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COSMIC CREATION
AND
ATOMIC ENERGY

by

V. WALLACE SLATER

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COSMIC CREATION AND ATOMIC ENERGY

V. WALLACE SLATER, B.Sc., F.R.I.C., M.I.CHEM.E.

December, 1950

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FOREWORD

THIS booklet is based on a lecture given at the Annual Convention of the Theosophical Society in England, at the Besant Hall, London, on May 29th, 1950. The object of the lecture was to present in a reasonably popular manner the latest theories of atomic structure, atomic energy, and the creation of matter in their relation to certain theosophical concepts. The lecture is published by the Theosophical Research Centre in the hope that it may serve as a basis for further study and research.

The author is indebted to Mr E. L. Gardner and Dr C. G. Trew for their helpful and constructive criticism in preparing the lecture for publication.

BOOKS FOR REFERENCE

Atomic Energy, H. D. Smyth (1945).

Atomic Energy in Cosmic and Human Life, George Gamow (1947).

The Nature of the Universe, Fred Hoyle (1950).

Secret Doctrine, Vol. I (3rd Ed.), *Cosmogogenesis*, H. P. Blavatsky.

Cosmic Creation and Atomic Energy

Introduction

The subject of atomic energy has been so widely publicised and has had such a popular appeal during the last five years, that as theosophists we should have some appreciation of the great progress which science has made, since the Secret Doctrine was written, towards an understanding of that potential energy which is locked up, constrained, within the "scientists' chemical atom,"* and which is associated with the whole process of creation. This lecture is an attempt to lead other students, by the study of modern science, to elucidate the earlier theosophical descriptions of the work of the Third Logos in preparing the field by creating matter for the Second Logos.

The English poet, Coventry Patmore (1823-1896), by intuition expressed in his *Unknown Eros* what the scientist now proves by experiment :

" But for the compulsion of strong grace
The pebble in the road
Would straight explode
And fill the ghastly boundlessness of space."

Theosophical literature has put more emphasis on creation than annihilation and it is therefore from the aspect of cosmic creation that the subject of atomic energy will be presented. It may be asked, "What does anyone know about the cosmos?" This lecture gives the reply, "A great deal." Quite a lot is known, though the subject stretches beyond our solar system, even beyond our galaxy.

* The term "scientists' chemical atom" was introduced in *The Field of Occult Chemistry*, 1934, to distinguish it from the "occultists' chemical atom" and from any other use of the term atom such as the "ultimate physical atom" or anu.

Some technical terms will have to be used but these have been limited to a minimum. Also some statements are made dogmatically from a scientific point of view. This is because I have avoided going into detailed scientific proof which can be found in standard works to which reference is made in the bibliography. In general it may be stated that the facts given in this lecture, when put forward as such, can be "proved" by chemistry, physics and mathematics.

Behind the technicalities it is hoped that the reader will also approach the subject in the spirit of reverence for Him.

"Whose wisdom mightily and sweetly ordereth all things,
Whose strength, upholdeth and sustaineth all creation,
Whose beauty shineth through the whole universe."

Structure of Physical Matter

In order to understand something about creation, it is necessary first to examine what has been created. Let us therefore look at the mineral kingdom and at the physical matter which the mineral kingdom uses for its manifestation. It is as well to keep in mind, as a theosophical background, that we are concerned in this study with both the Second and Third Aspects of the Logos, called by C. Jinarajadasa in *First Principles of Theosophy*, Life-Form and Force-Matter. However at this stage we will use the eyes of material science only.

Compounds and Elements. We see around us a huge variety of substances comprising the mineral kingdom. These may be naturally-occurring as minerals, natural gases, water, etc., or artificially-produced as chemical compounds, metals, etc. There are thousands of different kinds of "mineral matter," different kinds of substance, all known as *chemical compounds* but these may all be analysed into what are called *chemical elements*, of which there are only 92 different kinds. For example chalk is a compound of the three elements calcium, carbon and oxygen; clay is a compound of aluminium, silicon and oxygen; sugar is made up of carbon, hydrogen and oxygen; and so on. The whole range of matter of the physical plane could thus eventually be resolved into 92 simple elements such as carbon, hydrogen, oxygen, aluminium, etc.

Periodic Classification. These 92 elements may be classified into a series with the lightest at one end and the heaviest at the other ; thus hydrogen and helium are at the light end while the heaviest natural element, uranium, is at the other. This series forms a table of octaves and is therefore known as the periodic classification, although knowledge of atomic structure has modified the earlier forms so that the third and fourth "octaves" now contain 18 elements, while the fifth contains 32 elements with sub-cycles and sub-sub-cycles within the major true octave cycle.

THOMSEN'S PERIODIC TABLE

								H									He														
		Li	Be	B	C	N	O	F			Ne																				
		3	4	5	6	7	8	9			10																				
		Na	Mg	Al	Si	P	S	Cl			A																				
		11	12	13	14	15	16	17			18																				
K	Ca	Sc Ti V Cr Mn Fe Co Ni								Cu	Zn	Ga	Ge	As	Se	Br	Kr														
19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36														
Rb	Sr	Y Zr Nb Mo Ma Ru Rh Pd								Ag	Cd	In	Sn	Sb	Te	I	X														
37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54														
Cs	Ba	La	RARE EARTHS				Lu	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	-	Em									
55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86
-	Ra	Ac	Th	Pa	U																										
87	88	89	90	91	92																										

The elements may be called by their number in the series instead of by name, in which case hydrogen is No. 1, or as it is known in chemistry atomic number 1, while uranium is atomic number 92.

Atoms and Atomic Structure. Let us now look at these elements in more detail. If we take a lump of one of them, say a piece of copper, and break it up into smaller and smaller particles, we shall eventually reach a size—which happens to be one forty-millionth of an inch—beyond which we can no longer cut our element. This is the *atom* of that element because, from the chemical point of view, it can be divided no further. Every element can be so broken up into its atoms and there will then be 92 different kinds (sizes and weights) of atoms. In thought we have thus reduced the whole physical world into 92 different kinds of atoms and we understand that the complexity of physical matter is merely the result of these atoms (elements) combining in an enormous variety of ways to produce the large number of chemical compounds.

If we could look at these atoms with an imaginary super-super-microscope we should find that each atom, instead of being a nice compact ball, is mainly a piece of space, with something very small in the centre, which we call the *nucleus* and which has a *positive* charge : around the atom we should find *electrons* which are little pieces of electricity with a *negative* charge.

The difference between positive and negative electricity may be appreciated by considering that they are each a kind of vibration, that the positive is one kind and the negative another—and that the two opposite vibrations harmonise, so that positive is attracted by negative, but that two of the same kind, two positives or two negatives, are out of step and so are repelled by one another.

The size of our nucleus is about one two-million-millionth of an inch, so that we can realise how much space there is in the atom, if we remember that the atom is one forty-millionth of an inch.

Having looked at physical matter, as it were from the outside, the atom, if we now look at the nucleus, we still find that the nucleus itself is not just a simple, homogeneous

sphere, but that it is comprised of a number of still smaller bodies of two kinds : the one, *neutrons*, which are neutral, and the other *protons*, which have a positive charge. Perhaps one analogy is that we should imagine that we have in the centre of the atom the mothers (or protons) with the children (or neutrons) and around the outside a guard of fathers (which we call electrons). It should be stated here for completeness, although it need not be stressed, that the proton itself is complex and comprises a neutron plus a *positron*, the latter being a positive electron.

Hydrogen is the lightest atom ; it has in the centre (nucleus) just one proton and in the outside ring just one electron. The next is helium with two protons and two neutrons in the centre and two electrons outside and so the periodic system progresses until uranium is reached with 92 protons and 146 neutrons in the nucleus and 92 electrons outside.

Element	Atomic Number	Atomic Weight	Nucleus		Outside Electrons
			Protons	Neutrons	
Hydrogen ...	1	1	1	0	1
Helium ...	2	4	2	2	2
Lithium ...	3	7	3	4	3
Beryllium ...	4	9	4	5	4
Boron ...	5	11	5	6	5
Carbon ...	6	12	6	6	6
Nitrogen ...	7	14	7	7	7
Silver ...	47	108	47	61	47
Uranium ...	92	238	92	146	92

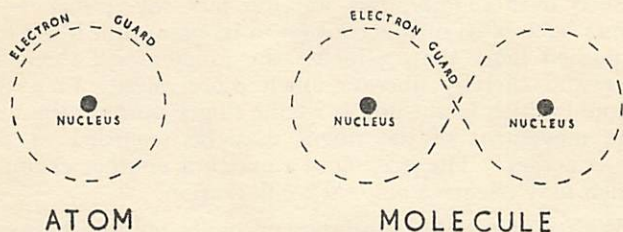
In the foregoing abbreviated list of atomic structures the atomic weight is given for the most abundant isotope (or form) of the element. Thus there is a form of hydrogen known as deuterium which has one proton and one neutron in the nucleus, one electron in the outside and an atomic weight of 2. It will be noted that the weight of the atom is principally in the nucleus so that the atomic weight is the sum of protons and neutrons in the nucleus. Also since the proton carries a positive charge there are as many negative electrons in the outside as protons in the nucleus.

Compounds and Molecular Structure. Thus far we have probed into physical matter, breaking it down from the complex array of materials provided by Nature into its elements, its atoms and its ultimate physical units of energy the electrons, protons (neutrons and positrons) and neutrons. We will now reverse our approach and see how compounds are formed. While an element, such as copper, is a form built up of the same kind of atom, a compound is made up of a group of different atoms. For instance, water is a compound of hydrogen and oxygen ; common salt is a compound of sodium and chlorine ; and sand is a compound of silicon and oxygen. The unit of the compound, that is, the group of atoms giving the compound its peculiar characteristics, is called a *molecule*. Taking the same examples, a molecule of water comprises two atoms of hydrogen and one atom of oxygen ; a molecule of common salt comprises one atom of sodium and one of chlorine ; while a molecule of sand has one atom of silicon with two atoms of oxygen. Sugar is more complicated, its molecule having twelve atoms of carbon, twenty-two of hydrogen and eleven of oxygen.

How do the atoms link up to form molecules ? Every atom has its outer ring of electrons, the fathers protecting the mothers and children (protons and neutrons) at the centre. The atoms combine by linking up electron orbits, for example, two sets of fathers agreeing to share their duties and living together to form a stronger guard over and around the two groups of mothers and children.

To sum up, the physical plane matter consists of 92 different elements—92 kinds of atom—and each atom has enclosed in the centre numbers of neutrons and protons, with electrons around and outside at a relatively great

distance from the centre. Then the atoms are linked up with other atoms to make molecules, the outer electrons sharing one another's duties as guards. When two atoms are near to each other and one atom feels that it has not enough protection, while the other has more than it needs, then the two sets of electrons may agree to share their duties and so form a new compact molecular unit.



Such is the picture of the sub-microcosm, at the physical plane level; but it is a static view. If we are to understand anything about cosmic creation, we must pass to a more dynamic view, which we will apply first to molecules and then to atoms.

Molecular Energy. (Dynamic view of Compounds).

When two atoms come together, the electrons have to re-arrange their duties, so that there is a certain amount of excitement. Excitement means energy, so that whenever there is a change in the chemical constitution of compounds, a change of molecules—either for atoms to link up or to separate—then there is a change of energy. This is the energy of chemical transformation and very often that energy appears as heat. We will call this *molecular energy* to distinguish it from atomic energy.

Take, for example, the link-up of oxygen with other atoms, known as oxidation, this oxidation may be slow, as when iron rusts; or it may proceed at a medium rate, as when coal (carbon) burns in air; or it may be a little faster, as when gunpowder explodes. Or it may be very rapid as when T.N.T. (tri-nitrotoluene) is detonated.

Normally all chemical compounds in the crust of the earth are in a state of stable equilibrium. There are a few *metastable* compounds, such as coal and oil, but in general our physical plane matter is stable. The idea of metastability is so tied up with the release of energy, whether molecular or atomic, that it is necessary to understand what the term means.

Metastability may be described thus: if a ninepin is pushed over slightly, but not too far—say 3 inches—it comes back of its own accord on to its base; but if the top is pushed more than 3 inches the ninepin will then fall over and thereby liberate much more energy than the amount which is put into it by the finger pushing the top. The movement of the finger may be regarded as the *trigger* action. The striking of a match is another example which may trigger a colossal conflagration.

With a metastable substance normally nothing happens until it is triggered off, when energy can be released—the equilibrium is upset and the substance of a chemical compound, takes up a new configuration. Coal has to be heated to a certain critical temperature (ignition temperature) before it will burn; the two sets of atoms, carbon in the coal and oxygen in the air, have to be heated to such a temperature that their respective guards' objections to one another can be overcome. One way of picturing this is to think of the atoms as bouncing balls hitting against one another. Rise in temperature means that the balls begin to bounce more rapidly, hitting each other with more and more force. Remember that the outer skin of each ball is really a guard of electrons: eventually the bouncing becomes so violent that the balls merge into combination as has already been described under the subject of molecular structure.

In the case of gunpowder, a mixture of carbon, sulphur and potassium nitrate, the same thing happens but the result is more violent because the oxygen has to break away out of the potassium nitrate molecule, and then combine with the carbon and sulphur. In the molecule of the explosive known as T.N.T. (tri-nitrotoluene) both carbon and oxygen atoms are in the original molecule so that in this case, for the re-arrangement to take place,

the molecule has to be so shaken up or deformed by a blow, or great heat, that the oxygen and the carbon in the compound, which are normally some distance apart, can come close together, and eventually combine with complete break up of the molecule. The oxygen says to the carbon: "I would rather be with you at your end," and there is an explosion.

For over 100 million years Nature has been storing up metastable compounds such as oil and coal. Man is rapidly squandering this stored-up energy, these metastable substances. He could, of course, use trees and vegetation, as he indeed does, but this would not meet his needs for long, and thus we come to our own main subject, atomic energy, providentially provided for man at this time.

It is of interest to note that the life of the vegetable or animal kingdoms is now required to produce metastable substances. The mineral kingdom (I refer of course to the earth's crust) reaches perfection in this the fourth round of our chain and so is too stable to generate or liberate energy, *i.e.* molecular energy, by itself. These remarks only apply to compounds—molecules—such forms apparently being those particularly used by the mineral kingdom. We shall later see that among the atoms there is metastability but in that case it is not the life of the mineral kingdom but of some parallel life-stream. This idea is in conformity with the statement by C. Jinarajadasa (*First Principles of Theosophy*) that "a stream of life through electrons, ions and chemical elements is also probably distinct" *i.e.* distinct from the stream evolving through mineral to vegetable. It seems to the writer that molecular energy is an expression of the life of the mineral kingdom, that the forms (crystal structures, etc.) have been stabilised as that kingdom reaches perfection and now those forms and materials may only be further modified by the intervention of a higher kingdom. Hence the stability of so-called inert mineral matter. Atomic energy, on the other hand, is an expression of a different life-stream which has not yet reached stability as we shall see later.

Atomic Energy Release

Methods of Energy Release. Before proceeding further namely from the subject of molecular energy to

atomic energy it would be well to define what we understand by energy, or rather by energy release. The liberation of energy means either that work is done (something lifted or moved) or that heat is generated (rate of vibration of matter increased). We are concerned with three methods by which energy is released :—

(a) **Gravity energy** as when a hammer falls by its own weight and may do work by driving in a nail.

(b) **Surface energy** as, for example, when two drops of water merge on a sheet of glass with the rapid formation of a single larger drop. If there is a trace of oil in the water one can see that as soon as the two drops approach and touch there is immediately considerable turbulence—this is visible because of the rainbow effect of the oily water. This turbulence, increased rate of vibration, increased excitement is the result of, what is called, surface energy because it arises from a change in the surfaces of the two drops.

(c) **Chemical energy** as in the examples which have been given when dealing with molecular energy. The chemical energy in exploding petrol with air may do work in driving a motor car engine; the chemical energy in burning coal generates heat. In the definition of energy reference was made to work done, or heat generated; actually work and heat are interchangeable so that usually both work and heat are generated and this is particularly obvious in considering chemical energy.

We now have to consider **atomic energy**. While molecular or chemical energy is concerned with the linking-up of atoms in molecules by means of the surrounding electrons, atomic energy is concerned with the nucleus inside the atom itself, it is indeed concerned with the changes within that minute nucleus in the centre of the atom well protected by its guard of electrons.

Thus molecular energy is *outside* the atom while atomic energy is *inside* the atom.

For the benefit of purists it may be noted that it might have been better if molecular energy had been called atomic energy since it is due to the linking up of atoms by

electron rings, *i.e.* by outside links. The atomic energy, so-called, would then have been called *nuclear energy* because it is due to changes in the nucleus inside the atom. However, I propose to keep to the popular expressions and will continue to call nuclear energy by its now-established title of atomic energy. This can be justified by realising that it is the nucleus which really defines the atom; that is to say it is the number of protons in the nucleus which gives the atom its number and hence its chemical properties.

Transmutation of the Elements. As it is the content of the nucleus which defines the kind of atom and since it is necessary after creation for the 92 kinds of atom, the 92 elements, to be stable, it is necessary that the nucleus should be well protected and the atom uses electrons for this purpose. Atoms may combine or separate or rearrange themselves by agreeing to share the duties of the guardian electrons between two or more atoms, but those guards will not allow any interference with the nucleus. That was why the old alchemists failed in their efforts to transmute the base metal into gold.

It was not until 1919 that one type of atom was changed into another when Rutherford transmuted nitrogen into oxygen. To do this, or in fact to carry out any transmutation, it is necessary to find a small particle, travelling at an enormously high velocity, with which to bombard the original atom. Rutherford used alpha particles, which are nuclei of helium atoms with a positive charge. These are being continuously shot out of radium, and when one hits a nitrogen atom which has a nucleus with 7 positive charges, the high speed enables the extra charge to attach itself to the nucleus and the atom is then an atom of oxygen with 8 positive charges. Such bombardment, however, by a charged particle has little chance of achieving much by way of atomic change as will be explained shortly, and it was not until the discovery of the neutron that an easier method of attack could be used.

An atom has at its centre the positive nucleus with negative electrons around it. It has therefore a double protection. By having negative charges outside, particles which might damage the nucleus are either, if positive, attracted to the outside and kept outside, or if they are

negative, they are just pushed off. In the centre the positive charge gives a further protection, for if a positive missile did get there, then the positive nucleus would repel it. This will be understood by remembering what has already been explained, that like charges repel while unlike charges attract.

What is required is a neutral missile to penetrate to the nucleus, and it was with the discovery of the neutron that man found out how to hit the nucleus at the centre of the atom and so to change the atom. The spectacular change came when the uranium atom was split into two. Prior to that man had only shot off corners of atoms, but when neutrons, obtained from radium were shot at the nucleus of uranium, the atom was split into two almost equal halves, thus making two nuclei, *i.e.* of different atoms near one another in the periodic system. An enormous release of energy resulted. This touched the very core of the scientists' physical atom and man was able from physical plane matter to release the Divine Energy locked up at the Creation, thus opening up a channel between the higher planes and the physical.

Methods of Atomic Energy Release. In order to understand how atomic energy is released we must revert to the idea of metastability. It has been pointed out that, from a molecular point of view, mineral material has reached substantial stability except for the products of vegetation and animal processes. This is not the case with regard to atoms (elements) which are mostly metastable. This means that the nuclei are metastable in the sense that they can link up with other nuclei, or they have a tendency to break down into smaller nuclei, if they can be subjected to a trigger action to set them off.

The small atoms like hydrogen, helium, lithium, etc. have the metastability of wanting to fuse together while the heavy atoms like uranium, etc., tend to split.

Silver is the element which is somewhere near the centre—Atomic number 47—so that the metastability of atoms of the physical plane is such that all atoms below silver in nuclear size want to become bigger and fuse with other nuclei, whereas those above silver want to split up into smaller nuclei. Thus theoretically all elements except silver

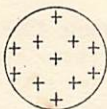
could liberate vast amounts of hidden energy in one of two ways:

(i) **Fission.** In the large elements like uranium, the nucleus is a compact mass in the centre, with 92 positive charges. If, as a trigger, the nucleus is hit by a neutron, it may deform the centre so that it becomes narrow waisted. The positive charges of the waist will cause the two parts to fly apart and this may go on until we reach the size of the silver atom or nucleus. The amount of energy thus liberated will be realised from the fact that one gramme ($\frac{1}{32}$ th of an ounce) of uranium is equivalent to 19 tons of T.N.T. in energy release.

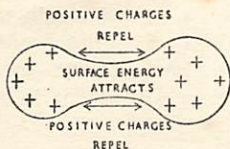
Release of atomic energy by *fission* is due to the principle that *electrical energy of the same charge (positive) repels*, as illustrated in the diagram.

(ii) **Fusion.** With hydrogen we have such a small nucleus that we have a surface energy effect. The nucleus must be regarded as a droplet (later we shall speak of nuclear fluid) and the fusion process is the merging of two droplets. Instead of hitting the nucleus with neutrons the hydrogen atoms must be so excited that the electron cushion guarding the nucleus is pushed and, as it were, dented, until the hydrogen nuclei just touch. Immediately there is the effect of water drops merging on a sheet of glass. In this case the positive charges of the nucleus repel the two nuclei, but if the energy and excitement is sufficiently great it may send the nuclei together with sufficient force to overcome the electrical repulsion and the nuclei may just touch one another. This is possible for the light elements because the electric charges are so much smaller than those of the heavier elements (*i.e.* beyond atomic number 47). Then, on touching, the surface energy begins to act and for small droplets of nuclear fluid this surface energy is greater than the electric repulsion. In defining energy, one example given was that of surface energy, when it was pointed out that when two drops of liquid had merged, there was considerable turbulence in the newly formed larger drop. For atomic nuclei this is atomic energy.

Thus release of atomic energy by *fusion* is due to the principle that *surface energy attracts*. See diagram.



NUCLEUS OF LARGE
ATOM WITH
POSITIVE PROTONS

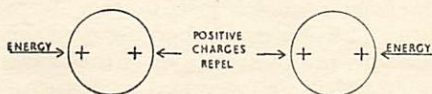


NUCLEUS DEFORMED

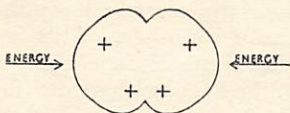


TWO NUCLEI
FORMED BECAUSE
REPULSION OVER-
-COMES ATTRACTION

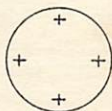
FISSION



TWO NUCLEI OF
SMALL ATOMS



IF EXTERNAL ENERGY
GREATER THAN
REPULSION NUCLEI
MAY COLLIDE



SURFACE ENERGY
ATTRACTION HOLDS
NUCLEI TOGETHER
TO FORM ONE
LARGE NUCLEUS

FUSION

Summing up the two ways of releasing atomic energy, fission and fusion, the electrical repulsion and surface energy attraction approach equality at about the size of the atom (or rather nucleus) of silver and it is partly because of this that the silver nucleus is stable. Atoms larger than silver have a fission metastability, while atoms smaller than silver have a fusion metastability. It will be obvious that since hydrogen is the farthest from silver, on the light side, it will be the most metastable of the lighter elements, while uranium at the other end of the periodic system will be the most metastable of the heavier elements.

Thus the best opportunity for energy release by atomic transformation lies at the two opposite ends of the periodic system.

For fission, *e.g.* of uranium, we have the method of neutron bombardment deforming the nucleus.

For fusion, *e.g.* of hydrogen or helium, we have the method of excitement by raising the temperature.

As a point of fact the elements which produce the greatest energy are the heavy form of hydrogen (deuterium) at the light end, and the light form of uranium, U.235, at the heavy end.

Use of Atomic Energy by Man. Although the subject of this lecture is Cosmic Creation, some reference should be made to the liberation of atomic energy, and its use by man. This may be stated briefly by pointing to a few examples.

The atomic pile generates heat by the fission of uranium; the heat is converted to electricity by means of steam generation.

In the realm of transmutation man is now able to produce, to make, elements which do not exist anywhere in the known universe—a remarkable achievement. Thus, while uranium, atomic number 92 was the heaviest natural element, man has made the following (dates of first “creation” are also given):

			ATOMIC NUMBER	DATE
Neptunium ...	...	...	93	1940
Plutonium	...	...	94	1940
Americium	...	...	95	1944
Curium ...	...	...	96	1944
Berkelium ...	...	...	97	1950
Californium	...	...	98	1950

An idea of the energy, which can be released by atomic transformation, may be obtained from the following figures, for heat generated when uranium is transmuted into plutonium via neptunium (see above list). For this transmutation a plant of a size to produce 2 lbs. of plutonium per day will at the same time generate sufficient heat as a result of this transmutation process to raise the temperature of 150 tons of ice cold water to the boiling point *every minute*. This is what happened at the Hanford Plant, where erection started in June 1943 and which operated in 1945.

Cosmic Energy

Great as is the energy obtainable by man from uranium it is infinitesimal compared with the huge reservoirs of another fuel in the universe. The suns, the stars, use this atomic fuel to supply light and warmth to the worlds. The energy in the stars, including our sun, is the result of nuclear fusion, the combining of hydrogen atoms to form helium—four hydrogen atoms giving one helium atom. In order to achieve the release of energy by this process, the hydrogen atoms, nuclei, have to get close enough for the electrical repulsion to be overcome and for the surface energy effect to attract and fuse. The method of achieving this is described as *thermo-nuclear fusion* because an enormous temperature is required to upset the metastability.

For hydrogen (actually deuterium) fusion the temperature must be several hundred thousand degrees Centigrade (°C.). Such temperatures are beyond our comprehension. A vague idea may be obtained from the following scale of temperatures :

Melting ice	...	...	...	0°C.
Boiling water	...	...	...	100°C.
Red heat ...	...	...	...	900°C.
White Heat	...	...	...	1400°C.
Electric arc	...	...	...	3400°C.
Thermo-nuclear fusion of hydrogen				about 1,000,000°C.

The highest temperature reached on this earth, except by atomic means, is about 4000°C.

The energy possible from hydrogen fusion is such that one gramme of hydrogen, if subjected to a temperature of 1,200,000°C., could generate the energy of 5,300 horse power for a period of 6 hours.

The fusion process for hydrogen has already been described. The result in our sun is to maintain a surface temperature of 6000°C. Internally it is 20,000,000°C. and has a pressure of 160,000 million atmospheres. There must have been a trigger action to start off the hydrogen combination, but once started the energy generated is sufficient to maintain the temperature above the critical one, below which fusion would stop.

The conditions are similar at the centre of all the stars but surface temperatures vary.

A few facts may be stated to complete the picture.

The stellar reaction is the transformation of hydrogen into helium and it is catalysed by carbon and nitrogen. Hydrogen is the most abundant element in the universe. The sun has been in existence for 2 or 3 thousand million years but has used up only a few per cent of its hydrogen and can keep going for at least 10,000 million years more.

It will be realised from what has been said that although hydrogen requires such enormously high temperatures for thermo-nuclear fusion to take place, the other light elements will require still higher temperatures.

I mention this because, in general, we have no temperatures in the universe at this time which will enable atoms, other than hydrogen, to combine and so when we ask ourselves, "How was matter created?" we are asking when and how were conditions in the universe such that the 92 elements could have been formed from the "proton" of the Secret Doctrine?

Creation of Matter

How did all this begin? We will first confine our attention to matter itself, and particularly physical matter, the first Outpouring, the work of the Third Logos.

“Fohat digs holes in (koilon) space”

“Father-mother spin a web.”

What now has science to say?

Although all the 92 elements except silver could release energy by fission or fusion the activation energy (excitation temperature) required to trigger the reaction, is so high that even the very high stellar temperatures and energies can only act on hydrogen, while other elements remain practically unchanged.

Thus the “atom cooking” must have taken place at a time in the long past when temperatures and pressures were so terrific that every element could be subjected to thermo-nuclear reactions.

Calculation shows that to have the present proportions of the light elements in the periodic system the alchemical equilibrium must have been established at 8,000 million °C., and at a pressure of 7 million million atmospheres. The density of matter would then have been 10 million times the density of water. But when we consider the heavy elements which now tend to split we have to go back still further, to a time when the conditions were such that they could have been formed by fusion. For such conditions the density of “matter” would have been 100 million million times that of water. That happens to be the density of nuclear fluid to which I have already referred, that is the substance of which the neutrons and protons at the centre of the atom comprising the minute nucleus are composed. It has been pointed out that these are droplets of a fluid.

What was space like when it had the enormously high density of nuclear fluid, when it was a continuum of nuclear fluid?

“And the earth (physical matter) was without form and void; and darkness was upon the face of the deep.”

There were no stars, no separate atoms. The matter which now fills the whole visible universe, as seen by the Mt. Wilson telescope, namely 500 million light years across was squeezed into a small sphere merely 6 million miles across, that is ten times the diameter of the orbit of the moon.

All then, at the birth of the physical plane, was primordial fluid, nuclear fluid.

“And God said, Let there be light: and there was light.”

Something happened to break the nuclear fluid into separate drops, enormous drops, hundreds or millions of miles across. It is a property of nuclear fluid that no drop can be stable until it is smaller than one million millionth of an inch* (which happens to be about the size of an atomic nucleus), so that once separation begins in primeval space, then it must proceed rapidly breaking up into smaller and smaller drops until it reaches the size of atomic nuclei.

To quote Gamow, an eminent atomic scientist : “ Thus the continuous nuclear fluid which formed the original universe, was pulverised into an incredibly large number of small droplets which, enveloping themselves with electronic shells (also formed out of the original fluid), became atoms of various chemical elements.”

Summing up we may say that the atomic energy hidden in the interior of the nuclei was concentrated there in the very first days of the creation of the universe. The rapid drop in temperature stabilised the elements as there was not then enough vibration for them to change again.

Cosmic Creation

After the creation of matter comes cosmic creation. The 92 kinds of atom of the physical plane have been stabilised, the work of the Third Logos has been done. The next stage is for forms to be built, or rather to take shape, under the influence of the Second Logos. The stage has been set for the Second Outpouring at the physical level.

* I have given earlier, the size of the nucleus as half this size.

Three kinds of energy were mentioned when defining energy: chemical, surface and gravitational. The first two have played their part in the creation of matter, both atomic and molecular. The third, gravitational, now comes into play.

The original gas, formed from the nuclear fluid is extended throughout space and the next stage is for this gas to be attracted by gravitational forces into huge clouds. These clouds are the fore-runners of the huge galaxies.

Within the clouds, the gravitational energy continues to act and creates the temperature to set off the trigger for the combination of hydrogen, by fusion into helium atoms, and so the stars (each a sun) are formed. The temperature, when the nuclear fluid dispersed and the elements were stabilized, had dropped below the temperature for thermo-nuclear fusion and it is for this reason that generation of heat is required again for the next stage in cosmic creation.

Our galaxy, the milky way, is a disc 60,000 light years in diameter and 10 light years thick with myriads of stars each a fiery furnace generating energy by thermo-nuclear fusion of hydrogen atoms, but not having temperatures high enough for other alchemical reactions.

There are two theories for the formation of the galaxies, that is for the grouping of the stars into galaxies. According to Gamow the stars were formed first as a fairly uniform distribution in space and then they aggregated into giant stellar systems, the galaxies.

According to Hoyle the galaxy starts its life as a rotating flat disc of gas formed before any stars appear. The gas then becomes irregular and cloudy, and gravitational forces eventually condense the clouds to form stars.

From a scientific point of view it does not really matter which theory we accept. It is simply a question of whether the stars formed uniformly in space and then collected into galaxies, or whether matter collected into galaxial areas and then formed into stars within each area as a galaxy of stars.

From the theosophical point of view this may be important as Hoyle's idea would support the idea of separate galaxial Logoi first marking out their area in space before

creating the forms. This is the area within the "Ring Pass Not" of the Cosmic (galaxial) Logos, just as each Solar Logos, "commences by defining the limit of his field of activity, a vast sphere whose circumference is far larger than the orbit of the outermost of His future planets." (G. W. Leadbeater, *Textbook of Theosophy*).

This section must not be left without reference to another idea of Hoyle's, namely his theory of continuous creation: "Material simply appears—it is created." His idea is that hydrogen atoms are continuing to be formed in space and that the suns, spinning through space, pick up the hydrogen and so continue to be able to generate energy by thermo-nuclear fusion. The inference is that this has gone on from time immemorial and will continue indefinitely, continuously creating new matter and new suns.

What does H. P. Blavatsky say? "Nature runs down and disappears from the objective plane, only to re-emerge after a time of rest out of the subjective." (*Secret Doctrine*, 3rd Ed., 1, p. 173). Let us welcome Hoyle's idea of creation going on now at the present time, as distinct from an act once and for all in the past. This "continuous creation" doctrine is important as a recognition of the dynamic nature of the universe and an acknowledgment of the great fact of "continual becoming." We disagree if "continuous" means for ever. All that it needs to correct it, is the idea that it is only like this "for an age," *i.e.* for an eternity or age of Brahma.

Many other scientists hold that the cosmos (and I would not like to say how wide or how narrow I would define their cosmos) was created at a time which, as theosophists, we might consider as the beginning of our Chain. We might then add Hoyle's idea by admitting that matter continues to be created for the period of the chain in order to supply energy to the system, but that creation will cease, or go in reverse at the end of the chain. Science has not yet got the answer, but theosophists may learn much by studying modern science in the light of the Secret Doctrine. Continuous creation of a limited duration seems more in line with theosophical ideas. We cannot accept the idea of creation going on for ever and ever. We feel there must be a going-in and going-out of creation.

Cosmic Chronology

We have so far reviewed the structure of physical matter, molecular and atomic energy, the creation of physical matter and of the cosmos. How long has this taken?

According to the scientific calculations:

The galaxy is 4,000 million years old.

The earth is 3,000 million years old.*

According to the *Secret Doctrine*:

One Day of Brahma (one chain) is 4,320 million years.

One Night of Brahma (Pralaya) is also 4,320 million years.

The present fourth Chain (Earth Chain) is 2,000 million years old.

This comparison suggests that dense physical matter may not have been formed until the beginning of our Chain, an idea which would make us reconstruct our ideas about the Moon Chain. Namely that it did not reach the physical and may not have been our present satellite moon. This is not so revolutionary since we are given to understand that the dense globe of the Moon Chain was etheric and not dense physical.

To review the history of our Hierarchy:

In the 1st Chain, Brahma's Body of Darkness, we only reach lower mental.

In the 2nd Chain, Brahma's Body of Light, we reached the astral.

In the 3rd Chain, Brahma's Body of Twilight, we reached the etheric.

In the 4th Chain, Brahma's Body of Dawn, the dense physical is prepared for the first time.

As humanity in this 4th Chain we are helped at the physical level by the Lunar Pitris of the Moon Chain, and we prepare the dense physical for the future just as the Asura Hierarchy (the Humanity of the First Chain) prepared the lower mental for us.

* For the earth different methods of calculation give figures ranging from 2,000 to 3,500 million years.

As H. P. Blavatsky said in her *Key to Theosophy*: "We believe in no creation, but in the periodical and consecutive appearance of the universe from the subjective to the objective plane of being, at regular intervals of time, covering periods of immense duration."

"The Universe disappears at regular periods, when the Universal Night sets in. The Hindus call such alternations the Days and Nights of Brahma. During the Nights All is in All; every atom is resolved into one homogeneity"—the nuclear fluid of science.

Third and Second Logos—First and Second Outpourings

The Third Logos prepares the field, followed by and paralleled with the work of the Second Logos.

First Outpouring—Third Logos manifests as Energy-Matter.

Second Outpouring—Second Logos manifests as Life-Form.

"When the worlds had been prepared to this extent (by the Third Logos) and most of the chemical elements already existed, the second outpouring (Second Logos) took place . . . It brought with it the power of combination. It proceeded to combine those elements into organisms which it ensouled and in this way it built up the seven kingdoms of nature," C. W. Leadbeater, *Textbook of Theosophy*, the seven kingdoms being the three elemental kingdoms and the mineral, the vegetable, the animal and the human.

The three elemental kingdoms ensouled the matter of the higher mental, the lower mental and the astral planes successively and then came the mineral kingdom ensouling etheric and building dense physical bodies with the characteristics of focus (position), stability, resistance and inertia.

Thus we see for the present Chain the relationship between:

Physical matter and mineral kingdom

Third Logos and Second Logos

The two Logoi are intricately mixed in action and therefore are more correctly described as aspects of the One. Matter cannot exist without Life.

Again to quote from C. W. Leadbeater's *Textbook* :
"In the mineral kingdom we include . . . liquids, gases and etheric substances . . . When mineral evolution is completed, the life has withdrawn itself again into the astral world, but bearing with it all the results obtained through its experiences in the physical."

Thus when the mineral kingdom life withdraws from the physical plane matter, the physical plane itself will cease to exist and Cosmic Creation, as I have outlined it, will go into reverse.

Stanza I. The Night of the Universe (Pralaya)

(1) The eternal parent, wrapped in her ever-invisible robes, had slumbered once again for seven eternities.

(2) Time was not, for it lay asleep in the infinite bosom of duration.

Stanza III. The Awakening of Cosmos

16. (1) The last vibration of the seventh eternity thrills through infinitude. The mother swells, expanding from within without, like the bud of the lotus.

17. (2) The vibration sweeps along, touching with its swift wing the whole universe and the germ that dwelleth in darkness, the darkness that breathes over the slumbering waters of life.

18. (3) Darkness radiates light, and light drops one solitary ray into the waters, into the mother-deep. The ray shoots through the virgin-egg, the ray causes the eternal egg to thrill, and drop the non-eternal germ, which condenses into the world-egg.

Secret Doctrine.

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