

THE RETURN OF THE ETHER PART 3



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DYNAMICS AND THE CONTINUUM

Dynamics and the Continuum

Faraday's Unified Theory

Faraday did not hold with action at a distance. He introduced the concept of a physical field to account for the interaction of electric forces across finite distances. [*Speculation Touching Electric Conduction and the Nature of Matter*, 1844] He points out that according to the atomic theory of matter, atoms were not considered as being in contact, therefore to account for the forces between particles, a role had to be given to the space between particles. Faraday held that void space could not have causal or dispositional properties analogous to material bodies: 'mere space cannot act as matter acts' [*Electricity* Vol 3, p194]. The agency of the interatomic void was inconceivable and he concludes that the theory of atoms and void space should be rejected. In 1837 Faraday demonstrated that the induction of electric charges between bodies took place along curved lines which he explained as a transmission of force through a 'dielectric' medium surrounding the bodies.

Faraday's lines of force originally conceived as an heuristic device, or symbolic of the alignment of charged particles, graduated to a metaphysical position: they represented the alignment of forces and the objects or bodies referred to as particles were really centres of that force. His theory of matter is summarised by P. M. Harman:

'Faraday goes on to argue that all knowledge of matter was limited to ideas of the "system of powers or forces in and around" material substances, and he asserts that matter should not be envisaged as consisting of extended, impenetrable atoms surrounded by forces of attraction and repulsion, but that matter should be represented as a plenum of "powers". He declares that "the substance consists of the powers", maintaining that it was impossible to conceive "matter independent of the powers". According to this theory, 'particles of matter' were in reality 'centres of force'. This theory of matter resolved the problem of explaining the mode of transmission of electrical forces, "for matter will be continuous throughout, and in considering a mass of it we have not to suppose a distinction between its atoms and any intervening space." [*Metaphysics and Natural Philosophy* The Harvester Press 1982, p 85]

Interactions in this continuum amount to exchanges between different concentrations of forces and their alignments. This resonates with vector calculus where gradients, curls, sources and sinks transform the shapes and movement of the electrical or other phenomena. Faraday was not a mathemat-



-ician and his theory, based on powerful philosophical intuition and imagination, had to wait for Maxwell to formalise in the famous equations. However the equations on their own do not encapsulate Faraday's intuition of the oneness of Nature.

Newton's impenetrability and inertia (passivity) of matter become derivative or secondary in Faraday's dynamical vision:

' . . . the mutual penetrability of matter depend upon the relative disposition of the powers and matters qua centres of power will therefore mutually penetrate to the very centres like the conjunction of two sea waves of different velocities into one.' [*Electricity*, Vol 2 pp289-293]

His analogy with the sea is edifying because he also envisages charge as simply a description of direction! Imagine a curved line of force a travelling in direction x and another b behind it travelling in the same direction; if both a and b are each considered part of two waves then b will push a along or 'repel' a ; if a encounters a wave c travelling in the opposite direction then they will conjoin or 'attract'. This was illustrated in 1867 by P.G. Tait in his experiments with smoke rings and is discussed in the previous essay. Faraday believed that the propagation of forces could be caused by the vibrations in the lines of force. In this analysis, force becomes a by-product or useful shorthand for waves, motion (vibration or frequency) and direction.

The menagerie of particles and forces in the standard model have fallen into the same trap as the empiricists in the 18th century, namely of dividing matter up into primary and secondary qualities and then being at a loss as to how to fit them back together. It is the intellectual mis-step of assuming that an abstraction which can help in analysis or mathematics has phenomenal reality or is an element of ontology. This results in false dichotomies which are impossible to later synthesise.

Faraday extends his theory to gravity:

' . . . the power is always existing around the sun and through infinite space, whether secondary bodies be there to be acted upon by gravitation or not; and not only around the sun, but around every particle of matter which has existence.' [*Electricity*, Vol 3 p574]

Following Parmenides, Faraday viewed nature as one consistent whole, packed and vibrating with energy (force, power, mass etc being interchangeable) and Western poets and artists have intuited a similar vision:

Dylan Thomas' poem *The force that through the green fuse drives the flower, . . . drives my red blood . . .* and van Gogh's paintings at Figure 1 below.



Figure 1

Surely this is closer to the truth than the arid, positively medieval pursuit of how many particles can fit on the point of a needle. Also compare the above images to von Karman vortex street in fluid mechanics in Figure 2 below. Vortices occur throughout Nature: in weather systems, fluids, electricity so why not gravity. It has the same dynamic structure to radiation in Figure 3.

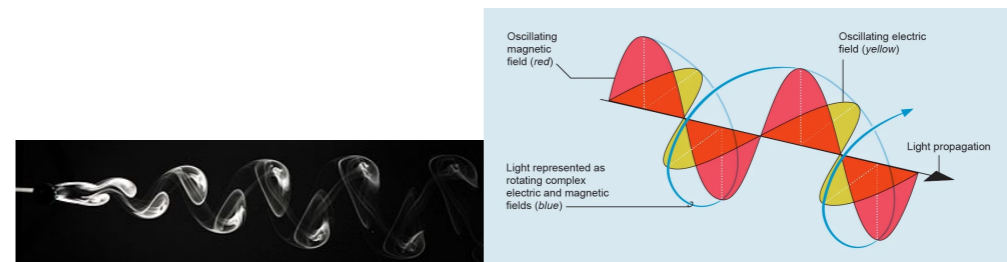


Figure 2 Karman vortex street

Figure 3 wave of radiation

It is a repeating pattern of swirling vortices, caused by a process known as vortex shedding, which is responsible for the unsteady separation of flow of a fluid around blunt bodies. It is named after the engineer and fluid dynamicist Theodore von Kármán, and is responsible for such phenomena as the 'singing' of suspended telephone or power lines and the vibration of a car antenna at certain speeds.

The Return of the Ether

With Maxwell, mathematical formalism dominated and matter becomes a mathematical entity rather than a substantial reality. Nevertheless he encountered the same problem of action at a distance and re-introduced Newton's idea of a mediating ether in the form of fields:

‘ . . . it is more philosophical to admit the existence of a medium . . . than to assert that a body can act in a place where it is not.’ [*Action at a Distance*, Papers Vol 2 p312]

and

‘ . . . the theory I propose may therefore be called a theory of the Electromagnetic Field, because it has to do with the space in the neighbourhood of the electric or magnetic bodies, and it may be called a Dynamical Theory, because it assumes that in that space there is matter in motion, by which the observed electromagnetic phenomena are produced.’ [*A Dynamical Theory of the Electromagnetic Field*, Papers Vol 1 p 526]

Maxwell believed that the electromagnetic phenomena were produced by the motion of particles of matter and communicated via the field by a ‘complicated mechanism capable of a vast variety of motion’ subject always to the general laws of motion. His models followed the Lagrangian formalism of analytic dynamics rather than a description of the actual physical structure involved.

‘It appears therefore that certain phenomena in electricity and magnetism lead to the same conclusion as those of optics, namely, that there is an ethereal medium pervading all bodies, and modified only in degree by their presence; that the parts of this medium are capable of being set in motion by electric currents and magnets; that this motion is communicated from one part of the medium to another by forces arising from the connexions of those parts; that under the action of these forces there is a certain yielding depending on the elasticity of these connexions; and that therefore energy in two different forms may exist in the medium, the one form being the actual energy of motion of its parts, and the other being the potential energy stored up in the connexions, in virtue of their elasticity. . . Such a mechanism must be subject to the general laws of Dynamics, and we ought to be able to work

out all the consequences of its motion, provided we know the form of the relation between the motions of the parts.’ [*ibid* Papers Vol 1 p532]

This followed William Thomson's (Lord Kelvin) paper in 1847, *On a mechanical representation of electric, magnetic and galvanic forces*, [Mathematical and Physical papers, 1882-1911, Vol 1 pp76-80] in which he describes the movement of electric and magnetic forces in terms of the linear and rotational strain of an elastic solid medium. So the ether becomes a material substratum of the field. A number of years later Lord Kelvin published another paper, *Dynamical Illustrations of the magnetic and heliocoidal effects of transparent bodies on polarised light*, [Proceedings of the Royal Society 8 (1856) pp150-158] arguing that the magnetic-optic rotation discovered by Faraday could be explained by a vortical motion in the ether.

‘Maxwell's theory of the field as a mechanism of ether particles brought the field concept into harmony with the mechanical theories of optics which had been firmly established in the 1830s. The wave theory of light as undulations in a luminiferous ether, conceived as transverse vibrations at right angles to the direction of the propagated wave (like the undulations of a plucked cord) provided a paradigm . . .’ [P.M.Harman *ibid* p135]

Maxwell believed that a mechanical explanation of the field was essential to its intelligibility.

In addition to using the dynamics of light to explain the electric-magnetic field, Maxwell turned to fluid dynamics to illustrate how Faraday's lines of force might operate.

‘We should thus [of lines of force] obtain a geometrical model of the physical phenomena, which would tell us the direction of the force, but we should still require some method of indicating the intensity of the force at any point. If we consider these curves not as mere lines, but as fine tubes of variable section carrying an incompressible fluid, then, since the velocity of the fluid varies inversely as the section of the tube, we may make the velocity vary according to any given law, by regulating the section of the tube, and in this way we might represent the intensity of the force as well as its direction by the motion of the fluid in these tubes. This method of representing the intensity of a force by the velocity of an imaginary fluid in a tube is applicable to any conceivable

system of forces, but it is capable of great simplification in the case in which the forces are such as can be explained by the hypothesis of attractions varying inversely as the square of the distance, such as those observed in electrical and magnetic phenomena. In the case of a perfectly arbitrary system of forces, there will generally be interstices between the tubes ; but in the case of electric and magnetic forces it is possible to arrange the tubes so as to leave no interstices. The tubes will then be mere surfaces, directing the motion of a fluid filling up the whole space. It has been usual to commence the investigation of the laws of these forces by at once assuming that the phenomena are due to attractive or repulsive forces acting between certain points. We may however obtain a different view of the subject, and one more suited to our more difficult inquiries, by adopting for the definition of the forces of which we treat, that they may be represented in magnitude and direction by the uniform motion of an incompressible fluid.'[*On Faraday's Lines of Force*, Papers Vol 1p 158-159]

Maxwell goes on to demonstrate that from an analysis of his fluid based model a similar inverse square law to that of Coulomb's for electric charge can be obtained.

'Now we found . . . that the velocity of our imaginary fluid due to a source S at a distance r varies inversely as r . Let us see what will be the effect of substituting such a source for every particle of positive electricity. The velocity due to each source would be proportional to the attraction due to the corresponding particle, and the resultant velocity due to all the sources would be proportional to the resultant attraction of all the particles.' [*On Faraday's Lines of Force*, Papers Vol 1p 175]

It strikes me that Maxwell sought and found a consistent thread running through Nature and 'charge' instead of remaining an occult quality of 'matter' (much like 'gravity') could be re-interpreted as a type of motion. Also the idea of tubes, with and without intersections resonates with modern developments in geometry such as the Hopf fibration discussed in the previous essay. Part of Maxwell's philosophical outlook was to identify the connections between disparate phenomena and he defended this approach and drew wider conclusions from it.

To support this philosophical outlook of Faraday and Maxwell of analogies in Nature revealing a consistent universal underpinning of all disparate

phenomena one can look at the transformation of all matter, once heated, becomes some form of fluid.

'Take anything in the universe, throw it into a box, and turn up the heat. Regardless of what you start with, the motion of this substance will be governed by the equations of fluid mechanics. . . .When things get hot, everything looks the same. . . .Take any element in the periodic table and heat until it melts, so that it is either a liquid or a gas. The motion of every element is governed by the same set of equations. The only reminder of what you started with is to be found in a handful of parameters of these equations which describe among other things, the density and viscosity of the fluid. These will differ from element to element. But the basic set of equations are the same, regardless of whether you are working with an alkaline earth metal or an inert gas.' [David Tong, *Lectures on Theoretical Physics Vol 4, Fluid Mechanics* CUP 2025 p 1]

In addition to finding this unifying principle, it allows the physicist-philosopher to visualise structures in Nature described in *Imagery in Scientific Thought* by Arthur I. Miller

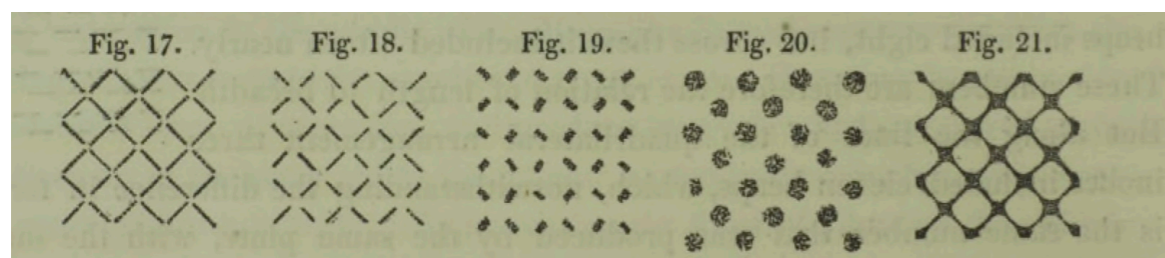
'Anschauung, refers to the intuition through pictures formed in the mind's eye from previous visualizations of physical processes in the world of perceptions; Anschauung is superior to viewing merely with the senses. In short, lines of force were seen everywhere.' [Birkhauser Boston 1984, p110]

Shapes in Motion

There are three interesting analysis that exemplify Faraday's intuition that there is only one substance and the variety of phenomena is accounted for by motion and concentration:

(i) Faraday's 1831 paper *On a peculiar class of acoustical figures; and on certain forms assumed by a group of particles upon vibrating elastic surfaces* [Philosophical Transactions of the Royal Society, Vol121, pp299-318] includes many experiments based on Chladni plates which illustrate the regularities in shapes produced by a vibrating surface. Here is the results of one of them at p326 involving sand:

‘Very often the lines of sand are not continuous, but separated with extreme regularity into portions as represented fig. 17. The portions of these lines were sometimes, with little sand on the plate, very small, fig. 18; and when more sand was present they were thickened occasionally, fig. 19; then assuming the appearance of heaps arranged in straight lines at angles of 45° to the lines regulating the position of the water-heaps which formed them, and just double in number to the latter. At other times the sand instead of being deficient at the intersecting angle would accumulate there only, fig. 20; and at other times would accumulate there principally, but still show the original form by a few connecting particles, fig. 21.’



I believe Rupert Sheldrake has conducted similar experiments with water which he described at a conference in 2019, filmed on You Tube.

(ii) The periodic table has 118 elements and of those, by far the greatest is Hydrogen. Not only does it account for 75% of all phenomena but it is the building block out of which the others are constructed. For example a Carbon atom with 6 of each of protons, neutrons and electrons could be viewed as 6H. These elements are neutral as the electrons balance the protons but are driven to share electrons with other similar or dis-similar atoms to achieve a more stable compound or molecule. For example sodium and chlorine forming salt. H can be fused into Helium at very high temperatures and then into Carbon. In order for H, a gas to be transformed by combination into a solid like carbon a huge amount of energy is needed: the mass of H atom is 1.0079, of a C atom 12.0107 grams/mol. When the H atom is fused within the body of the sun it produces radiation and heat. So in effect the phenomenal world is just varying densities of radiation which traditionally gets split into light and matter (in its various states).

So the continuum as far as frequency goes moves from zero (ie a straight line representing darkness, or silence) to approaching an infinite compression which takes the form of a solid object with too much mass to move as

radiation but retaining inertia or persistence . The intermediary phases being gas and water each phase becoming less viscous.

(iii) It is not simply Einstein’s equation of $E = mc^2$ but his explanation of magnetism in his STR which highlights relative motion If an electric current is moving along a section of wire with equal numbers of protons and electrons and an electron is close by it will be attracted to the wire by the magnetic field created by the moving current. This is the standard explanation. In the STR explanation, the time frame of the electron is used and the current is not moving as both it and the lone electron are moving at the same speed; while the negative charges are stationary in this time frame, the positive charges are moving backwards, and introducing time dilation means that there are more positive than negative charges in the section of wire and this is the reason the lone electron is deflected. Magnetism is an emergent phenomena, dependent on relative motion. If a lab assistant were travelling through the lab at the same speed as an electric current, neither would experience magnetism.

I believe all these notions are intimately connected with consciousness. Each individual consciousness experiences inertia which is the apprehension of stability and persistence, while in reality, it is sitting on a sphere spinning at 460ms^{-1} and orbiting the sun at 107,000 km per hour, while the sun is rotating at around 2.2kms^{-1} and travelling around the Milky Way galaxy with the rest of the solar system at 828,000 km per hour.

Our consciousness experiences nothing of this. We can only be the still point of this vast moving edifice if each individual consciousness is at its centre along the lines of Leibniz’s Monadology.

The mechanics of a system of complexity through transformations in a continuum may be attainable but leaves open the question of what exactly is the continuum: a vacuum, ether, an electric field, a superfluid, plasma. It is the age old problem of ‘substance’. Physics can explain how the phenomena interact but not what the phenomena is. The standard model is an infinite regression and will never solve this question. The other question is why anything exists at all and there is a summary of Leibniz’s answer to this question in the Additional Material accompanying this essay.