



Sympathetic Vibratory Physics

The Ether and Its Functions

Professor George Frazer Fitzgerald

“My system, in every part and detail, both in the developing of this power and in every branch of its utilization, is based and founded on *sympathetic vibration*. In no other way would it be possible to awaken or develop this force, and equally impossible would it be to operate my engine upon any other principle.”

John Keely, 1888

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THE ETHER AND ITS FUNCTIONS.

By Professor GEORGE FRAZER FITZGERALD.

"All are but parts of one stupendous whole
Whose body nature is, and God the soul."

We often speak of space as being empty. We speak of an empty room when it is quite full of air. We speak of empty space between the stars. From this point of view the first line of the above couplet should run:

"All are but parts of one stupendous *hole*."

When we more carefully consider matters, however, we must concede that this way of speaking does not accurately represent even the popular view of nature. Still less does it represent the view that must be taken by every diligent observer and accurate thinker. In the case of an empty room, everybody acknowledges that it is really full of air, and that to speak of it as empty is not absolutely accurate, though sufficiently so for ordinary purposes. It does not deceive those whom we are speaking to. Quakers even have not objected to use the term. It is defensible on the same plea as stating that one is "Not at home." Neither statement is verbally accurate, but neither statement deceives, and each is, in consequence, quite legitimate. It does not appear at first sight, however, that there is any obvious way in which it is inaccurate to speak of interstellar space as empty. There are, no doubt, stars and comets and nebulae and meteors, but between them surely space is empty. And yet even popularly a place is spoken of as -full of light." Surely the space all round the sun is "full of light." Can we, with perfect accuracy, speak of a space as empty which is full of light?

There have been several theories as to the nature of this light that fills space. At one time it was supposed to be some sort of process or feeler that was projected out of people's eyes by which they felt objects. What the cause of day and night can be, seems a serious difficulty to this hypothesis. It would, anyway, justify the suggestion as to the uselessness of the sun which came out by day, though it would hardly explain the usefulness of the moon. This view is not even held by "cranks" nowadays. Light is attributed to the sun, to lamps, to candles, and not to the eyes of the observer. Metaphysicians may ask for the sense in which one can speak of light being present without an observer, but even in this age of skepticism, these very important metaphysical questions have not yet attracted popular attention. We are content to assert that in some sense or another we are justified in speaking of light being due to the sun, or a lamp.

A more recent view was that light was due to small particles emitted by bright bodies. This was a hypothesis with many things to recommend it. In this case it was certainly inaccurate to speak of interstellar space as empty. It must be choke full of these minute particles, hurrying about in all direction at the almost inconceivable rate of one hundred and ninety-two thousand miles a second. Can a space thus actively occupied be accurately described as empty? Even in the shadow of the earth there must be innumerable such particles. The stars are shining there. The earth itself must be emitting immense numbers of them, for we know that it is cooling all night, and the phenomenon of giving out heat by radiation is essentially the same as that of giving out light by radiation. There are, however, several very serious difficulties in the way of believing this hypothesis. One of the most serious is that one must suppose, upon this hypothesis, that the light travels

more quickly in water than in air, while it has been proved by a direct experiment that light travels more slowly in water than in air. There are, in addition, several other difficulties in this hypothesis. Very curious and rather inexplicable fits of easy reflection and easy transmission have to be attributed to these light particles. In order to explain them, Sir Isaac Newton suggested that all space was full of a fluid which in some way caused these inexplicable fits. Such a suggestion almost surrendered all ground for the hypothesis that there were any light particles at all. Once it is conceded that there is a medium filling space, why not attribute light to the vibrations of this medium in the same sort of way as we attribute sound to the vibrations of the air? This is, in fact, the hypothesis now held, and while it explains almost every fact connected with light, there are no known facts necessarily inconsistent with it.

Still, there are people who do not believe in this medium. They seem to think that the sun may act upon us here without any intervening medium. Such people do not appreciate the difficulty in thus explaining what becomes of the action during the eight minutes it takes to reach the earth after it has left the sun. The light takes eight minutes to pass over the intervening space. What is it during, these eight minutes? One view was that it existed as small particles traveling with an enormous velocity. This hypothesis is untenable because it does not explain a number of other light effects. The other view is that it exists as some sort of periodic change in structure of an intervening medium which is called a wave of light in the ether. This is consistent with all known phenomena, and no other hypothesis has as yet been published which has been shown to explain in an intelligible way the phenomena of light.

But there are other phenomena due to the air, for instance, in addition to sound. It has chemical actions, it can blow things about by winds, it can burst strong vessels by its pressure. Are there *no* phenomena due to the ether except light? Surely a medium whose vibrations are so important can hardly fail to possess other properties. Lord Salisbury, no doubt, said in his inaugural address last year, as President of the British Association at Oxford, that the only function of the ether was to undulate. This was a most extraordinary mistake for even a politico-scientist to make. It is one of the glories of British science that by Faraday and Clerk Maxwell a sure foundation has been laid for the theory that electric and magnetic forces are due to the ether. *Its only function is to undulate!* One might as well say the same of the atmosphere or of the waters of the sea. No doubt the undulatory, electric and magnetic properties of the ether require us to suppose a very much simpler nature for the ether than for any known form of ordinary matter. Ordinary matter, with which we are so familiar that we treat its wonders with contempt, is fearfully and wonderfully complex. We cannot hope to explain the innumerable properties of air, for instance, which is quite a simple form of matter compared with most other commonly occurring forms, without attributing to it some very complicated structure. The properties of the ether are so simple that there is every hope that we may be able to explain its properties by attributing to it a simple structure. So far as is known we need only attribute to it the ability to produce electric force and magnetic force in order to explain all the phenomena which can be repeated in any properly equipped laboratory. It is as if we had an invisible bar by means of which we could either push or pull or twist objects at a distance. These are very simple operations, and if they were the only ones that the invisible bar could perform we might very fairly describe it as possessed of very simple properties. No real ordinary matter is so extraordinarily simple as that.

A solid glass bar, for instance, would prevent our pushing our fingers across it; it would bend light that passed through it; it would reflect light from its surface; it would absorb heat; it could be melted if raised sufficiently in temperature; it could be acted upon chemically by hydrofluoric acid; and it would possess innumerable other important properties, so that we could hardly fairly describe it as possessed of very simple properties. Of course no one can prophesy that there may not be found many other important properties of the ether which may show it to be very complicated. The very fact that matter is so complicated, and that ether is so intimately connected with matter, shows that the ether may be very complicated too. At present, however, it seems as if

these complications were due to the complex nature of matter, while a comparatively simple ether would suffice to explain all we know.

In the beginning of science it was difficult for people to believe that we were living at the bottom of an ocean of air. Winds were looked upon as subtle entities rather than as movements of the air. The rising of water in pumps was ascribed to an unexplained natural principle of abhorrence of a vacuum. In a similar way we have, until within the last few decades, been content to explain electric and magnetic forces by a natural principle of attraction of electricity and magnetism. As soon, however, as the existence of winds and the rising of water in pumps, the height of the barometer, and the flight of balloons were all explained by the varying pressures in an ocean of gas, people gave up their former obviously unsatisfactory and provisional explanations, and nobody now doubts the theory that these phenomena are all due to a medium whose vibrations constitute sound. All these properties have been shown to be consistent properties of a single medium, and consequently nobody doubts of the existence of this medium. We now are persuaded that we feel this medium when the wind blows us; we see its action when balloons rise; we hear its vibrations in sound. In a similar way electric, magnetic and light phenomena are all consistent properties of a single medium, and consequently no one should doubt of the existence of this medium. We should feel this medium when a magnet pulls at a piece of iron we hold; we should see its action in a flash of lightning; we should see its vibrations in light.

But, it may be said, nobody has been able to explain these properties? Well, neither has anybody been able to explain the properties of the air. Some of the simpler properties of the air can, no doubt, be explained by supposing it to consist of countless small elastic particles of different sizes and weights jostling one another about. The elasticity of these particles is, however, unexplained, and a great many of their properties, notably the whole series of these chemical properties, are still in that obviously provisional condition of being described as simply *properties* of doing this, that and the other. The electric, magnetic and luminous properties of the ether are very much simpler than the innumerable properties of air, and it is consequently not unreasonable to expect that they will be explained, and it is consequently unreasonable to doubt of the existence of the ether because of its possessing unexplained properties, while we have no doubt of the existence of air though it possesses very many more unexplained properties.

Several directions have been suggested in which we may look for explanations of the simple properties of the ether. It has been suggested that it may consist of particles somewhat like those of a gas, only *very* much smaller and moving, about with very much greater rapidity. It has not, however, been fully shown how this hypothesis can explain the electric and magnetic properties of the ether. Others have gone to the opposite extreme, and supposed that the ether may consist of smooth hard particles almost completely filling space, instead of being *very* small compared with their distances apart. These particles are supposed to slide or roll over one another so freely that they practically offer no resistance to matter moving among them. This seems in many ways a rather hopeful direction in which to look for an explanation of the properties of the ether. It has not, however, been fully worked out, though Prof. Hertz has shown, in his posthumous work, that such a supposition is not inconsistent with what we know of electric and magnetic actions, for he attributes all dynamical actions in nature to actions of this kind. It was the direction in which Clerk Maxwell sought for a dynamical, material system that would possess the same sort of properties as he showed that the ether must possess.

All these theories depending on the existence of hard bodies in space, whether like gaseous atoms they have large distances between them, or like the second hypothesis they have small distances between them, labor under the disadvantage of postulating the existence of these hard bodies without offering any explanation of the cause of their hardness, etc. A hypothesis like Lord Kelvin's, that material atoms are vortex rings in a continuous incompressible medium, only postulates the existence of this continuous incompressible medium. From this one postulate, and

the hypothesis that its various parts are moving in a variety of ways consistent with the postulate, it can be shown that indestructible atoms could exist. It does not seem impossible that all the complexities of nature may be explicable by this hypothesis. A being living in the midst of an infinite ocean of liquid, which was perfectly transparent and at rest, might never discover its existence, just as mankind lived for generations inside an ocean of air without fully realizing its existence, even though they had plenty of motion in the winds to help them. Such a being might be supposed some day to meet a great whirlpool and thus become suddenly alive to the existence of the medium around him. He would probably, at first, think of the whirlpool as an independent entity. He would, however, ultimately find that its effects extended to all places he could reach. No doubt, at a distance from the whirlpool, its effects would be very small, while near to it its actions would be so tremendous that maybe he could never get quite close to its central core. With this evidence before him, would not such a being be justified in supposing that this active thing was a kind of movement in a medium extending throughout all the space he could reach? We find a very similar state of affairs near atoms of matter. They have a central region where their action is so intense that we have no evidence that we can penetrate it. Around this and extending throughout space, diminishing in intensity the further we go from this central core, are actions accompanying this atom. Close in there are chemical actions. It may have electrical and magnetic actions. It always has gravitational action at all places, at least as far as the solar system extends. Is it then irrational to suppose that these atoms are themselves really only a particular kind of motion in a medium that fills all space? In order that an incompressible liquid should be able to transmit actions such as gravity, electric and magnetic force, light, etc., it must itself be full of motion. Lord Kelvin has shown that certain kinds of disturbances might be propagated in a manner somewhat similar to light vibrations, by a liquid whose parts were in intense motion. In order that the action may be propagated rapidly, the motion of the liquid must be very intense. The average speed of the motion of its parts must be comparable with that of the propagation of the disturbance. In the case of light propagation this is *very* great. Light goes one hundred and ninety-two thousand miles in a second. The parts of the medium must consequently be moving on the average with a velocity comparable with this. Some years ago, Prof. DeVolson Wood proposed to calculate the average velocity of the parts of the ether in a somewhat similar way. There was, at that time, a very serious objection to this. Prof. Wood was applying the theory of gases to this case. Now, though there is some similarity between the cases, there is an essential difference. Disturbances, such as sound waves, are propagated by the compression and rarefaction of a gas. Light is known to be propagated by some other kind of action, we don't know *exactly* what, but it certainly is *not* by compressions and rarefactions in the ether. It was, consequently, quite illegitimate to apply a calculation which was only known to be true of this kind of motion to quite a different kind of action. Before such a proceeding would become in any way justifiable, it was necessary to prove that this quite different kind of action could be propagated at all by a medium whose parts were in intense movement, and Prof. Wood had not at that time shown reason for believing this.

If the parts of the medium are really moving at these tremendous speeds, every cubic foot of the medium must have some energy in it. If the medium be at all dense, the energy of its motion will be very large. Each cubic foot might, for instance, be looked upon as a cubical box containing whirling wheels. If the wheels are massive, and whirling with tremendous rapidity, there will be a great deal of energy in the box. If the wheels are very light, there will not be very much energy, even though they are whirling very rapidly. Can we make any estimate as to whether the medium is rare or dense? Most of the estimates that have been made lead to the conclusion that it is very rare. They each depend upon some unproved assumption. We have no conclusive *proof* as to the density of the medium. It is generally thought that, because we do not directly perceive the medium, it must be very rare. This is by no means the case. To return to the being immersed in the ocean of liquid, he was unable to perceive. Whether it were a dense liquid or no, would not make any difference to him. If it were dense, he would, no doubt, in moving his limbs, feel that he had to exert himself a good deal in order to start them moving on account of all the surrounding liq-

uid be would have to set moving. If he was suddenly transferred to a very rare medium, he would perceive the difference. Like the ancient mariner, he “felt so light, almost,” “he thought that he had died in sleep,” “and was a blessed ghost.” But then this was supposed not to be one of the experiences of this being. He was always accustomed to have to move all this dense medium whenever he moved his limbs. In fact, he had never attributed this inertia to the medium at all. He had always attributed it to his limbs. In a similar way we, when we move a stone or a bit of lead or platinum, attribute its inertia to the body moved, while really the inertia may be due to the medium we move along with the body. This must actually be the case if the hypothesis already mentioned, as to the nature of matter, be true. If matter be itself only a part of the medium, which is possessed of some peculiarity of motion, then the inertia of matter is merely the inertia of the medium itself. If this be so, it would appear as if the medium must be *at least* as dense as platinum. When we move a piece of platinum, we may not move *all* the medium inside it, and in that case the density of the medium may be much greater than that of platinum. There is nothing certainly known to disprove such a hypothesis. If, for instance, the medium be five times as dense as platinum, *i.e.*, about one hundred times as dense as water, all that it would require would be that when we move water about we are only moving the one-hundredth part of the medium that occupies the space of the water, and this does not seem at all an impossible hypothesis. If this be so, how much energy may there be in one cubic foot of ether? There will be about one hundred million of million of million foot pounds of energy. This would supply a million horse-power for five thousand years. Such a calculation as this does not pretend to prove that there *is* this energy in each cubic foot of the ether. All it pretends to is to show that in our present desperate condition of ignorance, we know nothing with absolute certainty that *disproves* the possibility of this energy being there.

Is this energy available? Well, it is not safe to prophesy what is and what is not possible. Most prophecies as to what is and what is not possible have proved untrue. Until, however, we have discovered how to utilize the immense known stores of energy in each cubic foot of gross matter, in the earth, in the water of the sea, and in the air about us, energy whose nature is pretty well known and whose amount we can approximately estimate, until we have found out some way of doing this, it seems very unlikely that we shall be able to utilize the energy of the ether, even if we are right in our hypothesis that it exists.

Each cubic yard of air possesses more than four foot tons of energy, owing to the motion of its molecules, and yet we have not found out any way of using this. If we could only catch hold of whichever of the molecules we wished and harness them to a car, and let these go when we had got all the energy out of them we required and harness up fresh molecules, it would enable us to use this energy. The discovery of how to use the chemical energy of coal would be absolutely nothing compared with this. It has been suggested that some of the minuter bacteria are able to do this. Is it impossible that larger organisms may be able to do it? Is it impossible that they may develop the ability thus to sort out the molecule they require in their own superficial cells? If bacteria have developed this ability in their cells, may not mankind by judicious selection or by other means attain a similar ability? We could easily fly then; we could do many other wonderful things. We may fly before that. A surface set suddenly in motion with a velocity greater than that of sound in air would, at least temporarily, have a pressure of nearly fifteen pounds per square inch on its surface, and an area of twelve square inches would then support a heavy man. This is, however, quite beside the matter in hand.

And what *is* all this fierce motion in space which we desire to direct in accordance with our wishes? How do we now direct motion in accordance with our wishes? Is there any motion directed in accordance with our wishes? Certainly there is, if “in accordance with our wishes” has any real meaning. We can often direct the motions of our limbs in accordance with our wishes. By experience gained in childhood, by carefully conducted education, by following the experience of others, we direct many, very many, motions outside our bodies in accordance with our

wishes. We do this by learning what we call the law of nature, or the rules of that great organism with which we have to work, and accommodating ourselves to them. But what is the “we” and what are “our wishes?” What is the “I” of another person? In old times people used to attribute feelings and sensations and thoughts to the heart, liver, spleen, etc. Nowadays we locate all these in the brain. Why? Because we find that an animal can get along very comfortably without a liver or spleen for a short time, so long as its nervous system, of which the brain is such an important center, is kept in working order. So long as the brain is in working order a person can feel and think. If it is out of order or improperly supplied with blood the feeling and thinking are disordered. There is every reason to suppose that our feeling of light is concerned with one series of brain cells, our feeling of sound with another; that so long as we feel light there are certain changes, *i. e.*, movements going on in one set of brain cells; while we are conscious of beauty some kind of change is going on, maybe not only in our brain cells but a concomitant change affecting our whole system. Somebody has recently shown reason to suppose that angry passions produce a poison which disorders the digestive system. It is quite likely, after all, that the spleen may be concerned in these things, and the liver too. Anyway, what is of importance at present is that the only way in which another person's angry passions exist as a reality for *me* are as very complicated movements in their organism. We do not know what movements in the brain cells correspond to the sensation of red light, nor what to a shrill sound. Neither movement is probably one bit *like* the vibrations of the eye molecules, nor of the ear molecules, that excite the cell motions. A waving flag may signal to a general information as to an enemy's manoeuvres which leads him to rearrange his infantry, cavalry, and artillery. But these movements of his army are not a bit like the waving flag which started them. We can, however, trace a connection between them. They are things of the same kind. They are both movements of matter. Similarly, the movements of the ear-drum and those of the brain molecules are things of the same kind. Every action I can perceive in another person is of this same kind. But the shrill sound I perceive is not of this same kind. Ugliness and guiltiness are not movements of matter. But then I can not perceive the shrill sound that another person feels. We may both, no doubt, in a colloquial sense, hear the same sound, but I am not conscious of the other person's feeling. The same source causes two feelings, one in me, the other in the other person. I feel my own feeling, I cannot feel the other person's feeling. The only way in which the other person's feeling exists for me is as a movement in his brain, the only way in which my feeling exists for him is as a movement in my brain. We know as yet no way of getting behind this. There seems every reason to think that what is behind this movement may be as complicated as the army manoeuvres compared with the waving of a flag. It is hard to see how otherwise to explain the fact that brain movements can correspond to such a variety of feelings as light and sound, beauty and ugliness, goodness and guilt. It is well to call all these “feelings,” notwithstanding the boy who defined an abstract term to be a thing like conscience that one cannot feel. It is always necessary to recollect that to *me* these feelings are the only reality; other people's feelings are to me an elaborate and frequently erroneous inference.

One of the most interesting investigations of the present day is as to the positions of atoms in molecules. The whole system is too small to see. We can form some rough conception of their arrangement from their behavior, just as we can form an estimate as to the orbit of a double star from the changes, in its spectrum, even though the components are far too close to be separately visible. We are gradually learning how to read, in the spectrum, the story of what is taking place in molecules, too. There is some prospect that we may some time even be able to tell what movements in the brain cells correspond to a sensation of red light, and, if the world lasts long enough, and mankind is good enough, we may be able to discover what movements in his system corresponded to Wilberforce's determination to put down slavery.

But if the spleen is involved in angry passions, it is evident that motions outside our brain and even our nervous system are involved in feelings and thoughts. Where does our brain end? Where does movement cease to have a corresponding thought? Surely all movement must have a

corresponding thought. And perchance when we know the movements corresponding to a determination to abolish slavery we may be able to form some dim conception of the thoughts that correspond to the movements of the earth, of the solar system, to the development of species of animals and plants. These thoughts will not be our thoughts, nor our ways their ways. That they are not does not necessarily place them beyond investigation. We already know much about four dimensional space, and can state things true of multi-dimensional space, though even of four dimensional space we can form no concrete conception. In the same way we may hope some time to make scientific statements about the thoughts of the universe, though we may be quite unable to reproduce them as our thoughts. Even now we deal with the universe as with a person. How do we get others to do what we wish? By making them feel our wishes directly? No. By paying attention to the laws of their nature and by so acting ourselves as to cause them to act as we wish. Is not that also a description of how we act on nature? How do others act on us? By speaking to us with signs. Does not nature speak to us in the same way? We interpret other people's signs and judge that they have corresponding thoughts. Are we then wrong in considering the signs of nature as the language in which the thoughts of nature are expressed?

All the greatest, wisest, best have implored and exhorted mankind to believe this. Prophets and seers, philosophers and poets, have taught mankind this faith. We have faith in the existence of the thoughts corresponding to other people's brain-movements. Without this faith life would be a mockery. Is it not almost a mockery without the greater faith? The greatest, wisest, best have said so. It is the almost necessary conclusion of science. Science has by itself no *proof* of the existence of other people's thoughts. Science then cannot be expected to prove the existence of these thoughts more complex, indeed, than other people's thoughts, but which can, for all that, be safely called thoughts. Do we not show our wisdom by holding fast by the teaching of the greatest, the wisest and the best? Is it not the most glorious prospect for science that it may one day give a definite form to the greatest thoughts of mankind's greatest sons ?