula as later used by Sagnac (Equation 1 above); he had applied the Sine of the latitude to the result, because the circuit was level on the ground and the projection, on to the cross section of the Earth at that latitude, gives the area that is rotating once per turn, at the angular velocity of the Earth.

Michelson (1897) had carried out a test, for a different reason, using a vertical circuit of 200ft by 50ft in an East-West plane, and no fringe shift was evident; that area would give a fringe shift, due to the Earth's rotation, that would not be discernible.

The fact that, in the 1925 test, it was the anticlockwise beam that was retarded, relative to the clockwise beam, is significant. In a Sagnac laboratory test (Figure 1) the beam travelling in the same direction as the rotation is the one that is retarded. The M & G result conforms with the Sagnac test, because the rotation of the Earth, that causes the retardation, is anticlockwise when looking down from over the North Pole. That test is, in effect, a Sagnac test, with the angular velocity of the Earth, and applying the Sine of the angle of latitude to Equation 1.

The fringe shift caused by the Earth's rotation on a Sagnac disc test of 1m diameter would be 4×10^{-11} fringes at mid-latitudes, and would not be discerned. The M & G test was successful in discerning the rotational effect of the Earth by having a large enclosed area fixed on the Earth.

5. Ring-Laser Tests

The development of the ring-laser has led to a far more accurate method of measuring the Sagnac effect. The accuracy in Sagnac's time was 1:100.

In 1963 Macek and Davis carried out a Sagnac test using lasers on a rotating disc of about the same size as had been used by Sagnac. Their tests gave an accuracy of 1 in 10^{12}.

Bilger *et al* (1995) carried out a test, using a ring-laser, that was fixed to the Earth, as was the M & G piping system. Their aim was to determine the rotational effect of the Earth on the behaviour of the laser light, which was sent in opposing directions around a circuit. The circuit was a square of area 0.75 m^2 and they used a piping system filled with a Helium-Neon gas. The test was done at a Latitude of $43^0$29'S in New Zealand, 30m underground, fixed in a cubic meter of concrete, tied into basalt.

The ring laser has a property that provides the beating of counterpropogating modes at a frequency df given by df = [4 A ω] / λP where ω is the angular rotation, λ the wavelength of the light used and P is the perimeter of the ring laser. They achieved an accuracy of frequency measurement of better than 1 part in 10^{20}. The accuracy of this result is a twelve order of magnitude improvement on the M & G test, while the area concerned is less by a factor of 277,000 (Anderson *et al* 1994).

It is important to recognise that the rotation that caused the retardation of the laser was clockwise when viewed from over the South Pole. This retardation was in the opposite sense to that in the northern hemisphere M & G test. This Bilger *et al* result also conforms with the Sagnac effect.

6. Synchronisation of Clock Stations

The international standards for the synchronisation of clocks on the surface of the Earth are published in the International Radio Consultative Committee (CCIR) 1990 report. The international definition of the second is similarly to be found in the Comité Consultatif Pour La Définition de la Seconde (CCDS) 1980 report.

Further practical proof of the Sagnac effect is in the measurement of the relative time keeping of standard clock-stations around the Earth. It is found that, when signals are sent from one station to another, allowance has to be made for the fact that the signals do not travel at the same speed Eastward and Westward around the globe. Saburi *et al* (1976) carried out a test between clock-stations, which were at almost the same latitude, in the USA and Japan. They sent an atomic clock by air transport from the USA to Japan to compare the difference between this Washington-synchronised clock and the station in Japan. They also sent a signal via a satellite, in the same direction. They calculated, from the Sagnac effect, that there should be a difference of +0.333μs (Japan ahead of USA, because of the effect of the rotation of the Earth) caused to the signal, by the rotation of the Earth. They then applied this correction to the signal. The difference between this corrected signal result and the actual difference seen between the air-transported clock and the Japan clock was -0.02μs; this agreed to within 6%. They then 'corrected' the result for the relativistic effect as calculated by Hafele & Keating (1972); this increased the difference to +0.06μs and made the results somewhat less compatible.

Tests that purported to confirm the requirement of Special Relativity, that moving macroscopic clocks run slow, were carried out by Hafele & Keating by flying atomic clocks in opposite directions around the Earth. These tests have been shown to be seriously flawed and to provide no such evidence (Kelly 1995). That paper relied on estimates derived from the graphs published in 1972 by Hafele & Keating. The original test results, contained in an internal report (Hafele, 1971), have now been obtained direct from the United States Naval Observatory (USNO). These

confirm that the conclusions in Kelly (1995) are correct. Hafele, in that report, stated that *"Most people (including myself) would be reluctant to agree that the time gained by any one of these clocks is indicative of anything"* and *"the difference between theory and measurement is disturbing"*. A full analysis of the shortcomings of the tests is given in a separate paper (Kelly, 1996). This shows that a test of an accuracy improvement of two orders of magnitude would be required, before any credence could be placed in the results of such a test.

7. Discussion on the Sagnac Effect

As was shown in Kelly (1995), the difference in time for the light signals to traverse the spinning disc in opposing directions ($4A\omega/c^2$) is that calculated by a stationary observer in the laboratory. However, this also corresponds to the actual fringe shift detected by the splitter/interferometer on board the spinning disc. How is it then that the interferometer rotating with the disc records the same time difference as that calculated by the stationary laboratory observer? Relative to the interferometer, the light path length is $2\pi r$ for one circumference of the disc and that is the path that the light signal appears to have travelled. If the light had travelled at a speed of c relative to the interferometer then no fringe shift could be observed on board the disc. Thus, the light signal is not travelling at a speed of c relative to the interferometer, which records that the light has completed one revolution of the disc at speeds of $c \pm v$ in the two opposing directions (v being the speed of the interferometer relative to the laboratory). This is the relative speed of the light; the absolute speed (relative to the laboratory) is c.

The light behaves as if the rotation of the disc had no effect on the light, when viewed from aboard the disc or from the stationary laboratory. This result is, to the accuracy of this test, compatible with the postulate of the Theory of Special Relativity which states that the speed of light is independent of the speed of its source. Indeed, if the speed of the light is independent of the motion of the source, it cannot at the same time adapt to the motion of the disc to yield speeds of c in both directions.

Dufour & Prunier (1942) repeated the Sagnac test; they then carried out a test with the beginning and end of the light path on the spinning disc, but the middle portion reflected off mirrors fixed in the laboratory (directly above the disc). The fringe shifts were the same as in their Sagnac-type tests. This is further confirmation that the light is travelling at constant speed relative to the laboratory and not relative to the disc. The Sagnac effect is not an 'effect', but rather a confirmation of this fact. They then showed that the photographic record of the fringe shift and/or the origin of the light may be made on or off the disc, without affecting the result; this is because it is the behaviour of the light relative to the splitter/interferometer that is being measured. If light were sent in opposite directions from aboard an object travelling in a straight line, the signals would not meet to be compared. The literature refers to the Sagnac effect as arising from the rotation, simply because it has been only upon such a rotating apparatus that an interference pattern can be examined.

The light is oblivious to the movement of discs of any radius. On a disc of radius approaching infinity the light path approaches a straight line. It follows that observers aboard an object which is travelling in a straight line at constant speed v, relative to the laboratory would, if they could measure it, record the speed of light relative to themselves as $c \pm v$. These observers would record the same time as observers in the laboratory.

The fact that the same conclusions are applied, for straight line movement and for movement in a circuit, is compatible with the statement of Einstein in his first

1905 paper. Having concluded that his theory applied to a straight line he continued *"It is at once apparent that this result still holds good if the clock moves from A to B in any polygonal lime"* and *"If we assume that the result proved for a polygonal line is also valid for a continuously curved line… thence we conclude that a balance-clock at the equator must go more slowly… than a precisely similar clock situated at one of the poles"*. Einstein thus applied the derivation of a straight line result to a circuit in the same way as done here. Because the Theory of Special Relativity applies to circular motion, it applies to the case of a Sagnac-type test.

Motion in a straight line at constant speed does not affect the measurement of time or distance, as compared with the time or distance measured by stationary observers. It is the relative speed of the light, and not the time, that is changing.

Some authors imply that the Sagnac effect is a relativistic effect, or that it is compatible with the theory of relativity; eight such references are given in Hasselbach & Nicklaus (1993). The CCIR (1990) report *"Relativistic effects in a Terrestrial Coordinate Time System"* sets out the internationally agreed method of synchronising clocks on Earth. It gives three effects described as *"corrections of the first order of general relativity";* these are listed as the velocity effect correction calculated under the Special Theory, the correction for the difference in gravitational potential under the General Theory and a third correction named as *"for the rotation of the Earth"* ; this latter correction is the Sagnac correction (but not named as such). It has nothing whatever to do with relativity. It is the correction necessary because light does not travel around the globe Eastward and Westward in equal times. The 1980 CCDS publication by the International Committee for Weights and Measures gives the same list of corrections to be made when comparing the time on clocks on the Earth. Langevin (1937) also attempted to prove that the Sagnac result is explicable by relativity theory; this was discounted by Dufour & Prunier (1942).

Some authors, e.g. Post (1967), assume that the Sagnac effect can exist as well as relativistic effects. This cannot be so, because the Sagnac effect proves that light does not travel at the same speed relative to the interferometer on a spinning disc. The Sagnac effect is in contradiction of Special Relativity.

It was shown in Kelly (1995) that the Theory of Special Relativity has no relevance in trying to explain the Sagnac effect. As seen earlier, the speeds involved in a Sagnac test are so low (13m/s on a 1m radius disc to yield a shift of one fringe) that no relativity effect could arise. In any case the relativity effect would be too small by a factor of 500,000,000,000 on a disc of 1 km radius giving the same fringe shift as got by Sagnac.

The Sagnac effect is a non-relativistic effect which measures absolute rotation. It is enormous compared with relativistic time-dilation. The result of the Sagnac test is obtained by taking the speed of light relative to the rotating disc as $c \pm \omega r$, where r is the radius to the interferometer.

The above tests, by Sagnac, M & G, Dufour & Prunier, Macek & Davis, Saburi *et al* and Bilger *et al* are all experimental evidence of the behaviour of light on a rotating object. While the accuracy of the earlier tests might have left some lingering doubt as to the veracity of the results, the more recent laser-type tests are to a level of accuracy that leaves no room for scepticism. An explanation that conforms with all of these tests is required.

8. Time and Space Absolute

It follows that space and time are absolute, not relative, and that absolute space is a basic co-ordinate frame for all measurements in the Universe. This means that the speed of light has an absolute limit of c, but may have a speed, relative to an

observer, that is less or greater than c. The limit of the relative speed is thus 2c. This explains the behaviour of superluminal objects that are observed separating at speeds in excess of c (see Cohen *et al*, 1977). This is explicable by the relative speeds of the objects, as viewed from Earth, if they are separating transversely at high speed (say 0.5c), and also approaching our galaxy, with a small subtended separation angle.

Several paradoxes that derive from Special Relativity are dispelled, because time and distance are equal in the laboratory and aboard moving objects. One is the 'twin' or 'clock' paradox, which predicts that one twin, who travels away from Earth at very high speed, returns younger than the other (Einstein, 1918); a varying value of π for rotating concentric circles of different radii does not occur (Ehrenfest, 1909); a fast moving long ladder cannot be fitted into a short stationary garage (Rindler, 1982).

9. Aberration of Light

Stellar aberration was discovered in 1725 by the British astronomer James Bradley. He showed that light coming from a star, as viewed from Earth, has an apparent position which allows for the orbital speed of the Earth around the Sun. Consider the viewing of a star that is near the North Pole star in the Northern Hemisphere; a telescope has to be aimed at the star, allowing for that orbital speed; thus, when the Earth, on its orbit around the Sun, is going to the left of the direction of the starlight, the telescope has to be tilted to the left; when travelling to the right it has to be pointed the other way. The tilt is zero when the Earth is at the points in its orbit, where there is no motion of the Earth to the right or left of the direction of the starlight. The time of the year determines the direction in which the Earth is moving relative to the light coming from the star.

Many theories emanated from these results. Bradley's aberration could be explained as being like the behaviour of falling rain when viewed from a moving vehicle and if light was assumed to be composed of particles. On the other hand, a wave theory of light would fit the aberration phenomenon, provided that the light travelled through an 'ether' that was unaffected by the motion of the Earth. This latter was unlikely because the 'ether' would have to pass freely through the Earth without any effect upon that 'ether'.

Arago showed in 1810 that star-light is reflected and refracted on glass in exactly the same way as was light that emanates in the laboratory. These two requirements were apparently contradictory because the direction of the light, viewed through a telescope, showed that the Earth was orbiting around the Sun; but the refraction and reflection of the light seemed to show the Earth to be stationary. This was a great mystery to the scientists of the day.

In 1842, the Irish scientist Stokes proposed a 'jelly ether' theory that persisted into this century. This theory proposed that the light was 'dragged' along by this supposed 'ether'.

In 1871, Airy carried out an experiment in which he filled a telescope barrel with water and found that the position of a star did not alter from the position as viewed when the barrel was filled with air. Because light travels slower in water, one would expect that to keep the star-light in the field of vision, the telescope would need to be tilted further.

The Fresnel drag coefficient was invented to explain this effect, and the reflection and refraction puzzle. The light was assumed to be 'dragged' sidewards by the water by precisely the required amount. This requirement was partly instrumental in the later development by Einstein of the Theory of Special Relativity.

Following from the M & M, M & G, and Saburi *et al*, and Bilger *et al* tests, it is clear that light on the Earth is not affected by the motion of the Earth around the Sun, but is affected by the spin of the Earth on

its axis. How then can these facts concur with the facts of stellar aberration?

10. Requirements of New Theory

Based upon the tests described in this paper, any theory on the behaviour of light on Earth has to satisfy the following conditions:-

1 The speed of light as measured on Earth must not show any effect caused by the orbital motion of the Earth around the Sun, to the accuracy of the 1964 M & M-type test done by Jaseja *et al*.

2. Light generated on Earth does not spin with the spin of the Earth upon its axis. This means that light sent Eastward around the Earth will come back at a different time from light sent Westward. This is proven by the M & G, Saburi *et al* and Bilger *et al* tests.

3. Light generated in the laboratory is not affected by the motion of the object upon which it is generated. This includes a spinning disc or an object moving in a straight line. The normal Sagnac-type test upon the Earth, using a spinning disc, shows that the light is not affected by the movement of the disc, but moves at constant speed relative to the laboratory. This is proven by Sagnac, Dufour & Prunier and Macek & Davis.

4. Light coming from a distant star subtends a certain angle to the orbital path of the Earth. The speed of the Earth on that orbital path requires that a telescope viewing that star be tilted. Refraction and reflection of starlight should be similar to that of light generated upon the Earth. Filling the barrel of a telescope with water will not affect the apparent position of a star as viewed from Earth.

11. New Theory

A new theory is now proposed which satisfies all of the above requirements. on the behaviour of light

Light, generated upon the Earth, travels with the Earth on its orbit around the Sun, but does not adapt to the spin of the Earth upon its axis.

The light is in a frame of reference with its origin at the centre of the Earth. That centre travels on its orbit around the Sun, but does not spin with the Earth.

This is a proposal which has not previously been postulated as an explanation of the behaviour of light.

12. Michelson & Morley Test Gives a Difference

Heretofore, the null result of the M & M test has been viewed as sacrosanct, no matter what the accuracy of the test undertaken.

Hawkins (1988, page 27) states *"The special theory of relativity was very successful in explaining that the speed of light appears the same to all observers (as shown by the Michelson-Morley experiment)"*

If the theory proposed in this paper is correct, the effect shown by M & G and Bilger *et al* tests should eventually be picked up on a more accurate M & M-type test.

The M & G test relied on the spin of the Earth to show a fringe shift. The velocity of the Earth's surface at the relevant latitude was about $345ms^{-1}$ and was outside the detection limit of the M & M-type tests done up to the Jaseja *et al* test in 1964.

However, an M & M-type test by Brillet & Hall (1979) eventually reached the accuracy where the spin of the Earth should show an effect in line with the M & G test. The accuracy was 4000 times better than that of Jaseja *et al*. Their test results were analysed by Aspden (1981) who showed that the test indicated a diurnal variation that was, to within 3%, the spin velocity effect of the Earth, in the

correct direction (355m/s at the latitude of the test).

This is in agreement with the theory proposed in this paper.

Tests done on a North-South line would not have any effect from the spin of the Earth. An East-West test would have the maximum effect, with lesser effect in between these two extremes. In future a North-South orientation should be adopted to measure the speed of light. Even in this case, the length of the path should be short, or the curvature of the Earth may also have an effect because otherwise the light would be crossing the lines of gravitational force at different angles.

The speed of light upon the Earth is thus not constant in all directions, and is not measurable as such. It varies depending upon the compass direction in which the measurement is being made.

This statement is in direct contradiction of the Special Theory of Relativity. Einstein on the first page of his first paper (1905) stated that *"the unsuccessful attempts to discover any motion of the earth relatively to the 'light medium'"* suggested to him the idea that there was no such thing as *"absolute rest"*. But, it is possible to measure motion of the surface of the Earth relative to light (Brillet & Hall).

The measurement of the speed of light has been accurately deduced, without actually measuring the speed, but by measuring the frequency and the wavelength. By this method, the effect of the spin of the Earth does not arise. By this method, the agreed value of 299,742,458m/s has been defined by the CCDS (1983).

As mentioned earlier, the Saburi *et al* test, on synchronisation of clocks at various sites on the Earth, also confirms that electromagnetic signals (and thus light signals) do not travel at the same speed relative to the surface of the Earth, in an Eastward and a Westward direction. This is independent confirmation of the phenomenon that breaches the null result of the M & M test.

The new theory is the explanation of the Sagnac effect, the M & G test, the breaching of the null result of the M & M test and the Saburi *et al* test.

13. Discussion on New Theory

The tests by Sagnac and Michelson were carried out on the presumption that there was an 'ether', whereas they are now shown in this paper to be direct evidence of a different phenomenon, namely that light on Earth behaves in a manner different from that assumed to date.

The Theory of Special Relativity has two requirements relating to the behaviour of light; that the speed of light is measured as a constant by observers travelling at uniform relative speed in Inertial Frames and that the speed of light is independent of the speed of its source (see Einstein 1905 and 1922). Neither of these requirements is compatible with the theory here proposed.

The gravitational attraction between the Earth and the Moon does not rely on any spin of either body. The gravitational lines of force between the Sun and the Earth must move around with the Earth as it moves on its orbit around the Sun. Any light emitted upon the Earth adapts to the motion of the Earth when within the influence of the gravitational field of the Earth.

There is a choice here between assuming that magnetism or gravity is the influence that determines the behaviour of the light on the Earth. The Pole effect of the Earth's magnetic field would give a biased effect. Gravity meets all the criteria.

In relation to the zero effect of the Earth's orbital speed as measured in all M & M tests done prior to 1979, relativity theory is, in effect, equal to that put forward in this paper. It is worth recalling

that Einstein had known about the M & M test as early as 1899 and in 1922 suggested that M & M was the trigger to relativity (see Highfield & Carter, 1993, p 111).

However, on the important question of the effect on the measurement of the speed of light in opposite directions upon a spinning disc, or in an East-West direction upon the Earth, relativity theory has no explanation. The M & G and the Saburi *et al* and Bilger *et al* tests are all in contradiction of the Special Theory of Relativity; the new theory conforms with those test results.

The CCIR and CCDS reports, discussed earlier, both use *"local geocentric reference frames"* for time comparisons. They have two methods of comparing time; viewed (a) *"from a geocentric, earth-fixed, rotating reference frame"*, or (b) *"from a geocentric, non-rotating, local inertial frame"*.

These methods recognise that in case (a) a Sagnac correction is applied, whereas in case (b) no Sagnac correction is required, and examples are worked to show this. This conforms with the theory proposed in this paper, whereby electromagnetic signals do not adapt to the spin of the Earth; a Sagnac-type correction has to be applied. Here we have an international body, as far back as 1980, using an element of the theory put forward in this paper, but for a different reason, namely that they found in practice that this gives the correct method of synchronising clocks on the Earth.

The original Sagnac test had an accuracy of 1 in100 and may have been discounted for that reason; however the more recent Bilger et al test has an accuracy of 1 in 10^{20} and leaves no room for scepticism.

Signals coming from the Viking craft, that was placed upon Mars, behave peculiarly when passing very near the Sun. Earlier, the fact that light emitted upon the Earth, takes up the orbital speed of the Earth was discussed. The Viking test results are mentioned as of possible interest in this context. An electromagnetic signal that passes very near the Sun (whose gravitational pull is about 300 times that of Earth) may, in some way, be grossly affected.

In Shapiro *et al* (1977) it is recorded that, when the signal came to within three radii of the centre of the Sun, the data became erratic. They asked *"What of the other anomalous results? How can they be explained?"* Their analysis showed that the corona of the Sun or any errors in measurement could not account for the erratic results. In Reasenberg *et al* (1979) it is recorded that when the signal from Mars to Earth was close to the Sun the signals *"were markedly inconsistent with each other as well as with the rest of the delay data"*. They deleted these figures from the analysis while remarking that *"no definitive explanation has been obtained for these anomalies"*.

Is the change in the speed of light, coming from Mars to Earth, relative to fixed space or relative to the Sun? This evidence from Mars shows that the alteration in speed must be relative to fixed space, because the signal takes longer and longer to reach Earth from Mars (see Schwinger, 1988) as it gets nearer to the Sun.

14. Fresnel Drag Theory

As calculated by Fresnel, the required sidewards 'drag', that would bring the light from a star straight down the barrel of a telescope, even when that barrel was filled with water, is $1-(1/n^2)$ where n is the index of refraction of the light in the medium.

The theory of the drag of light also applies to light travelling in flowing water or other media on Earth. This theory states that the speed of light travelling with (and against) the direction of the flow of a medium is not simply $c/n \pm v$, where v is the speed of the medium. The drag factor is applied to the velocity v to yield $c/n \pm v\,(1-1/n^2)$ just as in the case of the starlight discussed earlier.

A further refinement of the drag amount was proposed by Lorentz; this would alter the drag by a slight amount. A debate ensued as to which theory was correct. The prescriptive tests were those done by Fizeau (1851), Michelson & Morley (1886) and Zeeman (1915). However, these tests are substantially challenged as not having the required accuracy to decide between the conflicting theories of Fresnel and Lorentz (Lerche, 1977). A detailed analysis of the earlier tests is given by Lerche and in particular of the Zeeman tests. The accuracy of the equipment used, the need to have laminar flow in the water pipes (flow was 1000 times too great) and other inaccuracies in the equipment and the test are discussed. Lerche concludes that an experiment, with an improved accuracy of one order of magnitude, is required to decide between the conflicting theories.

Tests, using a ring laser, by Macek et al (1964), using the liquid CCl_4, did not show conformity with the drag theory for light in liquids. A later analysis of their results, carried out by Kantor (1971), shows that the results of the test are not reliable and that the formulae used are not correct. A more accurate repeat of this test is required.

In 1968, Ockert analysed the Fizeau experiment based upon the extinction theory of light. This theory is based upon the fact that the history of a beam of light is extinguished when the beam passes through a very small thickness of material. For air at ground level, the effect takes place in about 1mm of distance. Ockert showed that, using the extinction theory of light, if the light is taken as travelling at a speed of c relative to the tube (but not relative to the flowing medium), the experimental results conform with the Freznel drag coefficient of $(1 - 1/ n^2)$.

Ockert summarised his conclusions as follows: "the *incorporation of the detailed mechanism by which light traverses a moving medium leads to analytical results which vary from observed and verified experimental results, unless the analysis includes a c – v effect for slowing or speeding the light relative to the physical medium moving at velocity v relative to the laboratory"*. He commented that this was not consistent with Einstein's theory, and thought it might conform with a convected ether theory.

However, his analysis conforms with the new theory put forward in this paper. This theory, which is substantiated in the Sagnac type tests, requires that the light travels relative to the laboratory and not relative to the flowing water.

Katz, on the other hand, states that *"The speed of light in a medium must clearly be with respect to a coordinate frame fixed in the medium, for the very structure of the medium, the position of the atoms and molecules, provides a preferred reference frame"*. This idea would have a problem with stellar aberration.

The Theory of Special Relativity gives the same result as the Fresnel drag theory. Under Relativity Theory, light travelling through a pipe filled with water will travel at a reduced speed of c/n in the water, as observed by an observer travelling with the water, where n is index of refraction of water. Because under the Theory of Special Relativity, the speed of light has to be the same to all observers, the laboratory observer should measure a different result, altered by the equivalent of the Fresnel drag (see French, 1968, p131).

If Ockert's theory of extinction of light is applied to the Freznel drag of starlight, the same result is achieved. Ockert's analysis shows that, in the Fizeau test, the change due to the velocity v of the fluid is $v(1-1/n^2)$; this can be ± depending on whether the fluid is flowing in the same direction as, or in the opposite direction to, the light signal. In the same way, if the fluid is flowing sidewards or in any other direction, then the amount of the alteration will be the same $v(1-1/n^2)$. The light coming from a star would, in this theory, arrive at the Earth at a speed of c relative

to outer fixed space and be shifted sidewards by this amount.

Ockert assumes that the light always continues in the same direction while passing through the fluid; this includes continuing in the same direction after the light has been extinguished and re-emitted.

In summary, Ockert's explanation of the Fizeau test, and of the tests on the aberration of starlight, conforms with the new theory in this paper.

15. Comparison of Theories

Table 1 shows a comparison of the new theory with the Theory of Special Relativity, in relation to conforming with the results of the various tests discussed in this paper. There are some other tests that evince the same results as some of the last seven quoted in Table 1.

It will be seen that the new theory satisfactorily explains the experimental results of all the tests, whereas the Theory of Special Relativity does not conform with seven of the ten.

The cases of the stellar aberration and the Freznel drag (and Fizeau experiment) have been addressed above.

In the case of the M & M test done to 1964, both theories give the same result.

The new theory postulates that light on the Earth moves with the Earth upon its orbit around the Sun. Thus, the light speed measured in any direction will not be influenced by the orbital motion of the Earth.

In the case of the Sagnac test the new theory states that light moves relative to the laboratory (not to the moving object). This is in conformity with the result of the Sagnac test.

Relativity states that time aboard a moving object is observed as shorter than when observed in a stationary frame. This is not in accord with the Sagnac test results as discussed earlier.

The Michelson & Gale test shows that light does not take up the spin movement of the Earth. This accords with the new theory, which postulates that light moves with the Earth upon its orbit around the Sun, but not with the Earth's spin movement.

Relativity has a difficulty with this test, because the light is shown to go around the globe at different speeds Eastward and Westward.

Dufour & Prunier, as described earlier, showed further positive proof that light moved at a speed of c relative to the laboratory, and not relative to any moving object. That moving object could be moving in a circle or in a straight line.

Relativity, on the other hand, postulates that light moves, relative to any object moving in a straight line, at the constant speed of c.

Thus, Dufour & Prunier conforms solely with the new theory. Dufour & Prunier recorded that their test results were not in conformity with Relativity.

Macek & Davis carried out a very accurate Sagnac test. This answers any objection to the Sagnac test which states that the accuracy of the test, done so long ago, was not sufficient to be taken seriously.

Saburi *et al.* carried out the test comparing an airborne clock with a signal sent from USA to Japan.

This test shows that a signal sent around the Earth does not travel at the same speed Eastward and Westward. This conforms with the new theory, because if the light does not take up the spin velocity of the Earth (as proposed by the new theory) this will be the result. Relativity, on the other hand, cannot accept that the light is travelling at speeds of $c \pm v$, where v is the surface speed of the Earth caused by the spin.

Bilger *et al.* carried out a very accurate M & G test in the southern hemisphere. Again this answers the criticism that the 1925 test was not of sufficient accuracy, and that it was done so long ago. As in the case of the M & G-type

tests, the new theory conforms, but not Relativity.

The Brillet & Hall test, as analysed by Aspden, has been discussed earlier. This result shows that, on a very accurate M & M test, the spin velocity of the Earth is detected. This indicates that the velocity of the surface of the Earth, at the place of the test, affects the result of a measurement of the speed of the light. At a site, at mid-latitudes, the movement of the surface of the Earth, caused by the spin of the Earth upon its axis, is about 350 m/s. While this is about one hundredth of the orbital speed (30,000m/s), the equation requires that this be squared. Therefore the alteration sought is about one ten-thousandth of the effect that would be caused had the orbital movement alone affected the speed of the light. It has been only in recent years that the required accuracy has been attained, to measure to this level.

Table 1. Comparison of Theories on Behaviour of Light

Theory	New Theory	Special Relativity
Tests		
Stellar Aberration (1725-1871)	yes	yes
Fizeau (1851)	yes	yes
M & M (1887)	yes	yes
Sagnac (1914)	yes	no
M & G (1925)	yes	no
Dufour & Prunier (1942)	yes	no
Macek & Davis (1963)	yes	no
Saburi et al (1976)	yes	no
Brillet & Hall /Aspden (1979-81)	yes	no
Bilger et al (1995)	yes	no

Relativity theory cannot accept that the movement of the surface of the Earth, measured in a test that was over a length of less than one metre (as was the Brillet & Hall test), should show any difference in an Eastward and Westward direction.

It can only be explained by the new theory, which states that the light moves with the orbital velocity of the surface,

but not with the spin velocity of that same surface. How else could such a test show the spin velocity effect of the Earth, but not its orbital velocity effect?

The seven tests listed in Table 1, which are not satisfied by the Theory of Special Relativity, were performed many years after the Theory of Special Relativity was promulgated (1905). That theory satisfied all the known phenomena to the date of its publication.

Einstein did not address the contradiction to his theory in the M & G, Sagnac, or Dufour & Prunier tests that were published during his lifetime. Sagnac was published two years before the General Theory of Relativity and M & G nine years afterwards. The French work of Dufour & Prunier could not have been known to Einstein until after the war.

Perhaps the accuracy of those three tests at 1:100 was not sufficient to persuade scientists of their veracity. There was also the problem that those tests were advocating that an ‘ether’ existed and that they did not seem to conform with the Theory of Special Relativity, that was in accord with all the known phenomena. As the years have passed, the evidence of test results, that do not conform with Special Relativity, has mounted with ever more accurate results.

It should be noted that all of the tests in Table 1, but the first three, confirm *that*

it is possible to detect absolute motion from a test done solely within the Earth's frame.

The new theory shows that the speed of light is not, in all circumstances, independent of the speed of the source of the light. That this is true is deduced from the fact that light, emitted upon the Earth:-

: takes up the orbital motion of the Earth, around the Sun, but

: does not take up the spin motion of the Earth upon its axis.

If the light had taken up the velocity of the surface of the Earth caused by both of the above, then the light would be travelling at the same speed in all directions, as measured by any observer upon the Earth. In that case Relativity would have fitted the tests.

The speed of the light, generated upon the earth, is not independent of the motion of the Earth around the Sun. The fact that the speed of the light, relative to nearby space, is not changed by the component of the surface velocity that is caused by the spin of the Earth upon its axis, shows that the light in general is actually travelling relative to space and not the spinning Earth. In the case of light emitted upon the Earth, the light speed is not independent of the speed of the source (the movement of the Earth, relative to nearby space, on its orbit around the Sun)

Under the new theory, when light escapes from the gravitational influence of the Earth it would travel at c, relative to the point where it escapes from the Earth's influence. The angle at which it escapes would be influenced by the orbital motion of the Earth. It may be possible to detect this influence by measurements from a distant space probe. At what stage would the light escape from the influence of the Earth? This is a problem to be solved.

The behaviour of light in outer space would not be as heretofore assumed. The new theory gives speeds of $c \pm v$ for the speed of the light where v is the straight-line speed of the observer, relative to the spot in fixed space where the light was emitted. The Theory of Special Relativity on the other hand predicts that the speed will be measured as c by the observer who is travelling in a straight line at constant speed.

It seems reasonable to assume that light in outer space follows the lines of gravitational force. As light, generated upon the Earth, moves with the Earth's gravitational field, it seems reasonable to assume that it moves with gravity in general. In that case, any movement of our total Universe would not be detectable, because all the light in the Universe moves with the gravitational field of that Universe. Using light, or other electromagnetic radiations, cannot measure any movement of our Universe relative to anything else.

Synchronisation of standard clock stations at various sites on the Earth uses a Sagnac correction, to allow for the fact that the Earth is spinning, while a signal is travelling from one station to the other. Under the new theory, this correction may need a slight amendment (presently unquantifiable) to allow for the difference in the behaviour of the signal near the Earth, from that when further away from the influence of the Earth's gravitational field, on its way to a satellite station and back.

The new theory contradicts the portion of the Special Theory of Relativity which requires that time runs slow and that objects are shorter in the direction of travel. It gives an explanation which is compatible with absolute time and distance.

16. Neutrons, Electrons and the Sagnac Effect.

The behaviour of neutrons was shown by Werner *et al* (1979) to be the same as that of light in a Sagnac-type test. They used an area of 8.864 cm^2 and could swivel the apparatus to face all points of the compass. Their results were in agreement with the Sagnac formula (Equation 1). They

showed that there was no effect if the plane of the apparatus was in a North-South plane of longitude and that the effect was at a maximum when the plane was in the East-West plane of Latitude, with a smooth curve forming the intervening results. This confirms that it is precisely the rotation of the Earth that causes the effect on neutrons. The facility of swivelling the apparatus did not exist in the M & G or the Bilger *et al* tests described earlier. Neutrons are not affected by magnetic or electric fields but are subject to gravity (Dabbs *et al* 1965). The Werner *et al* test shows that neutrons travel with the Earth on its orbital path around the Sun, but do not adapt to the spin of the Earth upon its axis.

The behaviour of neutrons gives support to the proposal that light, generated upon the Earth, travels with the gravitational field of the Earth.

The behaviour of electrons was shown by Hasselbach & Nicklaus (1993) to be the same as for neutrons or light when tested on a Sagnac-type apparatus. They got a fringe shift of 0.06 using electron beams in a vacuum. These tests demonstrate that electrons also travel relative to the laboratory and not to the rotating apparatus. No test has yet been done to determine whether electrons travel with the Earth on its orbital path around the Sun (as has been shown for light and neutrons). However, it seems likely that all three behave similarly. Gravity seems to be the only common factor that could influence all three in this manner.

If electrons move as suggested, this would have the extraordinary result that, on Earth, electricity would flow more quickly going Westward than Eastward.

A puzzle posed in Kelly (1995) can also be explained. The enigma was derived from a test by Pegram in 1917. In this, a stationary radial conductor inside a rotating solenoid developed no charge; whereas when both the conductor and the solenoid were rotated together a charge developed. This result is not in accord with the Theory of Relativity, according to which the relative motion of the conductor and the solenoid should always be the determining factor.

That test can now, under the new theory, be interpreted as meaning that the magnetic field did not rotate with the solenoid. This idea conforms with a test done by Faraday (test number 3090, 1852). In that test, he showed that rotation of a magnet on its longitudinal axis did not produce a charge in a nearby conductor; this result was queried by later authors and appears to have been lost in antiquity. The lateral movement of a magnet relative to a conductor certainly causes a charge. An apparatus to reproduce the Pegram test is presently under construction by this author and the results should be interesting.

17. $E=mc^2$ Consistent with New Theory

The factor $\gamma = [1- v^2/c^2]^{-1/2}$ applied in all relativistic calculations on distance, time, mass and energy is a direct consequence of the Theory of Special Relativity (Einstein, 1905) in relation to the behaviour of light. While its application to time and distance is contradicted in this paper, the application of γ to mass and energy is consistent with the new theory. In 1904, Lorentz had derived a relationship between energy, mass and c^2 a year before Einstein published his Theory of Special Relativity. In 1906, Einstein derived the equivalence by a different route from that in his 1905 paper, by considering solely the momentum of photons as they moved from one end of a closed box to the other. He arrived at the $E = mc^2$ equivalence, where E is the energy and m the mass. Using this equivalence and the relation E=pc, where p is the momentum of a photon, French (1968) derives the other mass and energy relationships $E = E_0\gamma$ and $m = m_0\gamma$. These important equivalencies, which are not being questioned in this paper, do not thus depend for their derivation on time-dilation or distance-shortening, which is here contradicted.

18. Suggested Tests

A static ring-laser test in space, with transmission of the results to Earth, launched away from a space probe, in rapid motion far away from the gravitational influence of the Earth or other massive body, could give confirmation that light behaves differently when away from the gravitational influence of the Earth. That test would confirm that absolute motion of an Inertial Frame can be detected by an experiment done solely in that frame. This can also be achieved by carrying out an M & M test aboard a frame of negligible mass. Because the light will ignore the movement of the Frame, the absolute motion of the Frame will be detected.

A similar test could also be done on the moon, to confirm the effect on the speed of light of its orbital movement around the Earth, its spin upon its axis, and of its orbital movement around the Sun.

The effect of the Earth's spin upon the speed of light, as measured on Earth, could be measured at different latitudes and in different directions. It could also be done at the South pole, where there is a suitable covered arena.

A test could be devised to prove if electrons travel with the Earth on its orbital path around the Sun.

A careful analysis of the signals from Mars or another planet to Earth, as they pass right close to the Sun, would be of interest in relation to the new theory.

A repeat of the Pegram test is in hand.

19. Epilogue

The theory put forward in this paper is based upon many experiments carried out with increasing accuracy by different scientists over the past 270 years. As Newton stated *"the best and safest method of philosophising seems to be, first to enquire diligently into the property of things, and of establishing these properties by experiment, and then to proceed more slowly to hypotheses for the explanation of them"*. Faraday, in similar vein, remarked (1852, p.55, Pt 1) *"I have always endeavoured to make experiment the test and controller of theory and opinion"*.

It is interesting to reflect on what Michelson wrote in 1897, when commenting on the null result of the tests to detect a difference in the speed of light when measured in line with and at right angles to the direction of the Earth's orbit:-

"In any case we are driven to extraordinary conclusions, and the choice lies between these three:-

1. The earth passes through the ether (or rather allows the ether to pass through its entire mass) without appreciable influence.

2. The length of all bodies is altered (equally?) by their motion through the ether.

3. The earth in its motion drags with it the ether even at distances of many thousand kilometres from its surface."

Michelson did not think of a Theory of Special Relativity or of a fourth possibility, namely:-

4. Light, generated upon the Earth, travels with the Earth on its orbit around the Sun, but not with its spin upon its axis.

This fourth possibility is that put forward in this paper.

Conclusions

Time and distance are absolute, not relative.

The speed of light has an absolute value of c and a relative limit of 2c.

Light, generated upon the Earth, travels with the Earth on its orbit around the Sun; it is independent of the spin of the Earth upon its axis. The speed of light generated on Earth is thus not independent of the orbital motion of the Earth around the Sun. There is a difference in the speed of light as measured upon Earth, which depends on the compass direction in which the line of flight is aimed.

The Sagnac effect is a non-relativistic effect which measures absolute rotation. It is enormous compared with relativistic time-dilation.

It should be possible to detect absolute motion of an Inertial Frame in outer space, by an experiment carried out solely within that Frame.

It is postulated that light travels with gravity on Earth and presumably does the same in outer space.

It is proposed that electricity probably travels faster going Westward than going Eastward.

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