confounded with respiration, and the mistaken conception was spread abroad that plants breathe in direct opposition to animals by absorbing carbonic acid and exhaling oxygen. By means of anæsthetics we can separate these two phenomena. An aquatic plant placed in etherized water ceases to absorb carbonic acid and emit oxygen. It however, remains green, and breathes as animals do, a phenomenon which existed before, but was hidden by the assimilation of the carbon; still, further back, we can encounter one of those phenomena long considered chemical and which nearly escape vital acts inasmuch as in the laboratory some of them can be reproduced without the aid of life. I speak of fermentations. These are produced by a microscopic fungus, which decomposes fermentable matter, nourishing itself with a portion, while the remainder forms a new product which stays in the liquid. These fermentations, in spite of their extreme tenuity and their inferiority in the organic scale, are susceptible of being stupefied by ether and losing their active power. We may place them with impunity in close contact with the liquid, but the latter remains undisturbed.

Thus, from the very bottom of the ladder, from the simplest protoplasm, and the most insignificant fermentation to the most elevated creature to be found on the earth, we find always the same characteristic and fundamental property of life, modified, it is true, to a degree which forces us to follow the thread of its diverse forms step by step, but always identical in substance, and invariably demonstrable by those infallible reactive agents, anæsthetics. Without this property there can be no life, or rather no active life, no exterior manifestations. With it, any plant or animal, no matter how simple in construction, develops, grows, prospers and reproduces itself. It is easy to see, therefore, that sensibility is the principal attribute of all organic beings, and in some way the cause of everything that takes place within us. If, as Condillac says, we should take an immovable and insensible image and endow it gradually with all our senses, it would soon rise from nonentity and begin to augment the sphere of its knowledge. By giving it the sense of hearing, we open that vast field of observation and reasoning which procures sound, but it could form no idea of the existence of matter, or of sunshine, or of taste. It could only conceive one thing, until put in complete possession of the other senses.

Intelligence, that precious gift which alone renders us superior to other creatures, is, therefore, nothing more than the result of our accumulated impressions, controlled one by the other, and we may even affirm that the man who has felt is alone capable of thought. The development of our minds should be adequate to the development of our sensibility, and in fact, it can be observed everywhere, that those persons whose senses are the most refined, possess the highest form of intelligence. I may even go so far as to parody the famous proverb and say to my neighbor; "Tell me what you feel, and I will tell you what you think."

Not so very long ago, as we have seen, Linnæus refused to admit of sensibility in regard to plants, saying that it was an attribute of the animal world only. An attentive investigation, however, causes us to reject such distinctions to-day. Let us even go further back, leaving behind us the lowest forms of organic matter, and see if any phenomenon approaching sensibility is to be met with. In a word, let us ask the following question: Is matter sensible?

Referring once more to Claude Bernard's definition of the term, "sensibility is the *ensemble* of all kinds of modifications determined in living beings by different stimuli," we find no possibility of its application to the properties of matter, for it distinctly states that the condition is an attribute of living beings only. But a mere definition should not arrest our investigation, for it is nothing more than the result of knowledge hitherto acquired, and as such admits of change. The substance of it all amounts to this; given a living being placed in immediate contact with matter, and the matter will act upon the being, producing sensation. But how do we know that the living being does not in its turn act upon the matter and modify its condition? I will even affirm that life does act upon certain substances, for fermentation is a positive proof that this is the case. If I place a sweetened solution of wine in contact with the air, a short time will suffice to develop therein millions of tiny living creatures proceeding from atmospheric germs. This fermentation increases with great rapidity, producing a chemical effect, so that after a certain time the sugar will be transformed into carbonic acid and alcohol. The presence, therefore, of life in the liquid served to modify the properties, and in this we see one of those strange occurrences where the so-called vital forces are so closely allied to chemical processes, that we hardly know whether the phenomenon is the result of the biologists' skill or the chemist's. Each of these *savants* have claimed it as their own, and with reason too, for chemistry and biology are twin sisters who can never quarrel.

When the sugar is once transformed into alcohol another organism appears, which, in its turn, determines the transformation of this substance into another, acetic acid, by means of an analogous fermentation. It is a remarkable fact, however, that while the chemist has, as yet, been unable to produce alcoholic fermentation by means of the action of matter upon matter, he can, on the contrary, easily determine the second without the aid of life at all. It is, therefore, the presence of these bodies which acts, and not the construction of the fermentation. It is not that life decomposes the liquid, but that the liquid decomposes itself when assimilated with certain agents. It is therefore sensible of their action.

Once *en route*, it is not difficult to multiply examples and to demonstrate that light, heat, electricity and all other forces which operate upon our sensibility, are uniform modifiers of matter. What is a photographer's negative but a glass plate sensitive to the action of light? Is not a piece of wire about which we pass an electric current sensible of electricity, inasmuch as it acquires thereby a new property, that of attracting a like piece of wire? It becomes, in fact, magnetic.

Heat, as we can observe every day, modifies bodies to such an extent, that beneath its influence they liquify and evaporate. All these facts demonstrate clearly that matter is sensible of exterior agents. According to the second part of Claude Bernard's definition, it possesses the "aptitude to reply to the provocation of these stimuli by means of modifications."

Consequently, universal attraction, that law which affirms that all bodies attract each other in direct ratio to their mass, and in inverse ratio to the square of their distance, is merely a simple and general way of expressing the sensibility of matter.

CONTRIBUTION TOWARD A NEW COSMIC HYPOTHESIS.

By Samuel J. Wallace.

Our familiar knowledge and ideas in astronomy relate generally to matter in large bodies, and in great numbers of small bodies, which now and then fall into the larger as meteorites. This seems to show a condition of slow centralization, as if to finally collect all matter, however far distributed, into a few large bodies. And a consistent conception requires in its plan, somewhere, a means of decentralization, or distribution of matter through space again, to form a closed system of action.

Gravic force as one of the interchangeable forms of kinetic energy also requires a starting place; some way by which the energy continually changed into mass motion and heat of bodies gravitating into each other shall be changed back again into gravic force.

I think the luminously hot gaseous nebula shows the earlier stages of these two required dispersions taking place together.

The fall of matter from space into central masses takes up just so much gravic energy. This is changed into mass motion and heat, so that on mechanical principles, each particle bears just enough force still to carry it back into space again.

This leads us up to the idea of the life of a particle in the universe, as being through an endless series of cycles of change from space into masses and from masses into space, each being, as it were, almost an eternity in duration, making a grand orbit, something like this:

Meteoric matter falls from space into planets and suns; planets fall into suns; suns grow continuously larger, accumulating the momentum of particles acquired in falling from space, as motion and heat; the heat of overgrown suns at last becomes so intense, from accretions and collisions, that it flies into a still higher form of repulsive energy, as gravic force, causing disruptive explosions; the particles, by this change into gravic force outward, receive a projectile force carrying them out into space again; and particles from space fall again into planets and suns.

This forms a closed cycle of action. The projectile and outward gravic forces may carry part of the particles forward into space till they become parts of other systems to run like courses; and part may be driven back at last to rebuild another system instead of that destroyed. Some might be driven back by the extra-force given others, and form nuclei of one or more suns. And the disrupted parts going in different directions might form a number of nuclei, having such dispersive motion as to carry them continuously apart, as in some reported cases.

The history of a nucleus having such an initial projection might be something like this:

I. It might pursue an interminable course; should this lead laterally near any region having matter in great quantity, it would be deflected to pursue a great curve, attracting to itself distributed matter within its reach, from gravitation.

II. The growth of a body pursuing a curved course would produce in it a rotary motion, which would be the resultant of the course and force of its own prior parts and those of its continued accretions, and of the combined attractions on its several parts of all matter passed, which of course would predominate on the inner side of its curved path.

III. Matter drawn into a moving body would come in curved lines and spiral courses, tending to form great rings and to produce planets, whose courses and velocities would be the resultants of the total averages of those of the various particles uniting to form each of them.

IV. Secondary bodies of large size would approximate primaries in the nature of their actions, falling in by slow degrees: those of long life as secondaries tending to eventual motion in one general direction, from having similar producing forces and from their actions on each other neutralizing conflicting equivalents; giving to each such position as its resultant velocity leads to, by union or separate course, together with revolution, and possibly secondaries to them.

V. Differences of inclination of orbits of secondaries may occur from the course of primaries having been at some time near regions having predominant quantities of matter to be drawn in on special sides, which unites to form bodies having their special courses; and, from analogous causes some smaller bodies might chance to have courses contrary to others.

VI. The four terms of orbital and rotary velocity, heat, and loss from radiance and from a resisting medium, would form a sum equal nearly to the energy of fall from infinity to the mean position of each body, qualified by whatever initial velocity and direction each particle may have had from its prior projections.

VII. The distance of each body from its primary would depend on its velocity in proportion to that which fall from infinity would produce; and all causes changing orbital into rotary motion, into heat and radiance, and into friction on a resisting medium would shorten the mean distance; but add to the velocity.

These I think are about the things which would occur, stamping the history of the system upon its internal peculiarities.

Now, does this sort of hypothesis come nearer accounting for the solar system than the original or present day forms of the "nebular hypothesis?"

I think that requires far too extravagant a conception of a common initial force taking possession of the matter thinly distributed through so immense a region as a globular space extending far out beyond the orbit of Neptune; and that it does not account for the variations of detail, nor for a final closed system of action, as does this.

I have no faith in this stuff about burnt out worlds, thinking that planets and suns grow warmer instead of colder as they slowly grow larger from fall of meteorites, as now going on.

Gravic force, which causes gravitation of bodies toward each other, probably has some resistance and loss in passing through large bodies; which would heat them and give ample source for all extra heat in the sun and large planets, and the interior of the earth; and would give ample time to geology for all its work. In fact, it may thus greatly increase the stores of heat beyond that given off by radiance, and that gained by falling from space; and so assist in forming the store for final dispersal.

The analogies of the other forces in passing through massive media seem to force us to expect such loss causing heat; and there is reason to suppose there is a slight resisting medium to matter in space: the dynamic equivalent of this loss of gravic force, in the life of the particle.

Without a resisting medium to matter in space it is hard to understand how matter can congregate into masses instead of always flying off again with equivalent velocity.

And it is equally hard without a resistance to gravic force in bodies to understand how gravic force can act to cause gravitation, or how the particles in a fixed body, radiating its force, can ever again get energy for dispersal into space.

But the arrangements may be so wonderfully balanced that the one propulsive gravic force may bring particles together from far space to form solid bodies and suns, and then when their course is run, store up energy in them to carry them back into space again, to go onward and build up new systems of glory.

The mountains of the moon, which have been called dead volcanoes, are simply the drop marks of great meteoric masses falling into the light meteoric dust forming in the outer part of the moon. They are similar in their peculiar forms to the rain drop marks familiar to geologists in sand-stones; and have the same peculiar raised rims and concavities, with the bodies which produced them still standing in their centres.

Some seem to have exploded like shells, sending masses in various directions tearing great furrows, some radiating across the whole face of the moon.

They may represent an enormous period, as the absence of wind and moisture would permit marks once made to remain until obliterated in a like way; water, if there, being a frozen dust, and if ever melted sinking into the deep porous mass.