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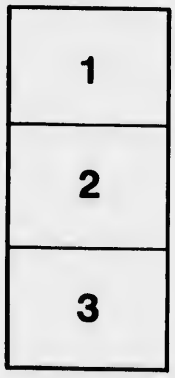

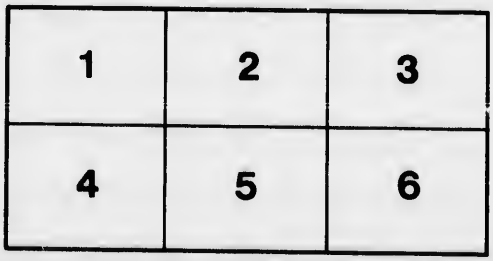

The Why of Gravity.

—BY—

J. A. ALLEN.

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THE WHY OF GRAVITY.*

TO what is gravity due? What is its cause? Is it not due to the essential oneness of matter, of all matter—to its inseparability; for matter is a unit-entity. We cannot get outside of it or void it. We speak by it, we hear by it, we live by it, we are it. It is everywhere always, whether curdled into star-clusters or continents, whether hard as granite, or soft as water, or thin as air, or inexpressibly tenuous as ether. It is one universal, indivisible organic whole, from which not the smallest particle can ever be separated. We never find, and never can make, the smallest portion of space matter-void. Do what we will, matter is doggedly, persistingly, always present, just as truly as is space itself; refusing to be shut out from the one solid whole of the all matter of the universe, or, by any device or force, to be separated into disconnected parts; for, though it may be seemingly cut up into discrete portions, it never is so really, but is only expanded or stretched, or drawn out, by the energy of steam or powder, compelling it to be so, for though yielding, when so required, to the energy that for the moment can enforce compliance, yet, when this energy has expended itself in the work done by it, the matter soon returns to its old *status quo ante*, the amount of its reaction being, as always, measured by the amount of its action, and opposite to it. And so nothing is ever really lost or gained to the universe, while all is kept in a state of perennial activity and ceaseless change—matter unfolding itself in its myriad forms. Now, Sir Isaac Newton has shown us by his masterful mathematics, that every minutest portion of matter has

the most indissoluble ties of relationship with every other portion of it, whether near or far off. Hence the whole of matter is bound up as one indivisible whole by the most intimate ties. And could we get to Sirius, all there would be matter still, and all the way to it, and beyond it. Physically speaking,

> It is the all, "extends through all extent,
> Spreads undivided, operates unspent."

And matter can never be separated from all-matter, for the ties that bind it in the unity of the whole are all-penetrative, all-pervasive, unbreakable, universal—the most distant star and every particle in it being bound to our earth and to every particle in it. As that marvellous product of our humanity, the great Sir Isaac Newton, says—and he proved it—"Every particle of matter in the universe attracts [holds to it] every other particle with a force directly as its mass, and inversely as the square of its distance." So intimate is the union of all matter and of every, the least, particle of it to even every smallest particle of the whole of matter—such its sensitiveness throughout the universe—the same essentially in every part,

> "As full, as perfect in a hair as heart."

And here I have the audacity to change the great Newton's expression of "every particle attracts every particle" into that of every particle is united to every particle. And the whole may be written thus: "Every portion of matter in the universe is intimately bound up with every other portion of matter in the unity of the whole of matter, according to Newton's proved law of mass and distance.

But is matter one and inseparable? Is every particle of air, every drop of water, every piece of stone, as inseparable from all matter as a piece of a cube of steel from the rest of the cube? Yes. Try to empty a vessel full of air by holding its mouth downward and shaking it; it is of no avail. It is as full as ever. Now fill this vessel with water and turn it upside down. Well; we have got rid of the water, 'tis true, but have we got rid of the

matter. Far from it; the vessel is full of matter still; of the matter of the air, which has taken the place of the matter of the water. It is here, as it is always, after every effort, only an exchange of one kind of matter for another. We may make a hole in water with our finger, but on withdrawing it, and as fast as we withdraw it, the hole closes up again; but, while there was a hole in the water when our finger was in it, there was no hole in matter; for the matter of my finger was there to take the place of the matter of the water, and it is only by the substitution of one piece of matter for another that we can ever separate one piece of matter from another: for all matter is fixedly united to all matter by an infinite series of links—links all-convergent, all-divergent, inseparable—the great all-sided whole, star to particle and particle to star equally.

We may, indeed, separate portions of matter to almost any extent—as a stone from the earth—but only, as I said, by the substitution of other matter for the matter removed. But by no cunningest device can we get round Nature. No; we cannot outwit or humbug or coax her to be what she is not. By fundamental constitution she is ever unalterably one—a plenum, a continuum, with no break or void. Who ever saw a void? Who ever saw matter separated from matter with an interval of void-space between? With even all the resources of modern science at our command, the little glass bulbs, for the carbon filaments of our electric lights, cannot be made air-void; for even high-vacuum tubes, in spite of every effort to empty them, still contain "many millions of air-particles"; for matter is so indissolubly bound up with all matter everywhere, that every slightest particle refuses absolutely to be torn away from the whole of matter, so strong is the adamantine tie that binds every particle to every particle everywhere in the unity of the whole. While, if we could even get rid of the particles of the air, there would still remain behind in the bulb the tenuous matter of the ether, leaving matter a con-

tinuum still. And so matter is all annealed fast together, the far and the near, all to each, and each to all by the strong ligaments of cohesive force; and not at all less really are they welded in one, than are the particles, with one another, of a bar of steel.

Thus far I have endeavoured to show how indissolubly strong is the tie which binds every particle of matter in the universe to every other particle. So great, indeed, is this inherent force of the union of matter with matter, that, "to pull apart the particles of a pound of water, we should have to employ such an amount of mechanical power as is equivalent to the raising of fourteen tons to a height of one hundred feet," so enormous is the strength of the cohesive grip that binds them together as in a vice of steel. Whereas, on the other hand, not all the mechanical or other power or enginery of the world combined could avail to so separate these tiny particles from one another as to leave a void between them. For the all-matter of the universe is an integer; and, in the essentiality of its unity, can never be separated, being by inherent constitution not many discrete parts, but one entity in the unity of the whole, and every corner and cranny of nature is crowded to the full with the ubiquitous matter of the universe.

Thus is gravity the cement of the universe, and the slightest touch at the centre of the mass—and its centre is everywhere—is felt pulsing to the outermost rim of nature, not so much as a rate as a state. As the poet sings:

> "The spider's touch, how exquisitely fine,
> Feels in each thread, and *lives along the line.*"

For, though light travels from the sun to us at the almost inconceivable speed of 187,000 miles a second; yet what a laggard it is when compared with the travel-rate, if it be a rate, of gravity, which bounds over its 90,000,000 of miles in the twinkle of an eye. Of this gravity Professor O. Lodge writes, that "its force is practically instantaneous and can scarcely take time on its journey, else there would be aberration." And the

able mathematician, Arago, too, speaks of it as "instantaneous"; and, if matter be a unit—all in one, even this may lose somewhat of its wonder; and how marvellous is matter, which, continuous with everything physical in the universe, is incessantly throbbing, every particle of it, with the wholesome energy of unrest. And this motion, peculiar to itself of every particle, as the spectrum and Mr. Lockyer make known to us—this concatenated, all-divergent, sensitive motion of vibration, may be witnessed by us, conveyed as it is by celestial telegraphy through the boundless ocean of the omnipresent ether, from a particle in a star, many billions of miles away, to the brain and eye of the beholder here on earth, producing in him the *same special* vibration of each individual particle; for the space occupied by each given particle in the star and in the eye on earth is an uninterrupted continuum, all held together by the tie of the unity of all matter. And if this were not so; if the chain had one severed link anywhere, we could not see the star. Hence is there no void in matter.

Now, Newton proved that the force of gravity (I presume to employ here, for gravity, the tie of unity) which holds a hundred weight to the earth, and which opposes the energy of our muscles to lift it from the earth, is the very same force exactly which ties the moon to the earth and the earth to the sun, by the same invisible, but no less real, bands of force. And his proofs involve this, that these bonds can never be severed, though, as I affirm, they may be lengthened indefinitely. For as he has proved every particle in the universe attracts [is bound up with] every other particle directly as is the quantity of matter in it, and if one particle has the force of one particle, then the weight of a whole world of particles—myriads of myriads of them—would have myriads of myriads of equal ties, and would be bound with a proportionately greater amount of force, as we know it would be, and from this allegiance to the unity of all matter the smallest and remoteet particle is not absolved.

Then how unassailably great must be the force of the sun, himself 500 times greater than our earth and all the planets rolled into one, and with what a grip of force must he hold our little world as we might hold a pound. And hence we may cease to wonder, that in spite of all the fearful motion-energy of our planet, as she bounds along with such headlong impetuosity in her onward course, that even she can be easily bridled and restrained from breaking away from all control, held as she is by the strength of the tremendous grip of every one of the countless particles of his mass. From the unity of the whole, then, what could separate our earth or a single particle of it? And is not this the real gravity—this tie of inseparability? The earth is stubbornly reluctant to let go a hundred weight that is bound to her; but refuses absolutely to allow one particle of her matter, to be separated from all matter, now or ever. On the ground of this hypothesis, metaphysics has no part at all. But to the idea involved in the word "attract," I am not reconciled. Nor was Newton himself, as a real causa causans; but only as a kind of ad interim provision, till such time as might be discovered the true cause, for which he had sought, but in vain. The word attract (ad traho) has a metaphysical ring about it, as of a something that refuses to give content, for who can visualize even in imagination the necessary physical nexus, or see why a particle in Sirius should attract or pull towards it a particle on earth and vice versa; but that a particle in the one should be bound, by intervening matter, to a particle of the other in the one great warp-and-woof of all things, in the veritable unity of a seamless whole, of which everything can be readily conceived, as affecting everything, and of everything in return as being affected by it, ("action and reaction being always equal and opposite") as when a pin-prick of the finger is felt and registered in the brain—this unity seems a readily realizable conception. Is the other equally so? Now, I know that many acute thinkers feel a great difficulty in

this matter of the *attraction* of every particle on the earth by every particle in the sun. It is to many a real pons asinorum, over which the intellect refuses to be able to cross. But does not the doctrine of the unity of all matter afford such an open highway as needs no bridge at all.

But that this subject of gravity may be looked at from every side, I shall now quote what others have written on the subject. And first, Humboldt writes, "The amount of matter in every celestial body gives the amount of its attractive force, and Newton succeeded in discovering the force from whose action the laws of Kepler necessarily result"; and Newton himself writes, "The power of gravity arises from some cause which penetrates the very centre of the sun and planets without any diminution of its force." Again, writes Helmholtz, "In gravity we have discovered a property common to all matter." This is strong language—the language, too, of experienced, and subtile, and profound thinkers—the very luminaries of the world of science. Such is gravity, proved in very deed to be a supreme force in the Universe, and I only want to learn if its great power is due to mere attraction, or if it stands always at the very heart of nature, on its own solid feet, "in se ipso totus," in single selfhood, owing nothing to anything, a primordial organic unit, that cannot be separated into disconnected parts by any power whatever.

I want to see if anything underlies this great power, gravity, constituting it what it is, and, if so, what it is that does so. But why disquiet ourselves? Why not rest content with the observed fact? Because, as Professor Tait says, "reason cannot content itself. . . . . with a mere series of observed facts. . . . .we are forced to inquire into what may underlie them," and the ablest and most inquisitive minds in the world have, age after age, thought their time not ill-spent—from Newton to to-day—in trying to get to the root of this matter—*the cause* of gravity. But the great Clerk Maxwell tells us their pursuit has been fruitless. Of every such theory he

says, "we are forced to conclude that the cause of gravity is not to be found in any them."

But is it not great presumption on my part to imagine that I can do what these great men, so vastly my superiors in intellect and knowledge, have failed to do? True, but yet I cannot help thinking what I think. But why should matter, a lump of clay, say, attract (draw to it) a lump of clay, or of limestone, or of flint? Does not all this look as though we deemed that there was something uncanny, some ghost of "occultism," in it, some sleepless spirit of the unseen, that spends its time in drawing every particle of the universe to every other—"angeli rectores,"—till Newton exorcised them, by proving with his masterful mathematics, that gravity and motion were quite adequate in his hands to explain the laws of the universe itself. And so they were dismissed as superfluous. And to-day the whole, as explained by him, rests on the solid Gibraltar of very truth itself, and, so Pope writes,

> "Nature and nature's laws lay hid in night,
> God said, let Newton be and all was light."

Still, when even he turns aside to matters lying outside of the sphere of his marvellous special power, where he stands all-victorious and alone, I do not feel that I am equally bound to follow him, especially where he himself had hesitated uncertain, leaving posterity to discover the *cause* of that gravitation, through which he had achieved so much. But, unfurnished as he was in his day with the vast wealth of knowledge which the ages after him have hived up for us, what prodigies did he not perform; and shall we, "the heirs of all the ages," who look down to-day from the Pisgahs of science on the broad, cultivated plains strewn thickly with monuments marking her conquests and acquisitions—the spolia opima of all-conquering mind—shall we, even the weakest of us, (only dazzled, instead of being encouraged, by the splendour of their success), stand back in the blighting indolence of despair, when the present blossoms in so many fields with the flowers of hope, and do nothing to relieve the darkness

on this special point. And the question now before us is this: is the theory of the unity and inseparability of matter here advanced only a new apple of Sodom from the fruitful land of dreams; or does it afford an *adequate explanation of the cause of gravity*; yea, is not gravity a very necessity of the constitution of the kind of world this is; is it not, a priori, a foregone conclusion, involved in the conception itself of such a world as ours—a world in which nothing is unconnected, but every special thing only a part of a united whole, as united as my hand is to my head; and that consequently, whatever seems to leave it for an instant does not leave it really, but must return, because the ties of unity cannot be severed.

Thus, we see that the force of gravity, while a great reality—a thing in itself—is due to the unity, to the absolute inseparability of matter from all-matter, which all-matter is penetrated through and through, from centre to circumference by the indissoluble ties of force—so wholly one is it, that nothing can ever separate even one smallest particle of it from the sum-total of matter. If anyone thinks he can do so, let him show it.

But I cannot say that every particle "*attracts*" every particle; for that is something not provable by his mathematics, but I do hold that every particle of matter is bound up with, is knit to, every other particle in the unity of the whole of matter.

Now, let us suppose two pieces of India-rubber, the one a tiny cube weighing a pennyweight, the other a cube of a dozen pounds, and that these cubes have been joined on to one another, and let us further suppose them severally stretched by attaching to each of them—the thin pennyweight end and the great cube-end--a vice by which to draw them out by the employment of an equal energy of some kind by which to stretch, and which does stretch, them. Now, in such a case, while the pennyweight portion would become largely extended, the thick solid cube would be but slightly affected. Let us further suppose that the energy applied to stretch the two bodies has

been withdrawn, and so, that the two bodies are allowed to take their own course, would it not be found that, while the great cube was extended very slowly and slightly, almost imperceptibly, the pennyweight portion, on the other hand—stretched to a considerable degree—would bound back with a quick recoil to its first normal position, its reaction being the equal of its action. So, too, in the case of a stone forced above the earth by an energy (and every body above the earth, whether a stone on a projecting cliff, or a body of water on the side of a mountain, has at some time been lifted there by an energy of some kind, and is, so, itself now possessed of that energy), but as soon as the energy has spent itself in the work done by it and can do no more, then the body, if nothing interfere to stay it, will bound with speed to meet the earth, while the great earth itself, too, will (and scientists agree here) move slightly and slowly, according to a known law, to meet the stone; for though the ties of matter to matter are, as such, reciprocally strong, and those of each ultimate particle for ultimate particle equal, yet the incalculably greater number of the particles (and, consequently, of the ties) in the vast body of the earth, as compared with those of the stone, binding the earth to it, renders it correspondingly hard to be moved out of its settled normal state of inertia; whereas the stone, with infinitely fewer ties or staying powers, is easily and rapidly moved to a distance. And here we must again call to mind, that the stone in the upper air was not there of its own sweet will, but had been *forced* (out of its state of rest in opposition to the pre-existing natural ties of matter binding it to the matter of the greater earth) into the air by an energy of some kind, and so had this energy, that lifted it there, *stored up in it*, and so, was capable—as in the case of a bent bow—of returning or of similarly expending it; in short, was capable of re-acting—of giving back what had been *first given to it*; for, the power that constrained it having been withdrawn, the stone bounds back to its normal,

constitutional state. It is all in accord with Newton's great law of action and reaction—Newton's third law of motion being this, that "when one body exerts force upon another body, that other body reacts with equal force upon the one." But, again, though the force of the tie of matter to all-matter is never reducible to nil—Sir Isaac Newton's proofs forbid that—yet a particle in Sirius, distant many billions of billions of miles, and, so, as it were, attenuated and weakened by being stretched, could not have the strength of tie, that a body on the earth close to it and unstretched would have for the earth, and, accordingly, Newton's law tells us that, as the distance diminishes, the force increases (by squares) as when, conversely, we see that the light of a candle thrown through a small hole on to a screen, diminishes in intensity by squares, as the screen is moved farther and farther from it, till at length it seems only a weak, diffused glimmer; and *vice versa*. So when we wish to lift from the ground a weight of a dozen pounds, the unity of the matter with the matter of the earth, tying it to it, demands some power on our part to lift it; but if the weight were one of a few hundred pounds, its ties to the earth being proportionately greater, it would demand a vastly greater amount of energy to do so. For every portion of matter in the universe has to all other matter a force of tie of exactly the same equal strength as every other equal portion of matter has; but, of course, profoundly modified by distance or nearness. For, though the sun has by countless billions of billions more ties of force than the weight, yet the immeasurably greater nearness of the weight to the earth than to the sun gives the weight a far more than countervailing advantage, and hence it falls to the near earth instead of falling into the infinitely greater mass of the distant sun; for the great Newton's law of "inverse squares" comes in here to outweigh the greater number of the threads of tie so abnormally stretched (and, so, weakened by being so stretched,) to the vast distance of over 90,000,000 of

miles, compared with that of the few yards' distance of the lifted weight; and this, as a fact, is, however explained, known to be the case.

Now, take the case of our planet-world! Spun off or left behind by the rotating and condensing sun-nebula, of which it had till then probably formed a connected part, it continues still to move as it did then with the same speed, and this continued energy of first communicated motion is so great that, as Professor Tyndall writes, "by the simple stoppage of the earth in its orbit, the heat would equal the heat derivable from the combustion of fourteen globes of coal, each of them equal to the earth in magnitude." Still, though rolling along with such headlong velocity, it is *bound fast by that cable of countless strands* by which it is anchored to the great sun, so that, struggle as it may to get free, it is forced to travel its wonted rounds, ever on the point of escaping, but never escaped. For no monster devil-fish ever held more firmly in his suckers his small finny prey than does the vast sun-mass our little world. We may, indeed, move particles and masses from one another, but never one of them from the all-matter of the All; for that, growing as it does out of the fundamental unity of all things, is in the nature of things impossible. But if I am wrong—and there are a thousand presumptions, a priori, in favor of such a conclusion—in holding the belief that the cause of gravity lies in the oneness and inseparability of matter, I have at least given a cause, a known cause, to account for it—not some mere brain-born metaphysical abstraction, but a "vera causa," a something that everyone may see, and handle, and prove for himself, and know if it does or does not supply the "missing link," or, rather, the overlapping, yet all-pervasive force, that, holding the all in one, shows how things *must* gravitate, for they are held together as one cemented whole, and must so hold until Newton's law of mass and distance fails us and all things drop apart into lawless chaos. But, mistake me not, gravity, rightly ap-

prehended, is for me a great reality—one of the two great powers, (Matter and Energy) that between them rule the cosmos, and, by their ceaseless antagonisms, keep things going, in a state of wholesome activity. But some one may say, how ridiculous, how grotesque, a lump of India-rubber drawn out to explain the world. It is enough to make one laugh. But, I reply, "*non satis est risu diducere rictum*," and a laugh or sneer is not always the highest proof of highest wisdom. But Lord Kelvin uses it, too, and even shoe-makers wax to the same end; and why not?

Now, Clarke Maxwell, who by his own great achievements, has won the open ear of the world to listen willingly to what he says, and who has had the advantage of the matured thinking of all the profound and subtile minds who preceded him from Newton's day to the present, to give precision to his own judgment, and who believes fully in the infallihility of Newton's great law, yet expresses it by a new formula, thus: "Between every pair of particles there is a stress of the nature of a tension"; and this, to-day, is, I conceive, the way in which physicists regard the matter. Now, though he is in full agreement with Newton, he puts Newton's conception into a new form of words. And though he does not tell us *why* there is this "stress and tension," yet his formula seems to bring the matter more in sight—more nearly in accord with the theory of gravitation, which I have ventured to propose. For "stress and tension" can scarce exist *per se* in isolated unrelation to anything. In void space they could not exist (with nothing to attach themselves to.) Indeed, could exist only as "stress and tension" between something and something, involving the necessary concept of something at both ends to keep the line between the pairs of particles taut. As when a string is held strained between two fixed points. Now the "pairs" of particles in the universe are countless billions multiplied by countless billions, between "each pair" of which (up and down, and backward and forward and crosswise) there are

these countless "stresses and tensions," and this implies for every pair of them two fixed points of support, *i.e.*, a universality of tie-connections. But where are to be found the two fixed points of support for every pair of particles everywhere, but in the universality of the tie of every particle of matter in the Universe of all matter. And if this be so, it comes very near the theory I propose. For here we have plenty of points of support for every "stress and tension," if there be such, of every particle of the universal all. But in empty space there could be neither stress nor tension, and I cannot help thinking that this theory of mine of the unity and inseparability of universal matter—capable as this is of proof—is the most easily realizable by the mind as a satisfying account of why bodies throughout all nature affect and are affected by one another, in the one substance of a unified whole, bound together inseparably by those sensitive nerve-threads, that, permeating the whole, feel every slightest touch from centre to circumference, like the struck chords of a musical instrument vibrating throughout responsively, because they must.

Now, as when we speak of plant-life, we include in our thought every plant from the highest to the lowest, with all their individual properties; some nutritious, some poisonous; and, as when we speak of the animal world, we mean thereby every animal in it—elephant, sheep, wolf, cobra, man, and not any particular animal; so, in accordance with the view of matter which I have been seeking to enforce, I speak not of any special form of matter, as of the diamond, or arsenic, or loadstone, or lime; but of that universal, overlapping matter—matter as such—that includes every form, species and variety of it. But there are a vast number of special kinds of matter with special powers and properties of their own. And, so, some one may point to the natural (or manufactured) magnet, the loadstone, an exceptionally rare product, and, believing that it possesses by native constitution some occult power of attracting iron to it; and, so, preoc-

cupied by current ideas of the inherent force of attraction of all matter for all-matter, may ask if this case of the loadstone is not a clear instance of attraction of matter for matter by direct natural endowment. To this I reply, no. The loadstone does not really (but only seems to) attract iron to it. "Terrestrial magnetism is due," Lord Kelvin tells us, "to the greatness and rotation of the earth." "Any linear current of electricity," says Professor Lodge, "magnetises at right angles to it everything that surrounds it." And Ampere says, "around each molecule of a magnet a current circulates in planes perpendicnlar to the axis of each molecule; and magnetism is nothing more than a whirl of electricity; and an electric whirl exists in every magnet and in every part of it, and is *the cause* of its properties. A magnet is merely an assemblage of polarized particles." In a whirlpool of electricity iron fillings will be sucked up, and, if the electric charge be made strong enough, pieces of iron will be dr: .n up into it, but this is not attraction, but only something incidental to the electric vortex, which by its power and velocity whirls them up into itself. But this whirling motion is no more attraction in any proper sense of the word than can that of the many scattered sticks and straws on the edge of a whirlpool, when getting sucked into it, and so whirled into contact with one another, be called the attraction of sticks and straws for sticks and straws, or of these for water; so "things are not always what they seem." So, too, gravity, real and omnipotent as it is—one of the two coequal powers of the universe—may be found, if we look behind and below mere phenomena, not to stand in regal isolation by right divine, the one great incomprehensible over-lord, but may be only the necessary outcome of the primordial constitution of things, owing to the essential unity of all things.

Now, Newton did not believe that gravity was *of itself a force* so boundlessly dominant by virtue of native constitution, that it could overleap empty space; though

he did hold that "gravity did in very deed exist, and did act in accordance with the law laid down by him" of mass and distance. From which the inference that something—a very real something, too—did intervene; that there must be some line or bridge to span space to enable gravity to pass and repass from sun to earth and from star to star. And is not this supplied amply by the omnipresent ether with its countless myriads of easy roadways through all nature, where matter is everywhere ready to convey instantly each slightest intimation from mass to mass and from particle to particle?

But, before proceeding further, I had better give Newton's own conception of gravity in his own words, where, in a letter to Bentley, the great critic, he thus writes: "that gravity should be innate, inherent and essential to matter, so that one body may act upon another *at a distance through a vacuum without the mediation of anything else, by and through which* their action and force may be conveyed from one to another, is to me *so great an absurdity* that I believe no man who has in philosophical matters *a competent faculty of thinking, can ever fall into it.*" So that, according to Newton, the man who does not believe in an ether has not a competent faculty of thinking. On which Lord Kelvin comments: "Thus Newton, in giving out his great law, did not abandon the idea, that matter cannot act where it is not"; and if, as Lord Kelvin again tells us, "the ether is a material which fills all space, as far as the remotest star," we can conceive why matter always gravitates to matter, because, as filling all space, it is bound up with (tied to) all matter everywhere, with a strength of tie relatively proportionate to the quantity of the matter, *i.e.*, to the number of the particles there; *i.e.*, again, to the number of the ties of force there; for, as says Newton, "every particle of matter attracts with a force directly as its mass," etc. That is, if a stick be lighter, if a stone be heavier, it floats or sinks accordingly. Having fewer particles in a given

space, as compared with the water, it floats; but if having more particles in the same space, *i.e.*, if having more ties binding it to the great earth, it sinks. A cannon-ball lying on the earth is tied to it by gravity, but on being shot upward from the earth by the energy of powder, it is stretched, elongated, *cloignèd* to a certain height before it begins to fall. Now, I wish to represent to myself and to you what takes place on this occasion. The ball is held to the earth by Newton's law of mass (*i.e.*, of the number of particles that compose that mass) and by that other "law of inverse squares," which, since the ball is on the earth, gives it great force. Now, the ball is driven upward by the motion imparted to it by the separating and expanding motion of the molecules of the propelling powder, in opposition to the mutual forces of the gravitation of the earth and of the ball combined, while every tie of the earth and of the ball holds it down opposingly. Let us represent to ourselves the tie of gravity, that holds the great earth and the ball together—a tie strong in the exact proportion to the quantity of matter in both. A stone forced from the earth into the upper air by an energy is yet tied to the earth—really tied to it, as a consequence of the essential oneness and inseparability of all matter, which is a universal integer, an undivided, indissoluble whole, that no power on earth has ever been able to break up into unconnected parts or to create a vacuum there, its native build forbidding that. And the stone is the more strongly tied to it and by it, by reason of the immeasurably greater mass of the earth with its consequent innumerably greater number of ties—the more the matter the more the ties, the more the inertia—and these ties are further strengthened by the nearness of the two bodies to one another, in accordance with Newton's law of inverse squares. But when an energy (*e.g.*, the separative energy of powder) forces the stone above the earth, in spite of the restraining, but ever yielding, ties of matter, those ties are

never ruptured, but only stretched and weakened, as in the like case of elastic India-rubber threads on being similarly stretched, and, so, weakened, which threads, so long as not severed, have the pull-back of elasticity in them—elasticity being the resistance reactively of a body when being disturbed from its *status quo* of inertia. And no Gulliver was ever more firmly pinned to the earth, by countless Lilliputian ties, immovably, than a stone to our world, or the moon to our earth, by the innumerable ties of matter, from every minutest point or particle, binding the one to the all and the all in one—one vast whole of intimately related parts, which even in the smallest particular case are never really separated, but only *eloigned*, and whether close as steel or tenuous as the ether, are always one matter, constitutionally, indissolubly one. Hence, is gravity a universal necessity.

Now, a body driven out of a state of rest by an energy will react with equal force (as in the case of a piece of wood or steel when bent). But everything is modified by the law of the squares of the distance. But the essential consideration is this, that the matter of the universe is one, and refuses to be split up or separated into unconnected parts under any circumstances whatever, and all the resources of science have consequently proved unavailing to deprive a small glass bulb of even all the air it contains, so as to render it mere empty space. Nor can I help regarding elasticity as other than an *effect* of this ruptureless unity. When matter is strained abnormally, it will, as soon as the strain is removed, return upon itself, and hence action and reaction are equal.

The ether which fills all space "to the remotest star," the most tenuous of all bodies and all pervasive, yet possesses, as Clerk Maxwell tells us, "elasticity and tenacity." Lord Kelvin, too, writes that "the Luminiferous ether is the only substance we are confident of in Dynamics"; that "of one thing we are sure, and that is the reality and substantiality of the ether." Now, just as

I do not regard our world either in its axial or orbital movements, as slipping through or sliding under our atmosphere, but as carrying it with it as itself moves ; so may I not believe that any portion of that ether which is never absent anywhere, interpenetrating all parts of all bodies, is ever severed from the whole body of it; but that the ether, infinitely light and tenuous "one million times lighter than our atmosphere here" is not split up or disrupted by our planet or by any other body, but only accompanies them ever. It is true that Lord Kelvin may not hold this view. Still, he is hardly assertive of the contrary, but only says that "perhaps the luminiferous ether is split up by a comet passing through it." But here he only says "perhaps." And, though he again speaks of "cracks in the ether," yet all this I relegate to the limbo of unverified hypotheses. He himself tells us he looks on it as "hardly more than a vague scientific dream." Still, he holds that "the ether itself is a scientific reality." Even the material of Encke's comet, "if forty-five billions times less dense than air at atmospheric pressure," is still continuous. May it not be that through the ether (inconceivably light and perennially elastic as it is) continuous without a break, no body ever passes ; but that it yields, and yields always, with less resistance than even the film of a soap-bubble. So may we conceive of the ether, which, if left to itself, simply, *i.e.*, if no energy keeps it strained, must spring back elastically, and, so, fulfil Newton's law of reaction being the equal of action. And if, as we know, the great sun in his onward journey through space draws along with him all the planets, satellites and comets of his proper system, why not draw with him him the ether, too? And, if our world carries with it through the heavens its "cloud of all-sustaining air," why not carry the ether also? From the centre of nature—and its centre is everywhere—to the utmost bounds or no bounds of the Universal All, gravity rules over mass and particle equally; for the ties of matter to matter are so universal and unbreakable,

that the utmost efforts of science have failed to make even the smallest vacuum. The ties are everywhere, but the more the matter, the more the ties; hence is it easier to lift a feather than a ton-weight, and that, while the effect of a feather falling on us would be scarce noticeable, a ton falling on us would crush us utterly. And this, though a feather and a ton would fall to the earth with the same acceleration.

Now, there are a thousand a priori presumptions against my being able to give the why of gravity. Still, if one has what he deems a pregnant idea, why not give it to the world, that it may be elaborated by abler minds; or, if there be nothing in it, that the whole bubble be at once burst by the Ithuriel spear of truth, to vanish into the limbo of the forgotten, where so many other theories have gone before. Yet can I not help thinking that I have caught the true central thought that underlies and enfolds the whole. It is not claimed to be a great feat—a very small one, indeed, if one at all—compared with the many great achievements of the real masters of science, who have done so much to unriddle for us the mysteries of the universe.

Now gravity might under certain conditions, writes Lord Kelvin, "be explained on the vortex theory," were it not for certain insuperable difficulties; "but no finger-post," says he, "pointing toward a way that can possibly lead to a surmounting of this difficulty, or a turning of its flank, has been discovered or imagined as discoverable." And, so, there is little hope to be looked for from that quarter. But when an energy (*e.g.*, the separative energy of powder) forces a stone above the earth, in spite of the restraining, but ever yielding, ties of matter, those ties are never ruptured, but only stretched and weakened, as in the like case of the elastic India-rubber threads on being similarly stretched, which threads, so long as not severed, have the pull-back of elasticity in them—elasticity being the resistance reactively of a body when being disturbed from its *status quo* of inertia.

Of Le Sage's theory of push, even if there be allowed to be in the universe those ever flying corpuscles, Nicola Tesla says, that coming from all directions, they would neutralize one another, and could, so, have no effect. Let me add, too, that Newton himself disavowed a push theory.

Now, a body, as we have seen, driven out of a state of rest by an energy will react with equal force—Newton's third law of motion being this, "that when one body exerts force upon another body, that other body reacts with equal force upon the one." And so, when a cannon ball is driven upward by the separative energy of powder, and when the powder has expended its separative heat-energy, in the work done by it, in lifting the ball, then at length comes into play, reactively, the opposite influence acting on it, and it begins to fall, with accelerated motion, stage by stage, corresponding exactly to that with which it had, stage by stage, ascended, and when it strikes the earth and can go no further its molar motion, as a single body, is converted into molecular or heat-motion, and so, as it had begun in separative heat-motion, so it ends, too, in separative heat-motion, and so action and reaction are seen to be equal and opposite. But we must ever bear in mind that this elasticity of the ether is a state of the ether, a property of it and of every molecule of it always; and Lord Kelvin tells us, that, unless the perfect elasticity of the ultimate molecules of matter be admitted, the doctrine of the conservation of energy could not be maintained. But elasticity is not something new imparted to the ether ab extra (as motion-energy may be imparted to matter) but is an ever inexhaustible property of it—its own inherently and always, though a secondary one. This is true, for matter is one and inseparable. And gravity, truly interpreted, is the refusal of any one particle of the all to separate itself from the unity of the whole—but must return—no rebel particle anywhere.

But this ether-elasticity, unlike the energy of the sun, I cannot regard as dynamical, but only as a negative, passive force due to its refusal to be separated from the matter of the whole body of the ether, which, though it may yield and yield ever to pressure, reacts, as soon as as the pressure is withdrawn, to its wonted, natural, first state from the unnatural enforced condition to which it had been for a time constrained by some imperious energy momentarily dominating it. "Just as particles when polarized," writes Faraday, "are in a forced state and return to their first [constitutional] condition in the reverse order in which they left it." The purpose of the ether seems to be to convey impressions made on it by something else, as when it conveys to us the vibrations of heat and light.

Matter though it may be expanded, stretched, *eloigned* to any required distance, can never be sundered, but always reacts—like a string of india rubber with a risilient power equal to the power that first stretched it. But how could I who am not a trained scientist from my youth upward, succeed where the trained masters of science have failed? True! But again, what was Newton, at one period of his life, but a simple farmer lad, trying experiments of his own suggesting—leaping now against the wind, now with it, now in still air, to learn the amount of its power and of its resistance. But do we owe everything to our great trained thinkers, but nothing to our Faradays, Davys, Rumfords, Joules, Henrys, Bells, Teslas, Edisons, Marconis, etc. And though "the greatest genius that ever existed," as the great French Mathematician, Lagrange has pronounced Newton to have been, has failed, like so many others, to discover the cause of gravitation, "the greatest of all physical mysteries," is all the world to look on only in dispair. On a certain assumption, Newton had proved his theory mathematically. But he was not satisfied. *What* really was the underlying *causa causans* was still the unanswered

question, as himself tells us. Yet if all matter be, as it is, always one, an indivisible whole, the cannon ball resting on the earth and shot upward is not really severed from the earth, but only *eloignèd* from it for a second; for if reaction be the opposite and equal of action (*i e.*, of the energy that carried it up) then as it seems to me, the cause of gravity is answered; that is, the ball must return to the earth which it had been forced (apparently) to leave for an instant. It was thus that having lighted on a conception, which, I could not help thinking, had its great trunk-root deep down in the lowest soil of Nature, and which was drawing its nutriment, not from a mere sapless "*conceptus mathematicus*," but whose smallest and remotest fibres—to employ the strong words of Newton himself—had "penetrated to the very centre of the sun planets;" and if action and reaction are equal and opposite, then the ball, whenever it had reached the end of its tether, must, I conceived, come back to its *status quo ante*; and so the cause of gravity, seemed to me to stand fully revealed. And Newton's "concept" worked out by him with a power and a brilliancy almost super-human in its massive grandeur and completeness, being now based on reality, on the very underlying *causa causans* itself, which he had been always seeking, but which, though never losing full faith in its existence as a great reality, he had never been able to visualize in idea—but, being now made known, all his mathematics stand for ever sure. Through his great penetrative genius, it was to him "the evidence of things not seen."

Now let me put, in the place of the elastic air and ether, which we cannot see, a thin screen or sheet of elastic india-rubber which we can see, and can observe how it acts; and let us suppose, further, this rubber held firmly to the ground, though a foot or two above it, and with a thin veneer of wood a couple of feet square, under the rubber. Then let an energy of some kind—steam or powder—be put under the veneer. Now, as the expanding

energy presses against the wood, and the wood against the rubber, the rubber expands elastically, and continues to expand so long as the energy is unexpended. But as soon as the energy is spent in the work done in the expanding and lifting, and can do no more, then, conversely, —reaction being the opposite and equal of action—the energy, so bountifully stored up potentially in the rubber, (for the energy imparted to anything is stored up in the body to which it has been imparted) begins to act in a reverse order, with a resilient power equal to that with which, stage by stage, it had before expanded, and the rubber now contracting elastically brings down the wood to its first position. *This*, then, and not the attraction of matter for matter, of which we know nothing and of which Newton knew nothing; but only (on certain grounds which never really satisfied him) assuming its truth provisionally, built up his magnificent scheme of the cosmos. *This*, as I have been endeavouring to show, is the real (though misnamed) gravity, which, besides being solidly based on the known, falls in exactly with the mathematical proofs of the great master. It is the case of a body having had to leave the earth, under compulsion, again returning to it because it must—always must, so long as matter is an indivisible entity, never separable into discrete parts. A cannon ball shot skyward never really leaves the earth behind it, but is held to it ever by the unbreakable, but yielding, ties of the unseverable union of all matter to all matter, which is capable of being stretched to any required length, but cannot be ruptured, so as to leave a void between, as Faraday says, "We cannot procure a space perfectly free from matter"—cannot find it or make it. While experts tell us, that in the little glass bulbs for our electric lights, even after exhaustion, there are "many millions of air particles." Now Newton himself writes that the theory of attraction, which in his hands, answered so admirably as a good working hypothesis, yet failed to satisfy him. He regarded it

as "only a mathematical concept"—"*mathematicus duntaxit conceptus*"—and said further, that the grounds of these "properties of gravity he had not yet been able to deduce,' nor, for the two centuries since, has any one been able to do so; and yet the cause of gravity was, all the time,' as simple as it was near to each of us. And, *if* the theory I propose be true, then this mystery of the ages will be resolved, while the powerful mathematical reasoning of this wonderful man, founded, as it will be, on the solid truth of things, will lose no whit of its force, and satisfied reason will rest henceforth content. What Newton did is to me simply marvellous. Of him his great personal foe, Leibnitz, affirmed that "taking mathematics from the beginning of the world to the time when Newton lived, what he had done was much the better half."

A stone lying on the earth, and a stone separated from the earth (*i.e.* above it) are in two wholly different physical states. The first is inert, cannot move itself: the other has stored up in it the energy that lifted it to where it is, and through this energy (nov its own energy) it can react oppositely, as could a stretched india-rubber string. So, too, a piece of india-rubber has itself no energy, but when stretched, it has in it the energy of the stretcher, and owing to this imparted energy it can, when left to itself, react. It was through not seeing this that that very able man, Professor Tait and his fellows made their very serious mistake of making all energy (kinetic and potential), only kinetic—indentifying, as Grant Allen has pointed out, "energy with motion instead of with separation," (or with the energy that caused the separation) "as if kinetic energy were the normal form, and potential energy a peculiar manifestation of it," whereas potential energy, as in the case of a bent bow, is the real parent and cause of all energy. And a stone forced from the earth into the upper air by an energy is yet really, tied to the earth, as a consequence of the essential oneness and inseparability of all matter, which no power on earth has ever-

been able to break up into unconnected parts or to create a vacuum there—its native build forbidding that. And the stone is the more strongly tied to it and by it, by reason of the immeasurably greater mass of the earth with its consequent innumerably greater number of ties. But when an energy (*e.g.*, the separative energy of powder) forces the stone above the earth, in spite of the restraining, but ever yielding, ties of matter, those ties are never ruptured, and the stone returns to the earth again.

Now, I see no reason compelling me to believe that a sheet of wood or iron forced up slowly, or a cannon ball however rapidly, sets aside or splits the ether which yields and yields continously, or that it is ever ruptured or displaced by planet or comet or anything else; but the lightest of all bodies, continues to be elastic everywhere and always.

Now, the two great antagonistic powers which divide between them the empire of "the All" are Matter and Energy—separative energy—Energy which, as heat, separates the particles of water into steam, or which, as expanding powder or steam, will separate a stone or cannon ball from the earth, by lifting it into the air; but which, when so lifted, the inseparable unity of all matter will at once bring down again to the earth. Yet, oddly enough, as it seems to me, our scientists have been seeking to manufacture, out of the energies—the *active* powers of the world—that gravity of matter, which is of all things in nature the most fixedly settled power—passive, inert, never moving, unless when compelled by an energy to do so, and then instantly returning to its old *status quo*. But this great Newton, though he knew not what specifically was *the* cause of gravitation, though he tells us himself, that "he had not been yet able to deduce from phenomena the reason of the properties of gravitation," and only claimed that his great achievement was "merely a mathematical concept." Still it

was far more than this, for he felt in every fibre of his being that there was an underlying cause, ever present and resistless, to which all the marvellous power of gravity was due—a power, he tells us, "that penetrated to the very centre of the sun and the planets [and of al suns and all planets] without any diminution of its force;" and in this I conceive there was something better than the attraction of matter, even the very *union itself of all matter with all matter—a union* organic, inseparable, eternal. And this unwavering faith that there was a cause adequate to sustain the whole weight of all phenomena was the *really essential* thing, and he accordingly proceeded with his great monumental work; knowing, as he did, that in the background of everything was the true reality—the great *causa causans*—which compelled them to be, as his mathematical genius had shown them to be. What matter, then, if, knowing not what the special cause was, his undoubting faith was that such a cause existed. But to return. Even that prince of physicists, Faraday, was so misled as to seek for the cause of gravity among the energies, and, at a late period of his life, to make electricity responsible for gravity; and, to that end, presented a paper on the subject to his fellows of the Royal Society. But his paper was afterwards withdrawn, at the instance, I think, of Sir George Stokes, as little likely to add to the great man's reputation.

Now, this question of stored up energy is of such deep importance in our present inquiry, that, even at the risk of being tedious, I must again dwell on it. A stone lying on the earth is in a state of inertia; it cannot move itself, it is devoid of energy; but, if lifted above the earth by the energy of my arm, it has my energy in it; and, owing to the possession of this energy, it can move. Again, if I fling a stone at anything, my energy is in the flying stone, now become the stone's energy; and if a pane of glass or the face of a man stands in the way, it or he will experi-

ence the effect of the stone's energy—an energy which I had imparted to it. Thus it is that the energy imparted to anything is *stored up in it*, and may be used accordingly. And so it is that a stone on the earth and a stone above the earth are in wholly different states physically. The one cannot act; the other can.

In the first part of this little brochure, I sought more particularly to show that all the matter of the Universe was, by primordial constitution, one and inseparable—matter everywhere linked to matter by adamantine ties. And the same lesson is impressed on me when I look at an object near or far; at a flower near me or a star a million million of miles distant. Now, what really takes place in such a case? Is it not this, vibration after vibration, in a direct line, of the whole intermediate matter of the infinitely tenuous, ubiquitous ether; link after link, an unbroken chain from flower and star to the sensitive brain cells, which thrill responsive with similar vibrations, that convey to the mind unerringly the specialty of the very object seen and recorded; just as a photographic plate must passively receive and represent the object presented to it? But, were only one link of the vibrating matter severed from the rest by a vacuum, neither flower nor star could be seen by the spectator, for matter must be continuous without a break anywhere, just as matter always is. Then, as respects matter itself, Prof. Tait writes, "the conservation of matter means this, that, do what we may, we cannot alter the mass or quantity of a portion of matter. We may change its form, dimensions, state of aggregation, or (by chemical processes) we may entirely alter its appearance and properties; but its quantity remains unchanged . . . . . The only other thing in the physical universe, which is conserved in the same sense as matter, is energy . . . the other objective reality." —(Tait and Rankine). Now, "were gravity," writes Professor Lodge, "a radiant force emitted from the sun with the velocity of light"—187,000 miles a second—"the

force experienced would come from a point a little in advance of the sun, and, so, there would be aberration. But gravity appears to be practically instantaneous." So, too, writes Arago; for is not gravity, indeed, a state of matter, which forbids any real separation—that "feels in each thread and lives along the line," a oneness all-pervasive, whose centre is everywhere always? But returning to the question of the necessity for the continuity of intervening vibrating matter between us and flower or star in order to our seeing them at all, and, therefore, of the necessity of the continuity of the matter itself that vibrates, I add that, just as in the case of a chain of many links fastened to a log with a horse at the other end attached to it to draw it, the rupture of a single link would render the purpose of the chain as unavailing, as if the chain had been wholly absent. But matter is one, inseparable, continuous; united to the matter that goes before and which comes after, and with all the matter all round of the universe everywhere. Hence is universal gravity a universal necessity.

When a pendulum-bob, attached to a given point by a string, and in a state of rest or inertia, is carried round by the hand a quarter of a circle from its place of repose, and then allowed to take its own natural course, it moves half a circle round in the opposite direction, owing to the energy that first lifted it having been imparted to it, and, so, been laid up in it as its own energy. This acquired energy then carries it back again to the point from which it had first started, and so (if nothing in the point from which it was suspended, has impeded it, and if the air be regarded as eliminated) it would continue to repeat its motion forward and backward, action and reaction being equal and opposite, and the energy renewable and renewed at every swing of the bob. Now the bob, you will observe, when it falls, does not fall passively, but actively, compelled at the end of each swing indifferently, when it had reached the end of its tether, to swing back again

each time, owing to the energy impared each time and stored up in it for a new start. Now let all this be carefully weighed in all its bearings on the current ideas of gravitation, and let unprejudiced judgment say to which the scale inclines. And, *if* what, in this little treatise I have written on gravity—its mode and cause—be true, the whole question will have to be carefully reconsiderd. I now commit my case to the public, and console myself with the thought—*parva cum magnis*—that even the great Newton was not at one period of his career valued as he ought to have been. Sir William Petty, a very clever man, and a Co-Fellow with Newton of the Royal Society wrote of him thus: "Poor Mr. Newton, I have not met with one man who put an extraordinary value on his book"—the immortal Principia—"I would give five hundred pounds to have been the author of it." Even the able Huygens thought it strange that Newton should have wasted so much good mathematics on a theory that seemed to him, on the face of it, "absurd." But, without thorough fairness of mind and clearness of judgment, even great mathematical ability can prevent no man from greatly mistaken views. "It has been the good fortune," writes Tait, himself a great mathematician, "of but a very few even amongst *the most gifted* of mathematicians to be able to thread their way in safety tnrough the *countless traps and pitfalls* which lurk unnoticed, often undiscoverable till they have done their worst in every part of every region of this fascinating domain."

Mathematics, ever since the times of Copernicus, Kepler, Galilei and Newton, has held a deservedly high place in the estimation of mankind, and when in its appropriate sphere of spacial relations can, in the hands of a real master, do wonders, as it has done in the past, but outside of that sphere, I would far more trust a Faraday, with his keen observations and experimental tests, than I would any mathematician without them. "Faraday,"

says Lord Kelvin, "without mathematics, divined the results of mathematical investigation, and, what has proved of infinite value to the mathematicians themselves, he has given them an articulate language in which to express their results." And Clerk Maxwell allowed that Faraday's mode of proceeding by experiment was a method superior to his own, the mathematical. And Huxley says, I think, somewhere that, after all, you get nothing in such cases out of mathematics but what you first put into them, or something to that effect. And we should always bear in mind what Professor Tait warns us of, "the countless traps and pitfalls which lurk unnoticed," in mathematics, "even by the most gifted."

Energy is a power which bodies have owing to their separation, but which they have not, but lose in the act of combination. A compound, then, is a body that having parted with its energy is passive, inert. The element fluorine is so energetic that it can scarcely be held in almost any vessel as a single substance, so bent is it on combining with the material of the vessel got to hold it; yet when combined with lime as a fluoride of calcium how tame it is. As fluor or Derbyshire spar how very inert. Water, too, one of the most perfect of compounds is unenergetic—a slave to every impression made on it by any outside energy. Yet when water is resolved into its elementary constituents (oxygen and hydrogen, each in an unlike polar state—the oxygen negative, and the hydrogen positive—how energetic they are: separated by electric energy into single elementary bodies they have, as in all such cases, *stored up* in each of them the energy that separated them, and when they again, owing to their opposite polarites, combine, they give up their energies, and are henceforth, as being a compound, inert. As Herbert Spencer says, during "the combination of oxygen and hydrogen there is an unparalleled evolution [and loss] of heat."

Now, in contravention of Grant Allan's theory, that "energy is separative power," it was objected by an able chemist and mathematician, that the *compound* chloride of Nitrogen, was a singularly energetic body. But chloride of Nitrogen is not really a chemical compound at all. Now, instead of the chloride of Nitrogen, let us take the similar, but better known body, Dynamite. Now, chemists tell us that gun-power is not a chemical compound, but only a mechanical mixture, but in the case of Dynamite I can see no radical difference to distinguish it as a mixture from gun-power. In short, they both of them are not compounds at all, but only on their way to becoming such. When their several several elements (still in abeyance, in their several compartments) combine chemically, then, and not till then, have we a chemical compound, with the consequent loss, on explosion, of their energy. Those who read with care the newer or structural chemistry will see that this is as I state it—all chemical composition involving the loss thereby of energy; and, if not losing it, it is no compound. Still no body in our world is ever absolutely bereft of heat-energy.

Now, it is, in the very nature of things, hardly to be expected that this little treatise will be read without a strong barrier of prejudice against it, running, as it does, counter to ordinary habits of thought, and treated from a wholly new standpoint. Besides, we must not lay out of our estimation certain very human passions, which too often vex the souls of even philosophers, and stand in the way of well balanced judgment. It is related of the great Harvey, that of the physicians of England of his day, not one of them of over forty-five years of age at the time ever believed in his immortal work of the discovery of the circulation of the blood. And with what dull ears was Joule listened to, and Newlands by the great lights of the Royal Society, while the brilliant dealers in fireworks and sky-rockets meet with ready and high applause.

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