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THE NEW PHILOSOPHY

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THE NEW PHILOSOPHY.

THE NEW PHILOSOPHY is a quarterly magazine devoted to the exposition of the scientific and philosophical principles contained in the works of Emanuel Swedenborg, and as the organ of the Swedenborg Scientific Association it will be the means of promulgating the uses undertaken by that body. The magazine will contain essays on Science and Philosophy; instalments of some of Swedenborg's Scientific works; and the transactions of the Association.

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THE NEW PHILOSOPHY.

VOL. IV. OCTOBER, 1901. No. 4.

THE SENSES.

PART FOUR OF THE ANIMAL KINGDOM.

BY EMANUEL SWEDENBORG.

CHAPTER III.

Sense in General.

ANALYSES.

52. 1. Living is sensating, and, according to the excitation of the sensation, doing. Life is only half and thus imperfect in sensating, but perfect and full when conjoined with action; for sense rules over action and is in it,—is life in effect; otherwise it is only in causes, principles and as it were in potency, for in action there can be whatever belongs to sensation.

53. 2. The external senses give life to the body; for they are the external organs and sensories of it. But the internal senses give life to the superior mind, for they are its internal organs. In these latter the Understanding and Will meet; as do sensation and action in the body; for understanding is higher than sensating; for the understanding is furnished by the inferior organs and sensates according to their information. Thus in place of sense is understanding, in place of action is will. They change their names in a superior sphere or in every superior degree.

54. 3. The senses are given in order that they may instruct the soul, as also our rational mind [as to these things]:—1.

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What is going on in the macrocosm or in the world outside its microcosm, so that it may ascertain what the world is doing outside the soul. 2. That it may ascertain whether that which is bound to enter is suitable for the microcosm or not. 3. In order that the body may thus be inticed and united to the circumfluent world, and especially to the society and its members in which it is. 4. In order that its (the soul's) understanding may be instructed by the way of the senses, or a posterior way, and may grow into intelligence; thus that it may continually be more closely united to the superior power or to the soul, finally to the supreme mind, in order that this may, with its operations, more distinctly inflow. 5. In order that in the world we may acknowledge, venerate, and finally adore the great Creator; wherefore we see all these wonderful things and in the course of time, as we become adult, still more wonderful things. 6. Thus the senses explore the things which are the ultimates of the world, and which do not reach to the sphere of sight, of which otherwise we would have no cognizance.

55. The senses are the explorers of things in ultimates in order that the soul may ascertain them by the means [thus offered].

56. 4. As to what appertains more specifically to our senses, it is known that there are five:—1. The crudest sense, or touch, is stretched round about the whole cuticle to such an extent that nothing can attack, whether naturally from the world itself and its kingdoms, or contingently, which this sense does not apperceive and announce to its soul. Indeed if anything hurtful affects the surface itself as in diseases it [announces this]. Wherefore also the soul can enjoy the senses in order that in the cuticles it may cognize those things which affect the surface. 2. To the sense of touch succeeds that of taste, which sensates all those things which are dissolved in fluids, waters and salivas, and which strike it; wherefore it perceives whether the thing be good or whether it be evil; thus it perceives what is true and what is false, for these things are the very ultimate ends of sensations, namely, that they make discriminations. 3. To taste again succeeds in the matter of purity smell; for this sense perceives those things which float in the cruder atmosphere. 4. These three

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senses are neighbors to one another, and are constructed in the same modes with similar papillæ; but their differences are as between the prior and the posterior. Touch is the most general sense for it perceives a body or congeries of parts; but taste perceives the parts of this compound, as, for instance, those that float in water, such as salts, nitres, and those things which approach to that measure; smell, however, perceives the parts of these parts, not, however, whole salts, but the divided and smaller elements, such as the oily, fragrant, urinous, and volatile parts. Thus these senses taken together constitute one series, which embraces three degrees, which succeed each other as prior and posterior.

57. 5. But the superior senses, as hearing and sight, perceive the following things:—1. Those things which are distant, whether they endeavor to touch or not, as, for instance, sounds and objects. 2. Wherefore this sense is brought from a distance by the atmosphere, and such as it is brought away such it is brought in by the fibres, that the soul may recognize it. 3. They furnish the internal sensations themselves, for they bring in changes of state to the internal organs, which changes remain, whence is memory. 4. The change which is then brought in from the memory again brings in changes of state, whence are intellectual ideas, which remain in the superior memory, whence they are taken as auxiliaries when one reasons; for in every single one of such ideas there are many things. 5. Therefore these sensations are said to be superior which have like ends, namely, what is good and what is evil, what is true and what is false; what is good and what is evil are natural, but what is true and what is false are to be referred to the understanding, in order that it may judge not according to the goodnesses of the senses, but according to superior goodness, whence is truth. This is human.

58. 6. These two senses [namely, hearing and sight] constitute one series. 1. The consideration must be begun from lowest or ultimate things, or from the hearing of sound. 2. Then articulate sounds are to be referred to a kind of sight, whence is imagination; wherefore hearing and sight meet and the one instructs the other. 3. Finally this is to be referred to

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the inmost sense, whence is understanding. 4. Thus the series of these sensations is also triple, namely, hearing, sight and understanding, of which the differences are as between prior and posterior.

59. 7. All sensations [perform certain offices]:—1. They indicate to the soul the quality of the things which touch the sensories. 2. The soul is affected according to the disclosures of touch, if good, joyously, if evil, sadly, whence is affection which is natural; for all the senses have their own affections, according to the quality of the forms which touch them, according as these agree or disagree with the state of the soul, wherefore as they agree or disagree with the order of the universe and in their own universe. 3. The soul according to its affections immediately induces changes of state upon the whole organ or sensory. 4. Wherefore there are sensation affection and change of state which mutually and immediately follow each other; the organs are wonderfully constructed for all these things. 5. Sometimes the state is changed by lowest or corporeal causes, as by diseases, whence other affections and therefore other sensations take place. Sometimes the state is changed by inmost causes or those in the rational mind, before contact, whence also there is another sensation and another affection. (*See Boerhave.*) Wherefore all ought to be distinctly comprehended.

60. 8. Any external sensory, whether it be the tongue or the nostrils or the ear or the eye, is a kind of common sensory, consisting of infinite smallest things, which are themselves little sensories, which taken together constitute the common sensory. 1. These little sensories are fashioned for every kind of approaching objects, even so that they are recipients and deferents, when those things which touch are agents; thus they are passive respectively to objects, and active respectively to the office of carrying away to the other [sensories]. 2. The sensories or little sensories are pliable and elastic, even so far that, according to the nature of elastic bodies, they lose nothing from the impact. 3. They are fashioned for every variation of impelling or touching objects in that degree, and indeed from the greatest to the least. That which is greatest and least is too

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blunt and too sharp, and does not fall into that sense, but perishes and vanishes.* 4. Wherefore the sensory of one kind does not receive the things which are in a superior or in an inferior degree, but only to the greatest and least of its own degree, wherefore there are limits and spheres of sensation. 5. In order that the sensory may receive all these varieties the little sensories must all be perpetually various, even so far that it is necessary that not one papilla be in every way or absolutely like another. 6. And whatever one little sensory, whether it be a papilla or any other sentient part, feels, that another papilla notices, to the extent that every sensation is received by every little sensory, and thus by the common organ. 7. Every modification or tremor enters its own little sensory adequate to itself, and it enters the point adequate to it; thus since all the little sensories are various, all the various things enter. 8. Wherefore now in every sensation there are infinite things which concord. 9. Indeed, if it passes over into an elastic membrane, and if the sense is of its degree, so that it passes over into a cartilage at the same time, the more the sense is exalted, and becomes sensible in the common sensory or the brain.

61. 9. To the little sensories append and adhere the nerves which carry the mode even to the brain. 1. The nerves are compounded according to the degree of the sensation; thus very simple sensations receive simple nerves or compositions, compound sensations receive compound nerves; for the ascent from degree to degree is by composition alone and division of the fibres of various order; wherefore it is necessary in the cognition of the degree of the fibres to come at a cognition of the sensations. 2. Wherefore in every organ there are as many compositions of fibres as there are little sensories, for they are various, but still they are of one degree or series between the greatest and the least. 3. Contacts strike the little sensories according to their own figures or forms of modification: figures are of the impinging parts, forms are of fluids and atmospheres; the

*The passage is obscure. I take it to mean that which is greater than the greatest of the preceding degree is too blunt, and that which is less than the least of the preceding degree is too sharp, to fall into the sense of the preceding degree, therefore, it perishes and vanishes. Tr.

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former take on a vibration, but the latter a modification; thus vibration and modification mutually respond to each other. 4. Such as is the contact in the extreme little organs, such it traverses that whole fibre, and all the fibres into their antecedents, even towards their beginnings in the brain, or in the cortical substance; for which reason there is no fibre, there is no spherule of the cortical substance, which does not receive every part of the vibration or modification, even so far that they may be the beginnings not only of those fibres, but all the beginnings of the whole common sensory. 5. Not only the fibre carries this sense, but especially the animal spirit, which courses the fibres, which spirit is highly elastic, and does not lose anything from a received force, but presents the whole in the beginnings; thus such as it is in one extreme such it is in the other, which is the reason why the sensory fibres are softer and fuller of spirit than the motor fibres. 6. All sensation proceeds according to the fibres into antecedents or towards the cortical substance; but every action proceeds according to consequence, or from the cortex into the muscles; the motor fibres are distinct, and action proceeds according to certain fibres, not according to all.

62. 10. All sensations, while they are coming into the fibres and to cortical the substance, where the true common sensory is, indicate themselves and their mutations by the mutations of state induced upon those beginnings. 2. The purer the substance organically fashioned the more mutations of state it can receive distinctly. Its perfection consists in this faculty, and it is an attribute of it; otherwise it sensates nothing. 3. The external organs or those of sensation induce these changes of state upon the cortical beginnings, to which they are accustomed, whence is memory. When these mutations return ideas go forth from the memory; for every mutation comprehends one idea, and unlimited greater ideas in the degree that the sensory is purer; finally infinite ideas into which they can be changed in a moment. 4. The modification itself and the sensation exactly coincide, but the modification becomes sensation, so far as the recipient principle, that is, the soul, is endowed with life; modification is turned into sensation by the life of the soul. 5. The

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soul therefore is affected by the harmony and form of the modifications, whence is the affection of the sensations of the animus and of the mind. 6. According to that affection the state of the internal sensory is instantly changed, wherefore also the state of the external sensory. The state of the external is changed by external causes at the same time as by internal causes; for the fibre of the little sensory communicates with the motor fibre, with the fibre of the glands, and with all neighboring fibre; thus indeed the cerebrum and the cerebellum [are affected] from the prior; thus there finds place a concursus of affections, wherefore, immediately, a change of state. 7. Affections go before, but seem almost in an instant to induce change of state; for immediately sensation finds place, also change of state finds place; affection indeed is the means and thus the cause. 8. Affections are general, particular and singular, and are also to be referred to series and classes. The most general affections are good and evil, joy and pleasantness, and grief or unpleasantness. The fibre expands itself for good, and contracts itself for evil, of itself. 9. Wherefore all the organs, especially their parts or little sensories of every kind, can take on mutations of state, namely, according to all affections. A similar state is therefore induced upon the motor organs, and upon those of the entire neighborhood.

63. 11. Every sensation is carried both to the cerebrum and to the cerebellum; it is necessary that both become participant of the sensation. 2. For the cerebrum is what feels the modes, indeed also what gives forth affections. 3. But the cerebellum is what induces suitable changes of state upon the affection. 4. Wherefore to every single organ of the sensory is sent forth a nerve both from the cerebrum and from the cerebellum. 5. The fifth pair of the head is a nerve of both the cerebrum and of the cerebellum, wherefore it goes to all the sensory organs, and thus connects [them] with each brain; just as seeing is also from its softer part. 6. The organs themselves, namely, the external sensory organs, sensate nothing from themselves, but are only fashioned for the quality of the objects in order that they may receive and carry away [sensations]; they are instrumental causes; the cerebrum is what sensates, the cerebellum also; but

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this sense [of the cerebellum] does not come to the consciousness of our mind, but to the soul, to its first causes, which are fashioned to the order of the soul. 7. Although the soul is everywhere, still it cannot feel everywhere unless it shall have formed organs suitable for receiving; although there is one force, still the exercise of use arises from its form and tissue: thus in the cerebrum are organs altogether unformed for receiving, not so elsewhere; thus every tissue is from the same soul, but is operated variously according to the tissue. This will be further explained in the Chapter on the Brain.

64. 12. The senses can be sharpened, and indeed as follows:—1. From the greatest to the least [degree], in order that the sphere of sensation may be greater. 2. Then also that they [the sensations], can be more distinctly perceived. This appears in touch, taste, smell, hearing, sight, in animals, in the earlier and infantile age.

65. The causes of sharpening and perfection are as follows:—1. In order that all may act separately in least parts, and in order that they be not bound together nor adhere, as in compounds, when they grow soft. 2. In order that the sheath which covers may become softer, and that thus the little sensories may be the more laid bare. 3. In order that the little sensories themselves may grow soft, and capable of undergoing more changes of state. Wherefore [they are sharpened] lest they grow callous or coarse, and lest they cohere to one another and thus become useless, whence generally indistinct. 4. That the little sensories may be distinguished into smaller series. 5. Then in order that a more beautiful and softer variety may reign among the little sensories, thus that more suitable changes of state, even those agreeing with the related (affini) state? can be induced. 6. In order that the fibres themselves may grow tender [that is, sensitive] and grow soft. 7. All these [organs] arise from use and exercise; yea, the external organs like as the internal.

66. 13. It would seem as though there could be more than five senses, if we consider the whole series of the varieties approaching from the macrocosm, furthermore that objects are more distinctly apperceived by some [senses] than by others; one organ,—except the internal or brain,—receives the varieties

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of only one series or degree, wherefore the perfection is of the organs. This is called its proper sense; there can, however, be a double sense in one organ. Besides, 1. There can be an organ that can perceive divisions floating in water that are smaller than are the human organs. 2. There can be a sensory which apperceives smaller divisions of the effluvia in the air, perhaps also those which float in the ether, as, for instance, dogs can perceive odors imperceptible to men, etc., animalcula still smaller things. 3. There can be a sensory than can perceive the smallest effluvia in the purer ether itself. 4. Then also it can perceive the modification of that ether which flows according to the natural form, thence is animal magnetism, that they know their own region (quod plagam suam sciant).* 5. It will be demonstrated in the Psychology and below that our rational mind itself, or because we are rational, is the reason for our enjoying a duller acumen of sensation [than animals]. 6. From these things it is evident that there can be a sympathy of minds, from influx alone by the purer ethereal atmosphere, and that it is in the state after death, and that every one knows the thoughts of another. Not so in an imperfect state.

* The connection of this clause is very obscure. If anyone can suggest an explanation and rendering he would confer a favor. Tr.

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IDENTIFICATION OF HYDROGEN AND THE "THIRD FINITES" OF THE *PRINCIPIA*.

Composition of Water—Statement of Modern Science.

In the electrolysis of water, when the current of electricity passes through a volume of water, the water begins to give out gases,—oxygen gas at the positive pole, and hydrogen gas at the negative pole. If the respective amounts of these gases given off at any time be measured, it will be found that the amount of hydrogen gas given off is twice that of the oxygen. Meanwhile the volume of water is diminishing; with every particle of water that disappears a certain amount of hydrogen and oxygen gases makes its appearance.

The experiment is reversible. If through hydrogen and oxygen mixed in due proportions, a current of electricity be passed, its activity will cause the hydrogen and oxygen to disappear with an explosion; and where they were, water will appear.

Because these gases and water are thus mutually convertible terms, a water molecule is said to be composed of hydrogen and oxygen gases.

Composition of Water—Statement according to Swedenborg.

According to Swedenborg a water molecule is composed of Third Finites and Fifth Finites. That is, he states that a water molecule is a highly compressed molecule of ærial-elementary;[1] and he says that a molecule of ærial-elementary is composed of Third Finites and Fifth Finites;[2] from which we deduce that the water-molecule is composed of Third Finites and Fifth Finites.

STATEMENTS PARALLELED.

Here then we have a double statement of one and the same fact; giving definite basis for comparison.

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[1] *Principia*, Part III, chap. ix: 1.

[2] See Appendix, Note 1, Observation 1, for figure of ærial molecule, and the disposition of Third Finites and Fifth Finites in it.

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The molecule of water is composed of hydrogen and oxygen gases.

The molecule of water is composed of Third Finites and Fifth Finites.

Which of these two classes of finites constituting the water particles, answers most nearly in its characteristics to hydrogen gas?

COMPARISON OF THIRD AND FIFTH FINITES.

On comparing Third Finites and Fifth Finites some pointers are to be gained from the general laws laid down by Swedenborg concerning the relative nature and power of successive finites.

Third Finites take their rise earlier in cosmic history than Fifth Finites; therefore, according to the general law of the case,[8] as being formed earlier than the Fifth Finites, they are simpler, finer or smaller, swifter and more full of acting-energy. From which it follows that—

First: the Third Finites, being smaller, finer and less compounded than Fifth Finites, are individually less dense or heavy than they.

Second: the Third Finites are also the *swifter-movers.* To illustrate roughly: if two processions of Third and Fifth Finites, respectively, were to move in a double line past a certain point for an hour, the two lines starting "head and head,"—when time was called on them, it is certain that a great many more Third Finites than Fifth Finites would have passed by; as if the line of Third Finites was a line of small bodies moving swiftly, and the Fifth Finites a line of large bodies moving slowly. For, relatively, Third Finites always *run,* when they move at all; and Fifth Finites always *walk.*

Third: the Third Finites are also more active, having innately in them the more ready motile energy; for as being the more simple, and earlier formed, they are thus nearer, both in derivation and characteristics, to the *primum mobile* of the universe.

NEGATIVE POLE THE POLE OF INITIATIVE ENERGY.

Fourth: by this latter characteristic Third Finites would

[8] *Principia,* Part III, chap. iii, par. 2. Part I, chap. viii: 3. Chap. iv: 10, 11, 14, 15, 16. Chap. iii: 11. Part III, chap. iii; par. 1.

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naturally range themselves rather with the negative pole than the positive. For according to what Swedenborg says of the vortex sphere surrounding a magnet, and the way he figures its lines of force,[4]—emanating from and returning to it,—the negative pole is manifestly where the current of the vortex sphere is in its *outgo,* and takes head and initiative against the pressure and equilibrium of the surrounding medium with a radiant, active, out-going push and endeavor, swing and sweep. Of the two poles the negative pole is thus relatively *the initiative energy-pole.*[5]

WORKING SUPPOSITION DEDUCED.

As between Third Finites and Fifth Finites then, the characteristics of the Third Finites approach more nearly to those of hydrogen,—i. e. (1) hydrogen is less dense than oxygen; (2) in electrolysis of water twice as much hydrogen as oxygen passes off in any given time; (3) hydrogen always "flows out at" (*or ranges itself with*) the *negative* pole.

FURTHER TEST.

So far this affords a *working supposition* that hydrogen gas is constituted of Third Finites,[6] or those finites classed in Swedenborg's system as of the *third degree of derivation.* This may be brought to further test by looking for other large cosmic relations of Third Finites given by Swedenborg in the series of

[4] *Principia,* Part II, chap. xv: 1, 2, 8; chap. I: 1, 6, 10, 11, 19, 25; chap. xii: 1; Part III, chap. i: 1.

[5] This truth is the basis of the fact, that in all the delicate modern experimentation depending upon electric currents passed through a vacuum tube, it is the negative pole which is the active instrumental, as it were, and the phenomena of the negative pole which are significant.

[6] If so, these Third Finites are in all probability those *entities* which J. J. Thomson calls *corpuscles;* some thousand of which, as it is experimentally estimated, go to form the hydrogen atom. (*Inertia and gravitature,* Fessenden. *Science.* Aug. 31st, 1900; *Masses of the Ions.* J. J. Thomson. *Philos. Mag.* Dec., 1899; *Cathode Rays.* J. J. Thomson. *Philos. Mag.* Oct., 1899).

The fact that Swedenborg states the configuration of the Third Finite to be that of a *vortex-ring* gives interest to Fessenden's supposition, in the above article, that, "the atoms may be formed of vortex rings arranged in different kinds of space-nets, with the direction of rotation of the vortex rings such as will make these combinations stable."

In this connection "Conductors and Insulators" (Fessenden; *Electrical World,* March, 1893, page 157) has a particularly interesting suggestion.

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stock-substances of nature as laid down in his system; and by comparing the relations again with whatever is experimentally known of hydrogen.

CONNECTION OF MAGNETIC OR SECOND AURA WITH METALS.

A notable cosmic relation of Third Finites given in Swedenborg's system, is their presence throughout the Second or Interplanetary Aura,[7] as an inseparable part of its structure. The envelope of each molecule of this particular aura is formed of Third Finites.[8] In fact this Interplanetary or Second aura is the great interplanetary *storehouse* of this particular stock-substance,—i. e., finites of the *third degree of derivation.*

INTIMATE CONNECTION OF SECOND AURA WITH THE METALS.

This aura might also be termed the metallic aura,[9] for it is the aura especially and intimately concerned in the formation of metals.[10] It is from the molecules of this aura in fact that the "metallic particle" is derived by compression.[11] The Third Finites forming the envelopes of molecules of the magnetic aura are, according to Swedenborg, released or dissociated from their nexus and connection in the magnetic-ether molecule, under certain contingent circumstances bringing about the compression and collapse of the whole molecular form,—the so-released finites of the envelope being put to other uses, and moulded into other forms; all of which pertain to metals. The stock of Third Finites thus derived from the Second or Mag-

[7] Sometimes the molecules of this aura are called by Swedenborg the *Second Elementaries*, and the aura itself the *Second Element.* Very often it is termed by him the *magnetic aura*, from its peculiar association with that force. The phenomena of magnetism depend upon its presence: magnetic and electro-magnetic lines of force represent (*and literally are produced by*) the head and trend of that particular and characteristic current of motion, into which the disturbed area natively passes when there occurs in the general volume of the aura any disturbance of its even, equilibrated quietude. See Appendix, note 3.

[8] *Principia*, Part I, chap. ix: 1-7. See Appendix, note 2.

[9] It would answer then to Newton's surmise that the true atmosphere of the mundane system might be of a metallic nature. (London, Edin. & Dublin, *Philosophical Magazine*. Vol. XXIX, page 222).

[10] See "Concerning Iron," *Principia*, Part II, 10; also, leaflet, *Corpuscular Philosophy;* par. 2.

[11] *Corpuscular Philosophy*, par. 3.

For figure of Magnetic-Aura molecule and result of comparison or collapse, see Appendix, note 1.

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netic Aura, forms the distinctive Stock-Substance common to the metallic family.[12]

THIRD FINITES A COMMON FACTOR OF THE MOLECULAR CONSTITUTION BOTH OF WATER AND OF THE METALS.

According to Swedenborg, then, Third Finites are a stock-substance which both forms one of the constituents of the water molecule and enters characteristically into the metals. If so,—and if Third Finites are equivalent to hydrogen,—then hydrogen and the metals must have a profound inner connection as derived from a common stock and partaking in common of the native characteristics of that stock-substance.

HYDROGEN A METAL.

As a matter of fact hydrogen is now definitely classed among the metals. Richter says that hydrogen "displays the character of a metal in its entire chemical deportment and must be regarded as a gaseous metal." [13]

In this regard, therefore, our working supposition that hydrogen gas is constituted of Third Finites, stands confirmed by the test of experimental fact.

THIRD GREAT MACROCOSMIC RELATION OF THIRD FINITES.

Again,—there is a third most notable place, in the cosmic series and among substances, which is filled, according to Swedenborg, by Third Finites,—those finites which as we have just seen are common to the entire metallic family, inclusive of hydrogen.

ACCORDING TO SWEDENBORG A RELATIVELY PURE VOLUME OF THIRD FINITES ENVELOPS THE SUN.

Swedenborg says that a great volume of Third Finites exists around the solar center. It is there that they were first shaped. It is only there that the condition exists necessary to their formation.[14] They are always in effort and endeavor to that particular swift individual gyre or motion which is the fire

[12] This subject will be given particularly in a later section of this paper, treating of the *threefold formative* of metals, i. e., the alkali metals: the primitive positing of the heavy metals, and connection therewith of igneous rocks and the igneous factor of metamorphic action; the relation of vegetable life and water to secondary ore deposits.

[13] *Inorganic Chemistry*. Richter. Ed. 1896, pp. 47, 270.

[14] *Principia*, Part I, chap. viii: 4.

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itself of their degree,—and continually being reduced to relative passivity by the influence of certain higher substances;[15] and from the continuance, in some small measure in the vicinage, of conditions which primordially existed in an eminent degree, a certain volume of them is always maintained in existence there.[16]

THE SPECTROSCOPE SHOWS THAT A METALLIC AND HYDROGEN LAYER ENSPHERES THE SUN.

Compare with this the well known report on the subject given by modern experimental science. Spectrum analysis says that immediately around about the sun there exists a vast envelope of metallic particles in a high state of vibrant activity; and that the chromosphere of the sun is of glowing hydrogen radiating outward in great cloud masses and flying tongues of flame, sometimes to a distance of 200,000 miles; and then swiftly subsiding and disappearing, perhaps in a few hours.

SERIES OF THE MACROCOSMIC RELATIONS AND USES OF HYDROGEN AND OF THIRD FINITES PARALLELED.

According to Swedenborg, Third Finites form one of the two constituent substances of water. Third Finites constitute also the "particles" or stock-substance common to metals; and a vast volume of them in a state of vibrant endeavor is always extant immediately about the solar center.

According to Modern Experimental Data, hydrogen forms one of the two constituent substances of water. Hydrogen is a member of the metallic family; and the immediate envelope of the solar center is of glowing metallic particles and radiant flames of hydrogen.

CONCLUSION THAT HYDROGEN IS A COMPOSITE FORMED OF THIRD FINITES.

The series of the larger cosmic relations and uses is complete, and is paralleled at each successive point.

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[15] *Principia*, Part I, chap. vii: 7: 8.

[16] *Lesser Principia*, no. 86. The phenomena of Sun Spots is dependent upon the fact stated, i. e., that the condition which existed in eminent measure and activity during the primordial formative period, as a great cosmic instrumentality for the successive moulding of a certain series of cosmic substances, afterward exists, in a less measure, as part of the maintenance and preservation of that which is already formed.

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It may be accepted then as a definite working theory, well confirmed, that *hydrogen gas is composed of Third Finites.*

FULL EXPERIMENTAL VERIFICATION OF SWEDENBORG'S POSTULATE RESPECTING THIRD FINITES.

In the third point of these parallel series—(the existence of a volume of Third Finites, the metallic stock-substance, about the solar center)—is to be seen such experimental verification of an important postulate made by Swedenborg as has never been vouchsafed any other scientific worker.

When it was laid down in the *Principia* as a definite statement,—made with detail moreover, and an integral part of the early *formative history* of the Cosmos,—it was unsupported by any consent of the scientific workers of his time. It was certainly unconfirmed by any experimental data at that time part of public knowledge,—and data of that kind would have been publicly known and advertised. It seemed, therefore,—for several generations of men,—to be a statement not only *unverified,* but, from the nature of the subject, *unverifiable.* Yet it was laid down as one of the early postulates of substance and order, in the system.

Because of this, even those who were delighted with the logical coherence, the adequate sequence of cause and effect, in Swedenborg's cosmic system, could at best only reserve judgment; while most readers were disposed on this account to call the whole interconnected and dependent system a sort of beautiful bridge, one of whose arches manifestly rested on nowhere,—and thus little better than the fabric of a dream. Thus this particular statement was a stumbling-block in the way of the acceptance of his system.

Now it is precisely this point, this particular statement, which modern spectrum analysis has verified as if it had gone out to hunt evidence. In so doing its confirmation is notable also as being two-fold. It not only verifies what Swedenborg stated, on his sole authority, to be an existent fact. In addition, the fact, as Swedenborg connects it with the whole series of events given in his formative history of solar systems, throws a suggestive light upon one of the most puzzling problems arising in modern spectrum analysis—a Janus-faced problem,—"What

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is the connection between the solar activity and this presence of a volume of incandescent metallic particles immediately about it? Why are no other than metallic particles reported by spectrum analysis to be there?" This problem Swedenborg dealt with in its two-fold aspect, before it was known as a problem, or the spectroscope had place. And the answer is given by him in precisely that part, the definite statements of which were so many years regarded as not only unverified, but *unverifiable*.

Such experimental verification of a fundamental postulate of a cosmic system, occurring a hundred odd years after, and coming from sources then unknown and unforeseeable, is a notable thing in scientific history, and probably has happened to no other man.

APPENDIX.

OBS. 1.

Structure type of Swedenborg's "aerial-elementary" molecule.

A molecule of aerial-elementary is a sort of *bulla*,—one might almost call it an *inorganic cell*,—of inconceivable minuteness. It is formed of an outside layer or envelope of Fifth Finites, enclosing a small volume of the Second or Magnetic aura.[17] The molecules of magnetic aura in turn have envelopes of Third Finites. A cross-section of the general plan of a molecule of aerial-elementary is given in Fig. 1. The large black dots represent the Fifth Finites, which form the general envelope. The inside minute dots represent the Third Finites, which compose the envelope of the molecules of magnetic aura.

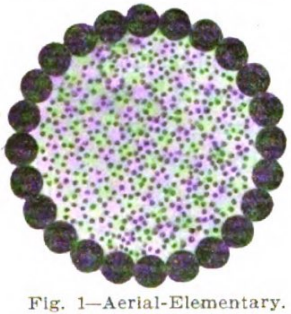

Fig. 1—Aerial-Elementary.

[17] A very small portion of *First Aura* also exists in the interior of the molecule of *Ærial Elementary*: it exists in the interstices of the molecules of the *Second Aura*. But as it also, under the conditions to be immediately considered, goes itself to form a particular metal (gold)—it needs no further mention here, for reasons to be treated later. Very probably it is the source of that extremely minute portion of gold natively present in sea water. *Principia*. Part III, chap. viii: sec. 1.

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Such an arrangement of Third and Fifth Finites characterizes the molecule of *aerial-elementary*. This arrangement might be figured roughly and in far-off image, by a large hollow rubber ball filled with a number of minute hollow rubber balls made of a finer kind of rubber, filled, in turn, with air. The analogies of the several envelopes of our composite rubber ball are manifest. There exists also an analogy to the air which occupies the interiors of the least and finest balls; for the central space of all molecules of magnetic aura is occupied by substance of a plane so subtle, fine and superior that relatively to the Third Finites of the surrounding envelope it is as it were *an intangible thing;* although in truth it is *by this* that the envelope itself is expanded and held in flexible tension; and it is due to the presence of this superior, subtle, intangible substance within the central space of the magnetic-aura molecule, *that the molecule itself is elastic.*[18] Thus it is within it as the air is within our finer hollow rubber balls. And from the elasticity thus existing in the volume of magnetic aura within, the molecule of aerial-elementary itself is rendered elastic.

Illustration.

Structural arrangement upon which elasticity depends.

Or, one might say,—from the eminence of the substances and forces involved,—that this superior subtler substance is within its envelope or "crust" of *relatively* lower and more material Third Finites, almost *like a sort of a soul* in a body. This at least is sure, that in case of any excessive compression or serious lesion of its envelope, it all escapes, irrecoverably,—withdraws itself,—flies away. For from the peculiar configuration of molecules of the magnetic aura the central, finer, subtler substance is always free to escape at the poles of the molecule, if its little home or cell or envelope no longer fits its innate activities. And it is relatively so supremely subtle, fluent and intangible that it can fly through the interstices of larger entities as if they did not exist.[19]

Relation between envelope of Elementary Molecule and its interior substance.

The first invisible "forms of use" of the mineral kingdom[20]

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[18] *Principia.* Part I, chap. ix: 3.

[19] *Principia,* Part. III, chap. vii, no. 5.

[20] *Lesser Principia,* nos. 92, 96. The *Sixth Particles* of the *Lesser Principia* are the same as the molecules of magnetic aura, in the *Principia.*

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are formed directly from the "Elemental Kingdom" or kingdom of the Four *Auras* (or *Ethers*).

They are formed by "great cosmic contingencies" bringing about the compression or collapse of sundry of their molecules. In case of such cosmic compression or collapse of molecules of "the Ethers,"—as when a hollow rubber ball is squeezed till the air is out and nothing is left but a mass of rubber-substance in the hand—so here! The relatively-superior, intangible, flowing substance occupying the central hollow of the elastic molecule of aura,[21] flows away and escapes. Hence the entire molecular form under compression collapses in on itself. All that remains after the active, intangible center (what we likened to its *soul*) has escaped,—the *residue* (the relatively crass body left behind),—is the mass of *finites* which constitute the envelope (or crust) of the aura-molecule.

Primitives of material composition derived from envelopes of Elementary Molecules.

This *residual mass,* now crowded and bunched and held firmly together by the *outside pressure* of its appropriate, encompassing atmospheres,[22] constitutes the active primitive particle, the invisible beginning of tangible material composition.

> N. B.—The law stands thus: *When molecules of the elementaries* (the Four auras) *are so compressed that they lose their relatively active and intangible central volume, the residual compactured-mass of those finites constituting their envelopes, forms the actual primitive-particle of material composite, or "chemical substance."*

Thus are derived the primitive, invisible "forms of use" of the mineral kingdom. Thus is primitively formed the water molecule, the first of true material substances. (See *Principia,* Part III., Chap. ix: 1.)

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[21] *Divine Love and Wisdom,* n. 313.

[22] That in both worlds the inert forms of use constituting their fixed plane are held together in mutual connection by encompassing atmospheres, see *Divine Love and Wisdom,* n. 302.

The phrase "appropriate atmospheres" is used because all compactures of the finer finites (or composite forms of use moulded of finer finites) are themselves held in form by the encompassing pressures of the higher, prior, and finer auras; but composite forms of use and aggregated compactures of finites of later derivation and thus grosser bulk are held in form by atmospheres of a lower, more ultimate, plane and nature. See *Economy Animal Kingdom,* Part I, n. 635.

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Residuum, when molecule of Aerial-Elementary is highly compressed.

To return now to our figure of the molecule of aerial-elementary, as illustrated by our large rubber ball filled with small hollow rubber balls. If a pressure be brought to bear upon the outside of our large rubber ball so great that it overbalances the supporting force of the air-filled balls within it, the air will be squeezed out, and the whole system of rubber envelopes will be reduced to a globular, resistant mass of rubber, which can be held in the hand.

In like manner if a molecule of aerial-elementary be sufficiently compressed, the intangible, subtle, superior, fluent substance—which occupied the hollow insides of the magnetic aura molecules, holding them in tension, expansion, and elasticity—will escape, flowing away, and leaving behind them their crass, emptied envelopes. And then the entire molecule of the aerial-elementary will collapse under the outside pressure into a small globular mass of Third Finites, surrounded by a double layer of Fifth Finites.

Figure 2 gives in cross section a general illustrative idea of the result of such compression of a molecule of Aerial-Elementary. Compare with it Figure 1.

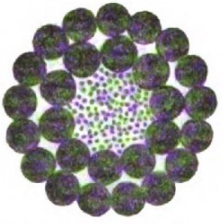

Fig. 2—Compressed Aerial-Elementary Molecule.

But since a most highly compressed molecule of aerial-elementary forms (or *is*) the actual water-molecule, this same figure (Fig. 2) will stand also for an illustration of a cross section of a water molecule.

On comparing this figure with Fig. 1 (which is that of an uncompressed aerial-elementary molecule) it will be seen that all which is now left of the elastic *compressible* aerial-elementary molecule, *is this globular mass of Third and Fifth Finites,*—finites which previously constituted, respectively, the envelopes of the molecules of that *central volume of magnetic or Second aura within* and its *general envelope without.* Which globular mass is practically *not further compressible;* since the finites or stock-substances composing it are already crowded together almost as closely as possible. From this it is that water is almost incompressible.

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The water-molecule is therefore this resultant globular mass of Third and Fifth Finites; from which we reach our conclusion that the water-molecule is composed of Third Finites and Fifth Finites.

Formation of primitive metallic particles from Second Aura.

It is to be noted that the manner in which the central mass of Third Finites, shown in Fig. 2, was formed from that volume of magnetic aura occupying the center of the aerial-molecule shown in Fig. 1—(*i. e.*,—by compression), answers perfectly to the condition postulated in the leaflet on *Corpuscular Philosophy* as being that which produced the metallic particle or primitive from the Second Aura. This is significant in view of the fact that one of the constituent substances of water, namely, hydrogen gas,—is a metal.

Obs. 2.

Factors of Magnetic and Electro-Magnetic Force.

Connection of the Second Aura with magnetic and electro-magnetic force.

The Second and Interplanetary Aura is often also termed by Swedenborg the Magnetic Aura, from its peculiar association with magnetism.[23]

This aura is practically *in plenum* from the envelopes of the solar center to the outmost reach of the solar system.[24]

The phenomena of magnetism depend upon its presence. Magnetic and electro-magnetic lines of force represent (and literally, *actively are produced by*) the head and push and trend of that particular characteristic, gyre or current of motion *into which the disturbed area natively passes, wherever and whenever there occurs in the general volume of the aura any disturbance of equilibrium.*[25]

Two factors present in all manifestations of magnetic force.

Two factors are necessary to the appearance of magnetic and electro-magnetic force upon the "external plane," or the plane of sensible-effects.

The first factor is the existence or production of such a more or less local *gyre or current* in the general volume of the Second or Interplanetary aura. This is the *active* "Elementary" (or Ethereal) factor.[26]

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[23] *Principia*, Part II, chap. ii: 6.
[24] *Principia*, Part II, chap. xv: 2; chap. viii: 1.
[25] *Principia*, Part II, chap. xv: 1 and 3.
[26] *Principia*, Part II, chap i: 1, 22, 10, 18.

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The second factor is the existence, in the course or *field* of that current (the field of disturbance), of a halitus of subtle metallic particles or "corpuscles;"[27] such a halitus of metallic particles or corpuscles as occurs characteristically (in more or less abundance) round about metals. The presence of this halitus of material corpuscles is so important to the actual manifestation of magnetic force upon the plane of tangible effect that upon its relative abundance depends the relative power of different magnets.[28]

This is the relatively passive factor; and it acts as an intermediate between the pure subtle substance and force of the current of magnetic aura, and the gross, inert plane of tangible material substance and mass.

There are then two factors, present and essential, in all production and manifestation of the magnetic and electro-magnetic energy as are actual "working force" in the world or plane of "sensible effect" and "physical mass:"—*i. e., First,* the current in the volume of magnetic aura, and, *Second,* that halitus of disengaged, floating (or free) metallic particles.[29]

FIRST LAW. **Presence of both factors necessary for production of working-energy on plane of tangible effect.**

To illustrate the mutual place and service of these two factors in the production of the mechanically-effective result,—take the last grinding down of hard steel files. For this grinding they use a stream of water-mingled-with-sand: the sand it-

[27] *Principia,* Part II, chap. i: 1, 10, 14, 28, 17.

[28] *Principia,* Part II, chap. ii, 1, 4.

[29] Here it is interesting to note Sir Wm. Thomson's surmise along the line of Swedenborg's dictum, called forth by the phenomena presented at the negative pole in the *Crookes tube,* i. e., that two things are essential to the electro-magnetic current; first, the *ether* stream; and, second, the presence of material molecules. *Geology and General Physics,* pp. 548-556. Macmillan Co., 1894. Connect with this the much later experiments of J. J. Thomson (given in papers before referred to) which fixes conclusively the fact that the *material particles* of residual gas concerned are not molecules,—are not atoms even,—but what he terms "corpuscles." For under the conditions of experimentation not anything is surer,—not alone by rational deduction, but by isolation and quantitative estimate,—than that the disengaged molecules of residual gas spoken of, are not merely dissociated into their correspondent atoms; their atoms in turn are dissociated into their own component "entities." In the case of hydrogen gas, each atom is dissociated into about a thousand of these component or prior entities, called "corpuscles," by Thomson. Here we are *experimentally* beginning to come into intellectual touch with those fundamental concepts and prior conditions of matter as to both substance and force, of which Swedenborg treats in his volumes dealing *with the higher physics.*

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self is of a grade so fine it is a mere impalpable powder. To direct the stream of water alone against the steel will not accomplish anything; neither will sand alone. But direct against the hard steel a stream of water filled with exceedingly fine sand, and the steel will cut like cheese. Here the sand gives to the stream of water weight, edge, and a certain flexible ponderability, which "mediates" between the pure fluent water, and the fixed ponderous substance of the steel.

Much like this is the mutual place and relation or consociation of the magnetic-aura-stream and the halitus of metallic-corpuscles in the production of "the common end" or effective result of *magnetic and electro-magnetic energy.*

AS A WORKING FORCE APPLICABLE TO THE PLANE OF EFFECTS.

SECOND LAW.

The first and active factor in all force is the motion of the intangible elementaries.

In this relation of the two factors of magnetic and electro-magnetic force, i. e., the active, and the relatively passive or intermediate,—is seen illustrated a certain *universal* as to the relation of the relatively intangible, superior substances of nature to the production of force upon the lower plane of sensible effect and tangible mass. For in Swedenborg's account of the two factors, and the manner of production, of magnetic force, it is there clearly seen that the very spring and source of the tangible magnetic force itself is the current and power of that magnetic aura; which aura is a substance so subtle and superior that it is, as it were, an intangible thing, relatively, to the plane or world of sensible forces and masses. And this so much so, it can only come to manifestation and operate effectively in that plane or world by the instrumentality of a *mediate.*

And this is according to a *general law* covering the entire ground of "produced force," i. e.—that motion is the source of all force, all production, all activity, all accomplishment;[30] and that motion itself always begins in an element and among substances which are subtler, superior, and, as it were, intangible,—relatively to those substances in which it at last comes to sensible manifestation to us.[31]

Thus the spring of all force upon the tangible sensible plane

[30] *Principia,* Part I, chap. ii: 4.

[31] *Principia,* Part I, chap. v: 22.

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of material substance, *is in the relatively intangible substances* of the Elementary Kingdom. And all motion, at its last remove, refers itself, as to its very origin, to the perpetual communication by the Infinite.[32]

THIRD LAW. **Passive factor is composed of same kind of finites as envelopes of Ether Molecules, which are the active factor.**

It is particularly to be noted that those particles which are the relatively passive and intermediate factors in this production of magnetic force (that is, the halitus of metallic corpuscles in its field) are homogeneous with those composing the envelopes of the magnetic ether, or *active factors involved.* For the particles or corpuscles of this metallic halitus, are themselves composed of Third Finites. This we know from the fact that the Third Finites are those which enter characteristically into the composition of metals, and are the one stock-substance common to the entire metallic family,[33] and that substance which enters characteristically into the metal forms that halitus of disengaged metallic corpuscles extant round about it.[34]

The very particles of this metallic sphere or halitus of disengaged metallic corpuscles therefrom, are composed of the same stock-substance as that which forms the envelope of the magnetic aura itself.

And this halitus or encompassing sphere of metallic particles, being thus composed of *finites homogeneous with those* forming the molecular envelopes of the second or magnetic aura, *is thus peculiarly apt and adapted to be at the serviceable disposition of the movements of that aura;* because the very particles of the halitus are from their innate force and nature, *apt to like movements;* and thus conjunction and harmony is possible between them; for no equilibrium of any sort can be formed without innate conjunction and harmony of motions.[35]

This then is the *third law* of the relation of the two factors involved in the production of magnetic and electro-magnetic forces:

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[32] *Principia,* Part I, chap. ii: 11.

[33] For this consult derivation of metallic particles or primitives in composition, in the paper itself, on "Identification of Hydrogen."

[34] *Principia,* Part II, chap. ii: 1; chap. xiii. Appendix.
Principia, Part II, chap. vi: 3.
Divine Love and Wisdom, n. 293.
True Christian Religion, n. 499.

[35] *Principia,* Part II, chap. i: 25.

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The relatively passive or intermediate factor, the halitus or sphere of disengaged metallic corpuscles, is composed of stock-substance, or finites, homogeneous with those finites forming the molecular envelopes of that particular aura which is the active factor involved.

The active factor of aura-current can produce no effect by (cannot unite to itself and dispose) a halitus or sphere of corpuscles composed of finites *not homogeneous with* those constituting the envelopes of its own molecules.

This is a law which holds good for each one of the four auras.

Each aura can bring the motive force of its current to effective operation in the lower plane only by the intermediation of a halitus or sphere of disengaged material corpuscles, formed of the same stock and substance as that entering into the envelopes of its own molecules. That is, its active current of motion can only come to manifestation upon a lower plane by the intermediation of a relatively passive halitus or sphere, the substance of which is *homogeneous with itself.*

It can effect nothing by a sphere which is not thus homogeneous.

Generic difference between mechanical and magnetic forces.

Mechanical force deals with tangible *material "masses:"* and the action of mass on mass.

The magnetic and electro-magnetic forces *deal with "spheres;"* the influence of sphere on sphere, and the action of sphere on bodies or masses; *currents of the second aura* being the acting instrumentality involved, and spheres, or a halitus, of metallic corpuscles being the intermediate substance involved,—intermediating, that is, between the plane of substance of the relatively intangible active aura and that of the inert material masses.

This, however, will be treated of in detail in a later chapter dealing with the cosmic place, relations and uses of the second aura, considered both as a substance and as an active force.

LILLIAN BEEKMAN.

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THE VALUE OF SWEDENBORG'S SCIENCE AND PHILOSOPHY: ILLUSTRATED BY A COMPARISON OF HIS THEORIES OF LIGHT AND COLORS WITH THOSE OF NEWTON.*

THE past year is a memorable one, in that it has witnessed the demonstration of the proposition that the scientific and philosophical works written by Swedenborg before his illumination are in substantial agreement with the science and philosophy used in the Writings of the New Church as the natural vessels to contain spiritual and celestial truths. This being granted, it follows that the study and proper understanding of Swedenborg's science and philosophy are of very great importance, for in the degree that the vessels receptive of influx are perfect, in that degree will the influx be received.

The initial conception of Swedenborg's philosophy and the one which reigns throughout it, is that nature is similar to herself in greatests and leasts, that in the leasts of nature, which are its interiors, there is the greatest perfection, universal laws are most completely operative, and therefore to understand the form and attributes of these leasts is to possess the key which will unlock all of nature's secrets. To determine the form, motion, and relation of the beginnings or *principia* of natural things was the aim of Swedenborg, the Scientist and Philosopher, from the beginning of his studies. In his letters to his kinsman, Eric Benzelius, he several times mentions his investigations on the hidden nature of water, air, and fire, which he determined to thoroughly investigate. The result of his investigations was the bullular hypothesis contained in his earlier works, which was further developed in the *Lesser Principia* and received its final form in the *Principia*. On the basis of experimental chemistry and physics Swedenborg reasoned that tangible matter is highly compounded of prior natural forms in

*Read at the meeting of the Swedenborg Scientific Association in New York City, May 28th, 1901.

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successive progression, increasing in complexity and celerity of motion and diminishing in size from tangible matter to the first natural point where is total motion. From 1717 to 1734 Swedenborg was engaged in these studies of the hidden motion and geometry of the interiors of nature, in determining the physics of the molecule and the atom and of degrees beyond them. This accomplished, he applied his laws to the human body and constructed his wonderful physiology; because he understood the *macrocosm* he could understand and explain the *microcosm*. He continually sought for the soul, finding traces of her everywhere in the animal economy, seeing the wonderful mechanism of the intercourse between the soul and the body, but failing to find the soul herself until his spiritual eyes were opened.

The vanguard of modern experimental science has arrived at the borderland of the kingdom of invisibles which Swedenborg long ago explored. The work of such men as Van 'T Hoff, J. J. Thomson, Fessenden and others has resulted in the conclusion that the atom is divisible and highly complex in its constitution, and the properties of the ether are becoming so varied and numerous that the day cannot be far removed when Swedenborg's magnetic element must be rediscovered. On all hands the truth of Swedenborg's Cosmology is being confirmed by the best experimental results, and his geometrical chemistry, as contained in the *Principles of Chemistry,* has lately been recognized by the great authority on stereochemistry as the original presentation of the modern hypothesis of the arrangement of molecules and atoms.[1]

In view of all this, how valuable should be an examination of the whole of Swedenborg's philosophy. Such fundamentally correct conceptions must surely involve others equally important; indeed, it may safely be said that only the surface of the mine of Swedenborg's philosophy has been touched, and that within will be found ores and precious stones of undreamt-of value. An example of this will probably be found in Swedenborg's theories

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[1] In the Introduction to his *Arrangement of Atoms in Space* (Longmans, Green & Co., 1898), J. H. Van 'T Hoff says that Eiloart, "in his *Guide to Stereochemistry*, goes back to Swedenborg's *Prodromus Principiorum Rerum Naturalium sive Novorum Tentaminum Chymicam et Physicam Experimentalem geometrice explicandi.*"

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of light and colors, which will now be considered and some comparisons instituted with those of Newton.

Both the present state of investigation and the shortness of time will prevent a complete presentation of the subject before us on the present occasion. It will only be possible to bring together and contrast some of the evidence at hand and point out the path which must ultimately lead to the solution of the complex problems confronting the student of light and color.

Goethe has well said:[2] "From time immemorial it has been dangerous to treat of colour, so much so, that one of our predecessors ventured on a certain occasion to say, 'The ox becomes furious if a red cloth is shown to him; but the philosopher, who speaks of colour only in a general way, begins to rave.'" Since ancient times the phenomena of light and colors have received the attention of philosophers and many are the theories of their causes which have been presented. Pythagoras taught that vision was caused by particles continually projected from the surfaces of objects into the eye, while Empedocles and Plato ascribed the excitation of the sense of sight both to emanations proceeding from the object seen and also from the eye itself. Aristotle opposed the doctrine of visual rays and emission theories in general, maintaining that light is not a material emission in any sense but an action of a pellucid medium, thus anticipating in a general way some of the best results of modern times. Epicurus, Lucretius, and others had a confused notion that the eye sees bodies at a distance in a similar way that we feel them by means of a rod, and this strange idea was accepted for many centuries until the Arabian astronomer Alhazen showed in the eleventh century A. D. that the cause of vision proceeds from the object and not from the eye.

The ancients were acquainted with some of the fundamental laws of optics, among which may be mentioned these: that light travels in straight lines, that the angle of incidence is equal to the angle of reflection, that water and air refract light, and that transparent balls of glass or crystal, or glass globes filled with water, may be used as burning glasses.

[2] *Zur Farbenlehre*, 2 vols., Tubingen, 1810. There is a later edition and a translation of the first volume by Charles Lock Eastlake, R. A., F. R. S., London, 1840, entitled *Goethe's Theory of Colours*.

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Alhazen made great progress in the explanation of reflection and refraction, and also entered into anatomical examination of the eye. Vitellio, a native of Poland, still further extended the knowledge of refraction and reflection, drawing up some improved tables concerning them. That universal genius, Roger Bacon, if we are to accept certain statements in his works as authentic, appears to have discovered the underlying principles of both the telescope and the microscope, and to him has also been attributed the invention of the magic lantern. The first telescope, however, was constructed by a Dutchman named Jansen, whose children while playing in their father's workshop accidentally placed a convex and a concave spectacle glass at a short distance from each other and noticed the apparent increase in magnitude of what they saw through the glasses. They drew their father's attention to the phenomenon, and he fixed such glasses in a tube and sold the instrument. Galileo, having heard of the instrument, made one himself, and with it discovered a satellite of Jupiter. Great progress was now made in the study of light and colors. Kepler, Porta, de Dominis, Snellius, Descartes and Grimaldi both enlarged the field of discovery and corrected previous results, preparing the way for Newton, who in 1704 published his *Opticks*, containing experiments of the utmost importance and presenting his theory of light and colors, which, although rejected as to part, is still accepted by the scientific world.[3]

Newton's theory briefly stated is as follows: Light consists of material particles or luminous corpuscles sent forth from a luminous body in straight lines which by their mechanical action on the retina produce sight. He says:[4]

"Are not the Rays of light very Small Bodies emitted from Shining Substances? For such Bodies will pass through uniform Mediums in right Lines without bending into the Shadow, which is the Nature of the Rays of Light. They will also be capable of Several Properties and be able to conserve their Properties in passing through several Mediums, which is another Condition of the Rays of Light."

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[3] For a condensed history of theory and experiment on light and colors see Preston's *Theory of Light*, Macmillan & Co., 1890, of which the present account is for the most part an abridgment. For original documents see Goethe, *Op. Cit.*, Vol. II.

[4] *Opticks*, Bk. III. Qu. 29.

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He also attributes the heat of substances to the agitation of their parts caused by the action of the rays.

This is therefore an "emission" or "corpuscular" theory, somewhat similar to those combated ages before by Aristotle. Newton was well aware of the "undulatory" theory, or that which considers light to be due to the periodic motion of a medium between the luminous source and the retina, but he thought that a ray of light could travel only longitudinally in a manner analogous to sound vibrations, and therefore, as Preston well says, he "fell back upon the emission theory, and developed it with a genius more than mortal." [5] Newton's theory of color is as follows:

Every color is simply a kind of light, thus when a ray of white light from the sun is passed through a prism the various kinds of light composing the ray are separated from each other, and when one of these kinds of light is again passed through a prism it remains unaltered as to color. He thus taught that there were seven different fundamental lights, violet, indigo, blue, green, yellow, orange, red, the mixture of which produced white light, and he considered this proved by collecting all the refractions of his spectrum by means of a lens and again producing white light. Newton not only thought that sunlight was composed of several different kinds of light, but in the first sentence of his *Opticks* emphasizes his opposition to all such theories as those held by Swedenborg in the following language:

"The Phenomena of Colours in refracted or reflected Light are not caused by new Modifications of the Light variously impress'd, according to the various Terminations of the Light and Shadow." [6]

Newton's corpuscular theory of light was opposed by Robert Hooke, and even long before Descartes, Leonardo da Vinci, Galileo and Grimaldi had written in favor of the idea that light is an instantaneous pressure of an elastic medium or a vibratile movement thereof. But the undulatory theory was first definitely stated by Huygens in 1678, and after remaining lifeless for almost a century was revived by Dr. Young, the discoverer of the principle of interference. It was still further strengthened

[5] *Op. Cit.*, p. 21.

[6] Book I, Prop. I, Theor. I.

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by Fresnel, who introduced the idea of transverse vibrations guessed at by Hooke in 1672. The undulatory theory teaches that the propagation of light is due to the periodic wave motion of a postulated medium called the ether, that there are millions of kinds of waves differing in length, that only a short range of these rays may be perceived in the spectrum from violet to red, and that above the violet are many waves decreasing in length and noticeable in fluorescence and chemical action, while below the red are many waves increasing in length and noticeable on account of thermal action or calorescence.

It should be noted that Newton also postulated an ether in which his luminous corpuscles travelled, and in which they were capable of exciting undulations.

"He also attempted to account for gravitation in an ether, but he published little of his theory 'because he was not able from experiment and observation to give a satisfactory account of the medium and the manner of its operation in producing the chief phenomena of natures.'" [7]

The student of Swedenborg's Cosmology may be interested in the following note, quoted from the same work, pp. 25-26: "To Descartes the bare existence of bodies apparently at a distance was proof of the existence of a continuous medium between them, for he regarded extension as the sole essential property of matter, and matter a necessary condition of extension. 'Ethers were invented for the planets to swim in, to constitute electric atmospheres and magnetic effluvia, to convey sensations from one part of our body to another, till all space was filled several times over with ethers' (J. C. Maxwell)."

Swedenborg's theories of light and colors are radically different from those of Newton. The whole scheme of his bullular hypothesis would effectually prevent the formation of any theory involving the shooting of corpuscles from the sun to the earth and thus into the eye and impinging on the retina, for, according to him, all space is filled with degrees of matter and natural substances, differing in degree of density of composition and inertia. From the very beginning he taught that light was produced by the undulatory motion of an elastic ether, and that colors are produced by the modification of this motion in the material objects receiving it. This theory he developed and modified, writing a great deal about it. Many of his most important statements have never appeared in print or been translated. He was a reader of Newton's *Opticks*, made references

[7] Preston, *Op. Cit.*, p. 26.

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to that work, and reproduced some of the diagrams. It does not appear that the undulatory theory of light, taught by him and as differing from all emission theories, was original with him, but that he received the fundamental ideas from outside sources and then applied his wonderful genius to develop them. It will not be feasible at the present time to analytically examine this development, but only to present the theory as fully formed in the *Principia* and the *Economy of the Animal Kingdom.*

Of the ether and the production of light he says: [8]

"Motion diffused from a given centre through a contiguous medium or volume of particles of ether produces light; for in consequence of this motion the ether is reflected from every entity it meets, and thus an idea of the object is presented to the eye. The central motion of the particles of the ether causes not only a rigid expansion of every particle, but also heat; and if this motion be urged from the centre to the circumferences, it causes light together with heat. If, however, it be urged from centres toward circumferences so as to become a local motion, but without the central circumvolution of every particle, it occasions light in a cold state [phosphoric light and electricity]. There are corpuscles which resemble a species of effluvia which are so small as to be enabled to move only a volume of ether, but not a volume of air; and these, if spontaneously moved, excite light to a certain distance. If they are not spontaneously moved, but are put in motion by means of the tremulation of the parts in any hard body in which they reside, in this case also light is excited, and in like manner electricity, so long as the tremulation continues."

Here and in other places Swedenborg teaches that light may be produced in a variety of ways and the light from the sun and fixed stars he teaches is propagated to the earth by the first element; then by the second element, and thus by motion in the ether, or third element, light is communicated to the eye, which is the organ of the ether.

Of the production of color he says: [9]

"Color, then, as we learn from phenomena, is a certain discrimination of light and shade, and a certain determinate ratio and analogy thence arising in those extremely minute objects which do not come distinctly within the visual perception. For in objects of this kind, the eye cannot discern between luminous and shady rays; wherefore it apprehends only the general image of the discriminations and differences, as represented under the beautiful appearance of colors. White and black are two opposites, as light and shade, the modifications of which are the intermediate colors. This is confirmed by the transmission of the solar beam through spheres of glass, bubbles and watery vapors; also, by its inflections and resilience; percussions by prisms placed in different posi-

[8] *Principia*, III, V, 21.

[9] *Economy of the Animal Kingdom*, n. 86.

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tions; by the appearance of colors in spaces where the shade perceptibly begins to discriminate itself from light; by various chemical mixtures and precipitations: by the beautifully colored objects of the vegetable kingdom in general; and by numberless other phenomena. From all which particulars severally illustrated, it may be clearly shown, that in color there is nothing which is real, but that it is solely an illumination which is produced by the sun, by candle-light, fire-light, and so forth, variegated according to the various constitution of the bodies interposed, particularly such as are transparent. With an attention to these principles, and after an ardent pursuit of this class of optical experiments, I have seemed to myself to have attained to the ratios of shades and lights by which single colors might be respectively designated, and in some manner also to the forms of the parts trajected by the beams."

A comparison, then, of Swedenborg's and Newton's theories of light and colors shows that they are opposite to each other in general and in particular, because in each case there was a fundamentally different view of the motion and constitution of matter. Newton teaches that light is produced by the projection of luminous corpuscles in straight lines and colors by the separation of the several colored lights, which compose white light, while Swedenborg teaches that light is not a matter in any sense but the motion of an elastic ether or ethers, and that colors are produced by the modification of light in material objects, according to the composition of their constituent parts and the arrangement of those parts.

Now, the theological writings teach the same doctrine, and, moreover, describe Newton's experiences in the spiritual world and the retraction of the theories on light and colors which he held while on earth.

The Writings teach that the spiritual sun communicates its heat and light, the Divine Love and Wisdom, to the inhabitants of the spiritual world by means of spiritual atmospheres, and that there is a correspondence between the natural sun, natural heat and light and natural atmospheres, and the spiritual sun, heat and light and the spiritual atmospheres. Indeed, this correspondence is often mentioned and most wonderful things taught concerning it.

Compare, for instance, the following quotation from the *Apocalypse Explained*, n. 726, ii, with the quotation made above from the *Principia*, iii, v, 21:

"Divine Truth regarded in itself is Divine Wisdom, which extends itself everywhere, like the heat and light from the sun in our world;

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for in the spiritual world, where angels and spirits are, the Lord appears as a Sun, from Divine Love; all that proceeds from that sun is called Divine Truth; and that which proceeds, produces; also, that which proceeds is Himself, because from [*ex*] Himself; wherefore the Lord in the heavens is Divine Truth. But that it may be known that the Lord has infinite power by [per] Divine Truth, something will be said concerning its essence and existence. This cannot be comprehended by the natural man from his light except by such things as proceed from the sun of the world, from which and by which it has all power in its world and the earths that are under its heat and light. From the sun of the world there went forth auras and atmospheres, which are called ethers and airs; whence nearest about it is the pure ether, and more remote from it ethers less pure, and finally airs, but the former and latter are around the earths. These ethers and airs when actuated as to volume [*volumatim*] produce heat, but when actuated as to least parts [*singillatim*] produce light. By these that sun exercises all its power and produces all its effect outside itself, thus through [*per*] ethers and airs by means of heat and at the same time by means of light. From these things some idea can be formed of the Lord's infinite power by Divine Truth. From Him as a Sun auras and atmospheres have likewise emanated, but spiritual ones, because from the Divine Love which makes that Sun. That there are such atmospheres in the spiritual world, may be manifest from the respiration of angels and spirits. Those spiritual auras and atmospheres that are nearest to the Lord as a Sun are most pure; but according to the degrees in which they are removed they are less and less pure. Therefore, there are three heavens, an inmost heaven in a purer aura, a middle heaven in an aura less pure, and an ultimate heaven in an aura still less pure. Those auras or atmospheres, which are spiritual because they haxe existed [*extiterunt*] from the Lord as a Sun, when actuated generally [*communiter*] exhibit heat, and when modified [*modificatæ*] as to least parts [*singillatim*] exhibit light. That heat which in its essence is love, and that light which in its essence is wisdom, are called specifically Divine Truth, and together with the auras, which are also spiritual, they are called the Divine proceeding. And from these the heavens were created, and also the worlds; for all things which exist in the natural world are produced from the spiritual world, as effects from their efficient causes. From these things the creation of heaven and earth by Divine Truth proceeding from the Lord as a Sun, which is above the angelic heavens, may be seen as in a natural mirror; and it can also in some degree be comprehended that the Lord has infinite power by the Divine proceeding, which in general is called Divine Truth."

It is also taught that there are colors in the spiritual world much more beautiful than those on earth; that there are colors there which do not appear on earth; that colors are produced by the modifications of intelligence and wisdom from the Lord with the angels, besides minute teachings of the correspondence of the various colors and confirmations in particular instances of the theories of light and color held by Swedenborg before his spiritual eyes were opened.

Swedenborg met Newton in the spiritual world, where he

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lived among the learned in the spiritual London.[10] Swedenborg says of Newton:[11]

"I have sometimes spoken with him; he is a very sincere man, and is among his own, and is loved. He said to me that he now knows that the Lord is the Sun of the angelic heaven, and that from Him is all light, which in its essence is the divine intelligence which gives intelligence to the angels and also to men, although men do not know that that light enlightens the understanding and causes it to think intelligently. He knew also that there is one life, which causes anyone to live, and that that life appears with them as light, and that thence is life and that it inflows into the inmosts of man and causes that this appear to man as of himself; he also said that there appear colors there much brighter than in the world and of a much greater variety, and that the colors there arise from the modification of divine light in the forms receptible of life in angels and in men and that thence are varieties of understanding.—He thus spoke concerning the planes of colors, that they were three, white from light, red from fire, and black from [shade], and that the varieties of all colors arise thence."

Elsewhere it is said that Newton shuddered at the idea of a vacuum, which he had held while in the world, having been taught the truth by the angels.[12] In the same connection[13] is given an account of his own description of his doctrine of light and colors as contained in his *Opticks* and his retraction of that doctrine. There now follows a complete translation of this important document:

"Concerning *colors*, he said, that in the world he had believed them to originate from substances, as it were variously colored matters, continually flowing forth from the solar Ocean, and constantly adding themselves to [their] similars in objects in the world; likewise when they pass through transparent things, following then the ways of light, according to its infractions and refractions, and proceeding as it were analogon to analogon, thus red to red, blue to blue, yellow to yellow, and so on, as in prisms, crystalline globes, vapors, whence are rainbows.

"But the Angels did not acknowledge this cause of colors, saying that there are colors in the spiritual world equally as in the natural world, and that they are more vivid, bright and variegated than in the natural world, and that they know that they are variegations of their light, corresponding to their love or good, and to their wisdom or truth, and that the sun from which their light proceeds is the Lord Himself, whose Divine love presents the appearance of a sun about Himself, and the Divine wisdom thence an appearance of light, and that from that sun, which, as was said, is pure love, such substances or matters do not flow forth, but that that pure light presents variegations of colors in objects

[10] *Last Judgment* (Post.), n. 273.

[11] *Spiritual Diary*, n. 6064.

[12] *Divine Love and Wisdom*, n. 82. *Last Judgment* (Post.), 266, (pp. 85, 86).

[13] *Last Judgment* (Post.), n. 267 (pp. 86, 87).

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according to the reception of wisdom by the angels, a red color in the degree that their wisdom derives from good, and a white [*candidum*] color in the degree that their wisdom derives from truth and the rest of the colors as they partake of their defect and absence, which there correspond to shade in the world.

"Moreover the angels by their spiritual ideas, by means of which they are able to tell and make known to full consent the causes of things, demonstrated that colors are nothing but variegations of flamy and of white light in objects according to their forms and that colors are not material, as neither light, because they correspond to the love and wisdom of Angels, from which they proceed by the Divine operation, and their love and wisdom are not material, but spiritual. Neither in the world are heat and light material, but natural, and they inflow into matters and modify themselves in them according to the forms of the parts, wherefore neither are colors material, as they would be if they existed from variously colored atoms.

"At last from some indignation they said, who does not see the paradox in the Newtonian cause, yea the incongruity? and they departed saying that they would return if he would think spiritually, or even naturally, concerning colors, and not so materially and sensually.

"Some spirits then approached and said to him, 'Think, we pray you, concerning colors, not from any little prism, or from some wall, but from the green color of all the forests and grassy plains of the whole earth in which you were. Can you conceive of a continual efflux of the color green alone from the sun, and at the same time an influx, and a continual renewal, also of a continual influx of gray or stony color into the mountains of the whole earth, and so on? Would you not, then, conceive of a continual ocean of green and stony colors alone? Tell whither they go, where they subsist, whether they proceed into the universe, or whether they somewhere fall downwards or ascend upwards? From them perhaps new earths exist, for that would be possible from such abundance [of colors], because they are material.'

"After he had thought concerning that subject more deeply, he said, 'Now I know that colors are the modification of light in objects, in the forms of which they make general planes, upon which light is variegated according to the forms of the parts, whence are colors.'

"These are Newton's own words, which he wishes that I should communicate."

So reads Newton's last statement of his theory of light and colors. What now is the position of modern science on these important questions? Long after Newton's death his theory of light and colors was received and supported by such men as La Place, but slowly the old ideas of motions and undulations in an ether revived, and after a long and bitter contest triumphed. Newton's theory accounted for a great number of the facts, but received its deathblow when the phenomena of polarization, interference and the rate of light transmission in rarer and denser mediums began to be grasped in all their significance. The emission theory of light was utterly rejected, and the undulatory theory universally received. Newton's theory, however, was

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not rejected, as a whole, for his idea of several primitive colored lights composing white light was retained [14] and much extended, so that it is taught at the present day that there are millions of waves differing in length, of which only those within a short range are perceived by the eye.

How much truth is there in this theory? and does it allow of such explanation or modification as to bring it into agreement with that taught by Swedenborg? Now, scientific facts and observations carefully made must point out the truth and confirm it, and if a theory be true, as Swedenborg so often says, all the facts of experience will hasten to confirm it. The history of science, however, furnishes numerous examples of the misinterpretation of the most carefully made experiments when a theory strongly intrenched and long received blinds philosophers and prejudices the experimenters themselves. The history of the phlogistic hypothesis and of emission theories of light are cases in point. But the day comes sooner or later when an erroneous theory must give way before a new interpretation of observations or the discovery of new facts which point conclusively in another direction. Now, the modern theory certainly does not seem to be in agreement with that taught by Swedenborg in his philosophical works, or in the Writings of the New Church. In order that the subject may be clarified and the present state of affairs more sharply defined let two cases be supposed:

First, a scientist in Newton's time, on seeing a beam of light passing through a prism or prisms, might conclude on beholding the spectrum either that there were several different kinds of light or that in some way the light passing through the prism had been so affected as to produce several modifications

[14] Goethe, whose *Theory of Colours* was quoted above, was a firm opponent of Newton's theory of light and colors from his youth to old age, as may be seen from the references under Color in Eckermann's *Conversations of Goethe.* The following quotations from his *Theory of Colours,* pp. xvii and xxviii, are interesting to the student of Swedenborg's theory: "The Colours are acts of light; its active and passive modifications." "Newton based his hypothesis on a phenomenon exhibited in a complicated and secondary state * * * the eye sees no form, inasmuch as light, shade, and colour together constitute that which to our vision distinguishes." Goethe's theory is worthy of a careful examination.

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of white light variously colored. Why should he at all conclude that there are various kinds of light in the beam prior to its transmission through the spectrum? Why should he *not* conclude that the form and arrangement of the parts composing the prism so refracted the light as to produce the spectrum?

Second, a scientist of the present day acquainted with both Newton's facts and those discovered since his time, but who had never heard of the wave-length color theory, might easily come to the conclusion that when a beam of light is received by material substances, it is in some manner modified and colors produced. Why should he conclude that there are different kinds of light composing white light or that there are waves of different lengths before there has been contact with matter?

Now, it is a notable fact that whenever colors are seen their production has in some way been associated with matter in some form or other, and experience shows that colors vary when forces are at work changing the chemical constitution and molecular arrangement of the matter associated in the production of the colors. The same statement holds in the refraction and reflection of light. A few of the many experiments and arguments which point to the conclusion that white light is not composed of many kinds of colored lights and that colors are produced by the modification in matter of a homogeneous radiation will now be given.

Studies in molecular and atomic constitution, and especially the results thus far attained in the science of crystallography, throw a great light on these questions. Mendeléeff says:

"Thus in the building up of similar molecules in crystalline forms we see one of the numerous means for judging of the internal world of molecules and atoms, and one of the weapons for conquests in the invisible world of molecular mechanics which forms the main object of physico-chemical knowledge." [15]

"The crystalline form is, without doubt, the expression of the relation in which the atoms occur in the molecules, and in which the molecules occur in the mass, of a substance." [16]

Some of the most striking features of the action of crystals on light are the following: the velocity of light varies according to the chemical nature of the substance through which it is

[15] *Principles of Chemistry,* Vol. II, p. 7

[16] *Ibid.,* note 5.

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transmitted; the index of refraction also varies: there is always less light after transmission than before it; some heat is always produced depending in degree on the darkness of the medium; the index of refraction changes according to temperature. It is found that the results of spectrum analysis vary with the composition of the prism, the spectrum being longer in some cases than in others; indeed, the refractive index may often be approximately calculated from the chemical composition and conversely the chemical composition of a prism may be calculated from its spectrum. E. S. Dana says of the relation of optical properties to chemical composition that it is "only a part of the general subject of the relation between crystalline form and molecular structure on the one hand and chemical composition on the other." [17]

The relation of crystallography to solutions presents important phenomena. A double refracting crystal loses its peculiar power when dissolved, and most substances which are optically active in a crystalline state are inactive after fusion. "The refractive power of liquids is a property which, like the molecular volume, is in general additive in character, although modified by constitutional influences." [18] The refractive index varies when the atoms or molecules of a substance are in a solid, liquid, or gaseous state. There are also cases of abnormal dispersion where certain substances in solution, when employed as refracting and dispersing agents, do not conform to the usual order of an increase in the index of refraction from the red to the blue of the spectrum, but exhibit the inverse relationship between refractive index and dispersion.

The subject of salts in solution is an extremely interesting one. It has been found that the refractive power of salt solutions is distinctively an additive property of the constituents, although the color of solutions in general is for the most part constitutive. There are several considerations leading to the conclusion that the ions of a salt in solution exist independently one of the other, so that we are justified in saying that "the

[17] *Text-Book of Mineralogy*, John Wiley & Sons, 1900, p. 226.

[18] *Introduction to Physical Chemistry*, by James Walker, Macmillan & Co., 1901, p. 144.

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colours of salt—solutions are essentially the colours of the parts of molecules, or ions, contained therein, and all salt—solutions which contain a certain ion must exhibit the characteristic colour of that ion. Should the expected colour not appear, we may conclude that the corresponding ion is absent." [19] Solutions of cobalt salts are red, as are also the sulphate, nitrate, and chloride, for the color is independent of the negative ions. When one of these solutions is boiled with an excess of potassium cyanide, it is *decolorized* because the free cobalt ions have entered into the composition of new ions. A nickel salt in solution is green, but the color is changed to yellow when, under the above conditions, the nickel ions enter into a new combination.

An analogous result is obtained by the discharge of electricity through gases.

"Thus, if we take a discharge tube, made of a piece of thermometer tubing of fine bore, with two small bulbs at the ends for the electrodes, and fill this with hydrochloric acid gas at a low pressure, the discharge is at first of a uniform greenish gray. However, after it has passed for some time, the colour changes, becoming green in the neighborhood of the positive terminal and red in the negative. Now, when a discharge passes through chlorine, its colour is green; while, when it passes through hydrogen, it is red. Thus the experiment shows that when the discharge passed through hydrochloric acid gas the chlorine accumulates at the positive terminal, the hydrogen at the negative." [20]

The change in the colors of substances, phosphorescing when a trace of another substance is added is very great. There are changes from faint orange to bright green, from white to intense red, from faint blue to intense green.[21]

Another suggestive field is to be found in the optical activity of liquids in reference to polarized rays of light, some turning the plane of polarization to the right (dextroratatory); others to the left (lævorotatory).

"All liquids when placed between the poles of a magnet or in the core of an electro-magnet become optically active. The character of the magnetic optical activity, however, is essentially different from that exhibited by liquids which are naturally active. If we place a tube containing a naturally active liquid between the prisms of a polarizing ap-

[19] *Solutions*, W. Ostwald, Longmans, Green & Co., 1891, p. 269.

[20] *The Discharge of Electricity Through Gases*, by J. J. Thomson; Scribner's, 1898, p. 133.

[21] *Ibid.*, pp. 142-3.

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paratus, and so adjust the prisms that no light passes through the system when we place a light-source at one end and the eye at the other; and if we then reverse the positions of the light-source and the eye, we find that the passage of the light is still obstructed. The sense and magnitude of the activity, then, are independent of the direction of the light. A naturally inactive liquid in a magnetic field behaves quite differently. If we first adjust the prisms so that no light passes, and then reverse the positions of eye and light-source, we find that light now traverses the system quite freely. We find, in fact, on readjusting the prisms to darkness, that a substance which appeared originally, dextroratatory is now to an equal extent lævoratatory." [22]

The evidence thus far advanced does not show positively that the waves are the result of the action of matter on a homogeneous radiation of light, but it does show that the production of color is altogether dependent upon the reception of the light in matter, and that the wave theory is founded on evidence which varies according to temperature and composition. A positive objection, however, is to be found in the fact that the supporters of the wave theory are driven to the conclusion that millions of kinds of waves, differing in length and rapidity of vibration, travel through thousands of miles with exactly the same speed. If this were not true, then the satellites of Jupiter, for instance, when they first appear, after having been eclipsed, should appear colored; indeed, Lord Kelvin speaks of the "old idea that the colour of a star may be influenced by its motion relatively to the eye of the spectator;" [23] red, if toward the earth; blue, if away from it, as being an explanation which modern spectroscopists have advanced as a possible method of determining the velocity of such stars.

This much may be said with assurance. The manner of the propagation of light, the causes of the production of color, and, indeed, the related subjects of the nature of electricity, of magnetism, the electro-magnetic theory of light, phosphorescence, heat, fire, and many others will depend for their solution upon a comprehension of the laws of motion of the molecule and atom and of the degrees which compose them. The student of Swedenborg's system finds that these are the very things which the prince of philosophers spent the greater part of his early

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[22] Walker, *Op. Cit.*, p. 147.

[23] *Popular Lectures and Addresses*, Macmillan & Co., 1894, Vol. II, p. 184.

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life in investigating, and he may confidently hope for a solution of all these problems by a careful study of the universal laws of the geometry and motion of the leasts of nature as presented in Swedenborg's Cosmology. ALFRED H. STROH.

NOTE AND COMMENT.

A PLEA FOR AN IMPORTANT WORK.

IT is obviously most important to bring to the confirmation and illustration of Swedenborg's First Principles of Nature, the mass of experimental data furnished by modern science. As Swedenborg himself says: "We do not learn from bare exposition, but from confirmation [drawn] out of posterior things and multiple collated experience. *Gen. Org.*, n. 273.) Few of us, perhaps, have hoped to see in our lifetime all the laws, conceptions and explanations of nature as unfolded before Swedenborg's high point of vision, clothed and intelligibly expressed in terms of familiar science; yet it now looks as though that possibility were more than a hope,—it seems a probability. Of the line of work on which this forecast is based, Miss Beekman's paper in the present number, on "The Identification of Hydrogen with the 'Third Finites' of the *Principia*," is at once a substantiation and an enjoyable foretaste. In the same series, we are given to understand, is to come studies on Oxygen, in the macrocosm and in the microcosm, treating of ozone and of the chemical and physiological aspects of the gas; What Gases are, according to Swedenborg; the Law of Gases and Solutions; Forces concerned in the first formation of Water from the Aerial Elementary; The Halogen Salts; and, The *Principia* and the Periodic System. The scientist will easily grasp the import and sweep of this program, while even for the general reader there is contained in Miss Beekman's introductory and general presentation—to which she affixes the substantiating basis and data for her deductions—much of interest and instruction.

But this rich pasturage cannot be made available to the reading public without the raising of necessary funds. Even the present paper has required for its publication the aid of private subscription; for the ordinary size of the *New Philosophy* would not have sufficed. Therefore the Business Manager cordially invites subscriptions to a special fund by which these important papers of Miss Beekman may be issued in this magazine without encroaching unduly on the other departments, and afterward be brought out in book form, by reprinting from the type set aside for the purpose. Prompt response is very desirable.

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PROBLEMS FROM KANT'S METAPHYSICS.

The following is from a private letter from an esteemed friend, Mr. Marston Niles, addressed to one of our editors, with a view to obtaining some light from the standpoint of Swedenborg's philosophy.

With the writer's permission we issue it here, hoping it may call forth a reply satisfactory to both the writer of the letter and to others interested in Kant and his relation to Swedenborg.

Kant says in his Metaphysical Foundations:—

A. "Matter fills a space, not by its mere existence, but by a special moving force."

B. "Matter, by its repulsive force alone (which contains the ground of its impenetrability) * * if no other opposing force contradicted this, would * * dissipate itself to infinity, and no assignable quantity of matter would be met within any assignable space."

"With merely repulsive forces of matter, all spaces would consequently be empty; in other words, no matter would properly exist at all."

C. "To the existence of all matters, forces opposed to the extending (forces), in other words, compressive forces, are requisite. * * * An attractive force must be assumed. * * * This attractive force belongs to the possibility of a matter (i. e., makes matter possible) as matter generally; consequently precedes all distinctions of the same; it must be ascribed * * * to every matter, generally and originally; * * an original attraction then belongs to all matter as a fundamental force pertaining to its essence."

Thus he makes matter to consist of an equilibrium between two opposite moving forces, one (A), that of expansion or repulsion; the other (B), that of attraction.

Now, what I cannot understand is, how any one can attribute (seriously) the existence of a thing either to its motion, or to its lack of motion, resulting from two mutually-checking motions.

It has never been known that motion or its lack increases or diminishes mass.

Before a thing can move, or can be at rest, it must Be. Once in being, it may be moved, and may be brought to rest.

Again (B) how can it be said that in the lack of an attractive force to counteract the mutually-repulsive forces, the ensuing unlimited expansion would bring about annihilation of the matter?

The effect of expansion is to separate more and more widely the various parts of a matter. But their separation no more invalidates their separate existence than their compression strengthens or increases it. Kant himself says, "Matter is divisible to infinity into parts, of which each one again is matter. (Met. Found. of Dynamics, Prop. 4.) If, then, matter is divisible to infinity (as every rational man must, I think, perceive by instinct, if he has not confused his mind with terminology),

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an ever growing distance between the ever multiplying parts can have no effect of annihilation upon any part. Attraction brings them together, if exercised, but *Be* they must, before they can together be brought. Here, Time and Space, which Kant thought he had wrestled down, seem to have crushed him between them. What effect can more remoteness have upon parts, as objects taken singly? None; but its effect is solely upon their *relations*. Their relations, however, are essential only *to the composite which they make up;* and they themselves must Be before they can be related. Abstract all Space: think of the parts themselves, of the *real things* and not of their Distances; and it may then be seen that neither expansion nor compression of any composite can affect the validity of any of its simples, although one or the other may destroy a *composite*.

It might perhaps be answered that Kant by "matter" here meant the phenomenal or visible alone, *qua* phenomenal. On the contrary, he says, "All its (Matter's) parts are substance, in so far as one can say of them that they are subjects, and not merely predicates, of other matters." "The conception of a substance signifies the ultimate *subject of existence*, namely, that which does not itself belong, as mere predicate, to the existence of another." (Metaph. Found. of Dyn. Exp. V, Obs.)

On these and several accounts, Kant thus far (which is but a little way) appears to me sheerly irrational, and seems to think by words merely, and not by *pictures of things*. Thus far I do not see any of the resemblance to Swedenborg which many have thought (or which Kant thought many had thought) him to show. Kant's method of investigation certainly is quite the reverse of Swedenborg's. Kant recognizes no connection between the visible *Existere* and the invisible *Esse;* for this reason (as I suppose), it must be that he does not trust the *Existere* as a true tale respecting the *Esse*, and seeks to set up an Esse of his own.

Swedenborg, on the contrary, enters in by the gate, even by the five porches of the temple; acknowledges that if we do not accept the things we have seen, there is no way to be brought to believe the things unseen. He humbles himself and is exalted; like a tower from foundation to pinnacle; he takes the lowest seat at the feast, and is invited up friendly. The other exalts himself and is abased, and (so far as I can see in this little book) takes ultimately (though without shame) the lowest room.

Must not any Metaphysics which is other than Physics turned into correspondences rot by its own decompositional forces? What other bridge between the two than Analogy?

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