

XXXIII. A suggestion in regard to crystallization, on the hypothesis that molecules are not infinitely hard

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XXXIII. *A Suggestion in regard to Crystallization, on the Hypothesis that Molecules are not infinitely Hard.* By S. TOLVER PRESTON*.

IN what follows, it is assumed (1) that molecules are *elastic*. This is not contradicted by any evidence, and is powerfully supported by spectroscopic observations. (2) It is assumed that molecules possess an *open* structure. This inference is equally not opposed to any observed facts, and is indeed strongly upheld by many. (3) The basis of the constitution of the æther, developed by the present writer in the *Philosophical Magazine* (Sept. and Nov. 1877, and Feb. 1878) is taken as a groundwork. Briefly stated, according to this the æther is to be regarded as a gas whose atoms are so small that their mean length of path is far greater than any planetary distances, the atoms automatically adjusting their motions (according to principles investigated in connexion with the kinetic theory of gases) so as to be capable of producing gravity under the sheltering principle of Le Sage.

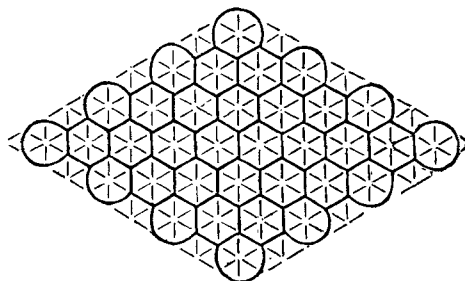
Since the elementary *ring*† is evidently the *simplest* form of open structure for a molecule, this form is taken (in the cases to be considered). The rings (relatively very large) constituting the molecules of gross matter are, accordingly, to be regarded as pervaded through and through (in their open structure) by streams of minute æther atoms, which automatically and inevitably adjust their motions so as to move equally in all directions. If we conceive (for the purpose of illustration) a number of rings [molecules] to lie in one plane with their peripheries touching, or very close, then, owing to their adjacent parts being now sheltered from the streams of æther atoms, which impinge with full energy elsewhere, the peripheries of the rings will be impelled towards each other (according to Le Sage's principle). As the ring molecules are (by assumption) elastic, they will naturally bend, and the contiguous surfaces will flatten (somewhat) under the powerful impulsive action of the streams of æther atoms, which tend to bring as much as possible of the mutually sheltered peripheries

* Communicated by the Author.

† I have before had occasion to remark that the common tacit assumption of molecules being *solid throughout* involves a waste of material that violates one of the first principles of large-scale architecture, where superfluity of material is recognized to be one of the worst faults, detrimental alike to the elasticity and stability of the structure. Dynamical principles are admittedly independent of *scale*. The elasticity of molecules (demonstrated by the spectroscope) would also sufficiently indicate an *open* structure, so as to allow a relative mobility of parts consistently with inseparability.

into contact. If we suppose the impulsive influence to be powerful enough to bring (sensibly) the entire peripheries of all the rings into mutual contact, the rings bending (from their elasticity) for this purpose, then it would appear that the whole must form a system of hexagons, as the annexed diagram (fig. 1) may serve roughly to illustrate.

Fig. 1.



gram (fig. 1) may serve roughly to illustrate. For the conditions of equilibrium would not allow any thing else. It is true that squares might conceivably be formed if the bending were sufficient for that purpose (and by a somewhat different arrangement of the rows), but it must evidently in any case (from the conditions of equilibrium) be some regular or geometric figure. Might not this possibly be capable of throwing some light on the phenomena of crystallization? It appears evident that the ring molecules, under these conditions, could also form hollow solid figures of geometric shape, if the rings were to unite at their peripheries or edges in a regular manner. But it will be seen that the tendency for the rings to unite at their edges or boundaries in a regular manner is *automatic*, since at their edges alone shelter exists, the streams of æther atoms passing freely through the open parts of the rings, so that there exist virtually "lines of impulsive action" directed symmetrically from edge to edge, producing automatically a *guiding* action, or (crystalline?) "building."

If there were any foundation for these data in reality, it would follow as an *à priori* conclusion, that leaving the ring molecules to themselves in an unhampered manner (as, for example, occurs in the process of melting or solution) would be most favourable to crystalline building. Also it would appear, equally *à priori*, that if the ring molecules were artificially interfered with (as by hammering for instance) they might (especially from their elasticity) be crossed or jostled up together irregularly, and so not unite symmetrically at their

edges, but sideways (*i. e.* in all conceivable modes); so that in this case a certain amount of sliding or play of the ring molecules over each other would be possible before they finally separate (which occurs when the substance is broken into parts). On the other hand, it appears equally evident that this sliding or play would be impossible in that case where the molecules are united symmetrically at their extreme boundaries or edges, so as to build up the crystalline structure. The above inference would at least be consistent with the observed fact that non-crystalline masses (such as hammered iron, for instance) are found to allow a certain amount of play or sliding of their ultimate parts over each other, before they finally separate. Crystalline masses, on the other hand (cast iron, for example), are found to break with any attempt to alter the position of their parts. These conditions of ring molecules (capable of bending into various forms within certain limits) might also possibly throw some light on the fact that the same substance may have occasionally various crystalline forms and sometimes even no crystalline form at all. Sulphur, for instance, may be brought (as is known) into a non-crystalline (amorphous) state, when it can be stretched like india-rubber. Other examples might be given.

It appears evident that, in addition to the bending of the peripheries of the elastic rings, the transverse sections (where in contact) would also flatten somewhat under the pressure due to the streams of æther atoms, which tend energetically to cause a closer approach. Under this flattening of the contiguous surfaces the lines of contact would come to have a measurable (though small) breadth, thereby increasing the area of shelter, and consequently the energy with which the ring molecules are made to cohere. This flattening of the contiguous surfaces would also have the effect of increasing the limits of elasticity of the whole structure. When the ring molecules are gradually pulled apart, there would first naturally be a gradual recovery of the circular form of periphery and diminution of the flattening (where contact exists), the area of shelter thereby becoming less and less, until finally, when the peripheries of the ring molecules are nearly separate, their energetic natural tendency to recover their normal (circular) form would no doubt cause them to spring apart, provided the tendency to recovery of form predominated over the residual impulsive tendency to approach (produced by the streams of atoms). Might not this possibly be capable of throwing some light on the observed mutual repulsion of the parts of substances when first brought into proximity, and their (contrary) impulsion towards each other (union) when

brought into closer proximity, as, for example, india-rubber, glass, plates of metal, and numerous substances may be made to unite on their parts being pushed into sufficient nearness by an adequate pressure. Fig. 2 may serve to represent

Fig. 2.



two ring molecules, pushed into such proximity that their adjacent parts are slightly bent and flattened, but the surface of contact is not yet sufficient to afford shelter enough to satisfy the condition that the impulsive tendency of approach can predominate over the (contrary) repellent action due to elasticity of form (*i. e.* the tendency of the rings to preserve their normal circular shape). The rings accordingly bound back (repel) directly the artificial pressure is removed*. Fig. 3 may serve to

Fig. 3.



illustrate the case where the ring molecules have been previously pushed into such proximity, that the bending and flattening of the contiguous surfaces has gone far enough to increase the shelter to such an extent that the impulsive tendency to approach can predominate over the residual elasticity of form, and so the molecules are impelled closer together (the shelter increasing with the contiguity of parts). The sudden flying of some substances into fragments (such as badly annealed glass for instance), under certain conditions, where the elastic ring molecules would be in a state of strain, and perhaps nearly at the point at which they would naturally spring apart in virtue of their elasticity of form, may perhaps serve as rather a confirming illustration of this view.

The writer at least ventures to think that the points dealt with may not be without interest or unworthy of attention, on account of the simplicity of the premises, by which some degree of insight would seem to be afforded into certain interesting but obscure phenomena, and under physical conditions that could not of themselves be said to be independently improbable, and which are even supported by some inductions and observations of modern science. Any light whatever that these premises might be capable of throwing on obscure facts might then legitimately be regarded as some additional confirmation of the validity of the premises, which themselves have been inferred on independent grounds.

The conception of *elastic*† molecules (rendered necessary by

* No doubt (in addition) the vibration of the ring molecules also plays a part here, as molecules are known to become completely dissociated by excessive increase of vibrating energy (at extreme temperatures).

† The conception of molecules of *open* structure (itself probable) would be fundamentally the only other hypothesis required to suit the above conditions.

the principle of the conservation of energy and by spectroscopic observations) would seem to be a highly practical one, much needed in physics. By it all idea of the inconceivable jar of the collision of *infinitely* hard molecules (or atoms) is avoided. On account of the perfect elasticity, all motions take place with complete smoothness, so that a perfect state of mobile equilibrium is rendered possible in nature, which (without due precautions) may well be competent to deceive the senses into the idea that in what we call "space" all is in a state of rest.

London, 1880.

XXXIV. On Unitation.—X. Practical Remarks thereon, together with Examples. By W. H. WALENN, *Mem. Phys. Soc.*

[Continued from p. 123.]

40. **T**HE next algebraic forms of δ that claim attention are those comprised under the formula $U_{kn}N$, k being a fundamental base such as 9 or 11, and n a whole number as a multiplier. This set of unitates may be said to be the entry to the domain which enables unitation to furnish easily the remainders to divisors in general.

41. In dissecting the expression $U_{kn}N$, it is observable that the next less number exactly divisible by k is $N - U_kN$, and that $U_{kn}N = U_kN + km$, in which m is a function of $U_n(N - U_kN)$. Each of the multiples of k up to kn may give a separate value when unitated to the base n . Let the multiples of k be $a_1, a_2, a_3, \dots a_n$ (so that $k = a_1, 2k = a_2, 3k = a_3$, &c.); then the series $U_n(a_1, a_2, a_3, \dots a_n)$ may be 1, 2, 3, 4, $\dots n$, or it may be other values. If $U_n(a_1, a_2, a_3, \dots a_n) = 1, 2, 3, 4, \dots n$, this is the same sequence in which the multiples of k enter into $U_{kn}N$, and $m = U_n(N - U_kN)$; if $U_n(a_1, a_2, a_3, \dots a_n)$ gives other values, means must be found to reduce them to the set of values 1, 2, 3, 4, $\dots n$, if $U_{kn}N$ is to be used for obtaining the remainders to the divisor under consideration.

42. If $k = 9$, then $a_1, a_2, a_3, \dots n = 9, 18, 27, 36, \dots n$; and to test whether $U_{kn}N$ is applicable when $kn = 72$, for instance, it is necessary to obtain $U_8(9, 18, 27, 36, 45, 54, 63, 72)$. This is found to be = 1, 2, 3, 4, 5, 6, 7, 0; therefore $U_{kn}N$ is applicable in this case in a direct manner. U_{kn} is not applicable when $kn = 27$; for then $U_3(9, 18, 27) = 0, 0, 0$: this result is also evident from the simple consideration that 3 is a submultiple of 9. If $U_{kn} = 45$, $U_5(9, 18, 27, 36, 45) = 4, 3, 2, 1, 0$; this can be reduced to the required sequence 1, 2, 3, 4, 0 by taking $m = -U_5(N - U_9N)$, or obtaining the complement to

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