

New Ideas  
that  
Change Einstein's Theories

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## Acknowledgments

I am very grateful for the advice I received from the late Professor Clive W Kilmister, over a period of forty-five years, before his death in May 2010. Clive, who spent many years in the Mathematics Department at King's College London, was one of the most scholarly authorities on relativity theory. Without Clive's guidance I could not have published many of my academic papers.

Secondly, I should like to thank Professor Alexander L Cullen FRS, who is now retired from the Electronic and Electrical Engineering Department at University College London. Alex is a highly respected authority on electromagnetic theory.

In 1998 I was aware that all authorities claimed that individual "advanced potential" solutions of Maxwell's equations (explained in Chapter 6) were only valid in an imaginary world where time was running backwards (*i.e.* in the opposite direction to the normal "arrow of time"). Hence, I was prepared for some criticism when I sent Alex a draft of my 1998 paper on electromagnetic "precursor transients" (see Appendix, Paper 2). He told me that the application of the advanced potential solution to a receiving antenna (or aerial) was invalid, and he produced an irrefutable seven-line argument to prove that it was invalid. His analysis was correct within the context of the generalized reception of electromagnetic energy, in a three-dimensional region of space, that he had naturally assumed.

There was then a three-way correspondence between Alex, Clive and myself. It was finally agreed that certain carefully specified advanced potential solutions are not only valid in the real world, but also they form an essential part of electromagnetic theory which provides the theoretical basis for special relativity when considering the passage of electromagnetic wave signals between inertial frames of reference (*i.e.* frames that are not being accelerated). The correct application of the advanced potential solution requires special relativity to be limited in its application to steady-state (non-

transient) electromagnetic wave signalling. Quantum theory has to be introduced to explain the extreme precursor transients associated with the arrival of the front edge of a pulsed electromagnetic signal (explained in Chapter 5).

The advanced potential solution provides an explanation of why the *observed* velocity of an electromagnetic wave light signal is always found to have a constant value, equal to  $c$ , that does not depend on the velocity of the source. The advanced potential solution dictates that the presence of a *material* detector changes the initial arrival velocity of the front edge of any approaching signal so that, in the steady state, the observed electromagnetic wave arrives at a velocity equal to  $c$  *relative to the detector*.

But the arrival velocity of the first few photons, associated with the initial precursor transient of a pulsed signal, is not restricted to  $c$ . These first few photons interact with the detector and set up the stored-energy fields of the detector. There is no need for Einstein's very restricted assumption that the velocity of light is always equal to  $c$  in empty space.

The advice I received from Clive and Alex enabled me to produce my year 2000 paper on: "The Relevance of Advanced Potential Solutions of Maxwell's Equations for Special and General Relativity" (see Appendix, Paper 3).

## Preface

The mathematics of special relativity is logically consistent and beyond question. But there has been a failure to understand special relativity as a theory of physics. This failure has held back the development of general relativity, and it has obscured the link between special relativity and quantum theory.

In this *Preface*, and in the *Introduction*, I will indicate where there are weaknesses in relativity theory, and I will briefly outline how some new ideas may be developed.

Einstein intended special relativity to be a theory of physics. He made precise statements concerning the way in which clocks may be synchronized when they are in relative motion. However, he also had to make some “time-assigning” assumptions to justify these statements. The inherent limitations imposed on special relativity by Einstein’s initial assumptions have been ignored for over a century.

There has also been a failure to understand the full implications of Maxwell’s equations. As was stated in the *Acknowledgments*, a crucial part of the advanced potential solution of Maxwell’s equations, which is directly relevant to special relativity, has been totally misunderstood. Furthermore, the major consequence for relativity theory associated with the electric field solution for a single charged body, situated in an otherwise empty Universe, has been overlooked.

New ways to develop special and general relativity may be readily achieved by examining two of the neglected aspects of Maxwell’s equations in more depth, and by studying the many comments made by Einstein concerning the limitations of his theories.

It is essential to clarify the “clock paradox”, which is also referred to as the “twin paradox” (explained in Chapter 7). Many relativists have caused confusion by failing to admit openly that there is a very real problem with the clock paradox. There are inherent difficulties in defining, with precision, the pivotal underlying concepts of both inertia and an inertial frame of

reference. These difficulties were clearly stated by Einstein. But this knowledge, on its own, is not sufficient to solve the problem of the clock paradox. It will also be shown that Maxwell's equations contain more information about the origin of time dilation than appears in just the simple mathematics of the Lorentz time transformation. It is then clear that the solution to the problem of time dilation is related to Einstein's clarification of Mach's Principle (explained in Chapter 3). However, before discussing time dilation any further it is necessary to consider a still more fundamental oversight.

Although the mathematics of special relativity is flawless there is a simple mathematical reason why the physical understanding of the theory has been unsound from the outset. A monochromatic (single frequency) electromagnetic wave is unattainable in the real world because such a wave is not permitted to have a beginning or an end. A monochromatic wave cannot carry any information, and it cannot have an observable velocity. The observed velocity of any physically realizable, quasi-monochromatic, electromagnetic wave depends on the material boundary condition imposed by the detector on the wave when it first arrives. The presence of this material boundary inherently introduces additional frequency components which will be time dependent. A full solution for all of these frequency components must be made before one may predict the observed velocity of any part of the wave.

One of the three main assumptions of special relativity is that the velocity of light must always have a constant value equal to  $c$  in empty space, which is independent of the velocity of the source. When interpreting this statement a conflict arises if one fails to divide the required analysis into two distinct parts. There has been a confusion over the separate wave and photon approaches which are essential when analysing the nature of all light signalling in special relativity. It is precise statements concerning light signalling that were used by Einstein to form the basis of his theory.

If a pulse of light is used as a signal, and the pulse has a very rapid rise-time at its front edge, then the first thing to arrive at an observer will be a photon having a very large energy. Why is this so? Simply because the mathematical description of the very fast rise-time of the front edge of the pulse will contain sinusoidal Fourier frequency components that extend up to a very high frequency, and the energy of a photon is proportional to its frequency. What can we say about the velocity of this first photon? The

answer is, very little! Quantum theory is needed for the solution, and this theory tells us that the location of the first photon, its arrival time, and its velocity, will all be indeterminate. Special relativity cannot predict the arrival velocity of the first photon. Special relativity may be applied to all electromagnetic waves, but it cannot deal with individual photons.

Nevertheless, it is important to find out what happens to the first high-energy photon associated with the arrival of a pulsed light signal. It is the answer to this question that is crucial if we wish to fully understand special relativity.

Any observation of a light signal requires the presence of a material detector. The electromagnetic wave solution for this detector, appropriate to special relativity, must be derived from Maxwell's equations. In the limit, it is necessary to consider an infinitesimal dipole antenna (or Hertz dipole) as the detector. The insertion of the dipole into a region of free space will perturb the field pattern that had existed prior to the presence of the dipole. The first few high-energy photons to arrive will set up new perturbation (or scattered) stored energy fields that are appropriate to the dipole in the electromagnetic steady state. These perturbation fields are often referred to as the "near fields" of the dipole. Although the near fields are very weak at appreciable distances from the antenna, they will still *extend to infinity* when the final electromagnetic steady state is reached. The advanced potential solution of Maxwell's equations (see Chapter 6) then requires that the arrival velocity of the following electromagnetic wave must be equal to  $c$  *relative to the detector*. In the steady state the electromagnetic wave may be considered to be guided onto the detector, at a velocity equal to  $c$  relative to the detector, by the perturbation fields that were initially set up by the arrival of the first few high-energy photons. Quantum theory indicates the nature of the transient solution. Special relativity (based on Maxwell's equations) provides the steady-state, or near-steady-state, electromagnetic wave solution. The observed velocity of any steady-state electromagnetic wave must always be equal to  $c$ , relative to the detector, because *it is the presence of the material detector that makes it so*. The detector will produce an initial slowing down, or speeding up, of the incoming energy if there is relative motion between the source and the detector. There will be a corresponding change in the radiation pressure force exerted on the detector.

These new ideas enable the mathematics of special relativity to be established without using two of the assumptions adopted by Einstein. A

theory with the minimum number of assumptions is clearly preferable. Einstein's own very clear suggestions may also be used to demonstrate this development of special relativity. Special relativity is not primarily based on Einstein's second postulate: "that light is always propagated in empty space with a definite velocity  $c$  which is independent of the state of motion of the emitting body". This second postulate arises directly from Einstein's third assumption of a time-assigning function, which he stated to be necessary in order to establish a definition of simultaneity when electromagnetic signals are passed between observers in two separate inertial frames of reference (see Appendix, Paper 2). After making this third assumption Einstein left the door open for a new specific interpretation of special relativity by stating: "We assume that this definition of synchronism is free from contradictions". The third assumption Einstein made is, of course, valid for the implied electromagnetic wave signalling process between observers that he adopted. But things have moved on since 1905. A quantum theory approach requires a modification to special relativity when dealing with precursor transient signals (see Chapter 5). Quantum theory dictates that it is the *act of observation* of an electromagnetic wave which may change the velocity of the wave. Special relativity, as a theory of physics, is then put on the same basis as quantum theory. Its predictions are indeterminate until the electromagnetic steady state is reached.

It is the appearance of the velocity of light  $c$  in the uniform plane wave solution of Maxwell's equations that has caused major confusion in relativity theory. This confusion arises because the uniform plane wave solution only applies to an electromagnetic wave (or other function) of unchanging form. As stated earlier, such a wave cannot carry information or have an observable velocity. The boundary condition imposed by any material detector inherently generates numerous frequency components. A full analysis at this material boundary is essential if one wishes to predict what may be observed.

Having clarified the physical interpretation of special relativity it is appropriate to consider general relativity. In Chapter 4 I consider a further example of where more new ideas may be developed by following up proposals that were initially put forward by Einstein. Einstein indicated two independent approaches that might be used to fully incorporate his formulation of Mach's Principle (explained in Chapter 3) into relativity theory. But only the first of his two possible approaches has ever been

seriously considered. The first approach attempts to link the origin of the local inertial force that may be exerted on a body to a gravitational interaction between the body and all of the distant matter in the Universe. It will be shown in the *Introduction* that this first approach leads to unacceptable conclusions.

Einstein's second way of interpreting Mach's Principle is fully discussed in Chapter 4. His alternative proposal suggests that the origin of gravity, and the particular value of the gravitational constant  $G$  we observe, might be generated by the rotational inertial motion of our Universe against a background of distant universes. A constant free-space value of  $G$  would be predicted to occur throughout our Universe. But the theory may also predict an observable increase in the value of  $G$  when it is measured within the boundary surface of a smaller, rotating, fluid body, such as the Earth. If confirmed, such a terrestrial observation would put the study of gravitation on a completely new basis. There were significant, unexplained, variations in the observed value of  $G$  in some measurements taken at the National Bureau of Standards, Washington, D.C., that initially confirm this prediction (see Chapter 4). These specific proposals concerning the origin of gravity are clearly speculative. Nevertheless, a fresh start needs to be made on the further development of Mach's Principle, along these lines, in view of the importance attached to this principle by Einstein.

Following this brief introduction to Mach's Principle, it is now appropriate to outline the approach that will be taken to clarify the clock paradox. In Chapter 7 a further development of Maxwell's equations is discussed which provides a rational explanation of the clock paradox. This development also requires a consideration of Mach's Principle. Relativists tend to forget some of Einstein's early comments. He made it clear that any attempt to define either inertia, or an inertial frame of reference, introduces an inherent problem which is linked to Mach's Principle. At a really fundamental level one reaches a circular argument. Special relativity can only state that a particular frame is an inertial frame of reference if this frame is found to be the one in which a standard clock indicates the largest passage of proper time between two events. Hence one can only establish the result that one is trying to deduce by making an observation! But there is a way forward.

Special relativity is inherently subordinate to Maxwell's equations. An examination of the deeper aspects of Maxwell's equations provides a

solution to the clock paradox. Mathematically, Maxwell's equations predict that a single point charge will produce an electric field extending to infinity in an otherwise empty Universe. But such a proposed situation is not tenable unless a second distributed charge, equal in magnitude and of opposite sign, is also present in the Universe to create the electric field. Hence, distant matter must be present in the Universe to validate Maxwell's concept of an electric field. This result indicates that a Lorentz time transformation correction only arises because of the motion of the clock or twin relative to a background frame of reference which is provided by distant matter in our Universe. There is then no clock or twin paradox, because the background matter of the Universe is providing a primary inertial frame of reference. A standard atomic clock will run at its fastest rate when located in this primary inertial frame.

An atomic clock will also run more slowly if it is located close to a massive object as a result of a gravitational interaction. There is an overall logical consistency if gravitational time dilation depends on a specific value of  $G$  that is created by the suggested rotational motion of our Universe relative to a background frame of distant universes, and if Lorentz time dilation depends on the motion of a clock relative to the background frame provided by matter in our Universe. At a fundamental level both forms of time dilation would depend on the motion of an atomic clock in space relative to distant matter, as Mach's Principle requires. The equality of inertial mass and gravitational mass, and the equivalence principle, would then follow as a direct consequence of Mach's Principle.

## Introduction

To give a flavour of the underlying problems with physics, I will describe a very basic example of our present lack of understanding. Consider Newton's third law of motion, which lies at the very heart of physics. This law states that action and reaction are equal and opposite. For example, if I push on a car to start it moving, and give the car some inertia, I will feel an equal and opposite inertial reaction force pushing back on my hand. Although Newton's third law of motion might appear to be obvious and, with hindsight, might even be considered to be a common-sense deduction, it has hidden depths.

Physicists who deal with the fundamentals of physics like to consider what actually *causes* the inertial reaction force on my hand when I push a car. One then needs to consider Mach's Principle, a fundamental principle formulated by Einstein and one that will be discussed in some detail in Chapter 3. It is sufficient to say here that the majority of eminent physicists working in this field of study claim that the best explanation for the cause of the inertial reaction force on my hand is that it arises from a gravitational interaction force between all of the distant matter in the Universe and my moving hand. But relativity theory requires that any change in the gravitational interaction force, produced by distant matter, can only travel to my hand at the speed of light! How can the *instantaneous* reaction force I feel on my hand, when I push a car, be caused by the motion of my hand relative to all of the distant matter in the Universe?

The currently accepted explanation for the cause of this inertial reaction force then has to be made even more complicated by stating that the changes in the gravitational interaction forces are travelling to my hand from both *future time* as well as *past time*, as advanced gravitational waves and retarded gravitational waves. These two sets of gravitational waves then

combine in *present time* to give an instantaneous inertial reaction force at my hand! Quite seriously, many leading physicists consider this to be the best explanation of the fundamental origin behind Newton's third law of motion. One has to invoke gravitational energy coming from both future time and past time to explain the instantaneous force I feel on my hand when I push a car in present, real, time. Such an improbable concept is only tolerated because all of the alternative theories, which would relate local inertial reaction forces to distant matter, are inherently flawed.

What has been forgotten by most physicists is that when Einstein clarified Mach's Principle in 1916 he clearly stated that the motion of distant matter, relative to local matter, must be the cause of *either* local inertial reaction forces *or* local gravitational forces. Einstein's alternative interpretation of Mach's Principle has been almost totally ignored. Why not try to satisfy Mach's Principle by relating local gravitational forces to the motion of distant matter? In 1964 Fred Hoyle made a partial attempt at this problem, which was later shown to be unacceptable. Since 1964 this aspect of Mach's Principle has been dropped.

If Einstein's alternative interpretation of Mach's Principle is correct, and if local gravitational forces are caused by the rotation of our Universe relative to a background of distant universes, then there is no problem with the instantaneous nature of inertial reaction forces. It is only necessary to meet one of Einstein's interpretations of Mach's Principle for the principle to be satisfied. Before venturing forward to discuss these new ideas in more detail it is worthwhile to briefly summarize the background to these ideas in Chapters 1, 2 and 3.

## Chapter 1

# Background to the Problems in Physics

The aim of physics is to produce theories and laws that enable us to understand how the Universe operates. A great deal of theoretical effort is being undertaken at the present time to achieve a better understanding of gravitation, electromagnetism and quantum field theory. It so happens that the Universe behaves in a way that enables us to produce a number of quite simply expressed mathematical laws that separately cover all of these individual topics. However, although there are some links between the individual topics, it has not been found possible to bring together all of the relevant individual theories so as to produce a single *Unified Field Theory*, or a *Grand Unified Theory*, or a *Theory of Everything*. These are all names that have been used to indicate a more generalized theory. At the outset it should be acknowledged that the use of the expression a *Theory of Everything* is a misnomer, despite its use by many physicists, as well as colloquially. The most that a *Theory of Everything* could realistically achieve would be to unite all of the presently known theories and laws associated with the various branches of physics and cosmology.

A further word of caution is necessary. The laws of physics can never be proved. All scientific laws or theories are inherently based on certain initial assumptions, which may be either stated or implied. Any given law or theory will only be valid within the limits imposed by these assumptions. The implied assumptions are sometimes hidden and are frequently only detected at a later date after analysing experimental or observational evidence.

James Clerk Maxwell produced the first successful partial *Unified Field Theory* in 1864. He combined the previously separate theories of electricity and magnetism to form the present-day theory of electromagnetism. Maxwell's four equations express mathematically four experimental observations. These observations are that an electric current produces a

magnetic field, a time-varying magnetic field generates a voltage in a conductor, free electric charges may exist, but free magnetic poles do not exist. Maxwell's equations give rise to the whole of classical electromagnetic field theory and, in particular, predict the existence of electromagnetic waves that can be radiated off into space. The frequency spectrum of electromagnetic waves includes radio and television signals, microwave communication signals, infrared radiation, all of the visible light frequencies, the ultraviolet region, and right through to X-rays and beyond.

Further deductions from Maxwell's equations led Einstein to produce the special theory of relativity in 1905. Einstein had to make three assumptions to establish special relativity. He first defined the principle of relativity. This principle states that the laws of physics should be the same in all inertial frames of reference (an inertial frame is one that is not being accelerated). Einstein then postulated that light always travels in empty space with a definite velocity  $c$  which is independent of the velocity of the source. The value of  $c$  is approximately 186,000 miles per second (or 300,000 kilometers per second). However, to make these two statements consistent with each other Einstein had to make a third assumption of some "time-assigning" functions that define how clocks might be synchronized, using light signals, by two observers who are in relative motion.

Einstein's second and third assumptions will be discussed in Chapters 5 and 6 and they will be shown to be unnecessary, provided a correct validation of the advanced potential solution of Maxwell's equations is undertaken. One only needs to assume Maxwell's equations and the principle of relativity to establish special relativity.

In order to deal with uniformly accelerated frames of reference Einstein introduced general relativity in 1916. He noted that if a body is at rest in a gravitational field, then the body feels a force exerted on it. This force will accelerate the body, provided it is free to move. However, if the body is in free fall in a gravitational field then a force is no longer felt by the body. In the frame of reference of the free-falling body gravity is no longer felt and the gravitational force has, effectively, disappeared. This fact is known as the *equivalence principle*. Hence, one can eliminate the complications associated with the acceleration of a body, produced by a gravity field, if one performs a mathematical transformation out of the original reference frame and into the new frame of the free-falling body. But the equivalence principle only holds locally. If all uniformly accelerated frames are to be

equivalent then Euclidean geometry cannot hold in all of them. A switch to Riemannian geometry solves this problem. The consequence is that the presence of matter is then considered to produce a warping of space-time in the new geometry.

As a result, general relativity is able to explain the apparently instantaneous, action-at-distance, effects of gravity that are inherent in Newtonian theory if angular momentum is to be conserved. In general relativity the warping of space-time acts as an intermediate step. Thus the presence of any massive body, such as the Sun, warps space-time over a very wide region. This initial distortion travels away from the Sun at the speed of light, producing a *steady-state* warping of space-time spread over the whole of the solar system. According to general relativity the planets do not feel the force of gravity. They just follow the equivalent of “straight-line”, free-fall, paths in the new distorted space-time geometry. All gravitational forces have been eliminated and have been replaced by a change in the geometry.

General relativity is not a theory *of* gravity. It is a theory that eliminates the complications produced by gravitational forces and the accelerations produced by gravity. Hence, one should never expect general relativity to be able to predict the origin of gravity, or to predict the value of the gravitational constant  $G$ . General relativity assumes that the degree of space-time warping, at a given distance from the Sun, is predetermined by the given mass of the Sun and the given value of  $G$ .

Einstein spent over thirty years in attempting to unite the general theory of relativity with electromagnetic theory, but he was unsuccessful. Most scientists consider that Einstein wasted his energies on his later attempts at unification. Very few physicists or mathematicians were involved with the development of any form of *Unified Field Theory* until 1980. But since 1980 there have been many fresh attempts at unification. What do these attempts involve?

To the best of our present knowledge there are only four fundamental forces in nature. These are the gravitational force, the weak nuclear force (that controls radioactivity), the electromagnetic force, and the strong nuclear force (that holds the nucleus of the atom together). Each of these fundamental forces may be considered to act through its own set of fields. A complete *Unified Field Theory* would unite the four sets of fields associated with the four fundamental forces in nature. But no such theory has

yet been discovered. From the time of Maxwell's partial unification in 1864, up to the present time, there has only been one further partial unification. This provides a link between the weak nuclear force and the electromagnetic force.

We now need to go back a long way, in the order in which theories have been developed, and examine a very important further complication. Fields are not the only way of considering how the four fundamental forces can act. Energy may also be considered to exist in minimum size packets, or quanta. For example, the energy contained in a single quantum of light, the photon, is equal to the frequency of the light multiplied by Planck's constant. This idea, discovered by Einstein, leads onto quantum theory. It also leads to the *uncertainty principle*, which I will briefly explain.

Suppose I am trying to find out the position of an electron and, at the same time, determine its velocity. To get the position of the electron accurately I will need to examine it using electromagnetic waves that have a very short wavelength because the limit of the accuracy of the experiment will be of the order of one wavelength. The wavelength of a given monochromatic (single-frequency) wave is inversely proportional to its frequency. I will therefore be using some very high frequency photons to examine the electron. However, we see from the previous comment on photons that high frequencies mean that each individual photon will have a lot of energy. Just a single photon will disturb the electron I am trying to observe and will change its velocity. Hence, there will always be an uncertainty in the combined accuracy of obtaining the position measurement and the velocity measurement for a single electron. If I try to get the position accurately I change the velocity, and if I try to get the velocity accurately I get a poor accuracy for the position measurement. Any classical measurement of a particular physical quantity will inevitably change what is being measured very slightly. However, this type of error can usually be calculated and then allowed for. But at the quantum level the error is much more fundamental. The uncertainty principle states that there is an inherent uncertainty about the way in which electrons, other atomic particles, or photons, interact with any material boundary. This uncertainty may be an uncertainty about the combination of the position and the velocity, or an uncertainty about the combination of the time of arrival and the energy.

One may then go one stage further and produce quantum field theories,

which have a very different mathematics when compared with Maxwell's field theory. Quantum field theories have been very successful in making predictions in particle physics. But they have inherent limitations because a field appears to be able to exist at a point in space and, at the same time, there is no limit to the amount of energy that may be carried by a field at this single point. This fact produces many infinities in the theory. These infinities can be ignored, or renormalized, in particle physics applications. However, in all of the attempts that have been made to unite quantum field theory and gravitational theory the infinities are a complete block to making any progress.

One further aspect of quantum field theory is of interest. The uncertainty principle states that there is an uncertainty when attempting to observe energy and time simultaneously at a given point. There is then the theoretical possibility of virtual particles, consisting of particle-antiparticle pairs, being created in a vacuum. These virtual particles are suddenly created, and they then very rapidly recombine and disappear. But during the very short time of their existence energy may exist in the vacuum. This idea is valuable for quantum field theory, and gives further knowledge of how atoms spontaneously emit photons (*e.g.* as shown by the yellow colour produced by a sodium salt when it is heated in a flame). Vacuum energy is also involved with the study of cosmological models and black holes. It is important to realize that the concept of vacuum energy can only be confirmed at the material boundary of some form of detector (the Casimir effect). It is a theoretical model that relates to material boundary conditions. We can never know what is actually happening in a vacuum until we take a look, and then we will inevitably change the situation by the very act of looking.

To get over the problem of the infinities at points in quantum field theory the idea of a *String Theory* has been proposed, where a string has finite dimensions. The vibrational mode of the string determines its frequency, its energy, its size, and which elementary particle it represents. The strings are then thought to exist in a rather unusual type of space that may have eleven, or more, dimensions. Three of these dimensions would produce our normal three-dimensional space. The fourth would represent time. The remaining dimensions would be wrapped up tightly and be invisible to us. These ideas can be taken further. In a more developed form of topology the strings can

become points and surfaces. So far, no proposed string theory, or superstring theory, has been developed to the stage where an experimental check could be made.

A *String Theory* might hopefully become very near to being a *Theory of Everything*. Such a theory would go even further than a full *Unified Field Theory*. As well as being able to unify quantum field theory and gravitational theory it should be able to explain the presently accepted constituents of matter – quarks and leptons. It might also be able to explain some of the basic physical constants.

Examples of the basic physical constants are: the velocity of light, the charge on the electron, the masses of the electron and the proton, Planck's constant and Newton's gravitational constant  $G$ . The gravitational constant is most unusual because it appears to be the only physical constant that is totally unrelated to any of the other constants. An interesting, and very significant, result comes about if we combine some of the constants in a particular way. We then get some dimensionless numbers. These are numbers which are both constant numbers and they also have no units. One example is the ratio of the mass of the proton to the mass of the electron, which is equal to about 1836. Another example is the fine structure constant, which is achieved by dividing the square of the charge of an electron by the product of the velocity of light and Planck's constant. The value of the fine structure constant is approximately equal to  $1/137$ . It is interesting to note that, on a classical basis, the electron in a hydrogen atom travels in an orbit around the nucleus at a velocity equal to the velocity of light  $c$  divided by 137. The fine structure constant lies at the basis of calculating how atoms are built up.

We may now return back to a much simpler level. When dealing with the assumptions and limitations of special relativity, in Chapters 5 and 6, we need only consider Maxwell's equations, Maxwell's field theory, electromagnetic waves and photons. It is important to re-assess the limitations of special relativity because so much that has followed special relativity is based on Einstein's initial assumptions.

Having discussed electromagnetic waves and photons as if they really existed, it is relevant to remind ourselves of the true situation, in a way that is often overlooked or ignored:

Electromagnetic waves and photons do not exist, as such, in free space. They are simply two alternative mathematical concepts that enable one to solve for the different effects that occur at specific *material* boundaries when one attempts to observe the electromagnetic energy that had *previously* existed in the region of free space that is now being occupied by the material of a detector.

A photon can only be postulated to exist as it is emitted or absorbed at a material boundary. A photon cannot exist in free space. If photons did exist in free space one would have to have photons changing their frequencies, and hence their energy contents, as they travelled in space towards a moving frame (the Doppler effect). Similarly, a monochromatic electromagnetic wave cannot exist in a finite region of free space because, by definition, such a wave is not permitted to have a beginning or an end. The presence of any realizable, material, detector will introduce very significant additional frequency components when an electromagnetic wave arrives at the detector. The continued overlooking of these simple facts lies at the heart of the problems that exist in interpreting the mathematics of special relativity. The mathematics is flawless but the interpretation has been naive.

The fact that electromagnetic waves and photons do not exist, as such, in free space has a more general consequence. When any interaction occurs between electromagnetic energy travelling in free space and a material boundary then *only* a mathematical wave analysis is appropriate if an overall steady state, or near-steady state, has been reached. And *only* a mathematical photon analysis is relevant if either the electromagnetic energy arrives as a precursor transient, or if the detection process involves a transient electromagnetic transition. There is no duality.

Consider the Young's slit experiment. A single, continuous, source of light is shone onto a metal sheet containing two slits. The slits act as two co-phased secondary light sources. A typical interference wave pattern is observed when the light falls on a screen, thus demonstrating the wave nature of light in this experiment. The wave nature of the light is still maintained when the intensity of the light is reduced to a very low level where, if it were relevant, a single photon would have to be postulated as passing through both slits simultaneously. But this is a steady-state

experiment overall and at no point along the path of the light is it appropriate to consider the electromagnetic energy as existing mathematically in the form of a photon.

Most scientists agree that all of the well-accepted theories of both physics and cosmology can only be approximations to an ultimate truth that is unlikely to be fully understood in its deepest meaning. Although the basic laws of physics may be expressed quite simply, the history of science demonstrates that these simply expressed laws may have a much deeper significance than appears at first sight, and they usually need to be extended when applied under extreme conditions.

The classic examples of such basic laws of physics are Newton's three laws of motion and Newton's law of gravitation. For over two hundred years these laws were considered to be able to produce a precise description of all possible motions of matter in the Universe.

However, since 1905 it has been found that Newton's laws have had to be extended, following Einstein's development of the special theory of relativity. But any modifications of Newton's laws are only needed if the velocities involved are significant when compared with the velocity of light, or when gravitational effects are on the scale of the Solar system. For the vast majority of problems, including sending astronauts to the moon, we continue to use Newton's laws. Nevertheless, long before any of the complications of relativity arose, Newton considered that there were deep philosophical problems with his own laws! These problems have never been solved, and will be discussed in Chapter 3.

It may well be slightly misguided to try to produce a full *Unified Field Theory* or a *Theory of Everything* before we have solved some of the many major problems in our fundamental understanding of Newtonian theory, electromagnetic theory, relativity theory, gravitational theory and quantum theory. At a really fundamental level we do not understand many basic aspects of physics and cosmology. It would seem more logical to attack these individual major problems with much more effort before attempting the grander problem of unification. I described one of these problems in the *Introduction*.

The aim of this book is to examine three of the major individual problems. After discussing Mach's Principle in Chapter 3, an alternative

interpretation of Mach's Principle will be discussed in Chapter 4 that is capable of explaining a possible origin of gravitational forces. All of the ideas I will put forward concerning the origin of gravitational forces are speculative. The reason I include them is because there are possible terrestrial observations that could be undertaken which, if positive, would totally change our understanding of the origins of gravity. In addition, this alternative explanation of Mach's Principle gets rid of the implausible explanation of the origin of inertial reaction forces that was discussed in the *Introduction*.

The rest of the book is not speculative. It is shown that Maxwell's equations, which provide the basis of special relativity theory, contain much more information than has been recognized. For nearly a century physicists and electrical engineers have failed to correctly interpret the advanced potential solution of Maxwell's equations. It is the advanced potential solution that leads to the concept of advanced electromagnetic waves. Until very recently all authorities claimed that advanced electromagnetic waves could only exist in an imaginary world where time was running backwards. Having assumed this "fact" they argued that individual advanced potential solutions needed to be forcibly rejected from Maxwell's equations. However, no theoretical analysis has ever been found to justify this claim, despite a great deal of searching. Some eminent authorities even went so far as to suggest that Maxwell's equations needed to be revised.

Maxwell's equations are at the basis of electromagnetic theory and special relativity. It is important to realize that special relativity is inherently subordinate to Maxwell's equations. Any failings of Maxwell's equations would inherently be reflected in both special relativity and general relativity. However, it may be shown that Maxwell's equations are not compromised. The incorrect rejection of the advanced potential solution relies on a causal argument, which happens to be valid in specific and commonly used circumstances. Nevertheless, a fuller analysis of the advanced potential solution shows that in other specific circumstances it is not only a valid solution, but it is also the necessary solution that forms the theoretical basis of special relativity. Special relativity only needs to assume Maxwell's equations and the principle of relativity. The other assumptions are superfluous. Special relativity is put on the same footing as quantum theory, in that *the act of observation*, using a material detector,

*changes what is observed.* Uncertainty then enters into special relativity as well as quantum theory.

A deeper understanding of Maxwell's equations also throws new light on the well-known "clock paradox" or "twin paradox" of special relativity. Studying the apparently simple concept of having an electric field produced by a single charged body, located in an otherwise empty Universe, leads to an explanation of why moving clocks go slow.

The complete book covers most of the material on [this web site](#) together with further explanatory chapters. The book is now available from booksellers:

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