THE RETURN OF THE ETHER PART 1

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FIELDS

Fields

Gravitational Fields

Einstein's field theory of gravity was a mathematical model describing a curved space-time fabric distorted by the energy-mass of accelerating (in the sense of constantly changing direction i.e. an orbit; not gathering speed) objects. He did this by arriving at ten field equations. The geometry of space-time accounted for gravity and solved the conundrum of action at a distance.

'The most fascinating subject at the time that I was a student was Maxwell's theory. What made this theory appear revolutionary was the transition from action at a distance to fields as the fundamental variable.' [Einstein, *Autobiographical Notes*, p31]

Einstein wished to unify this theory with Maxwell's field theory of electromagnetic phenomena encapsulated in the four equations. At a mathematical level this would involve deriving each set of equations from each physicist from something more fundamental. This proved impossible for a number of reasons: (a) the ontological belief that the field in both gravity and electromagnetism was separate from the matter (planets or particles); (b) the existence of charge in the electromagnetic field without a counterpart in the gravitational field; (c) the Copenhagen Interpretation of QM which re-introduced action at a distance at quantum level by faulty reasoning that is open to criticism on a number of fronts. (See material on *Magic Particles)*.

Faraday's solution of considering fields and their contents as aspects of the same force or power with the concept of charge being replaced by direction and speed (i.e. velocity) of the said force seemed to have disappeared from view. Even Maxwell's mechanical explanation of charge based on fluid mechanics from which he derived an inverse square law, (see material on Dynamics and the Continuum) replicating Coulombs law and Newton's law of gravity was largely ignored. Possibly because of the rapid discoveries and analysis at the quantum level and the controversies around them, caused the intellectual space to be used up. Retaining the concept of charges and fields in QM led to unwanted infinites and dubious mathematical devices e.g. renormalisation to make sense of the results.

Clearly if the ontological basis of each field theory: (i) QFT, (ii) electromagnetism and (iii) gravity, contain anomalies then the first task is to remove them rather than attempt mathematical contortions to accommodate them all. The anomalies in the first two relate to the infinite field around a point charge analysed below; the gravitational field also ran into difficulties.

The Gravitational Field Equations

Einstein's ten field equations can be summarised as

$$G_{\mu\nu} + \Lambda g_{\mu\nu} = \frac{8\pi G}{c4} T_{\mu\nu}$$

Where μ and v are variables taking values from 4x4 matrices. The left hand side determines the curvature and shape of space and the right hand side the energy and mass contained in it. G on the left hand side is a function of other tensors and captures the difference between flat and curved space; g is the metric tensor capturing the geometric structure of space-time; T is the stress energy tensor describing the distribution of mass and energy contributing to the warping of space-time; Λ is the cosmological constant originally introduced by Einstein to arrive at a static Universe; G on the right hand side is the gravitational constant used in Newton's equations and c the speed of light. Without the cosmological constant, gravity would force the universe to contract and so a balancing opposing force was needed to maintain the status quo.

Einstein relied on 3 principles:

(i) the *cosmological principle* that the universe is homogenous and isotropic to any observer – this assumption was later supported by the cosmic microwave background that showed an even distribution of mass and energy. A caveat to this is:

'In the standard big bang cosmological model the cosmic dynamics is described by GR and its field equations . . . . Two key features determine the form of the metric tensor: the large-scale isotropy and homogeneity of the Universe. These properties, which evidently can only be checked in the region to which we have observational access, are postulated in the Cosmological Principle. In fact, we cannot directly test homogeneity, since we cannot observe the large-scale structure on 3D spatial hypersurfaces. We observe on the past light cone at effectively a single cosmological time, which means that we can only directly test isotropy about our world line. Isotropy about all galaxy world lines implies homogeneity, so if our world line is not special, i.e. if we adopt the Copernican Principle, then we can deduce the Cosmological Principle on the basis of isotropy.' [*Vacuum Energy in QFT and Cosmology*, Adrià Gómez-Valent, Departament de Física Quàntica i Astrofisica Universitat de Barcelona September 2017]

So, if our world line is special, and I believe it is, because it is inhabited by intelligent beings, then this principle is of little use.

(ii) *Mach's principle* that inertia relates to the distribution of matter not space:

'In a consistent theory of relativity, there can be no inertia *relative* to 'space' but only an inertia of *masses relative to one another*.' [Einstein, *Cosmological Considerations in the General Theory of Relativity*, 1917b quoted by Christopher Smeenk in his essay in *The Cambridge Companion to Einstein*, CUP 2014, p228]

Here Einstein supports Mach and is a departure from Newton's view of an absolute space against which all motion could be measured.

(iii) *the equivalence principle*, that gravity is equivalent to acceleration. Alternatively that gravitational mass is equivalent to inertial mass, ie. being in free-fall is equivalent to being at rest. Imagine you are looking out the window of a tall building and someone has fallen off the roof and passes your window: the person accelerating towards the ground (at $10m/s^2$) would experience weightlessness and feel that he was hovering or at rest outwith any gravitational field. In a similar way the person looking out the window resisting the downward pull of gravity, seems to be physically equivalent to moving upwards outwith a gravitational field at an acceleration equal and opposite to that of the person in free-fall. [See pp174 -175 of the essay by Michael Janssen in *The Cambridge Companion to Einstein*, CUP 2014 for explanatory drawings. and Additional Material for *Farewell to Primitive Concepts* for deeper dive into 'mass'.]

The Cosmological Constant and the Expanding Universe

There have only been a few solutions to Einstein's equations and when Einstein later tried to arrive at a unified field theory, cosmology had moved on to consider the Universe as expanding, not static as Einstein had assumed, primarily due to Hubble's discovery of the cosmological red shift in 1929-1930 – that is the description of galaxies receding not because of their motion per se (as in the Doppler effect of sound waves) but because of the expansion of space which in turn supported the belief in vacuum energy. Einstein, not being an astrophysicist accepted the arguments from the Dutch astrophysicist Sitter and others on these matters and that is what lead him to believe that the introduction of the cosmological constant (to counterbalance the force of gravity) was his greatest blunder. Notwithstanding this it has continued to be used albeit with a different value to support the thesis of an expanding universe. Einstein did have reservations especially as the measured red-shift conflicted with other astronomical data:

‘There does arise, however, a strange difficulty. The interpretation of the galactic-line-shift discovered by Hubble as an expansion (which can hardly be doubted from a theoretical point of view), leads to an origin of this expansion which lies “only” about 10^9 years ago, while physical astronomy makes it appear that the development of individual stars and systems of stars takes considerably longer. It is in no way known how this incongruity is to be overcome.’ [*Relativity* Princeton University Press, 100th Anniversary Edition, p 154-155]

I believe this problem persists despite improved measuring techniques.

What is more alarming is that the expansion is accelerating, with the furthest galaxies accelerating at a higher rate. The go to explanation is that there must be dark energy counteracting any gravitational pull. The cosmological constant now serves as an expression for this dark energy. In the 1970’s the astronomer Vera Ruben discovered that spiral galaxies were rotating faster than the visible matter could account for and argued that there must be ‘dark matter’ contributing to the gravitational effects. Dark energy contributing 68% to all energy in the universe and dark matter 27% to all matter.

19th Century Solutions

Before introducing more unknowns it may prove useful to re-examine some concepts from earlier physical models and review the ideas of notable physicist-philosophers from the nineteenth century. The first question that springs to mind is whether the ether has returned under the guise of space-time.

‘ . . . William Thomson [aka Lord Kelvin] had considered the propagation of the electric and magnetic forces in terms of the linear and rotational strain of an elastic solid medium. Maxwell thus sought a physical theory of the field in terms of the formulation of a theory of the ambient ether as the material substratum of the field.’ [*Metaphysics and Natural Philosophy*, P. M. Harman The Harvester Press 1982 p134]

J. J. Thomson took this further by postulating electrical mass and using fluid mechanics as an analogy:

‘As long ago as 1881 he had shown that the mass of a charged particle increased the faster it moved. Thomson explained this qualitatively by analogy with a sphere moving through water:
“ When the sphere moves it sets the water around it in motion. The necessity of doing this makes the sphere behave as if its mass were increased by a mass equal to half the mass of a sphere of water as the same volume of the sphere itself. *This additional mass is not in the sphere but in the space around it* . . . If we adopt the electrical theory of the constitution of matter we may suppose that all mass is electrical in its origin, and therefore not in the atoms or molecules themselves but in the space around their charges.”

Now suppose that the whole of the mass of a corpuscle was due to its motion. Then there was the possibility of explaining all matter as electrical charges (specifically corpuscles) in motion. The potential for unification was enormous and was seized on by many physicists . . .’
[*J. J. Thomson and the Discovery of the Electron*, E. A. Davis and I. J. Falconer, Taylor & Francis 1997 p194]

If the percentage of so-called dark matter is 27% then the ordinary matter would be 73% then the dark matter is just under one half of ordinary matter which is close to the ratio found by J. J. Thomson.

I believe a limiting factor in this conceptual framework was the adherence to a particle model rather than a wave model which would have reinforced analogies with hydrodynamics. Notwithstanding this, if space-time is viewed as an elastic medium distorted by the differential movement of galaxies, one might expect not only a transference of mass into space-time but also a rippling effect, stretching out the fabric of space-time in all directions. This may account for the so-called dark energy. Alternatively Einstein’s cosmological constant may not have been a blunder and the universe is static: I’m speculating that the spin of the matter balances any force of gravity. See the Additional material *Matter of Mass*.

Alternative Cosmologies

It should be noted that the accepted version of cosmology involving the Big Bang, the expanding universe, dark matter and energy, black holes etc is being increasingly questioned. It is argued that the incoherence of the physics is primarily due to adhering to a gravitational model. There is an alternative electric model proposed by the physicist Walter Thornhill (1942-

2023) and I have included details of his books and related website in the Booklist accompanying this essay. Given that Wikipedia describes it as 'pseudo science' makes one pause and consider if it poses a threat to the accepted orthodoxy. After all A. N. Whitehead constructed his own Theory of Relativity based on Maxwell's electromagnetism which for many years had the same predictive power as Einsteins GTR. Perhaps it needs to be revisited.

Electrostatic Fields

While Einstein's gravitational field was predominately mathematical, the electro-magnetic fields of Faraday and Maxwell had physical reality but when combined with the artificial point particle led to theoretical and mathematical problems.

Coulomb (1736-1806) arrived at his law, which states that the force between two electric charges is equal to the product of their charges divided by the square of the distance between them (same format as that used for gravity). This is measured in amperes per second and is transmuted into a 'force' by applying 'k', the Coulombs [1] constant = 8.988 x 10^9 (Nm^2C^2). The same problem of action at a distance crops up as to how each charge influences the other and the solution was via a 'field'. Faraday (1791-1867) introduced the idea of fields and 'lines of force' to demonstrate how electric charge influences the surrounding space. [2]

Maxwell, in his paper, *Lines of Force* draws a sharp distinction between his mathematical explanation and physical causes:

'I have endeavoured . . . to lay before the mind of the geometer a clear conception of the relation of the lines of force to the space in which they are traced. By making use of the conception of currents in a fluid, I showed how to draw lines of force which should indicate by their number the amount of force, so that each line may be called a unit-line of force . . . I have found the geometric significance of the "Electrotonic State," and have shown how to deduce the mathematical relations between the electrotonic state, magnetism, electric currents, and the electromotive force, using mechanical illustrations to assist the imagination, *but not to account for the phenomena*.' (my italics)

[Philosophical Magazine and Journal of Science, Fourth Series, March 1861 p162]

If only some 20th century physicists had been as honest.

When attempting to calculate the electric field around a static point charge (radius of 0 i.e. a 'point particle') using Coulomb's law of electrostatics together with the equation for the energy density of the electric field, one finds that the point charge is surrounded by an infinite amount of energy. Using Einstein's $E = mc^2$ then it follows that there is an infinite amount of mass! This is similar to the problem of the Ultra-Violet Catastrophe.

Richard Feynman noted in his lecture on *Electromagnetic mass*

' . . . one large area that we will be concerned with in the future—the interaction of electromagnetic fields with matter. But we want to stop for a moment to show you that this tremendous edifice, which is such a beautiful success in explaining so many phenomena, ultimately falls on its face. When you follow any of our physics too far, you find that it always gets into some kind of trouble. Now we want to discuss a serious trouble—the failure of the classical electromagnetic theory. You can appreciate that there is a failure of all classical physics because of the quantum-mechanical effects. Classical mechanics is a mathematically consistent theory; it just doesn't agree with experience. It is interesting, though, that the classical theory of electromagnetism is an unsatisfactory theory all by itself. There are difficulties associated with the ideas of Maxwell's theory which are not solved by and not directly associated with quantum mechanics. You may say, "Perhaps there's no use worrying about these difficulties. Since the quantum mechanics is going to change the laws of electrodynamics, we should wait to see what difficulties there are after the modification." However, when electromagnetism is joined to quantum mechanics, the difficulties remain. So it will not be a waste of our time now to look at what these difficulties are. Also, they are of great historical importance. Furthermore, you may get some feeling of accomplishment from being able to go far enough with the theory to see everything—including all of its troubles.

The difficulty we speak of is associated with the concepts of electromagnetic momentum and energy, when applied to the electron or any charged particle. The concepts of simple charged particles and the electromagnetic field are in some way inconsistent. . . . It is all fine until we set *a* equal to zero for a

the field varies inversely as the fourth power of the distance from the center, its volume integral is infinite. There is an infinite amount of energy in the field surrounding a point charge. . . .You will notice that if we let the electron radius *a* go to zero, the last term (and all higher terms) will go to zero; the second term remains constant, but the first term—the electromagnetic mass—goes to infinity. And we can see that the infinity arises because of the force of one part of the electron on another—because we have allowed what is perhaps a silly thing, the possibility of the "point" electron acting on itself.' [The Feynman Lectures on Physics Vol II, Ch 28]

Feynman goes on to discuss the possibility of QM solving this problem of electrodynamics but he concludes:

'The quantum effects do make some changes—the formula for the mass is modified, and Planck's constant ħ appears—but the answer still comes out infinite unless you cut off an integration somehow— just as we had to stop the classical integrals at $r = a$. And the answers depend on how you stop the integrals. We cannot, unfortunately, demonstrate for you here that the difficulties are really basically the same, because we have developed so little of the theory of quantum mechanics and even less of quantum electrodynamics. So you must just take our word that the quantized theory of Maxwell's electrodynamics gives an infinite mass for a point electron.'

The description of the electron as a 'point particle' with no radius is a mathematical fiction: it does not tell us what the electron actually *is.* Treating a large mass as a point, as Newton did for the planets, works mathematically to represent the centre of mass as no further detail is necessary. Extending this to objects with a tiny size works in some situations but clearly not when applying calculus. Calculus doesn't work with these types of mathematical objects. Integral calculus was used *inter alia* to find the area of a circle by drawing increasing numbers of triangles whose area could be worked out easily, within the circle; but no matter how many triangles are drawn, theoretically there is always a portion of semi-circle above each triangle: as the number of triangles increases to infinity then the number of these portions reduce to zero. Neither of these values are *reached* theoretically. In the case of a point charge, as the distance to the charge decreases to actual zero, the energy around it will be ∞. So the model is not accurate. It is not simply a mathematical problem: Maxwell used the concept of fields to explain the behaviour of light which has no charge; whereas QFT tries to apply it to electrons with negative charges. Theoretically, the field should tear itself apart as the electrons repel each other.

[1]The coulomb, also written as its abbreviation 'C', is the SI unit for electric charge. One coulomb is equal to the amount of charge from a current of one ampere flowing for one second. One coulomb is equal to the charge on 6.241 protons. The charge on 1 proton is 1.6 x C. Conversely, the charge of an electron is -1.6 x C. A coulomb is an enormous charge: two 1 C charges that are 1m apart exert a force of 9 Newtons. That's over two million tonnes: 720 times as much as the thrust of a space shuttle solid rocket booster during lift off.

[2] Historically Faraday and Maxwell used the concept of a field to explain electro-magnetic radiation: the electric and magnetic fields oscillate to produce waves of radiation but the key difference is that the fields are neutral with balanced charges not simply one type of sub-atomic particle with a positive or negative charge. In QED the electron is an excitation in an electron field but it is not clear how a field of negatively charged particles can cohere.