

SCIENCE:

A WEEKLY RECORD OF SCIENTIFIC
PROGRESS.

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PUBLISHED AT

229 BROADWAY, NEW YORK.

P. O. Box 8888.

SATURDAY, FEBRUARY 5, 1881.

ON MATTER AS A FORM OF ENERGY.

In the vortex-ring theory of matter as propounded by Sir William Thomson, the characteristic differences between the elements is supposed to be due to complications in the rings themselves, as they may be knotted in innumerable ways. Several such forms are drawn in the memoir, and one such is stamped upon the cover of "The Unseen Universe," by Tait and Stewart.

This vortex-ring theory assumes that matter is a *form of energy*, not interchangeable with the other variable forms, such as heat, electricity, etc., for the simple reason that its *form* renders it impossible, but if the elements be forms of energy, the law of energy may possibly be traced in them. Now, the energy of a given mass of matter varies as the square of its velocity, but the *properties* of the mass vary with the form of the energy, that is to say, the physical properties of a heated body are not identical with those of the same body when it is cool, but possesses the same amount of energy in free path motion. The physical properties of atoms and molecules vary with atomic and molecular velocities; for example, whether a piece of iron or steel is magnetic or not depends upon its temperature, that is, its rate of molecular vibration. It is not, therefore, *a priori* improbable that such differences as exist between the ultimate atoms constituting what we call *mass*, may be due to relative velocities of rotation of the vortex-ring. Atomic weights represent numerically these constant differences, and one might expect to find in any one of these atomic weights the two factors that constitute energy, namely a mass (or its equivalent) and a velocity; so we might write $\frac{mv^2}{2}$ = atomic weight. Applying this to a specific

case, suppose $\frac{mv^2}{2} = 75$ = atomic weight of Arsenic; by inspection it is seen that $m = 6$ and $v = 5$. If $m = 6$ and $v = 2$, then $\frac{6 \times 2^2}{2} = 12$ = At. Wt. Carbon. Let a table now be constructed $m = 6$ and v with values 2, 3, 4, and so on, and there results a series of numbers N either exactly the same as the atomic weights of some of the elements or a very close approximation to such numbers. The elements have their symbols under E with their atomic weights as given under At. Wt. for comparison.

$$\frac{mv^2}{2} = \text{ENERGY} = \text{ATOMIC WEIGHT.}$$

	N.	E.	At. Wt.		N.	E.	At. Wt.
$m=6$ -----				$m=9$ -----	18	?	---
$\frac{6 \times 2^2}{2} =$ -----	12	C.	12		40.5	Ca.?	40
					72	?	m
$\frac{6 \times 3^2}{2} =$ -----	27	Al.	27		112.5	Cd.	111.6
					162	?	---
	48	Ti.	48		220	?	---
	75	As.	75	$m=11$ -----	22	?	---
	108	Ag.	108		49.5	?	---
	147	Di.	147		88	Sr.	87.2
	192	?	---		137.5	Ce.	137
$m=7$ -----	14	N.	14		183	Ba.	136.8
	31.5	P.?	31			W.	184
	56	Fe.	56	$m=12$ -----	24	Mg.	24
	87.5	Sr.	87.2		54	Mn.	54
	126	I.	127		96	Mo.	95.8
	171.5	Er.?	170.6		125	?	---
	224	?	---	$m=13$ -----	26	?	---
$m=8$ -----	16	O.	16		58.5	Ni.	58.6
	36	Cl.?	35.5		104	Co.	58.6
	64	Cu.	63.3			Ru.	103.5
	100	?	m		162.5	Rh.	104.2
	144	?	m		234	?	---
	196	Au.	196			Th.	233.9
		Pt.	196.7				
		In.	196.7				
		Os.	198.6				

By changing the value of m to 7, 8, 9, etc., a new series of numbers is obtained and the process is carried until the resulting number is higher than any known atomic weight, namely, that of Thallium 233.9. Where the number obtained is not that of any known atomic weight an interrogation point is placed. In several cases the resulting number is the same as the ones given by Mendelejeff as those of probable elements yet to be discovered; for example, in table $m = 9$. 72 is such a number and is marked m in the line of atomic weights.

Now, here is a series of forty numbers calculated serially, and thirty-three of them are either the exact atomic weights of elements or vary less than one unit from them, and it does not seem probable that so large a proportion could be the result of chance, for the numbers range from 12 to 234. Moreover, by carrying the process still further many more of the atomic weights are obtained. Thus, with $m = 13$ we have Co. Ni. Ru. Rh. and Th.

$m = 14$, Si. Cu. Cd. and one of Mendelejeff's hypothetical ones.

$m = 15$ only Antimony, 120.

$m = 16$ S. Te. Hg.

$m = 17$ Se. Ce.

$m = 20$ Ca. Zr.

It must be remembered that with this large value for m , only three or four calculations are possible without obtaining numbers quite beyond any known atomic weights; for instance, when $m = 20$, only three calculations can be made, two of which are atomic weights.

With 66 serial computations, 49 elements are determined; 74 per cent. and more than that if Mendelejeff's hypothetical elements may be counted.

If there be any underlying truth in this theory of calculation, then the conception of the elements will be much simplified, for it will dispense at once with complexity in the atom, and substitute a common form for all, differing arithmetically from each other in size and velocity. The only conception I have of the term m corresponding to mass, is a relative volume of ether in rotation with certain velocity.

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A. E. DOLBEAR.

RECENT ADDITIONS TO THE E. M. MUSEUM AT PRINCETON COLLEGE.

HENRY F. OSBORN, S. D.

The E. M. Museum of Geology at Princeton has recently purchased Messrs. Ward & Howell's well-known collection of fossil animals and plants. Under the partial supervision of these gentlemen the collection has been unpacked and hastily arranged in the cases, and as it has never been fully displayed before, it now appears to very great advantage and possesses peculiar interest. The east wing of the museum already contains the collections made by the Princeton western parties during the summers of 1877 and '78. These include several hundred specimens of fossil insects preserved in the delicate Miocene shales of Florissant, Colorado, and leaves from the same neighborhood. The former have already passed into the hands of Dr. Scudder for identification. Still more valuable is a large collection of fossil leaves from Strata closely overlying the Lower Eocene Lignitic Beds, near Black Butte, Wy. Terr. These have been studied by Dr. Lesquereux; he pronounces them of great novelty as contributing largely to our knowledge of the extent of the Eocene Flora, and they will form the subject of a special memoir to be published by the museum.

Among the western Vertebrate collections are nearly complete skeletons of various members of the Dinocerata family, parts of which have been figured and described in bulletins from the museum. These, together with numerous specimens of *Palaeosyops* and allied genera, from the now classical beds of the Henry's Fork and Bitter Creek country, Wy. Terr., together with a great variety of carnivorous, rodent, lemurine and perhaps insectivorous forms, many of which are undescribed, give an admirable idea of the fauna inhabiting the Lower Eocene. In addition to these are many complete turtles and remains of lizards, snakes and birds. Representing the Miocene is a collection from Colorado including widely different forms. Prof. Cope, who has kindly glanced over the whole collection, pencil in hand, pronounces several of these forms new to science.

The Ward collection is, however, of much greater value

to the general student, as it includes representative specimens from almost every age and country—from the disputed *Eozoon canadense* of the Laurentian to the Post Pliocene cave bear and Irish elk. It is the result of seventeen years of intelligent travel, purchase and selections. Mr. Ward's theory being to perfect the collection by constantly substituting the best obtainable examples of each type, not aiming at a complete series for each age, but giving a synoptic view from the dawn of life upwards. In this he has succeeded, we have little doubt, far beyond his own expectations at the outset, and although his catalogues have made this collection familiar to many palæontologists in this country, it well deserves a brief description here.

The Silurian corals, crinoids and trilobites fill the first cases. The latter are very fine. Among them is the outline of an *Asaphus gigas* indicating an animal over 12 inches long. On large stone slabs are other Crustacea, *Eurypterus* and *Pterygotus*. These are the earliest of a series represented in the Jurassic by a fine collection from the Solenhofen Beds and throughout by numerous Trilobites. The Solenhofen crustacea include, among others, *Pencus*, *Glyphea*, *Eryon*, *Limulus*, *Aeger*, and a very perfect *Megachirus*, while from the English chalk are some fine fossil crabs, *Enoplocytea*, *Hoploparia*, etc.

The remains of Devonian Ganoids are very numerous; *Osteolepis*, *Cheirolepis*, *Pterictylus*, *Cephalaspis* and other genera characteristic of the middle and lower Devonian. Most interesting, however, is a fine block containing a number of *Holoptychii* from the old red sandstone, which specimen comes direct from Hugh Millers's collection. From the Lias beds of Lyme Regis are well preserved specimens of *Dapedius*, *Lepidotus*, *Eugnathus* and others varying in length from one to three feet. There are fish remains from each epoch. The Solenhofen beds have furnished a very beautiful group, including *Cakuras*, *Lepidotus*, *Leptolepis*, *Aspidorhynchus* and others, imbedded in a clear yellow shale.

There are fine examples of *Lepidodendron* and *Sigillaria* from the English, Prussian and American coal measures; also, many ferns. Among these are perfect remains of *Sphenopteris* and *Pecopteris* from the Scottish coal measures, with a full series from Mazon Creek, Illinois. The fossil flora throughout is numerous, with good collections from the German, Italian and French Tertiary deposits.

From the Jurassic are eleven entire Saurians marked for their exceptional beauty, rather than great size. An *Ichthyosaurus*, over 11 feet in length, is the largest of a number of skeletons of this genus, and is finely preserved. One complete skeleton and several parts give a very correct idea of *Plesiosaurus*. A head of *Mistriosaurus* complete, rare in this country. From the Wurtemberg Lias is a large *Teleosaurus* with the ventral scales in position. There is also a humerus of *Pliosaurus*. Besides these are many fragments; the ossified Sclerotic of *Ichthyosaurus* and parts of the neck, pelvic and shoulder girdles affording a complete study. Probably belonging to the saurians, too, are the so-called bird tracks from the Triassic sandstone of the Connecticut River Valley, including tracks assigned to *Brontozoum*, *Anisopus* and other genera. Also of the five-toed *Cheirotherium*, supposed to mark the steps of *Labyrinthodon*.

The Echinoderms can be studied almost without interruption. In the earlier crinoid series are *Periochocrinus* and *Pentacrinus* from the older strata. The latter are represented beautifully and in profusion from the Lyme Regis locality, England. Among later forms are *Apio-crinus* and *Eucrinus* Lilliformis, a rare specimen from the Brunswick Muschelkalk. In the Echinoid series are perfect specimens of *Periaster*, *Holaster* and *Hemiaster*, in addition to many others. Beautiful specimens of *Asterias* and *Astropecten* and *Ophiuriderma* from the English Lias represent in part the Star Fishes.

The Cephalopods are a great feature of the collection,