

the frequency, the condenser capacity can be calculated by the formula

$$C = \frac{1}{L\omega^2}$$

where C denotes the capacity of the condenser, L the inductance of the receiver, and ω is 2π times the frequency. The value of the capacity for any frequency is not very critical, that is, a condenser will improve the working for a considerable range of speed.

At present the speed of operation of the separate Wheatstone transmitters is under the control of the operator, and is independent for each instrument. In London the speed of operation of each operator is noted daily, and if found to be below a certain required limit an explanation is required from the operator. With the use of the synchronograph it is practicable to operate a number of transmitters from the shaft of one alternator, and it may be so arranged that the speeds are fixed beyond the control of the operator.

THE SPEEDS OBTAINED BY THE WHEATSTONE SYSTEM.

The present perfection of the Wheatstone system is much superior to that obtained with the original instruments. This improvement is due to Mr. Preece, who has gradually increased the speed from one or two hundred to six hundred words per minute. The Wheatstone system has been in commercial operation for so long a period that the speed expected on any given line is accurately known, and may be represented closely by an equation of the form

$$KRW = a \text{ constant,}$$

where K denotes the total distributed capacity of the line, R the total resistance, and W the number of words per minute. This constant depends upon the kind of line used, and differs for iron and copper wire

THE ROLE OF COSMIC ETHER AND SOLAR HEAT IN THE DISINTEGRATION AND FORMATION OF MATTER.

NEW WORKING HYPOTHESIS.

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SOME twenty years ago, Prof. Maxwell, as the interpreter of advanced thought, expressed the view that all the physical manifestations, gravitation, cohesion, capillarity, elasticity, chemical affinity, heat, light, electricity, including magnetism, and even vital force, required the existence of a medium such as that defined by Plato, "a substance purer than air, which, being diffused throughout space, cannot be weighed," or as imagined by Newton, "a most subtle spirit which pervades and lies hid in all gross bodies." Maxwell's view has but grown apace with time, and so important a factor in physical science has this agent become that Dolbear, in a work in which the role of ether as the fundamental principle of all that our senses perceive is graphically described, writes: "Now, it is either that theory or nothing. There is no other one that has any degree of probability at all." Lord Kelvin emphasized our right to accept ether as the basis of synthetic conjecture when he said in his lectures on Molecular Dynamics at Johns Hopkins University, "Instead of beginning by saying that we know nothing about the ether, I say that we know more about it than we do about air or water, glass or iron. It is far simpler; there is far less to know. Its natural history is far simpler than that of any other body."

Ether is assuming no less an important role as the primary element of matter, and it may be affirmed that the doctrine of Epicurus, transmitted to posterity by the writings of Lucretius, is fast being relegated to the rank of a negative hypothetical system. His small, hard, lifeless atoms accounted for the permanence of bodies, but they utterly failed when that marvelous

active manifestation which it is not within human power to define.

Must we consider this verdict, based upon the evidence of but one branch of physical science, as final? Might a broader view of the question not elucidate fundamental features that would serve to transform what is now the property of science into a coherent system, showing a positive and logical sequence of the various phenomena known? It has seemed to me that a comparative study of these phenomena might furnish evidence pointing at least to a new line of thought that would eventually lead through the barrier now blocking the way. This paper is a record of the conclusions reached—a series of deductions based upon generally accepted scientific data. Indeed, if they are based on good ground, they tend to show that the formation of the molecule is an operation going on in space—on the sun, in the stars—now and ever since these bodies began their career, and that the molecule need not be referred back to the establishment of the existing order of Nature. Ether again appears as the fundamental principle of all that is physical and vital, all that serves the Creator's purpose in the development of another principle, far beyond ether and all its attributes—man's spiritual soul.

To argumentatively sustain the view that space is filled with a medium which transmits to us the light of the sun is unnecessary in these enlightened days. The postulate that motion cannot take place unless there is something to move is the ruling factor of all modern teaching. Mr. Cornu,* the distinguished president of the Astronomical Society of France, as conservative in his expressions on scientific subjects as his knowledge is profound, recently wrote: "Newton gave precision to the idea, vague before him, that force could not be transmitted without the intervention of a medium. Physicists and geometers have extended its application to many phenomena, electricity, magnetism, elasticity, etc., and have reached deductions that experience has generally verified in a most satisfactory manner. . . . One is forced to the conclusion that space is filled with an elastic substance. . . . Ether, hypothetical as gravitation is hypothetical, has, like it, demonstrated its existence by the imposing array of its active manifestations. Without its presence in space, all the labors of the last century would be reduced to naught."

The ether, according to Lord Kelvin, is practically a homogeneous solid differing from water, glass and metal in being very much more finely grained in its structure. Although possessed of rigidity, it is absolutely elastic, and thus allows celestial bodies, such as planets, to pass through it without offering computable resistance. The bulb of an ordinary incandescent electric lamp is filled with ether which has replaced the air withdrawn; that it is transparent (in the sense usually accorded this word) is demonstrated by the manner in which the light emitted by the carbon filament is radiated on all sides.

The structure of units entering into the formation of ether has been studied mathematically by Helmholtz and Sir William Thomson (Lord Kelvin). The vortex ring, to which allusion will again be made, has firmly implanted itself as one of the pillars of modern science. Nearly a quarter of a century ago Maxwell wrote concerning it: "The vortex ring of Helmholtz, imagined as the true form of atom by Thomson, satisfies more of the conditions than any hitherto imagined. . . . But the greatest recommendation of this theory from a philosophical point of view is that its success in explaining phenomena does not depend on the ingenuity with which its contrivers 'save appearances' by introducing first one hypothetical force and then another. When the vortex atom is once set in motion, all its properties are absolutely fixed and determined by laws of motion of the primitive fluid which are fully expressed in the fundamental equations. The disciple of Lucretius may cut and carve his solid atoms in the hope of getting them to combine into worlds; the followers of Boscovich may imagine new laws of force to meet the requirements of each new phenomenon, but he who dares to plant his feet in the path opened by Helmholtz and Thomson has no such resources."

Time has but sanctioned Maxwell's estimate. Diminutive beyond conception, millions of vortex rings enter into the formation of a single atom of matter, while their innate attribute, vibration, is constantly manifesting itself in modes, rhythms and degrees of intensity as varied as the multitude of manifestations of energy is great.

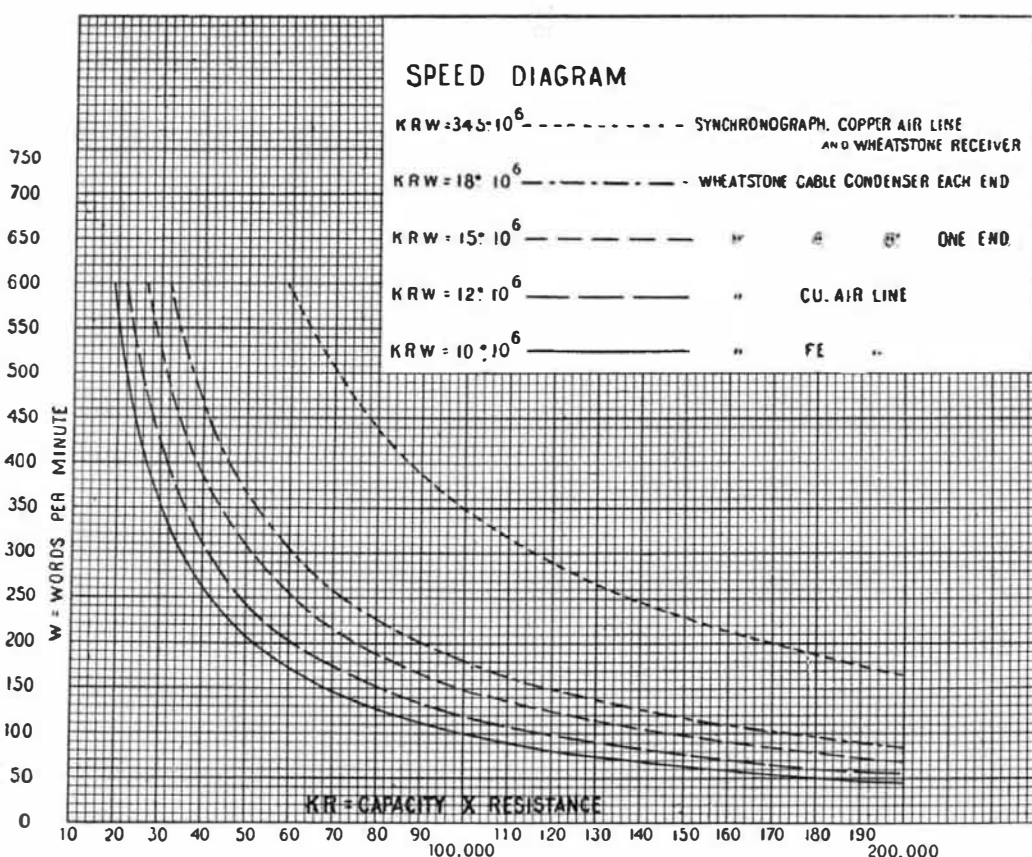
To more clearly define the hypothetical deductions forming the basis of this paper, it was deemed best to subdivide the general subject into a series of propositions and to append to each of these what sustaining evidence the various branches of physical science may have afforded.

DISINTEGRATION OF MATTER.

First Proposition.—The temperature of space being approximately that considered in laboratories as the probable point of molecular disintegration, absolute zero, the ether of space is endowed with disintegrating properties.

A feature relating to the ether of space that has received but little attention is its temperature. Text books on astronomy rarely allude to it, and the investigations published must have been few, judging from the paucity of references found in literature. That usually given, however, is 270° Centigrade below zero; and a recent study of the subject by Mr. Guillaume, of Paris,† showed that it could be approximately considered as being 267.4° below zero Centigrade. Seemingly of minor importance, this fact assumes suggestive value when the teachings of chemistry and physics show that an almost identical temperature, 273° below zero Centigrade, represents what in laboratories is termed "absolute zero," a condition of matter wherein chemical action is thought to become impossible, where, in other words, matter becomes dissociated.

As is well known, the elastic force of a permanent gas is increased by an elevation of temperature. "If a gas is placed in a closed inflexible vessel and heated," says Tyndall, "this increase of temperature is found to follow a definite course, or increment of elastic force due to the augmented energy of the gaseous molecules. Reckoning from 0° Centigrade upward, we find that every degree added to the temperature produces an



and for cables. The values of the constants determined by a series of experiments extending over a long period are

- 10 × 10⁶ for aerial line of iron wire.
- 12 × 10⁶ for aerial line of copper wire.
- 15 × 10⁶ for submarine cable with condenser at one end.
- 18 × 10⁶ for submarine cable with condensers at both ends.

These equations are exhibited in graphical form in Fig. 14, where the values of KR are abscissæ and W ordinates. With these variables the curves become equilateral hyperbolas, having the axes as asymptotes. There is one curve given for each of the four constants above representing different kinds of lines. It is to be noted that all the curves terminate at the limit of 600 words per minute, as this is found to be very near to the mechanical limit of operation of the receiver due to the inertia of the moving parts, the spattering of ink or other causes.

A copper aerial line having KR equal to about 80,000 will reduce the Wheatstone speed to about 400 words a minute; and when a line exceeds this it is customary to insert an automatic repeater, by which the speed is maintained over longer distances. Speeds of 400 words a minute are regularly maintained in England in commercial working, while the limit of the commercial working in the United States is considerably lower, about 200 words per minute.

A fifth curve is added in Fig. 14 to represent the speeds obtained with the Wheatstone receiver when operated by the synchronograph. The ordinates of this curve are about three times those of the corresponding ones for copper air line for all values of KR.

A curve for the synchronograph and chemical receiver might be given which would lie above any curve shown because of the shorter code permissible with this receiver. There would then be no limit at 600 words due to the mechanical construction, so that the curve would extend up into thousands of words per minute. The curve is not shown, because the experiments have not yet established the law of speeds for this combination of instruments.

(To be continued.)

product of modern times, the spectroscope, revealed molecular vibration. We are returning to the broader conception of Thales, who imagined the substance of which the world is constituted as essentially one capable of assuming shapes and functions as diverse as the resulting phenomena are numerous. Indeed, the day is probably near when scientific research will confirm the loftier doctrines of Heraclites, who saw through the light of his genius that matter was in reality the active manifestations of a primary element endowed with vibratile energy, a living, animated, divine entity.

While the existence of a primordial homogeneous substance is rapidly affirming itself, the part played by it in the organization of what might be termed the "chemical atom," the ultimate particle of matter as matter presents itself to our senses, is still unknown. "The formation of the molecule," writes Maxwell, "is an event not belonging to that order of nature under which we live. It is an operation of a kind which is not, so far as we are aware, going on on earth or in the sun or the stars, either now or since these bodies began to be formed. It must be referred to the epoch, not of the formation of the earth or of the solar system, but of the establishment of the existing order of Nature, and till not only these worlds and systems, but the very order of Nature itself is dissolved, we have no reason to expect the occurrence of any operation of a similar kind." The results of experimental investigation have apparently sanctioned this view; the futile efforts of the chemist to disintegrate the body that is now considered as the ultimate indivisible particle of matter have added potent evidence in favor of the generally accepted axiom that, although an ethereal principle may form the texture of matter as our senses recognize it, there is nevertheless a barrier that none can trespass, a transition stage between ether and its

* Member of the Astronomical Society of France. The bulk of this article was prepared from a paper written for the Astronomical Society of France, and submitted for criticism to Mr. Guillaume, referee of the said society, whose many valuable hints are hereby gratefully acknowledged by the author. The original paper having been accepted, it will appear in the Bulletin de la Société Astronomique in due time.

† Matter, Ether and Motion, 1894.

* Revue Scientifique, February, 1896, pp. 133 and 136.

† Revue Scientifique, March, 1897.

increase of elastic force equal to $\frac{1}{273}$ of that which the gas possesses at 0° , and hence that by adding 273° we double that elastic force. Now, supposing the same law to hold good when we reckon from 0° downward—that every degree of temperature withdrawn from the gas, we diminish its elastic force, or the motion which produces it, by $\frac{1}{273}$ of what it possesses at 0° , it is manifest that, at a temperature of 273° Centigrade below 0° , we shall cease to have any elastic force whatever. The motion to which elastic force is due must here vanish, and we reach what is called the absolute zero of temperature.*

This proportionate decrease of elasticity being a fixed fact, Clément and Desormes† inferred that, at 273° below zero Centigrade, gases would cease to exist as gases. The labors of Raoul Pictet have confirmed this view, and it has received the sanction of Maxwell.

Organized matter seems to lose its ability to undergo chemical reaction, a condition in which, according to Dolbear, "there is not only no selective action, but no cohesion among atoms." . . . "All molecules would fall to pieces," he states; "that is, to atoms—quite dissociated."‡

This is further sustained by the testimony of Lothar Mayer:§ "At the lowest temperature to which we can attain, the majority of chemical reactions studied under these conditions have been found to cease, or to proceed very slowly, so that it would appear that at absolute zero, -273° Centigrade—a temperature much below the lowest yet attained—chemical action would cease altogether from the absence of any form of heat motion whatsoever. Without heat there would be no exertion of the so-called chemical affinity." In other words, the staff sustaining the entire system as organized matter would disappear, and any substance taking part in its formation would reassume its original state.

An important feature in the case, however, is the fact that absolute zero has never yet been attained artificially, although it has been approached; hence, the total absence of heat which it represents may not result in a mere dissociation of matter into molecules or even atoms, but in complete disintegration into the true primary element of matter, ether.

Second Proposition.—Were absolute zero attained in our laboratories, the total absence of heat would cause matter to become dissociated into its primary element, ether.

Dolbear expresses the prevailing conviction of scientists when he writes that "all chemical phenomena are truly physical and referable to fundamental physical laws, and are fully explained when these mechanical conditions are pointed out." Berthelot's law, in virtue of which "the heat given out or absorbed in a given reaction measures the sum of the physical and chemical work accomplished in that reaction," affords a foundation which cannot be controverted. We have seen the influence exerted by a low temperature as shown by the labors of Clément and Desormes, Raoul Pictet, Lothar Mayer, Tyndall, etc. The influence of high temperature, on the contrary, is best shown by the spectroscopy, which has indirectly demonstrated that the temperature of a body "varies proportionately as the square of its amplitude of molecular vibration." The ether units of Helmholtz and of Thomson, the vortex rings, closely packed, vibrate with increasing energy and greater free path in proportion as the temperature is raised. Hence heat is the dominant factor of kinetic energy. As the temperature is lowered the oscillations of the ether units are correspondingly reduced and there comes a time when, all heat ceasing, vibration—shown by the spectroscopy to represent the active manifestation of atomic life—also ceases and the atom itself must succumb.

Further evidence may be obtained from the teachings of physics. It is generally accepted that free ether does not penetrate the individual atom and that it only fills the inter-atomic spaces. Once formed, atoms are held in their acquired shape by the vibrations of the surrounding ether. The law of the independence of the effects of force, applied in this connection, demonstrates that atoms are submitted to constant shocks from the surrounding ether units as long as the vibrations of the latter are sustained by heat. It naturally follows, therefore, that when the temperature is reduced to a point at which all heat is absent (absolute zero) the vibrations of the ether surrounding the atom cease, the force holding the ether units disappears, and the atom—until now held together by the repeated shocks received—becomes dissociated. We are thus brought back to the observations of physicists and chemists regarding the disintegrating influence of absolute zero, and to the hypothetical view formulated in the Second Proposition, that it is the atom, and not alone the molecule, that becomes dissociated.

A normal deduction which the foregoing remarks warrant is that space, owing to its proximity to absolute zero, must not only be the great depository of ether in its homogeneous state—capable of transmitting but not of absorbing radiant energy—but it must also be endowed with disintegrating properties. Indeed, it seems impossible, apart from all conjecture, that bodies unprotected by an atmosphere such as that intervening between our earth and the ethereal expanse should be able to resist the dissociating influence of so low a temperature as that of space, in view of what chemistry and physics have taught us on the subject. The following proposition may, therefore, almost be said to be beyond theoretical grounds:

Third Proposition.—The ether of space not only serves to transmit radiant energy, but it also acts, in virtue of its low temperature (or absence of temperature), as the disintegrator of bodies that are no longer serving a useful purpose in Nature.

The interstellar expanse is known to contain innumerable amorphous masses of undetermined origin. Is it reasonable to suppose that these bodies are perpetually accumulating in space and that Nature has provided no means for their gradual destruction? This subject will be considered farther on.

THE FORMATION OF MATTER.

It is reasonable to surmise that if the critical point of disintegration is represented by a condition wherein heat may be said to no longer exist, the critical point necessary for the formation of matter must at least be represented by an extremely high temperature.

The protective provisions of Nature, evidence of which we meet on all sides, could not be fulfilled were the transformation limits of such momentous functions as the creation and dissociation of matter not widely separated. Were moderately high or low temperatures capable of creating or dissociating matter, it becomes apparent that general chaos would soon ensue, through promiscuous elaboration and disintegration of matter.

That matter can be created under the influence of intense cold is an assumption that the condensation of gases and liquids might suggest; but, as we have seen, chemism becomes less active as low temperatures are attained, and it ceases or proceeds very slowly when absolute zero is approached. Hence cold can only be considered as a destructive factor. Heat would appear in the same light were ether considered as a gas, since heat but causes further separation of the molecules, the dissociation thus produced increasing in a fixed proportion as the temperature is raised. But it is perhaps needless to state, in the light of present knowledge, that ether is not an aggregation of molecules and therefore that it is not a gas! Ether, by reason of the tenuity of its units, may be considered as a homogeneous mass; so close are the vortex rings to one another that any oscillation in any part of the mass causes a correspondingly active motion in the surrounding units. Whatever be its vibratory amplitude, ether does not tend to become dissociated; whereas organized systems such as molecules always tend to fly apart under the influence of heat. "We cannot suppose the constitution of the ether to be like that of a gas in which the molecules are always in a state of irregular agitation," writes Maxwell,* "for in such a medium a transverse undulation is reduced to less than $\frac{1}{250}$ of its amplitude in a single wave length."

That a very high temperature is alone capable of so influencing the ether as to cause it to assume the condition we recognize as matter is also sustained by the known properties of vortex rings, and it is probable that if the creation of matter has never been realized in laboratories, it is because homogeneous ether has never been submitted to the influence of a sufficiently high temperature.

Fourth Proposition.—When through the agency of a high temperature a sufficiently high vibratory amplitude is reached, the ether units are capable of adhering to one another in fixed proportions and of forming elementary bodies, atoms, to which they transfer their vibratory energy.

We have already seen that, in virtue of Berthelot's law, "the heat given out or absorbed in a given reaction measures the sum of the physical and chemical work accomplished in that reaction." Again, we know that the temperature of a body varies proportionately as the square of its amplitude of molecular vibration. When vortex rings are submitted to the influence of heat, the amplitude of their vibrations is likewise proportional to that heat, but a sufficiently high temperature in their case brings other factors into play which form the prelude to the formation of matter.

Besides the inherent property of vibrating, vortex rings are capable of infinite changes of form and may execute vibrations of different periods, as molecules are known to do. "They are," to use Maxwell's words, "qualitatively permanent as regards their degree of implication, whether in 'knottedness' or 'linkedness' with other vortex rings," while the law of equality between action and reaction of Newton, and the general principle that a reaction, when equal to action, involves the preservation of quantities of motion in shock. We thus have ample grounds to sustain the hypothesis that when a homogeneous ether is exposed to a sufficiently high temperature, the vortex rings, by reason of the amplitude of the vibrations induced and the vigor of the resulting impacts, finally adhere to one another, become linked and knotted in groups, differing in kind, perhaps, according to the temperature, and finally form the system we recognize as the atom. Endowed with all the vibrating properties of the vortex rings which have entered into its organization, it thus enters into active life with all the attributes which chemistry would demand. Created by heat, sustained by heat, it could but succumb to the disintegrating influence of the absence of heat—the absolute zero.

FORMATION OF MATTER IN SPACE.

The ether of space, by reason of its homogeneousness, its density and its temperature, would seem to present all the conditions of a perfect medium for the creation of matter in accordance with the hypothesis submitted herein. The presence of a seething mass, such as the sun, in the midst of the ether of the ethereal expanse, seems certainly to suggest the possibility of phenomena surpassing in importance those already recognized; and if an intense heat can create matter, our luminary should indeed be able to supply it. Analyzed, this idea seems to gain force at every step.

Fifth Proposition.—The sun being surrounded by ether, the heat developed is capable of transforming that substance into elements which are immediately deflagrated and returned to space as products of combustion by means of the protuberant explosions.

Sir William Thomson,† by calculations based upon the mechanical equivalent of heat, supported the best theory advanced concerning the origin of solar heat—that of Helmholtz founded upon solar contraction. The theory that meteors contribute sufficient fuel to supply our luminary's tremendous heat, and other hypotheses so far devised, are usually considered as auxiliaries to that of Helmholtz. Many astronomers, however, even now consider the entire problem as unsolved. Young, for instance, holds that the subject is not yet understood; Flammarion believes that the prodigious radiation must be due to other causes, etc. Helmholtz's hypothesis appears as the true one for the maintenance of the heat of the nucleus, but the utilization of the surrounding ether by the sun seems alone capable of

accounting for the thermic and explosive phenomena of the surface, while complying with desiderata that science has established as laws by observation elsewhere. "If the sun be a burning mass," writes Sir William Thomson, "it must be more analogous to burning gunpowder than to a fire burning in air." The theory submitted herein seems to be the only one capable of satisfying this requirement; the chemical reaction already outlined is an exothermic one—requiring an auxiliary agent, heat, to start it. It seems to perfectly explain the tremendous explosions constantly occurring on the sun's surface. Once such a process started, it is known to continue indefinitely as long as the supply of the primary agent lasts. The fact that the ether of space is inexhaustible need hardly be insisted upon. If the deductions submitted are correct, therefore, the heat of the nucleus would be due to contraction, in accordance with Helmholtz's hypothesis, that of the corona including the protuberant explosions, to the transformation and immediate deflagration of the surrounding ether.

Sixth Proposition.—Cosmic dust is mainly composed of products of combustion, projected into space by the explosions on the sun's surface, and forms the coma and tail of comets, and indirectly meteoric bodies.

The process described would involve the presence, at least in the vicinity of the sun, of an immense quantity of combustion products, obscuring to a degree our luminary's radiance. Flammarion but voiced the observations of astronomers in general when he wrote: "The neighborhood of the sun is far from devoid of matter; there is a perpetual illumination of cosmic dust which the radiance of solar light hides from our view." In speaking of zodiacal light, he alludes to "an immense cloud of corpuscles surrounding the sun and extending beyond our planet's orbit." How clearly the products of combustion resulting from the deflagration of ether explains the presence of these corpuscles, need hardly be insisted upon. Hansky,* in his report upon the eclipse of August 9, 1896, notes: "Photographs of the corona show protuberances surrounded by dark spaces which could be masses of cold hydrogen in the act of being dispersed. . . . The hypothesis that coronal matter is projected into space along with other elements constituting the sun is very probably correct." That the protuberant explosions should be capable of projecting far and wide the products of combustion from the sun's surface is shown by the length of the prominences. In the clear air of Colorado during the eclipse of 1878, Prof. Young traced two of them five or six degrees—a distance of at least nine millions of miles from the sun.

The spectrum of comets shows bright bands so strikingly similar to those produced by carbon that these nomadic bodies are considered as consisting mainly of carbon. Newcomb† in this connection writes: "It may be that comets will hereafter be found to consist of some combination of solid and gaseous matter, the exact nature of which is not yet determined." Towne‡ states that the spectrum of the coma is produced by reflected solar light, "which indicates that comets are formed of solid particles floating in a gaseous atmosphere." Evidence sustaining the view that every part of the comet, except the nucleus, is formed mainly of particles of carbon—the solar products of combustion—appears on all sides.

The theory now generally accepted as to the composition of the tail, according to Prof. Young,§ is that it is "formed by matter expelled from the comet by some solar action." How so enormous a quantity of matter as that represented can be created without a corresponding decrease in the dimensions of the nucleus and coma is not explained, however. The presence in space of carbonaceous particles satisfies the needs of the hypothesis as regards the quantity of matter, while the continuous explosions on the sun's surface amply account for the repulsion, from the comet, of the matter forming its appendage, and truly ascribed by Prof. Young and other leading astronomers to solar action.

Might there be in the force so exerted, and in the presence in space of these products of combustion and other forms of cosmic dust, an explanation of the retardation in the periodic time of Encke's comet, which led to the hypothesis of Albers, that this body met with a resisting medium in space? Strongly supporting this view is the fact that of all comets known, Encke's moves in by far the smallest orbit. It is therefore exposed to the retarding influence of the resisting elements to a correspondingly greater degree, and yields to them, while all the other comets are in no way affected. If the area of resistance only reached as far as the earth's orbit, Encke's comet would feel its effects during one-fourth of its revolution. Faye's comet, whose motions were investigated by Möller to ascertain whether its period was also affected by a resisting medium, does not approach the sun nearer than Mars' orbit, and could not, therefore, be influenced—thus verifying Möller's results, but sustaining at the same time the conclusion of Albers.

The tail of comets, as is well known, appears quite suddenly. "The comet of 1843," wrote Tyndall, "shot out in a single day a tail which covered 100 degrees of the heavens. This enormous reach of cloudy matter is supposed to be generated in the head of the comet and driven backward by some mysterious force of repulsion exerted by the sun." In the light of the theory advanced, the problem seems to find a ready solution: A comet's nucleus, whether a nebula or composed of meteoric stones, is attracted by the sun from regions far beyond the limit of the cloud of cosmic dust. It is first perceived as a round ball devoid of appendage and travels at a fixed rate of speed. As soon as it strikes the area of cosmic dust—products of combustion in our case—it crowds this substance before it, forming the coma, which in turn gives off on each side of the path traversed what portion of the substance it cannot continue to hold before it, thus forming the tail. This would seem to explain a curious phase of the behavior of comets on their return, after sweeping round the sun—the fact that the tail, instead of following the head, precedes it. The sun, while still attract-

* Heat as a Mode of Motion, p. 72.

† Silliman, Principles of Physics, p. 456.

‡ Dolbear, Matter, Ether and Motion, p. 242.

§ Modern Theories of Chemistry, pp. 211; quoted by Dolbear, loc. cit., p. 349.

* Encyclo. Brit., vol. viii, p. 572.

† Popular Lectures and Addresses on Solar Heat.

* Bulletin de la Société Astronomique de France, March, 1897.

† Popular Astronomy, p. 407, ed. 1889.

‡ Astronomie Pratique, p. 392, ed. 1890.

§ Universal Guide and Gazetteer, p. 27.

ing the head of the comet, though with less force than before, continues nevertheless to eject its products of combustion, and these, impelled by the continuous explosions on the solar surface, which travel at a much greater speed than the head, form the tail as before; but it is also directed as before—away from the sun. Under these circumstances, the tail should disappear very soon, and this is precisely what happens.

"The meteoroids of the nucleus when they approach the sun seem to be repulsed," writes Swift. "Why the sun should attract a comet at one time and repel it at another is a mystery. Still, this represents what we see." In the light of the views presented herein, it seems plain that the comet would find itself repelled when near the sun by the coronal explosions. Indeed, it seems evident that comets owe their continued existence as such to this repulsive action; without it the majority at least of those entering our system would fall into the sun.

Why do not all comets and planets have tails? As to tailless comets, it is probable that the structure of the nucleus is not such as to mechanically influence or illuminate a sufficient quantity of cosmic dust to produce a tail of sufficient density to make it visible. Spectroscopy has shown that the nucleus is self-luminous, but that the tail shines with reflected light. So dense a body as a planet presents none of the attributes of a nucleus and is not self-luminous. If, therefore, it does leave in its wake a stream of cosmic dust, which is probable, there can be no reflected light to illuminate it, and it cannot be discerned.

To account for the various shapes assumed by the tail is also necessary. The nature of the nucleus and its outline must doubtless affect the medium traversed in such a way as to give each body its own identity. A semilunar nucleus, with its convexity forward, such as that seen in Coggia's comet for instance, would impinge upon the surrounding cosmic dust and gases in a manner differing greatly from that to be expected from one presenting a narrow transverse diameter. The various appearances presented by Halley's comet in different parts of its orbit illustrate this fact.

It seems quite probable, judging from the evidence adduced, that the coronal explosions have for their main function that of projecting far and wide the products resulting from the combustion of ether. At first consisting of gases, the rejected substances are gradually cooled and condensed by the low temperature of space. When they reach regions, probably beyond our planet, where the critical point, absolute zero, is reached, the process of destruction begins, and soon the units of ether, united by the sun, are dissociated and returned to space, Nature suffering no waste.

The fact demonstrated by Newcomb that not less than 146 billions of shooting stars fall upon our planet yearly gives an idea of the quantity of the inorganic matter surrounding us. The concentration of the cosmic dust in the wake of comets should therefore be marked in proportion. M. Schiaparelli has noticed that meteoric showers coincide precisely with the orbit of comets. "Shooting stars, uranuliths, and aeroliths seem united by a common origin," writes M. Flammarion. The products of combustion rejected by our luminary supply the required original cause. The belief that meteoric bodies can thus be constituted, however, in no way affects the view that other amorphous masses, especially the larger ones, such as the asteroids, may originate otherwise, or be the vestiges of former planets. On the contrary, the presence of all these varied masses of detritus could but sustain the view that space is the great field where the organized matter is constantly being created, but where refuse matter is gradually being disintegrated.

Considering the subject as a whole, we now find ourselves sustaining a general universal law that science has amply confirmed. We know that all heavenly bodies, suns and planets, after their nebular period has passed, begin their career with a high temperature as the ruling factor, and that a planet such as our earth is gradually cooled down by the influence of the low temperature of space. This influence probably never ceases. Protected by its atmosphere, our terrestrial abode is serving out its period of usefulness, and what we see of Nature's marvelous resources represents an interval in the downward progress of the planetary thermometric scale. The time will finally come when all organic form will become inorganic amorphous matter. Chilled in death as we all are, our earth will gradually return to the great storehouse whence she originated, in accordance with general principles (perhaps those herein enunciated) which form but a step in the scale of a great general law, that of evolution.

Experiments recently conducted by Immendorf show that there is no better material for packing ice with in stores than peat. But all peats are by no means of equal value. The most suitable is the mossy peat, which, whether applied in firm sods or in the form of a litter, by far surpasses all its rivals. The more earthy matter a peat contains, the less suitable it is in the ice house. Great attention should further be paid to the peat being kept dry, and moisture should be removed before the material is brought into the ice house. Although, on the whole, a loose material is a poorer conductor of heat than the same substance in a compressed state, large interstices and anything like air passages should be avoided. For these reasons, a slight compression is advisable, and the joints of sods should be smeared with loose peat. Suitable turf keeps the ice in much better condition than straw or sawdust. In the Mittheilungen aus den Gebiete des Artillerie und Genie Wesens Major Pettriss discusses other applications of peat.

A speed of 73 miles per hour is recorded for a locomotive on the Pittsburgh, Cincinnati, Chicago & St. Louis Railway in a recent run with eight heavy cars between Columbus, Ohio, and Xenia, in the same State, a distance of 55 miles, which was covered in 47 minutes, says The American Engineer and Car Builder. The actual time of the run was 56 minutes, but this included three stops, one crossing slow-down and a delay of four minutes at London, making a total loss of nine minutes. The locomotive was built by the Schenectady Locomotive Works.

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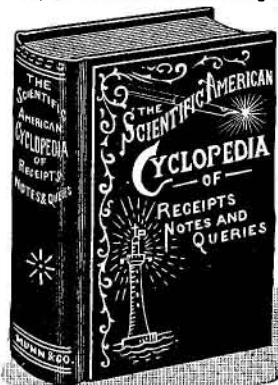
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