London:-There are many signs tending to prove the present time to be in many respects a critical one in the history of physical science. More especially is this the case in the broadest and most extensive field to which the science of physics seeks to extend its powers-in it, namely, of the cosmical forces, with their ulimate nature and laws of operation. Since the publication of the *Principia* the progress of cosmical science has been one of unmixed triumph for the law of gravitation, conceived as a principle of attraction interest in all matter, applicable to all bodies terrestrial and celestist. applicable to all bodies terrestrial and celestial, pervading all space, and capable of explaining the motions and periodical chaoges which successive observations brought to our view in our growing knowledge of the univerc. Of late yoars, it cannot be denied, a suspicion has been gaining ground that the monopoly, so to speak, enjoyed by this magnificent and triumphant by the late of the control of the contr

hypother is is liable to question.

Not that the slightest doubt exists, or need be started, as regards the absolute truth or the universal applicability of the law of gravitation. facts and phenomena, however, of great physical importance, which had either escaped the notice of illustrious men from age to age, or have been only brought to light by sids to ob-servation not within their reach, have opened new and almost startling fields of speculation and discovery in relation to this momentous theme. Anomalies have not seidom been en-countered in the study of nature by the single light of the established hypothesis. In the application of mathematics to physical facts and observations, cases have been found to resist every form of analysis based upon the exclusive truth of that assumption, or at best recourse has been had to a treatment through the use of empirical or exceptional formula aside of the original law. A query has thus been raised in the minds of many astronomers and physicists whether some subtle principle antagonistic to attraction does not also exist as an all-pervading element in nature, and so opera'e as in some way to disturb the action of what has generally been considered by the scientific world a unique

It is the aim of Dr. Winslow's recent work on "Force and Nature" to establish the existence, and to trace the fundamental laws of a repulsive force in nature complementary to the attractive force inherent in matter. In following out this thesis he has shown great subtlety and strength of reasoning, combined with much width of observation and a marked power in generalizing from facts. This is not the first time that his views upon this important problem have been submitted to the public. As early as the year 1853, a treatise was printed by him on 'Repulsion' as a Cosmic Force," In justice to the originality of his speculations, Dr. Winslow feels called upon to explain that he was at that time unacquainted with the "Theoria" of Boscoin which that learned Jesuit presented in 1745, the hypothesis of repulsion, and attempted its mathematical development as a middle range of speculation between the theories of Newton and Leibnitz. Acute and even prophetic as were Boscovich's ideas, they seem to have made no impression either upon his own or subsequent times; nor have they proved to Dr. Winslow himself suggestive either of law or fact during his observatious and researches in the same field. The general idea of "molecular repulsion" was indeed, as the author allows, as old as the early Greek philosophy, and was shadowed out in the poetical cosmology of Lucretius, though at no time brought within the range of inductive or experimental proof. A letter from Newton to Boyle is adduced by the author to show that the conception of a force unlike and opposed to gravitation had crossed the mind of great philosopher, although his views in the main were but conjectural, and were never carried out with the same full and clear development as his other leading hypotheses. Hooke was led, in 1862, by his observations upon comets, to conceive a repeliant agency proceeding from the sun, and urging the wils of those bodies in a direction contrary to that which gravitation would cause them to take. This agency he supposed to be light, and applied to it the name "levitation." Conjecture, more or less vague had been hazarded by Kepler, Euler, and others, that the light emitted by the sun might be a repulsive force per se; by others, that the sun's electricity exercises a repulsive influence upon distant bodies. The observations of Bessel upon Halley's comet impressed him with the idea of some element of power contrary to gravity inherent in the sun, and engendering in resisting medium a condition opposed to that of the cometary particles, to which he gave the name of polarity, considering it as something akin to magnetism. In 1858-60 this idea was revived and expanded by M. Faye, who from his own observations, as well as theor of Mr. Bond and others, upon the comet of Donati deduced the idea of a definitive repulsive intu' ence exerted by the sun upon comets in gene but not upon the denser cosmic bodies. 'nce de la chaleur solaire, et exercee au toin par la surface incandescente du soleil." dwells with interest upon the problem of determining the 'quality of those forces which govern the heavenly bodies around us." Dr. Winslow is particular in drawing attention to the date of this de laration of M. Faye, with the view of establishing his own claim to the priority of research and publication, It was in March. 1853, he tells us, that his first demonstrations of "repulsion as a plane tary, solar, and universal force" were given to the public. Whether this essay or treatise was published in America or England we are not given to understand. Since that time his un-dertaking has been furthered and stimulated, not only by the general drift of scientific thought in relation to cosmical and molecular physics but in particular by efforts like that of Professor Rankine in his "Outlines of the Science of Energetics." The writer has also to speak of direct encouragement and assistance given to his labors by Baron Liebig, as well as by Faraday, from whom a most generous and encour-aging letter reached him in the year 1858.

Molecular repulsion has, as a fact in physics, long been placed beyond dispute. The problem now before men or science-the problem which Dr. Winslow considers himself to have solved in the affirmative-is the extension of this law through all the acts and conditions of molecules to their grandest combinations and phenomena. It may one day be in the power of the calculus to assign to this universal law its definite and progressive quantities and functions. on the other nand, be reserved for this discovery to mitigate or clear up much of the reproach that, in a certain sense, may be said to hang over the department of analysis. There are certain anomalies or difficulties, such as those in the lunar theory in the problem of the tides, and in the secular variation of the earth's mean motion, which are held, so to say, in suspense for lack of the means of integrating the equations involved. What if it should turn out that the real defect lay in the assumption of an attractive force as the sole cosmical condition of the problem? Telescopic science, enlarging and defining the aspects and the range of the stellar universe, has added its suggestive voice to the demand for a wider conception of cosmical force. The spiral form of many nebulae, notably the great nebula in Orion, and anomalous forms like the "dumb-bell" in Vulpecula, seem at once to chal-lenge the exclusive dominion of a law which would account only for curves of the second order. We do not find Dr. Winslow making as as we think he might of these two branches of speculation. In his chapter on the Nature and Action of Force, he enters with fullness and vigor of reasoning upon the mechanical and crystallographic actions resulting from the primary forces in nature, and indicating in their products the "dual elements of attraction nd repulsion" at work in every action of those forces upon aggregates or combinations of atoms. Although not treated by physicists in general as an active agent in crystallization, repulsion is, he rightly urges, without doubt as present and effective as attraction in arranging molecules into geometrical forms, and expanding these forms into their grandest and most perfect proportions. As attraction is known as the force that moulds the faces and produces the shortest axes of crystals, it follows that repulsion must be that which shapes their salient diameters duces follows that shapes

raline solution, the particles are seen to repel and fly from each other like so many animaleuse or inflottesimal magnets. while in another direction they attract and atach themselves to one anotocc, assuming finally regular and solid geometrical forms, "While attraction appears to be the basis of solidity, repulsion appears to assume a higher function, and to inspire in matter a spirit of selection, adjustment, arrangement, order, and beauty, and to be an ascending force from inert or neutral atoms, adding to the solidifying force a kind of intelligent life like endowment."

The same basic force may in like manner be de tected underlying the great geological principles which resulted in the formation of the earth's crust. Without committing himself exclusively to any special earthquake theory, the student of pature cannot but recognize the persistent action of a repulsive force in the upheavals and fissures, the undulatory movements and shocks which disturb even now the equilibrium of the earth's surface, no less than in the vast basel ic and metamorphic deposits which denote a highly crystallizing energy at work in the ear-liest processes of solidification. The testimony of earthquakes to the truth of the hypothesis of terrestrial tension and repulsion is brought together with much diligence by the author, whose extensive travels in Central America and the islands of the Pacific have given him the means of personally testing and measuring the magnitude of those tremendous agencies. His reasoning, which is in part based upon, and in general compatible with, the careful observations and cautious views of Perrey and Mallett, goes to establish the existence of a powerful re-pulsive principle at work, radiating from the centre of the globe. From the immense stores of facts collected by these and other investigators, he thinks he can see his way to connecting this movement of the fluid mass confined within the solid crust of the globe with the varying attraction of the sun's mass at different portions of our planet's elliptical orbit. The general intensity of the seismic or plutonic force should be, according to this theory, inversely proportional to the length of the earth's radius The tables he has put together do much to

substantiate this view, so far as the numbers of recorded earthquakes with their corresponding dates are concerved. "For the six during which the earth is most remote from the sup, there stand 5175 against 6697 during the six months of nearest proximity of these two bodies, thus presenting a difference of 1522 in favor of the perihelic arc." If we proceed to estimate, however, these phenomena in the ratio of their intensity, rather than of their frequency, the results seems to us, at first sight at least, far less decisive, even if any law can be deduced from them at all. Picking out from the long list of earthquakes those which seem to have been the most violent or extensive, we find them occurring without much difference at all periods of the year slike. Of the two great catastrophes at Lisbon, that of 1531 took place on the 26th of February, that of 1755 on the 1st of November. That of Lima, in 1746, was on October 28. That by which the coast of Chili was permanently raised was on November 19, 1822: while one of the most violent on record in this country-by which, says Hoveden, Lincoln Cathedral was rent, a summa deorsum-took place April 15, 1185. That whereby parts of St. Paul's and of the Temple churches were thrown down was on the 6th of the same month, 1580. The late terrible shocks in South America occurred in the middle of August the extraordi pary cruption of lava in Hawaii during April of last year. The wonderful outbreak of Vesuvius described so graphically by Sir W. Hamilton extended with little intermission from November, 1765, to near the end of October, 1766. The greatest of anomalies is that lately recorded by Professor Phillips—that periodically Æina is most active during six months ending with July, Vesuvius during the six months beginning with that month. Dr. Winslow allows little or no force to the tidal influence of the moon upon the molten sea within our earth: else we might refer him to the most recent observations of Professor Palmieri, showing that the eruptive force in the case of Vesuvius is sensibly strengthened at the syzygtes and weakened at the quadratures of the moon. It is so far in favor of his hypothesis that none of the fiercest shocks can be pointed out at exact proximity to the June solstice.

The phenomena of comets have been studied by the writer with an amount of pains and an acuteness of reasoning to which we regret that we cannot do justice. On the nature and causes of waterspouts he dilates, it seems to us, with more originality than conclusiveness. Instead of seeing in this phenomenon the simple force of atmospheric pressure, he believes it to depend "positive radiation of the repulsive upon a force as a definite cosmic principle, which acts upon the body of the waters to rarify, in like manner (aithough in an opposite sense) as attraction acts to condense them." From what source this radial impulse is im-parted to the ocean, its surface being in the most signal instances calm at the time, and how it is combined with the rotary action of the descending currents of air, he for-bears to speculate, through he might trace here an analogy with the well-known syncronism of atmospheric and magnetic storms with disturbances of the earth's strata. He has done, however, good service to science by exposing the hollowness of referring these and similar systhe working of nature to the mere hypothetical notion of "reaction";-

To call these and similar phenomena simple "reaction" explains nothing; for reaction, as a word, means nothing unless it represents an word, means nothing unless it represents an idea of direct and positive physical force. If it mean anything, then, it expresses a force opposite in action to that which drew the particles towards the centre and increased the density of the comet's mass as it approached the sun. If it be a force—a positive principle exerting action opposite to altraction. principle exerting action opposite to attrac-tion—it is the equivalent of molecular repul-sion, admitted by every writer on molecular physics, and which has already been demonstrated to be susceptible in our own planet of swelling into indefinite volumes, of producing general radial phenomena, and of becoming an absolute planetary force, the properties of which are everywhere similar, and always ex-pressed in functions of a cognate and volumi-nously repulsive character. And it may well be concluded from all which precedes, that the final principle of nature which, inroughout our globe, expands matter, creates the waterspoot. globe, expands matter, creates the waterspout, guides the currents of vital force and molecules in the paim-tree and pine, lifts platonic fires thousands of feet high, shakes alike centre and circumference, causes flame to ascend perpendicularly from every radius of the sphere, is no other than a positive living force of respirator—a principle of energy the force of repulsion—a principle of energy the opposite of attraction; and that it not only performs the same function in every planet and comet, but also is the identical principle which, in every star and controlling central body of a system, determines and guides all radial phe-nomena in their outward courses, and in our own system, proceeding from the sun, projects the comet's tail in all its radial aspects in the same manner as repulsion, ever insensibly radiating from the earth's centre projects the ascending atoms or iumhous currents from a scenning atoms or iumhous currents from a burning tsper. It is one and the same principle, as universal in its reach as gravitation, and ever antagonistic to it, whether in a molecule or a world. It is the occult principle of energy, the final element of antithetic power, per se in polarity as will be more clearly seen terrefor

polarity, as will be more clearly seen liereafter. Pr. Winslow's volume is more conspicuous for bold and comprehensive generalizations than for the minute discussion of facts. Its ten-dency throughout is to take for granted, or to lay down as a solid basis for speculation, what may often be considered matter of no little doubt, if not opposed to the received current of scientific opinion. Thus the fundamental dogma on which he proceeds to build his entire struc-ture of proof is that space is absolute vacuum. ture of proof is that space is absolute vacuum.

'No ether, either ponderable or imponderable, exists there.' The hypothesis of an ethereal medium, either as engendering or transmitting light, or retarding the motion of bodies in space, will one day be classed, he thinks certain, with "phlogiston," vis merria, and similar baseless figurents of the schools. Light, in his view, is "only a compound resultant of molecular attraction and molecular repulsion." straction and molecular repulsion."
When to this highly sounding but vague definition he adds the still more obscura thesis that "light is generated by an equatorial product or function of thermic and other moleculochemical vibrations, in the same manner as magnetism is an equatorial product or function of electricity, and vice versa," we feel compelled to postpone our acquiescence till the author has hat repulsion must be that done more to clear up and substantiate his meaning. Again, he depends upon the assumed fact that "no physicist will admit that a single

molecule has ever dropped out of the globe or been annihilated." Now, in our present imper-fect knowledge, to say the least, of the ultimate nature of molecules, and of the possible state of tenuity in which the constituents of matter may tennity in which the constituents of matter may exist in the volatile or gaseous form, is it within the scope of science to lay down that none of the mineral or other exhalations given off by the earth under the radiant heat of the sun, or the action of volcanic tires, may be so far radiated action of volcanic tires, may be so far radiated from our surface into the upper strata of the air as to be absorbed into the absolute cold of space, a consequent loss of molecular bulk being entailed upon our globe? But for some such compensatory loss, indeed, the increase of the earth's bulk known to result from the constant accretion of meteorites would lead by rapid and calculable steps to disastrous consequences. A French savant has worked out in figures the number of years that our planet would take, on the basis of this handicapping by so many kilo-grammes of metal annually, ere its race was arrested in the vortex of the sun. We are glad to find the writer in antire account. to find the writer in entire accord with ourselves as regards one phase of the molecular or atomic theory, the assumed shapes of atoms or molecules. "Whether molecules possess hooks, or are cubes, spheres, ellipsoids, or of various other shapes whereby to be dovetailed or packed together, or whether they are surrounded with one or several atmos-pheres of ether or electric fluid, or suy other unknown or fauciful condition wherewith to fill up the spaces between their irregular attachments and peripheries," these seem to him scientific conceits which have had or will him scientific concerts which have had of with have their little hour. They may serve as rhetorical flights to dazzle a half instructed audience, or convenient aids to grasp what audience, or convenient aids to grasp what might be otherwise shapeless and intangible truths. But they have no place in the severe and sober nomenclature of philosophy. Allowing for a certain diffuseness and profixtly of style, besides that undercurrent of dogmatism and premature speculation we have already spoken of, Dr. Winslow's treatise is one which deserves thoughtful and conscientious study. He has the merit of breaking ground, in a tentative and suggestive sense, upon problems of the highest moment, which it may be re-served for some Newton of a future day to reduce to mathematical fixity and measure.

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