

CHAPTER ONE

THE HYDROGEN ATOM, ATOMIC BONDING AND THE PERIODIC TABLE

"If, in some cataclysm, all of scientific knowledge were to be destroyed, and only one sentence passed on to the next generations of creatures, what statement would contain the most information in the fewest words? I believe it is the atomic hypothesis . . . that all things are made of atoms — little particles that move around in perpetual motion, attracting each other when they are a little distance apart, but repelling upon being squeezed into one another. In that one sentence, you will see, there is an enormous amount of information about the world, if just a little imagination and thinking are applied."

Richard Feynman in *Lectures in Physics*

1.1 (HISTORICAL DEVELOPMENT OF QUANTUM THEORY - NOT AVAILABLE FOR VIEWING)

1.2 NEUTRAL INFLUENCE, NET ATTRACTION AND EXTREME REPULSION

The claim that the nucleus consists of a number of particles with a net positive charge is a hypothesis that is not in any way forced upon us by the evidence. The fact that many (if not most) physicists consider the hypothesis to be an unavoidable and empirically-compelled conclusion is a measure of the extent to which this view is irrationally entrenched in current theory. Far from being forced by the evidence, the conclusion has fostered the development of an increasingly implausible theoretical structure, an unwieldy framework that should prompt us to go back and question the original conjecture. Indeed, the entire complex story of quarks and gluons has its origin in the issue of how identically-charged nucleons can overcome their net forces of repulsion to cohere together in the nucleus, and at the same time generate the varied empirical data that is produced by the atom.

The proposal here is that the reader resist the pressure to accept the established view, at least for as long as it takes to read these few pages, and consider for a while the very real possibility that the positively charged nucleus, like the luminiferous ether and Ptolemy's spheres, is one of the phantoms of science, an entity with an impressive array of theoretical properties, all of which are meticulously related to the empirical evidence but which possesses no reality whatsoever. Instead, we present a very different hypothesis for the structure of the atom. We hope that the reader not be dissuaded by the simplicity of the model and we ask that an effort be made to read this chapter at least. By that point, the capacity of our model for explaining the structure of the atomic table will hopefully have become apparent. At that stage the reader can tell for himself if the hypothesis rings true or not.

We posit that the hydrogen atom is a simple and indivisible unit that is constituted by an internal polarity. Larger atoms are composed of fusions of these basic units. The polarity consists of a "positive" component - the B pole - which has been generated from the "negative" component – the V pole. We use the letters B and V ("being" and "void") to avoid confusion with the south and north poles of magnets, or the polarity between positive and negative charges. As we shall see, B and V underlie both magnetism and electricity and permit us to give a unified explanation of both. Thus, we envision that the B pole consists of something *substantial* (almost like a concentrated material particle in the old-fashioned sense) whilst the V component consists in some sort of *privation* of substance. Now that is not to say that the V component is simply nothingness, akin to the Newtonian concept of space as an empty void. That kind of nothingness, after all, might well exist in this portion of reality even if a B component had *not* been generated there in the first place. We envision that the V component is a void of a more radical nature – an "area" of reality where a B component has been generated

from a previous state of nothingness. In this sense, the V pole sounds a little like what is usually referred to as “anti-matter”. It is what is left when matter is generated from nothingness. But unlike a particle of anti-matter, *it cannot exist independently* of the adjacent B pole whose existence is actually giving rise to it in the world in real time. Apart from this passing mention, we ask that all talk of “anti-matter” be left there. This concept has no place in our framework.

The unit that comes into being as a result of the generation of this polarity will be referred to as the “genesis-unit”. The reason we use this term is primarily because the unit – as we shall see as we go on - will be invoked to account for the appearance of virtually all other material phenomena. This unit will be the basic locus of all causal activity in the world, whether that influence be gravitational, magnetic, or electrical. All causal activity arises in a unit of this sort and has its effects in one or more other such units. No more primitive source or target of causal activity exists in the world. The unit is not itself composed of smaller components of matter. It is the most basic instance of matter that exists, and, in fact, *constitutes* matter. The hydrogen atom is composed of a single genesis-unit, whilst heavier elements are constituted by multiple genesis-units fused together.

According to this account, there are really *three* different kinds of reality within the genesis-unit. Firstly, there is the positive B component concentrated presumably at one end of the unit. Then there is the negative pole from which the positive pole has been generated. Finally, there is nothingness, an area (or areas) distinct from the positive component that has come to be, but also radically distinct from the “hole” that has been left when the positive component was generated. If we allow that the positive component is concentrated at one end of the unit, whilst the negative component is a little more dispersed throughout the rest of the unit (although predominantly concentrated at the end opposite to the positive pole) then our model acquires surprising explanatory power. The picture we are presenting of the basic hydrogen atom retains its overall simplicity but we are now making the plausible assertion that the generation of the B component does not result in a simple, undifferentiated, homogenous “hole” in reality (the V pole). Rather, the process of generation of the B pole demands that this positive entity be, as it were, dragged up out of a well of nothingness. The deepest part of the well, i.e., the end of the resultant unit of matter that is furthest distant to the new positive pole, will constitute the most significant portion of the V component in the atom. In the intervening area between the extremity of the V pole and the positive pole, there will be a progressively diluted combination of void and nothingness (where void is conceived of as that which results when the B component is generated from nothingness).

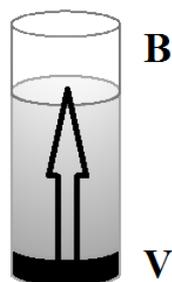


Figure 1.1 Schematic representation of the gradient of dispersion of the V component in the genesis-unit. The B pole is drawn up from nothingness, thus creating a well with a negative void at the deepest point, and a progressively weaker concentration of negative void and nothingness in the central portion of the unit.

If this unit constitutes matter but is not constituted itself by smaller pieces of other material, then what exactly does it consist of? It is proposed that the unit is constituted by the very work impulse that gives rise to the polarity within the unit. The polarity is maintained by the continuous presence of the work impulse at the heart of the unit, and this becomes the

fundamental building block of the universe. The empirical advantages of this claim will become more apparent shortly. We can speculate on what the polarity within the unit consists of, using analogical language that might help us in thinking about the dualism that obtains. What is more important, however, is what comes into being as a result of the action of this work impulse. From this moment onwards, a material entity is present in the system that interacts with the other entities that are present in the system. The reader is asked to be patient with the ethereal nature of this description of the fundamental building block of matter. What we are trying to do is make sense of empirical reality by constructing a framework upon simple principles. We need to develop the framework a little more as we go along, and then see if it has the capacity to explain the empirical evidence in a plausible way. The reader will soon have the opportunity to evaluate the explanatory merits of the system.

Figure 1.1 attempts to depict what such a unit might look like. The B pole is drawn up from the well of nothingness and thus is shown at the top of the unit. At the bottom of the well is the densest area of void. In between, there is a gradient consisting of a progressively lesser concentration of void. But the gradient is not composed of a mixture of V component and B component: rather it consists of a combination of void and *nothingness*. All of the B component is located at the top of the unit. The V component is mostly concentrated at the bottom, but is partially dispersed through the portion of the rest of the unit that lies beneath the B pole. The *total* magnitudes of the B and V components are, of course, perfectly equal: one was generated from the other and therefore they have a strict relationship between them of equality in magnitude yet contrasting in nature. The insistence that the gradient have these characteristics will permit an explanation of the various phenomena of attraction, repulsion and atomic cohesion that prompt the postulation of multiple forces in the standard model.

No doubt the reader is surprised (and possibly horrified) at the absence of the electron in this model. A little more patience and you will see how this simple picture can account for all the empirical data that prompt the postulation of the electron. The relation of protons and neutrons to the genesis-unit can be described in even simpler terms. But first we must consider how genesis-units interact with each other. Take first of all the case where two hydrogen atoms (or “genesis-units”) are located at a considerable distance from each other (see Figure 1.2). In this illustration, no attempt is made to show the perfect gradient with which, presumably, the V component diminishes as we move towards the B pole. It is merely to suit the artistic and (as we shall see soon) the mathematical limitations of this author that the V component is depicted as being dispersed into four progressively more insignificant portions. The important point is that the *total* magnitudes of the B and V components of each unit are perfectly equal. In this case, where there is a significant separation between A1 and A2, the distances between the like poles of the different units (e) can be considered to be identical to the distances between the unlike poles (d). The slight difference in length between d and e will give rise to a differential between the attractive and repulsive impulses that is of negligible import (we must imagine the units to be far more greatly separated in space in proportion to their own size than is shown in the diagram). Therefore each unit will present itself to the other as an electrostatically neutral entity.

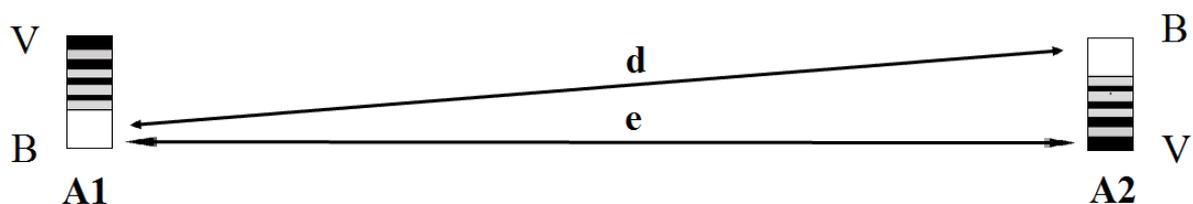


Figure 1.2 Two units at considerable distance exert no net electrostatic influence on each other

If two genesis-units have their polarities oriented in opposite directions, then the difference in distance between the like poles and the unlike poles will become more significant as they converge on each other. This is depicted in Figure 1.3. As the units continue to converge, a point will eventually be reached where the growing differential between d and e will entail that the magnitude of the attractive influences between the B of A1 and the V of A2 (and vice-versa) will significantly outweigh the repulsive influences between their opposite poles. At this distance, electrostatic bonds between atoms will be possible. Of course, there will be a *range* of distances at which electrostatic attraction will be felt, and the extent of this range can be established by empirical means.

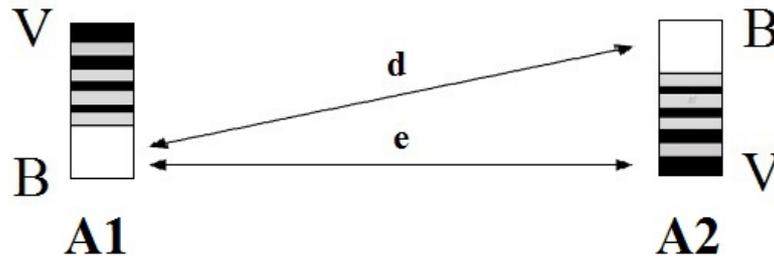


Figure 1.3 Genesis-units exerting net attraction on each other

As the units continue to converge on each other, the nature of the electrostatic dynamics between them will begin to alter once again. An effort is made to depict this new situation in Figure 1.4. As stated earlier, for simplicity the V component is shown as being dispersed throughout the unit in four separate portions, v_1 , v_2 , v_3 and v_4 . Consider first of all the repulsive influence between the B of A1 and the B of A2. Because each B component is located in a geographically concentrated area, we can express the repulsive tendency between the units as: Cb^2/d^2 , where C is the constant of proportionality for electrostatic influence, b is a measure of the electrostatic influence of the B component of each genesis-unit, and d is the distance between the B pole of A1 and the B pole of A2.

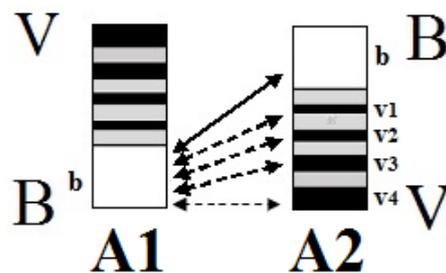


Figure 1.4 Closer proximity leads to net repulsion

The attractive tendency between the B pole of A1 and the V pole of A2 will be a bit more complicated to calculate. The V component is dispersed, which means that the differences in the *direction* of attractive influence between the B of A1 and the dispersed components of A2 (i.e., v_1 , v_2 , v_3 and v_4) will become more significant as the units converge, leading eventually to a drastic reduction in the net attractive influence. Let us consider this in more detail. The total attractive influence between the B of A1 and the V of A2 can be written as a sum of the individual influences in the following terms: $bv_1 + bv_2 + bv_3 + bv_4$, where bv_i is a measure of the magnitude of electrostatic attraction between the B component of A1 and the v_i portion of the V component of A2. Using the standard expression for electrostatic influence, this total is:

$$C b v_1 \cos \theta_1 / e_1^2 + C b v_2 \cos \theta_2 / e_2^2 + C b v_3 \cos \theta_3 / e_3^2 + C b v_4 / e_4^2 ;$$

where C is the constant of proportionality for electrostatic influence, e_i is the distance between v_i and the B component of A1, and θ_i is the angle between the vector bv_i and the vector bv_4 (for calculation purposes we are taking the direction of the vector bv_4 , the most substantial portion of electrostatic attraction between A1 and A2, as the norm for the direction of attractive influence).

Depending solely on the *relative height of the genesis-unit* and the *pattern of dispersal* of the V component throughout the unit, there can be no doubt that convergence of two units can diminish the magnitude of the overall attractive influence with respect to the magnitude of the repulsive influence. The mathematical formulation of the relationship between the height of the unit, the pattern of dispersal, the separation of the units and the consequences for electrostatic influence will be left to others. This author is not capable! However, enough has been said to illustrate the point that a relatively simple model of the atom can furnish an explanation of the empirical fact that atoms attract each other at a certain distance but repel at closer range.

Slightly different models can also offer plausible explanations, one of which we will consider here. Figure 1.5 displays a pair of genesis-units that are more elongated than the previous model. At the poles there will be a net attraction between the pair, but this will be offset by the larger repulsive tendencies towards the centre. As in the previous model, the V component is dispersed throughout the length of the unit, with the greatest portion concentrated at the end. The B component is entirely concentrated at the other end of each unit, but its magnitude will be precisely equal to that of the total V component. This goes without saying, since the V component results from the generation of the B. Say that one quarter of the total V component is concentrated at the end of any given unit. The net attraction at each poles will thus be approximately proportional to $BV/4$. If the unit is sufficiently elongated and the V is evenly dispersed along its length, then we can discount the attraction between the B of A1 and the portion of the V that is not located at the pole of A2. Taking into account both ends of the composite system, the total attraction will be approximately proportional to $2(BV/4) = BV/2$. Since the total B and V components are equal in magnitude, this can be simplified to $V^2/2$.

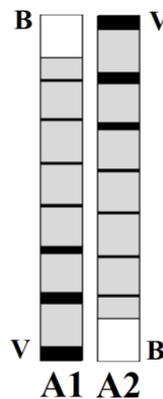


Figure 1.5 Modified model of the atom demonstrating the net repulsion of two units.

Now let us consider the net repulsion. It will be approximately proportional to $(3B/4)^2$. This follows from the fact that three quarters of the B component of A1 is dispersed along its length in such a way that it will be more or less directly contiguous to the three quarters of B component of A2. Thus the net attraction between A1 and A2 was proportional to $V^2/2$, whilst the net repulsion was proportional to $9V^2/16$, which, evidently, is greater than $V^2/2$. Of course, we have no empirical justification for asserting this particular level of dispersion of the V component, although it should be possible to derive the actual level of dispersion by empirical means. We only wish to illustrate that it is relatively easy to develop a model of the genesis-

unit that can explain why two units can repel each other when they are sufficiently close to each other.

The reader might justifiably ask why our model is anxious to account for *repulsion* between the component parts of complex atoms when we have already rejected the view that atoms contain a nucleus of similarly-charged particles? Because, firstly, it is clear that *pairs* of genesis-units do not normally fuse together to form a complex atom (as we shall see, a third or fourth genesis-unit is usually required). A natural repulsion at close proximity would help to explain that fact. Secondly, such a repulsive tendency aids us in explaining the phenomenon known as “nuclear fusion”.

Nuclear fusion requires a significant quantity of energy to happen, but (in the case of elements lighter than iron-56) it leads to the release of an even greater quantity of energy. If atoms were composed of genesis-units with balanced *non-dispersed* polarities then they should fuse together (with the B component of one aligned to the V component of the other) at relatively *low* energies, but this, manifestly, does not happen. The alternative model we are presenting (as in Figure 1.4) allows that atoms will experience a state of mutual repulsion at close range. To overcome this repulsion, the atoms will need to be hurtling towards each other with the kinds of high kinetic energies that are typical of particles in the interior of stars. Once the atoms have collided and are positioned even closer together than the mutually repulsive range depicted in Figure 1.4, then their electrostatic situation might be imagined as illustrated rather imperfectly in Figure 1.6.

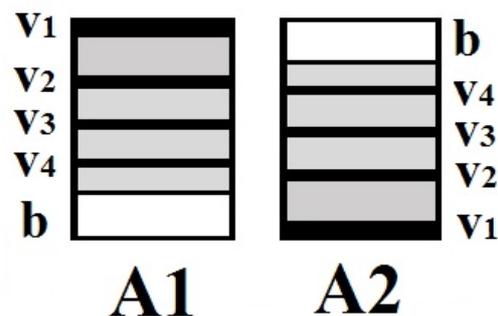


Figure 1.6 The unstable state of two units in close proximity

When two units are aligned in this way, their situation is made unstable by the fact that the v₂, v₃ and v₄ of A1 will repel the v₄, v₃ and v₂ of A2, and this repulsion exceeds the combined attractive influences of the two bv₁ attractive components. The diagram may not demonstrate this point unambiguously, but it is easy to imagine genesis-units of a certain height with a certain distribution of the V component which would entail that, when units are aligned side by side, the repulsive influence of the dispersed V components will exceed the combined attractive influences at either end of the units.

The net repulsive influence entails that the units will not stay aligned like this for very long after their initial collision. Indeed, we find that the isotope of helium with just two “protons” (²He) is extremely unstable and has only been observed on rare occasions for exceedingly fleeting moments of time. On our understanding, ²He is actually composed of two genesis-units forced together. Such a relationship cannot persist for long given their mutual repulsion. How then can multiple genesis-units be fused into an atom of helium, which (in the case of ⁴He) is believed to contain two protons and two neutrons?

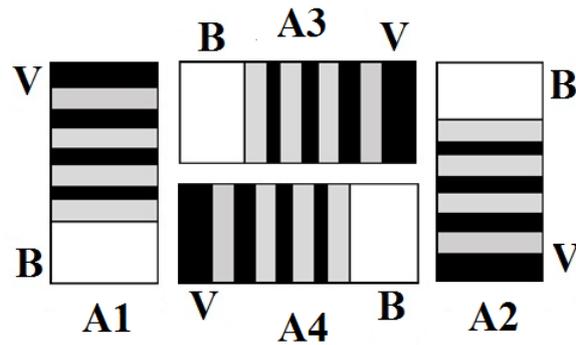


Figure 1.7 The fusion of four genesis-units to form helium

Figure 1.7 shows how such a fusion is possible. We imagine that the high kinetic energies of hydrogen atoms in the interior of stars will create the situation where multiple atoms will be thrown energetically together in every sort of relative alignment possible. Whenever four atoms are thrown together in an alignment similar to the one shown in Figure 1.7, they will immediately bond together in a stable manner. There will be a certain net repulsive impulse between A3 and A4, but this will be more than compensated for by the “capping” influences of A1 and A2. Indeed, the net attractive electrostatic influences of the overall structure entail that, once the initial force of repulsion is overcome, the process of fusion will release electrostatic energy as the poles of the capping genesis-units come into contact with the opposite poles of A3 and A4. This is the fusion energy that is the powerhouse of stars.

It is also clear from this diagram that a complex structure with just three units (i.e., without either A3 or A4) will be possible. And, of course, ^3He is a stable isotope of helium that occurs naturally in the universe. But it will be a rare element because, in the high energy situation in the interior of stars, it will have an extremely high probability of picking up a stray hydrogen atom and becoming ^4He .

The question that immediately arises is why such a structure that is actually composed of *four* genesis-units should have an atomic number of just 2? During this chapter the claim will be developed that the chemical properties of complex atoms are determined by the *residual* electrostatic properties of the genesis-units composing the atoms. This will be explained in more detail as we go along. Considering Figure 1.7, it can be seen that the electrostatic influences of A3 and A4 are very much directed towards other genesis-units *within* the structure. The B of A3, for example, is balanced on one side by the V of A1 and on another side by the V of A4. The poles of A1 and A2, by contrast, are only counterbalanced on one side only. This means that these units will exert more residual electrostatic influences *outwards* towards other atoms potentially in range. By “residual” we mean the electrostatic influence that is *not* already counterbalanced by an opposing influence within the complex atom.

As we shall see, the very compactness and symmetry of the helium atom means that it exerts relatively low residual impulses in any direction. It shares this characteristic with other members of the group of noble gases. Nevertheless, from outside the helium atom, it is A1 and A2 that “stand out” as far as electrostatic influence is concerned. This means that it behaves in certain experimental situations (such as the famous experiment by Moseley demonstrating a strict relationship between the emitted x-ray spectrum and the atomic number of an element) as if it were an entity that had *two* principal causal players within it. Data of this sort has traditionally prompted the inference to protons. In our model, the two players that dominate the x-ray spectrum of the helium atom are A1 and A2, since the influences of A3 and A4 are mainly directed to counterbalancing opposite influences within the helium atom itself.

On this model, what is normally described as a “proton” is a genesis-unit whose electrostatic influences are not mainly counterbalanced by the opposing electrostatic influences of other genesis-units in the complex structure. “Neutrons”, by contrast, are genesis-units

whose electrostatic influences are directed to other units in the composite atom. We see then that the electrostatic capacity of the “neutron” is mainly employed with the structural task of holding the atom together, whilst the “proton” has sufficient “residual” electrostatic influence to generate the kind of empirical data recorded in a pioneering way by Moseley. It is the number of “protons” then that will dictate the atomic number of the element.

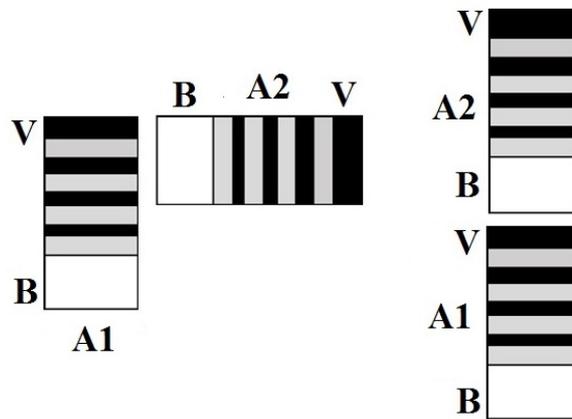


Figure 1.8 Alternate fusion patterns that are unstable

Figure 1.8 shows two different ways in which hydrogen atoms could conceivably fuse together. To the left, A2 is shown fused to A1 in a perpendicular alignment, with its B being held to the V of A1 by simple electrostatic attraction. To the right, the same poles fuse together in a vertical alignment. Are such alignments found in nature? If not, this would present a challenge for our model and may indicate that the shape of genesis-units is not accurately represented by simple cylindrical “wells”. The non-occurrence of such alignments would suggest two possibilities: firstly, perhaps the real shape of the genesis-unit is such that alignments of this sort would actually involve bringing portions of like poles together (this possibility is explored in Figure 1.9); or, secondly, perhaps the true shape of the unit permits alignments of this sort to happen in a fleeting manner, but there is something about the alignment that makes it very likely (in high energy situations) to fragment into individual units or transmute into an alignment of a different sort.

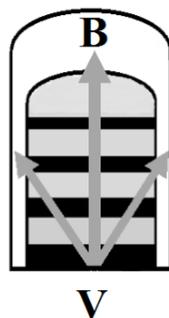


Figure 1.9 Alternative attempt to depict the genesis-unit.

Figure 1.9 presents an alternative image of the atom. The B pole is drawn up out of nothingness, creating a cylindrical well, but the B component is not located entirely at the top end of the unit. In this model, the real kernel of the V component is located at the *centre* of the bottom end, and the outermost “skin” of the cylinder which is most distant from this kernel consists in B component. However, if the B component is concentrated *principally* at the top end, then the

unit will have a definite, unitary direction of alignment and will give rise to the sort of empirical phenomena that we are anxious to explain, such as “magnetic spin”. The fact that most of the B component is concentrated on top, and the fact that the V component is dispersed throughout the rest of the unit, will entail that atoms will exhibit the diverse phenomena of neutral influence, net attraction and extreme repulsion described earlier in this chapter. But, on this model, it would be more difficult for two hydrogen atoms to bond end to end, which seems entirely possible for the original model. Consider the arrangement depicted on the left side of Figure 1.10. The proportion of B component located on the periphery of the V end of A1 counteracts the attractive influence of the B pole of A2 and makes for an unstable bond. However, when four units are thrown into the arrangement depicted to the right, the previous instability prompted by the repulsion of the B pole of A2 and the B component on the periphery of the V pole of A1 is now counterbalanced by the proximity of the V pole of A4. Indeed, the very symmetry of this arrangement ensures that the various electrostatic influences are perfectly counterbalanced, giving rise to a distinctly stable bond.

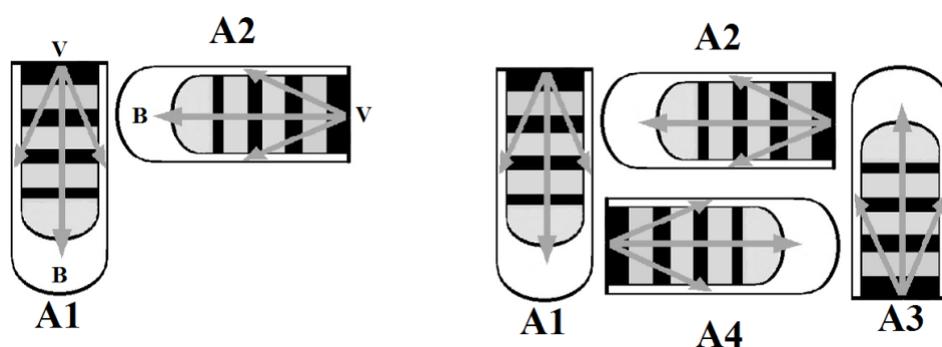


Figure 1.10 To the left is depicted an unstable arrangement of two genesis-units. The B pole of A2 is repelled to some degree by the portion of B component on the periphery of the V pole of A1. To the right we see a stable configuration of four genesis-units to form helium.

As this chapter progresses, it will be argued that symmetry of atomic structure - and the consequent electrostatic equilibrium that it guarantees - is the key to understanding chemical bonding and the mysterious orderliness of the periodic table of elements. But we must leave it to those with greater mathematical and geometrical expertise to work out the shape and distribution of the B and V components within the genesis-unit. The criteria for working out that shape and distribution are purely empirical. Among these are the observation that two hydrogen atoms will not fuse together in an atom without the presence of other “capping” units. The initial energies necessary for atomic fusion to occur, and the final energies released when the fusion of helium is achieved, are the key data for understanding the initial electrostatic repulsion between genesis-units and the final state of electrostatic equilibrium, resulting in the emission of energy. This data should yield the distribution of the B and V components around the genesis-unit, since it is this distribution that is responsible for the pattern of energy absorption and emission.

1.3 ELEMENTS HEAVIER THAN HELIUM

Moseley’s findings on the x-ray spectra emitted by various atoms constitute the essential starting point for developing a model of the atom. Moseley placed samples of elements in an evacuated glass tube. The samples were subject to causal excitation, resulting in the emission of x-ray radiation. The radiation was diffracted through a crystal, allowing its spectrum to be analysed. It was found that there was a strict mathematical relationship between aspects of the emitted spectrum and the atomic number of the element used in the sample. This establishes beyond doubt that the atomic number of an element is no mere convention. It is not simply a

way of categorizing elements in order of their relative masses. The number itself corresponds to a definite physical feature of the atoms of that element, and the consensus in the scientific community has been that the feature in question is the number of protons in the nucleus of the atom. As already stated, our approach interprets the atomic number to correspond to the *number of genesis-units* whose electrostatic influences are not counterbalanced by the electrostatic influences of other units in the complex structure. Using this approach, we intend to account for the structure of the periodic table and explain the bonding characteristics of the various groups of elements.

The *fusion* that takes place when helium is formed is something radical and bears little relation to the kind of attachment that takes place when atoms settle into the states of electrostatic equilibrium that occur during *chemical bonding*. Indeed, as the famous experiment carried out by Geiger and Marsden under the direction of Rutherford showed, matter that appears solid is actually made up mostly of empty space. This is usually interpreted in terms of atoms with a central nucleus and electrons spinning in a void, but it can just as well be understood in terms of a model of matter in which atoms are *smaller and more compact*, but held at a distance from each other by the electrostatic tension that keeps them in equilibrium. Our model of the atom helps to explain why these vast empty spaces exist within portions of matter. Atoms are held at a certain distance from each other because at that point mutual net attraction is the case; closer proximity would result in mutual repulsion. At this point of relative electrostatic equilibrium, the influences of the B and V components of the genesis-unit are reciprocated, even though the atoms that are “attached” to each other will not even be in physical contact. The *fusion* of genesis-units into heavier atoms differs radically from this sort of attachment and results in a structure that is much more compact.

The standard model asserts that the heavier atoms arise from the process of nucleosynthesis in which elementary particles are fused together to form nuclei. The nuclei later capture electrons in order to create atoms that are electrostatically neutral. The fusion of nuclei and the capture of electrons proceed in stages, with the electrons taking up positions in various shells around the nucleus, beginning with the innermost shell and only proceeding outwards when the inner shells are full. The shells each have a maximum capacity as far as electrons are concerned, and this capacity fulfils certain mathematical regularities depending on the number of the shell. Whenever the mathematical regularities fail to hold, reasons for the anomalies are given, some of which are plausible, some less so.

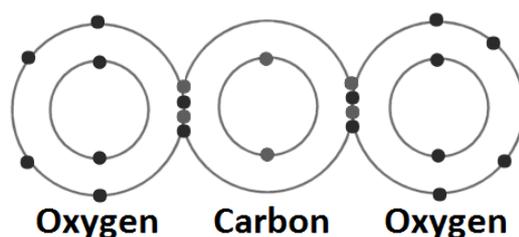


Figure 1.11 Carbon dioxide – a classic example of a so-called “covalent” bond. Oxygen, we are told, normally has six electrons in its outer shell and requires two more for “completion”. An atom of carbon, instead, is short four electrons in its outer shell. If an atom of carbon donates two of its electrons to two different oxygen atoms, receiving two electrons in return from each atom, then all three atoms will end up with full outer shells.

Along with this picture of the formation of the elements, there is an intuitively-attractive account of how chemical bonds are forged between atoms of different elements. Elements tend to bond with other atoms in such a way, we are told, that they end up with outer shells that are completely full of electrons. Thus an element that happens to have only one electron in its outer shell (such as sodium) might “donate” this electron to an atom whose outer shell lacks a single electron in order to be full (for example, chlorine). As a result of the donation, both atoms

become electrostatically charged in opposite ways and are attracted to each other to complete the bond and form the chemical substance known as sodium chloride, or common salt. Other elements bond by *sharing* the electrons in their outer shells. Figure 1.11 shows a simple depiction of how two oxygen atoms share electrons with a carbon atom so that all three end up with full outer shells.

Using this model of atomic bonding, the structure of the periodic table began to make sense. The periodic table itself had been drawn up in the previous century when chemists like Dmitri Mendeleev and others laid out rows of elements in order of ascending weight. A new row was begun when the chemical characteristics of the previous elements in the table began to repeat. As a result, the columns of the tables ended up containing elements with similar chemical properties. One of the most significant columns was that of the noble gases, a group of colourless, odourless elements that are extremely stable. A simple structuring of the table would place these elements in the right-most column, whereas the highly reactive alkali metals would be placed in the left-most column (containing elements that each had an atomic number one greater than the closest noble gas). In the early decades of the twentieth century, physicists such as G.N. Lewis began to realise that sense could be made of some of the regular features of the periodic table if they were understood in terms of elements with similar numbers of electrons in their outer shells. The noble gases were assumed to have full outer shells, meaning that they had no inherent tendency to seek chemical bonds that would lead to outer shell completion. The alkali metals, by contrast, all had only one electron in their outer shells and were highly reactive. By “losing” that electron, an element such as sodium (with eleven electrons originally and only one in its outer shell) assumed an electron configuration similar to that of the noble gas argon (which has ten electrons, eight of which are in the outer shell).

This impressively simple account of atomic bonding and the structure of the periodic table leaves many questions unanswered. Presentations of the subject make assertions like: “Because the second shell can only hold a total of eight electrons . . .”; but it is far from clear why the shells have certain capacities and why these capacities are determined by the particular mathematical formulae that govern them. There are also grave problems with the postulation of the electron itself, as we will argue later. One thing that *is* clear, however, is that the mathematical formulae and the numerical relationships that are captured by the structure of the periodic table *must* have a concrete grounding in the nature of the various elements and in their bonding characteristics.

Can we develop a more coherent and ordered theoretical grounding for the periodic table than the standard picture based on electron shells? The model presented below is rudimentary and is the fruit of a modest period of reflection on the structure of the table, but it nevertheless demonstrates that reasonable alternatives to the electron picture are possible. The synthesis of hydrogen atoms into more composite structures is described in terms of a few simple patterns of fusion.

Figure 1.12 illustrates two ways that genesis-units will be depicted in this chapter, depending on their overall role within the complex atom. To the left we have an illustration which shows the different polarities of the various genesis-units in the composite structure. On the right is a schematic diagram that will be useful when we come to consider the chemical bonds formed between elements. The grey horizontal lines represent the *binding* units, i.e., those genesis-units whose role it is to hold the structure together and whose electrostatic influences are largely counterbalanced by other influences within the structure. The ovals represent the genesis-units whose electrostatic influences are *not* largely counterbalanced by other forces within the atom. Thus they will have a primary role in determining the chemical properties and emission spectra of the element. It is the number of these kind of units that will correspond to the atomic number of the element. The fact that the oval units are depicted in this diagram larger than the binding units has no correspondence in reality. The two sets of

units are identical in nature but happen to play a different role in the cohesion of the atom. But the practice of depicting the outer units as larger will help us later to highlight the structural role they play in chemical reactions with other elements.

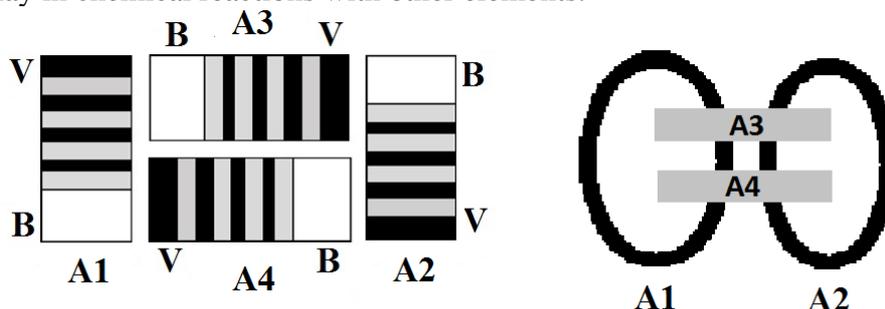


Figure 1.12 The helium atom. According to our model of atomic fusion, helium is composed of two genesis-units held together by two “binding units” – i.e., genesis-units whose role it is to hold the structure together and whose electrostatic influences are largely counterbalanced by other influences within the structure. On the right is the simpler schematic diagram that we will find useful later when we consider chemical bonding. The grey horizontal lines represent the binding units.

The helium atom fused from four hydrogen atoms becomes the fundamental building block or corner-stone upon which the stable heavier atoms are generally formed (although the isotopes of some elements may not necessarily be formed around a ^4He atom). ^4He is an extremely stable entity, a prime case of the kind of equilibrium enjoyed by atoms with an even number of genesis-units. An even number indicates greater reciprocity of electrostatic influences between the genesis-units. According to our model of causal interaction, causal tendencies such as attraction and repulsion always proceed in the direction of restoring equilibrium in the system. A balanced and compact unit such as the helium atom lacks the internal disequilibrium required to attract an entity with the opposite sort of disequilibrium. In the extreme circumstances that prevail in the interior of stars, this atom now interacts with other hydrogen atoms. The fusion of a new hydrogen atom onto the pre-existing structure will be more enduring if it is accomplished using two binding genesis-units to hold it to the stable helium atom (see Figure 1.13).

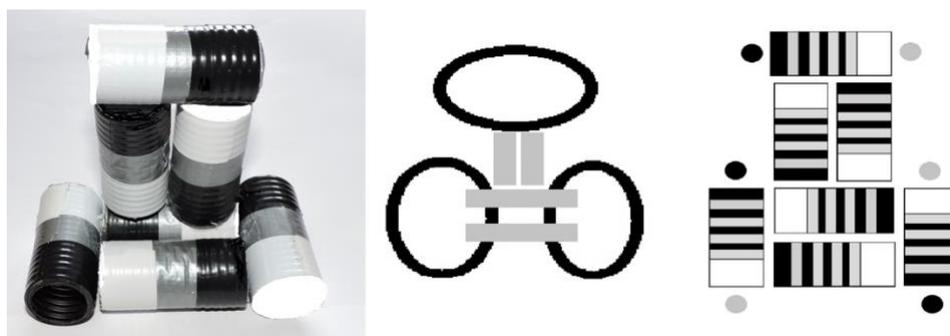


Figure 1.13 Lithium. On the left is a three dimensional model made from garden hose. The simpler diagram in the centre highlights the genesis-units whose electrostatic influences are not covered (henceforth referred to as “proactive” genesis-units”). We see that a genesis-unit has been fused to the helium atom by means of two binding units. If only one binding unit is used, then the lithium atom will be prone to bind to other atoms, producing heavier elements. But a lithium isotope without this extra binding unit is possible. ^6Li exists naturally and is stable. The image on the right is a more elaborate illustration of lithium showing the proactive units whose poles are “uncovered” and thus have the observable effects that lead us to assign the atomic number “3” to this element.

There are two stable isotopes of lithium. The most common has two binding units holding the final hydrogen atom onto the atom of helium (^7Li), whilst the other isotope uses only one binding unit in this role (^6Li). Presumably the reason why ^7Li is ten times more abundant in nature is the fact that ^6Li does not have the electrostatic equilibrium that this extra binding unit

brings. Thus it has a higher probability of being transformed into one of the heavier elements or fragmenting back into a helium atom and two stray hydrogen atoms. The image to the right of Figure 1.13 shows the lithium atom in more detail. We see how the three genesis-units at the corners of the triangle have the extremities of their poles completely uncovered (highlighted by the black and grey dots), thus enabling them to exert electrostatic influence on other particles in the vicinity. This atom, consequently, will generate empirical data indicating that there are *three* principal causal players within this element, at least as far as its influence on *other* atoms is concerned, prompting scientists to assign it atomic number 3. Henceforth we will refer to the genesis-units that have this role within the atom as being “proactive”. The four *binding* units at the centre, by contrast, have all the extremities of their poles covered: their electrostatic influences are counterbalanced by the other units in the structure and they will not have a noticeable influence on the observable behaviour of the atom.

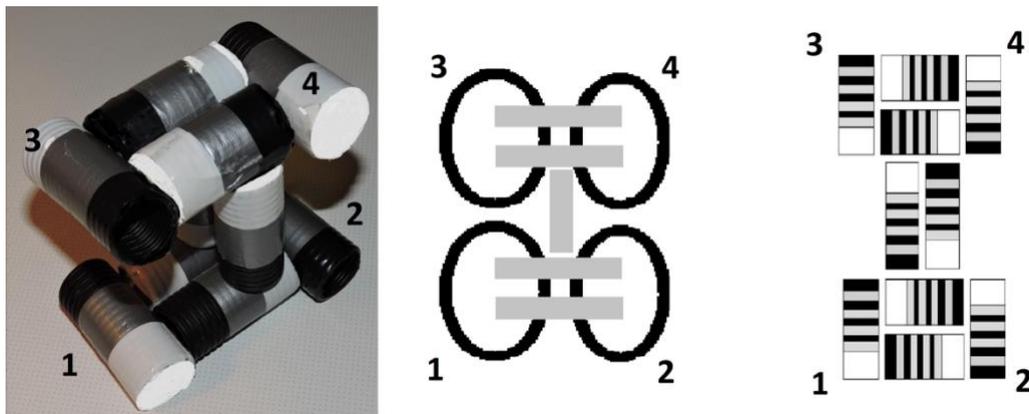


Figure 1.14 Three views of beryllium. On the left is the 3-D model of ^{10}Be , the most stable isotope of beryllium. Notice the way the two “binding” units are positioned in the interior of the atom. In the centre is a schematic flat diagram depicting the most common form of the element, ^9Be , consisting of two helium atoms fused together with a single binding unit. To the right we have the more elaborate flattened diagram of ^{10}Be which shows the polarities of the genesis-units. But the shortcomings of this flat diagram are evident if we compare the positioning of the individual units with the correct positioning on the 3-D model.

The next element on the atomic table is beryllium. The most common form of this element results when two helium atoms are fused together with a *single* binding unit, as depicted on the left of Figure 1.14. The most stable isotope of beryllium is ^{10}Be . This would consist of two helium atoms fused together with *two* binding units, as depicted on the right of the diagram. It is not surprising to learn that ^8Be is an extremely unstable isotope of beryllium with a half-life of only 6.7×10^{-17} seconds. The tendency of the relatively imbalanced ^8Be to degenerate into two much more electrostatically balanced ^4He atoms is just too powerful to allow the isotope to exist for long.

The most common form of boron, ^{11}B , is typically formed, on our view, when two atoms of hydrogen are fused (using two binding units) to the most common isotope of lithium, ^7Li (^{11}B is depicted on the left side of Figure 1.15). As we saw earlier, the ^6Li isotope also exists and is stable. As might be expected, the fusion of hydrogen atoms onto this form of lithium should lead to a stable isotope of boron that contains one less genesis-unit than the more common form. And we find that ^{10}B does indeed exist in nature as a stable isotope of boron, but ^{11}B is about four times more abundant in the universe.

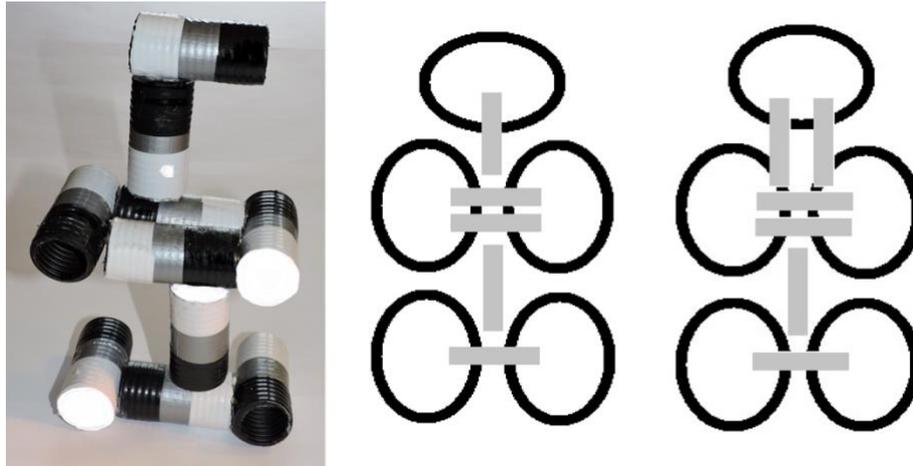


Figure 1.15 Isotopes of boron. The most common form of boron, ^{11}B , is depicted on the right. The original ^7Li atom can be seen at the top of the structure. To the left and centre we have the stable isotope, ^{10}B , formed by fusing genesis-units to the ^6Li form of lithium.

The most common form of boron (^{11}B) has an uneven number of genesis-units. As we shall see as we go along, genesis-units tend to be arranged in pairs in composite atoms because that is how their electrostatic influences prompt them to align themselves. The general tendency is for the units to position themselves so that they mutually balance their reciprocal influences to the greatest possible extent. In the high-energy inferno in which new atoms are formed, elements that have an *uneven* number of genesis-units often show a disposition to “pick up” a *single* genesis-unit and transmute into new elements. The unpaired genesis-unit in the original atom is like a hook for any stray unit that comes available for fusion. This propensity is not present in all atoms that have uneven numbers of genesis-units, because it depends on how those units are arranged and how well the electrostatic influences are already reciprocated. In the case of ^{11}B , there is indeed this tendency to pick up an extra unit, giving rise to the formation of ^{12}C , by far the most common form of carbon (Figure 1.16). Of course, different stable arrangements of units to form carbon are also possible. ^{13}C is a stable isotope, and like ^9Be would involve another of the pairs of genesis-units in the structure fusing together with the aid of two binding units, as was the case with ^4He .

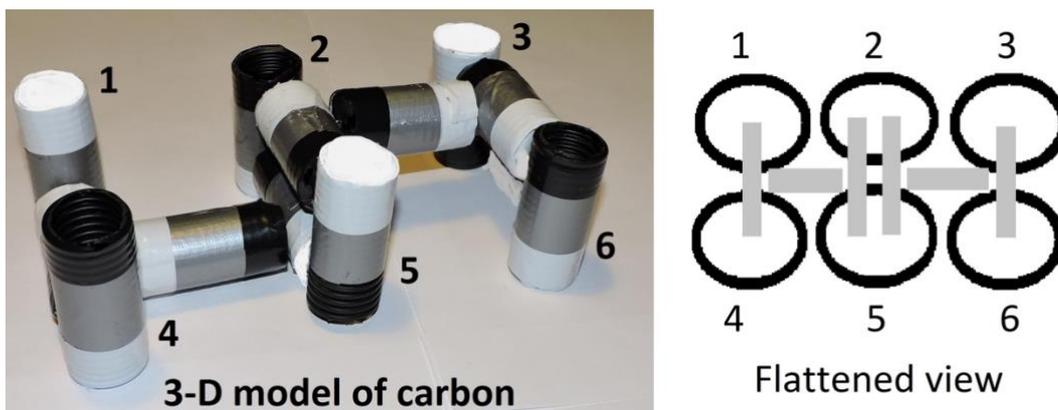


Figure 1.16 Carbon. The six “uncovered” genesis-units at the periphery of the atom give the element its atomic number. The most common form of the atom (^{12}C) uses six binding units as well

Oxygen is an interesting case. It has an atomic number two higher than carbon and an atomic weight that is four atomic mass units greater. Evidently, two proactive units have been fused to carbon using two binding units. But where exactly on carbon have these units been fused? The standard approach to the atom works out where each new electron is placed as the process of nucleosynthesis progresses and the latest electron is captured. We shall compare our view

to this standard approach in more detail later when we turn to the real meaning of the Pauli exclusion principle. According to Hund's Rule, orbitals (which can hold a maximum of two electrons with opposite magnetic spin) are each occupied *singly* with electrons of parallel spin before double occupation occurs. If we were to adapt this rule to our model of atom formation, then the genesis-units fused to carbon to form oxygen should be added on in the manner shown in the atom to the right of Figure 1.17.

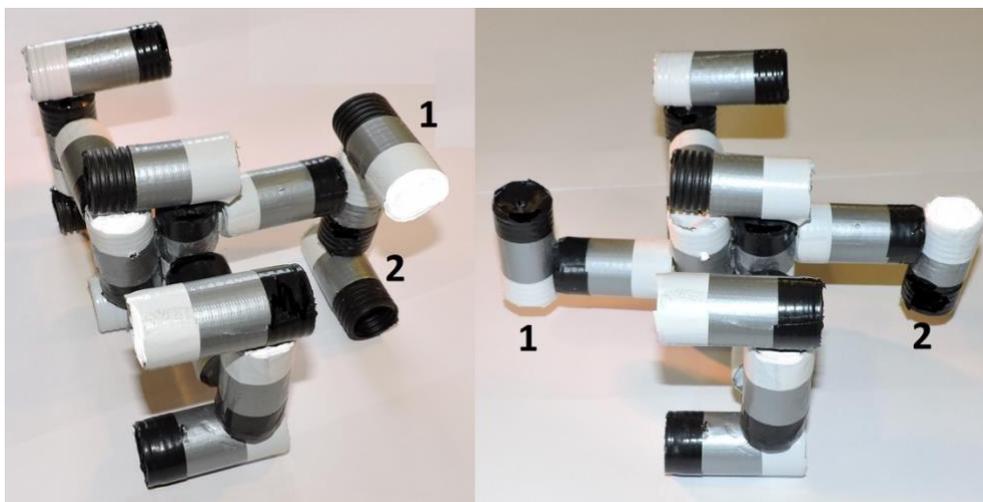


Figure 1.17 Oxygen. The version of the oxygen atom to the right shows a single proactive unit fused with a single binding unit onto each side of carbon. The chemical bonding behaviour of oxygen, however, leads to a rejection of this model of the element. The correct version to the left shown two proactive units fused using two binding units onto the same side of carbon.

Here, a binding unit and a proactive unit are fused onto each side of a carbon atom, in a bow to an adapted form of Hund's Rule. We will see later, however, how a structure of oxygen of this sort does not help us to explain the behaviour of oxygen when it comes to chemical bonding. If the structure of oxygen is as shown to the left of Figure 1.17, then we can do a better job in accounting for this behaviour. It may seem unwise at this point to disobey a respected rule of thumb like Hund's Rule solely on the basis of the structural features of a primitive model. Hopefully some of the strengths of our approach will become more evident by the time we come to discuss the exclusion principle.

The structure of lithium is our model for the formation of elements that have uneven atomic numbers, whilst carbon (i.e., ^{12}C) is the model for elements with even numbers. The basic principle is that two binding units are generally utilized for the fusion of a new proactive hydrogen atom to a composite structure that is composed of *pairs* of genesis-units in relative stability. For composite atoms that have a non-paired genesis-unit, by contrast, a new hydrogen atom can be attached to this "hook" without any other binding unit being required. The lithium model is repeated for boron, nitrogen (^{15}N), fluorine, sodium, aluminium, phosphorous, chlorine and potassium. The carbon model is repeated for oxygen, neon, magnesium, silicon, sulphur, argon (^{36}Ar) and calcium.

This approach to fusion helps to explain a pattern that is repeated regularly in the periodic table. As we move progressively through the table from the lighter elements upwards, the mass of the next element in succession rises by one atomic unit, then by three atomic units, then by one atomic unit, then three, etc.. Our model of atomic fusion readily suggests various explanations for this 1-3-1-3 pattern. The explanation given above perhaps comes to mind most readily: namely, elements that have an even number of proactive units are relatively stable and will have little residual electrostatic influence that would make them prone to picking up another genesis-unit; thus, two binding units are required for the fusion of a new proactive unit; elements with uneven proactive genesis-units, by contrast, will have a relatively high

magnitude of residual electrostatic influence, making it very easy for them to fuse another proactive genesis-unit without the aid of extra binding units. Another explanation also comes to mind: perhaps each element is not typically formed by fusing genesis-units onto the element directly below it in the table; perhaps it is formed by the fusion of *four* units onto the element that came *two places* earlier in the table; thus aluminium (atomic number 13 with atomic weight 27) is formed by the fusion of four units onto sodium (atomic number 11 with atomic weight 23); silicon (atomic number 14 with atomic weight 28) is formed by adding four units onto magnesium (atomic number 12 and weight 24). This latter explanation has a certain consistency in that it accounts for significant stretches of the periodic table in terms of a pattern of fusion in which *pairs* of proactive units are appended to pre-existing elements using *pairs* of binding units. Of course, there are exceptions to this rule, but these can be accounted for without having to stretch credulity too much.

Two elements are worthy of comment. The most common isotope of nitrogen is ^{14}N , whereas our first explanation would predict that the formation of nitrogen would proceed by using two binding units to fuse a proactive unit to carbon (^{12}C), thus leading to the formation of ^{15}N (and the second explanation would predict that ^{15}N would have been formed by fusing four units onto ^{11}B). It is interesting that ^{15}N *is* indeed a stable isotope of nitrogen, a fact that is consistent with our approach to atomic fusion. The abundance of ^{14}N in the universe, however, confirms that a single binding unit is sometimes sufficient to fuse a proactive genesis-unit to a composite atom consisting of stable pairs of genesis-units. Perhaps nitrogen differs simply because of its greater size. Empirical considerations such as size can be expected to exert an influence on the process of atomic fusion. General rules or principles may well hold in limited situations but will be modified or abrogated by changing empirical conditions. ^{14}N may have superior stability to ^6Li and ^{10}B because it is larger. It may be less likely to have a new genesis-unit fused to it immediately because the complex internal relationship of the seven genesis-units in the structure may confer on it a greater degree of internal cohesion than is the case with ^6Li and ^{10}B .

The other element that requires a comment is argon. According to our model, it ought to be possible to form argon from chlorine without the aid of an extra binding unit (or, alternatively, form argon from sulphur using four units in total). Chlorine has an uneven number of genesis-units and therefore has the “hook” that dispenses with the need for additional binding units. The standard periodic table tells us, however, that argon has an atomic weight of forty atomic mass units, indicating that four binding units were utilised to fuse the hydrogen atom to chlorine, an atom with an *uneven* atomic number! This seems a strong counterexample to our model. But when we examine the matter more closely, we discover that the abundance of ^{40}Ar in the earth’s atmosphere is an accident of the peculiar history of development of our planet. It was not formed by atomic fusion at all but has its origin in radioactive potassium - ^{40}K . ^{36}Ar , on the other hand, is by far the most abundant isotope of argon in the sun and the stars, just as our model would predict. According to the simple model of atomic fusion that we are following, argon ought to consist of eighteen proactive units and eighteen binding units, conferring on it an atomic weight of thirty six atomic units. And this is precisely the weight of the most common isotope of argon.

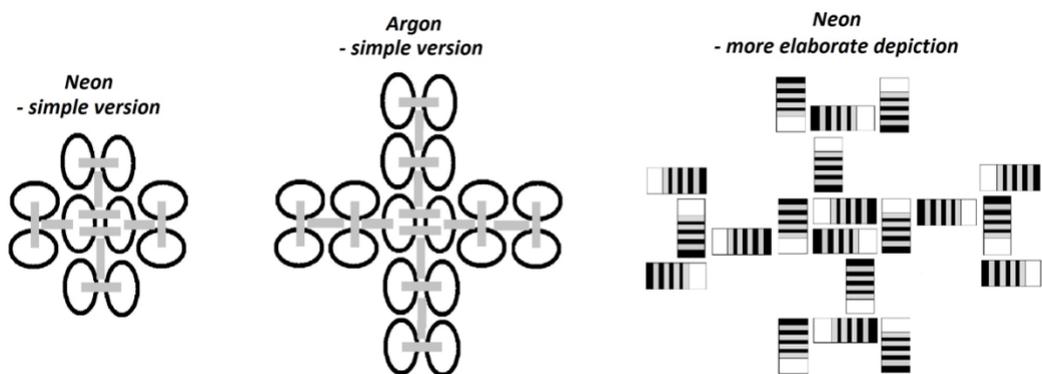


Figure 1.18 The structures of neon and argon. Both have exceptional stability because of their regularity of structure. The original helium atom is positioned at the centre of the arrangement. Each proactive genesis-unit is one of a pair, guaranteeing that its B-V polarity is well reciprocated. The overall symmetry of the structures ensures that residual attractions between the polarities of different sets of pairs are also reciprocated. Overall, there is relatively little disequilibrium in the composite atoms that would make them attractive to other atoms that have the opposite kind of disequilibria, thus they are almost completely non-reactive.

Figure 1.18 presents hypothetical structures for neon and argon. Every proactive genesis-unit is paired off, which means that their B-V polarities are reciprocated by the other member of the pair. However, we must assume that the influences of the B and V poles of a particular genesis-unit cannot be completely covered by the opposite poles of its partner, no matter how closely fused that partner might be. Take a pair composed of genesis-units A1 and A2, where A2 is situated to the right of A1. If a further genesis-unit is positioned to the left of A1, then presumably it will also be influenced by the polarity of A1, since A1's sphere of influence is precisely that – spherical in nature – and a partner can only be located to one side or the other. We refer to this influence as the “residual” influence of A. Most of A1's B-V polarity will be covered by A2 but it can hardly be covered completely. That is why *symmetrical* structures for composite atoms will be more stable. As well as ensuring that the residual influences of the various genesis-units are reciprocated evenly, giving compactness and cohesiveness to the structure itself, symmetry also makes the composite atom less likely to bond with other atoms. A symmetrical structure will be more balanced as far as the B-V polarities of its constituents are concerned. According to our model of causal interaction, the causal dynamics of any system is fundamentally directed towards achieving equilibrium. The most reactive substances are those in disequilibrium since they naturally give rise to processes that evolve towards equilibrium. Neon and argon are already stable and have little tendency to interact with other objects because they have little need to evolve towards equilibrium.

The structures of potassium and calcium are compatible with our model of atomic fusion. Potassium utilizes two binding units to fuse one proactive unit to ^{36}Ar , the most common isotope of argon. Calcium is formed when a single genesis-unit fuses to one of the “hook” units in potassium without the need for an additional binding unit. Alternatively, calcium may be formed by fusing two proactive genesis-units to ^{36}Ar using two binding units. This would give rise to ^{40}Ca , the most common isotope of calcium.

As the elements get heavier, more binding units are sometimes used for the fusion of new proactive units. Presumably this is a function of the changing empirical conditions as atoms become more massive. But the pattern of fusion that we have outlined is still followed in various stretches of the table, even for heavier elements. Titanium (^{48}Ti) is composed of twenty two proactive genesis-units fused together with twenty six binding units. Each proactive genesis-unit is paired off, so two binding units are utilized to fuse a new proactive unit and form the next element on the table, vanadium, which has twenty three proactive units and twenty eight binding units. Chromium is then formed by simply adding a proactive unit to the

hook unit of vanadium without the need for an extra binding unit. To create manganese from chromium, two binding units are again used to fuse a proactive unit, and then iron is formed simply by adding a genesis-unit to the hook unit of manganese. In turn, cobalt is formed from iron with the aid of two binding units.

It is not too surprising that the pattern of fusion that we have proposed should be generally applicable only to the lighter elements. Heavier elements are much more likely to be formed by the fusion of atoms that are *already composite*, instead of involving simple fusions of individual genesis-units to composite atoms. But even if our model of fusion cannot be extended to all of the heavier elements, our model of atomic stability and cohesiveness should still hold good. Atoms that have even numbers of proactive genesis-units arranged symmetrically ought to be less reactive. Let us see how this can be applied to the next noble gases - krypton, xenon and radon.

Krypton has an atomic number of thirty six, whereas argon had exactly half that number. Our hypothetical structure for argon (see Figure 1.18) had the pairs of atoms arranged in a more or less two-dimensional cross, with a pair of proactive genesis-units at the centre and two pairs arranged along each of the four arms. Krypton is formed from *two entire crosses* like these fused on top of each other. In that case there would be ample scope for the composite atom to absorb variable numbers of binding units at the various points of contact between the crosses. And indeed there are multiple stable isotopes of krypton, one of which is ^{80}Kr . This, we imagine, could be composed of the two crosses of argon (two atoms of argon composed of 36 genesis-units each) plus a binding unit for each pair of genesis-units in the arms of the cross to fuse the two argon crosses together (eight binding units) to give a total of 80 genesis-units.

The next noble gas is xenon and it has an atomic number of 54, exactly triple that of argon. We can imagine that it might be formed from three of the argon crosses fused together, this giving it the same symmetry enjoyed by the lighter noble gases. All of this is perfectly compatible with our model of atomic equilibrium. When we come to radon, however, composed of eighty six genesis-units, there is no obvious way of arranging this number into a symmetrical structure. And perhaps there is no need to do so, for when we look at the case of radon we discover that it is not generated by atomic fusion at all, and neither does it enjoy the stability and cohesiveness of the other noble gases. Radon is characterised as a noble gas because it is inert and does not combine readily with other elements. Like the noble gases, it is colourless and odourless. But it has its origin in the radioactive decay of other elements, and it does not have a single stable isotope. Its longest-lived isotope, ^{222}Rn , has a half-life of less than four days. Thus, the lack of a symmetrical structure for radon cannot be taken as a counter-example to our model of the stability of the noble gases, for radon is far from stable. This is undoubtedly due to many factors apart from the asymmetry, not least among them the process by which radon is generated.

1.4 CHEMICAL BONDS BETWEEN ATOMS OF DIFFERENT ELEMENTS

According to our model, the formation of the elements at the beginning of the periodic table involves the progressive fusion of new genesis-units to composite atoms that were already formed in the same fashion. We cannot rule out that some atoms (such as beryllium, perhaps) may derive from the fusion of two or more ready-made helium atoms, or indeed heavier elements. Once the genesis-units have been fused together, they are more or less in equilibrium, depending in part on whether or not they form a pair within the composite structure. But the equilibrium of a genesis-unit within the structure will also depend on the symmetry of the structure as a whole, as we have discussed earlier. Even if a genesis-unit is part of a pair, all of its B-V polarity will not be reciprocated perfectly by the polarity of its partner. Any causal agent in disequilibrium will exert its influence in all directions. The partner of a given genesis-unit, A1, may well reciprocate most of A1's influence, greatly diminishing it, but the fact that

the partner can only take up a position on one side of A1 means that A1 will still exert an effect on the other side if a third genesis-unit comes within range.

The upshot of all of this is that the bonding behaviour of an element on the macro-level will mirror the structure of the atoms of that element at the micro-level. A composite atom with a non-symmetrical structure will be more inclined to bond with other elements in such a way as to produce a compound structure that has symmetry. If the combination of two elements does not produce a certain level of symmetry, then they will not mix at all. Elements that already have symmetrical structures will be less inclined to bond with any other substance, although particular empirical conditions could coerce a symmetrical element into a bond of some sort.

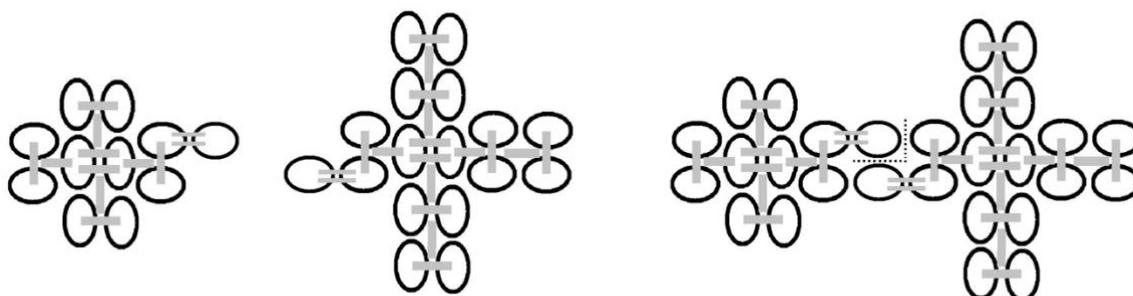


Figure 1.19 Atoms of sodium (left) and chlorine (centre). Sodium is formed from an extra proactive genesis-unit fused to a neon atom, whilst chlorine resembles an atom of argon with one proactive unit missing. These incomplete symmetries make both elements reactive because of the poorly reciprocated electrostatic influences of the unpaired genesis-unit in each atom. Thus they are prone to bond with other elements. To the right, we have a depiction of the sodium chloride molecule. The bond is held together by the residual electrostatic disequilibria of the “hook” genesis-units of sodium and chlorine.

The classic case of a chemical bond is that of sodium chloride, or common salt. According to the standard approach, sodium has a single electron in its outer shell, whilst chlorine lacks a single electron for the completion of its outer shell. Our model agrees that sodium has something “extra” whilst chlorine has something “missing”, and in both cases that something is the genesis-unit whose absence or presence would confer on the respective elements a much greater symmetry. Figure 1.19 attempts to represent what is involved in that evolution towards symmetry. It is important to emphasize that the depicted symmetrical structures are hypothetical and schematic in nature. The business of discerning the real symmetries that exist in composite atoms like those of sodium or chlorine cannot be accomplished without detailed examination of the empirical evidence. The principal point that we are interested in is the claim that the propensity of an atom towards chemical bonding is driven by asymmetry (which gives rise to a certain level of electrostatic disequilibrium); thus, the net result of chemical bonding is the creation of greater symmetry (and the better reciprocation of electrostatic influences). In this sense, our model has superior explanatory power to the standard approach. The standard electron shell model fails to give a coherent account of why the shells have various capacities and why atoms tend to bond in such a way that the maximum capacity of the outer shell is achieved.

Simple examples of the covalent bond are water (H_2O) and carbon dioxide. Oxygen is composed of four pairs of proactive genesis-units arranged in a cross-like formation, but with one arm missing. If two hydrogen atoms bond to oxygen then it achieves the kind of symmetry enjoyed by neon.

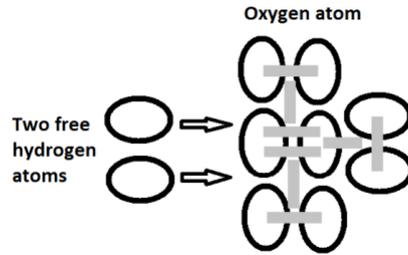


Figure 1.20 H_2O . Two hydrogen atoms bond to oxygen to form a symmetrical structure similar to neon

Earlier we had a brief look at the standard picture of the carbon dioxide molecule. The bond was considered to involve the sharing of pairs of electrons by each of two oxygen atoms and a single carbon atom. This filled the outer shell of all three atoms to eight electrons each. Our symmetry model of bonding sees the carbon dioxide molecule in very different terms, but agrees that oxygen is lacking two “somethings” and that carbon can supply that lack. Figure 1.21 shows two possible arrangements of oxygen and carbon atoms in such a way as to achieve greater symmetry.

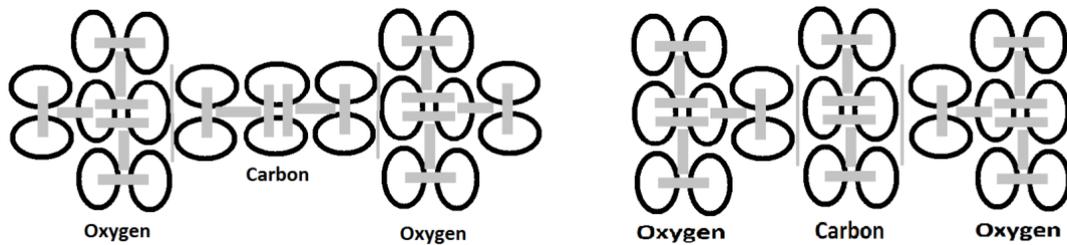


Figure 1.21 Schematic representation of the formation of the carbon dioxide molecule. Oxygen lacks a pair of proactive genesis-units for symmetry. The arrangement to the left shows how a single carbon atom could bond with two oxygen atoms to form a symmetrical arrangement. The arrangement on the right may also be possible.

Another straightforward example of this tendency towards symmetry is the molecule of methane (CH_4). Four hydrogen atoms will confer on carbon the perfect symmetry of neon (see Figure 1.22).

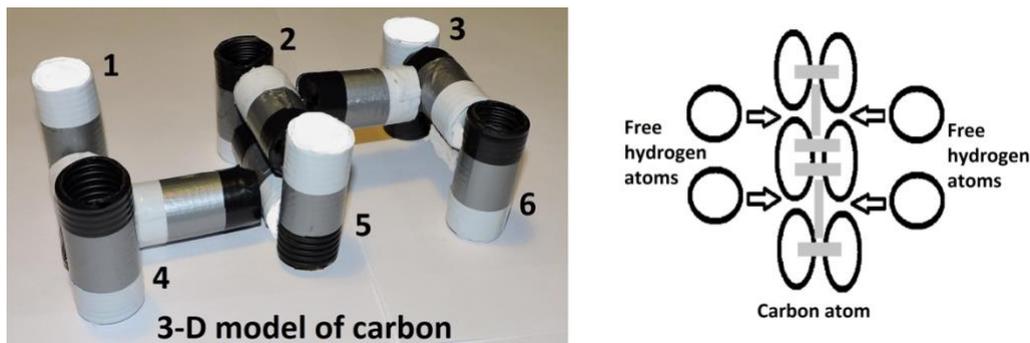


Figure 1.22 Carbon and methane (CH_4). On the left is a 3-D model of carbon, whilst, on the right, four hydrogen atoms bond to carbon to form a symmetrical structure like neon.

1.5 THE STRUCTURE OF THE PERIODIC TABLE AND THE MEANING OF THE NUMBERS

By this point it should be becoming clear how the structure of the periodic table is to be interpreted. The causal dynamics that underlies the process of atomic fusion is driven by the question of equilibrium. The progressive fusion of genesis-units onto composite atoms will not result in a stable and permanent element unless the new atom possesses a degree of internal equilibrium, and this will be largely dependent on the mutual reciprocation of causal influences by the various genesis-units making up the composite atom. A symmetrical arrangement of

pairs of genesis-units is the key to the stability of an atom, but elements do not require a perfectly symmetrical structure in order to enjoy a relatively permanent existence. A composite atom has a greater or lesser symmetrical structure, and its relative symmetry at the micro-level will dictate its degree of reactivity with other elements. All stable chemical bonds lead to a composite structure that is more symmetrical than their constituent atoms.

Different elements with similar features (as far as their symmetry or lack of symmetry is concerned) will have similar chemical properties. Each of the alkali metals from lithium onwards has the same structure as one of the noble gases with an extra proactive genesis-unit appended to it. Thus they are highly prone to bond with the halogens, which lack a genesis-unit in order to achieve symmetry.

Given this pattern of atomic bonding, it comes as no surprise to discover that the noble gases take on a paradigmatic quality as far as the formation of molecules is concerned. The noble gases have symmetry at the micro-level. Elements that have one more proactive genesis-unit than one of the noble gases will tend to bond to elements that have one less proactive genesis-unit in order to produce a symmetrical structure. Atoms that have two genesis-units more than a noble gas will bond to elements that have two units less (as is the case with the formation of beryllium oxide, for example).

Many bonding patterns can take place that increase symmetry but do not result in a structure that resembles a noble gas. Dilithium is composed of two atoms of lithium bonded together. Before the bond, the lithium atoms would each have had a genesis-unit that was not part of a pair. Once the bond is formed, these odd genesis-units will be attached to each other to form a non-fused pair, increasing the overall equilibrium of the structure. Bonds of this sort are easily explained using the symmetry model, but require a more complicated treatment using the valence electron approach.

It is important to keep in mind that the elements have no natural tendency to form bonds that increase symmetry *per se*. What drives the causal dynamics of entire systems is the tendency towards *equilibrium* between the various constituents of the system. Composite atoms like sodium or chlorine have internal disequilibria arising from the fact that their component genesis-units have influences that are not being reciprocated. The disequilibrium underneath is the motor that drives the causal dynamics of the system and causes sodium and chlorine to bond together in such a way that the various influences are reciprocated. Reciprocation is more likely when the arrangement of the structure is symmetrical. Thus symmetry is an indirect consequence of the natural evolution of a system, whereas lack of symmetry is an indication that an atom is likely to evolve in a certain direction.

-3	-2	-1	0	+1	+2	+3	+/- 4
				1 H			
			2 He	3 Li	4 Be	5 B	6 C
7 N	8 O	9 F	10 Ne	11 Na	12 Mg	13 Al	14 Si
15 P	16 S	17 Cl	18 Ar	19 K	20 Ca		

Figure 1.23 Periodic table based on the symmetry model of atomic bonding.

Figure 1.23 presents a periodic table for the first twenty elements. This is arranged in a way that highlights the tendency of the elements to increase their equilibrium through improved symmetry. Group 0 is the noble gases, elements that have their proactive genesis-units arranged

in perfect symmetry. Groups +1, +2 and +3 have one, two or three elements fused onto a symmetrical arrangement. Groups -1, -2 and -3, by contrast, are lacking one, two or three proactive genesis-units for a symmetrical structure. Group +/-4 has elements that have four genesis-units fused to a symmetrical composite atom, but can achieve symmetry if their bonding behaviour allows them to “gain” four more.

The number eight has a special significance in our attempt to organise the structure of the lower part of the periodic table. The standard model understands this feature in terms of the claim that the second electron shell has a capacity of eight electrons, whilst the s and p subshells of the third electron shell have a combined capacity of eight. According to that model, the elements are built up by adding protons (and neutrons) to the nucleus and electrons to the various shells. The elements up to argon are formed by progressively filling the first and second shells, and then the s and p subshells of the third electron shell.

Our model accounts for these numbers in a simpler and more concrete manner, citing equilibrium (and hence symmetry) as the explanatory key for understanding the structure of composite atoms. Helium was composed of two proactive genesis-units, and this corresponds to the standard model’s claim that the first shell has a capacity of two electrons. Around this helium core, four pairs of proactive genesis-units can be arranged symmetrically, corresponding to the standard claim that the second electron shell has a capacity of eight electrons. The cross-like structure of neon can once again become symmetrical if we add a pair of proactive genesis-units onto each of the four arms of the cross, corresponding to the s and p subshells of the valence model. In fact, extending the arms of the cross in a symmetrical banner *always* involves adding eight proactive genesis-units (one pair for each arm of the cross) on to the structure that was already there. Krypton, on our understanding, involves creating a composite atom from two argon crosses fused together. This is a leap of eighteen genesis-units from argon.

The structure of the standard periodic table perfectly mirrors this progressive development. The first row of the table has just two elements (hydrogen and helium) because the first milestone of symmetry is reached when helium is formed from two proactive genesis-units. The second row of the table has eight elements because the second milestone of symmetry is the cross-like structure of neon, formed by adding eight proactive units to helium. The third row again has eight elements because the next symmetrical structure can be realised by adding a pair of units onto each of the four arms of the cross of neon. The fourth row, by contrast, has eighteen elements because the next symmetrical structure involves fusing onto argon an entire cross-like structure composed of eighteen genesis-units.

The electron model is more laborious in the way it accounts for the structure of the table up to this juncture. The first electron shell has a capacity of two, and that explains why helium ends up in the rightmost column. The second shell has a capacity of eight, explaining why the second row has eight elements. The third shell is supposed to have a capacity of eighteen electrons, but its s and p subshells have a joint capacity of eight. The stability of argon (with eight electrons in the third shell), and the fact that the third row of the table has only eight elements, is thus “accounted for”, but in a contrived way. Similarly, Krypton is reckoned to have only eight electrons in its outer (fourth) shell, but the third shell is attributed eighteen electrons, and this is used to explain why the fourth row of the table has eighteen elements. Indeed the usual description of the fourth row of the table involves a progressive addition of electrons to the third and fourth shells in a somewhat haphazard fashion.

Our model has no difficulty in explaining the presence of eighteen elements in the fourth row of the table. Eighteen proactive genesis-units must be added to argon to achieve the next symmetrical milestone, krypton. Therefore there will be eighteen elements between argon and krypton. In the course of this progressive development, there will be other lesser milestones as well. The first two genesis-units added to argon will form the core of the new-cross like

structure that will be eventually fused to the first cross to produce krypton. This pair will render a particular (incomplete) symmetry to the whole structure and there will be consequences for the emission spectrum produced by the element. The fusion of four more pairs in a cross-like form around this central pair will represent a new watershed in symmetry. These various watersheds in symmetry will correspond to numbers like 2 (the pair of genesis-units forming the new core of a new cross-like structure), 8 (the four pairs of units fused to the core pair), 10 (a cross-like structure composed of a core pair with four pairs fused on to it), and 18 (a cross composed of eight pairs fused to a core pair). All of these numbers appear naturally in the periodic table. There are *two* elements in the first row, and *eight* in the next two rows. The fourth row has *ten* elements extra because it involves a fusion of a core pair plus four other pairs to argon. Rows four and five have *eighteen* elements each because they represent the progressive fusion of two more cross-like structures (composed of eighteen genesis-units each) onto argon.

We can see how quite a few features of the symmetry model have a corresponding feature in the electron model, but the symmetry model, at first glance, does not appear to have all the details found in the electron's model treatment of subshells. The first energy level or shell is said to have a single subshell (designated the *s* subshell). The second shell is attributed two subshells (*s* and *p*) of capacities two and six. The third shell has three subshells (*s*, *p* and *d*) of capacities, two, six and ten. In short, each shell has the same number of subshells as the number of the shell, and the capacity of each subshell increases in increments of four. Where does the electron model get its notion that the various energy levels or shells are divided into subshells, and on what basis does it claim that the subshells have these various capacities?

Before the notion of electron shells was developed, spectroscopists had identified characteristic series of lines in the spectra of the alkali metals. These sets of lines were given the letters *s* (sharp), *p* (principal), *d* (diffuse) and *f* (fundamental). As the electron model was developed, it was hypothesized that these series of lines were caused by the distinct energy levels of electrons located in subshells within each shell. In the mid nineteen twenties, Friedrich Hund designated the subshells themselves with the letters *s*, *p*, *d* and *f* (letters in alphabetical order starting from *g* would be assigned for the extra subshells contained within larger shells). This seemed to represent a significant step forward in theory because it allowed the assignation of precise energy levels to the various electrons using hard evidence from spectroscopy.

Coupled with this development, the Pauli exclusion principle armed physicists with a mathematical tool with which to work out the detailed electron configurations of the elements. According to the exclusion principle, each electron within the atom can be uniquely identified using four numbers, *n*, *l*, *m_l*, and *m_s*. The first number is the *principal quantum number*, and this designates the shell or energy level of the electron. The second number, *l*, is the *subshell*, designated with the numbers 0, 1, 2, 3, 4, etc., (which correspond respectively to the letters *s*, *p*, *d*, *f*, *g*, etc.). Each subshell in turn is divided into orbitals, and the number of the orbital is the magnetic quantum number, *m_l*. Any given subshell will hold $2l + 1$ orbitals (where *l* is the number of the subshell), whilst the orbital itself can hold a maximum of two electrons. The fourth number, *m_s*, is the *spin quantum number*. This can only have two values, up or down.

The exclusion principle states that no two electrons can have the same set of quantum numbers. Two electrons occupying the same orbital will have the same principal quantum number, subshell, and magnetic quantum number (the orbital that they occupy). Hence, in order to have a *unique* combination of quantum numbers, they will have to possess opposite spin. This principle was of assistance to physicists in building up the picture of the electron configurations of the elements in the periodic table. As electrons were assigned to each orbital and subshell, the exclusion principle, used in conjunction with the rules stipulated by Hund, provided a tool for discerning when the various energy levels were filled and when to begin assigning electrons to a new subshell. It also provided some sort of story for why the various

shells had the particular capacities that they had. For example, the second shell has a principle quantum number of two. This means that it has two subshells (0 and 1). The 0 subshell has one orbital, whilst the 1 subshell has three orbitals. Each orbital can hold two electrons, each with opposite spin. This means that the second shell has a maximum capacity of eight electrons. Of course, this falls far short of an *explanation*: it does not provide a causal story for why a shell has the particular capacity that it has.

The evidence from spectroscopy did not always fit in with the dictates of the exclusion principle, nor with the other mathematical principles that were being applied to the periodic table, so various explanations had to be developed to account for these anomalies. The shielding influences of electrons in the more complicated shells, or the interfering influences from the protons in heavier nuclei, were thought to be responsible for the fact that the empirical data did not always respect the mathematical model. Such rationalizations of uncooperative empirical data continue to be highly plausible. It seems natural that simple mathematical regularities should tend to break down in the case of larger atoms, extra electrons, heavier nuclei, and, in general, a proliferation of “interfering” factors.

It is not our task to investigate the extent to which the electron model “coerces” the empirical data to fit mathematical regularities. However, our symmetry model does demand a re-evaluation of the mathematical framework of the electron approach. This includes the rejection of the stipulation that an electron shell has a maximum capacity of $2n^2$. Such mathematical regularities *do* indeed approximate to the physical reality of atoms, but they have limited application only. The first, second and fourth stages of symmetry correspond respectively to the fusion of two genesis-units, the addition of eight further genesis-units, and the complete fusion of another eighteen genesis-units (i.e. $2n^2$ for $n = 1, n=2$ and $n=3$), but this actually omits the authentic third stage of symmetry (the formation of argon) which involved the fusion of eight genesis-units onto the cross-like structure of neon which comprises ten units. We find a confused correspondence to this fact of nature in various features of the standard model’s view of the evolution of the periodic table. For example, it assigns a shell configuration of 2, 8, 18 and 8 electrons respectively to krypton. In reality, the milestones of symmetry are achieved when composite atoms gain 2, 8, 8 and 18 proactive genesis-units.

Let us consider these contrasts in a little more detail. The electron model prescribes that shells have a maximum capacity of $2n^2$ electrons. As heavier atoms are progressively formed, the inner shells are supposed to be completely filled first before a new shell is begun, but this principle breaks down on the fourth row of the table with potassium. As the fourth row progresses, electrons are variously added to both the third and fourth shells until we arrive at krypton. At that point the third shell is eventually filled with eighteen electrons and the outer shell is filled with eight.

Consider how this account contrives the hypothesized structure of particular atoms to suit the mathematical regularity, $2n^2$. The third row of the table finishes with argon, which is supposed to have two electrons in the first shell, eight in the second and eight in the third. When the fourth row of the table is begun with potassium, a new electron must be added to the electron configuration of argon. But to which shell should the electron be allocated? According to the $2n^2$ regularity, it should become the ninth electron of the third shell. Indeed, one would expect that the fourth row of the table should involve the sequential filling up of the third shell to eighteen electrons before beginning a new shell. But the first row of the periodic table has the alkali metals, the group with the most distinctive properties of any group in the table. Potassium is highly typical of the alkali metals. Indeed, it was not conclusively distinguished from sodium until the nineteenth century. The three alkali metals above potassium all have a *single* electron in their outer shell, so it seemed essential to assign the extra electron in potassium to a new *fourth* shell, even though this violated the principle that inner shells be filled to capacity before new shells are begun.

Once the mathematical principle of $2n^2$ was violated, the assignation of electrons to the other elements in the fourth row of the table became problematic. It was crucial that the principle be resurrected before arriving at krypton, so decisions had to be made as to how the electrons were to be allocated for the rest of the fourth row. Potassium, as we said, had been given a configuration of 2,8,8,1 in the respective electron shells. Calcium came next, but it couldn't be given a configuration of 2,8,9,1 because it was too stable to have a single electron in its outer shell. So it was assigned 2,8,8,2, while scandium was considered to exhibit 2,8,9,2. The next eight elements were variously assigned electrons to both the third and the fourth shell until arriving at copper, at which point the third shell was finally filled with eighteen electrons.

This is surely a case of a flawed mathematical principle conflicting with sound empirical considerations. The decision to assign a single electron to the outer shell of potassium was a good one, based on the observed chemical properties of potassium and its undoubted relationship to the alkali metals. But the decision to revert to allocating electrons to the third shell (for elements after calcium) was prompted by adherence to an unsound mathematical principle that did not have a basis in material reality.

Consider how the symmetry model naturally accounts for the development of the periodic table as far as its fifth row. For what the electron model refers to as "shells", our approach will refer to as "layers". Whenever a layer of genesis-units is completely filled, symmetry prevails. The first layer, or symmetrical milestone, is the pairing of proactive units found in helium. This corresponds to the first row of the table and to the first electron shell in the valence model. The second layer involves fusing eight proactive units to helium, resulting in the symmetrical cross-like structure of neon. The fact that eight such units must be fused to helium means that there will be eight new elements between helium and neon, accounting for the fact that the second row of the table has eight elements. The same will be true for the third row of the table because the next layer is achieved with the fusion of eight proactive units onto neon to produce argon. The fourth and fifth layers are different to the previous three in that they consist in the fusion of an entire cross-like structure of eighteen proactive units onto the previous symmetrical milestones to produce krypton and xenon respectively. The fourth and fifth rows of the table are thus composed of eighteen elements. All of this provides a natural and unforced account of how the table of elements is structured.

1.6 A NEW VERSION OF THE EXCLUSION PRINCIPLE

Earlier we presented diagrams of the configurations of genesis-units fused together to form composite atoms. The main purpose of these diagrams was to present the basic structure of this new approach to the atom. We wanted to show, in particular, the way in which the *binding* genesis-units hold the *proactive* genesis-units in pairs to form the composite entity. When we look at the relationships between the pairs themselves, however, we begin to see the shortcomings of these diagrams. These deficiencies are all the more evident if we compare the diagrams to the 3-D models of the atoms. Take the case of neon, composed of a central core pairing with four other pairs arranged around it. The core pair of genesis-units will have their V-B axes aligned in opposite directions (see Figure 1.24). This is what bestows such equilibrium on the pair. When the next proactive genesis-unit is added on to form lithium, the V-B axis of the new unit will most naturally align itself in the opposite direction to the closest genesis-unit of the core pair (see genesis-unit number 3 in Figure 1.24). The tendency towards equilibrium will dictate the way in which each new genesis-unit aligns itself to the composite structure. When genesis-unit number 7 is fused to the structure (which creates nitrogen out of carbon), the new unit will not attach itself permanently to genesis-units 4 or 6 since this would produce a longer structure with less symmetry and more internal disequilibrium. The various influences emanating from the V-B alignments of the six existing proactive units in the structure will ensure that the most stable new structure consisting of seven genesis-units will

be one where the new hydrogen atom is fused to either unit 1 or unit 2. We cannot rule out the possibility that (within stars, for example) hydrogen atoms can be fused briefly to units 4 or 6, but such a structure will be imbalanced and will not endure as a stable element.

Our assertion that the first eighteen elements form somewhat flat, cross-like structures is based on the claim that the V-B directional alignment of the individual genesis-units is a crucially important causal factor in the formation of composite atoms. A new proactive hydrogen atom will be fused with an opposite V-B alignment to that of its closest proactive unit in the composite entity. Sometimes this will involve being fused *across* the ends of a pairing (as we saw with lithium). The overall result is a progressive weaving of genesis-units to form definite cross-like structures. One of the upshots of this pattern of evolution is that each member of a pair of proactive genesis-units will have an opposite V-B alignment. This corresponds to the standard claim that the pair of electrons in each orbital have opposite magnetic spin.

It is the tendency towards electrostatic equilibrium that underpins the validity of the Pauli exclusion principle. Each new genesis-unit appended to a structure will uniquely alter the equilibrium of the structure, for better or worse, and this will have undoubted empirical consequences that will be manifested in spectroscopy. The first three layers of symmetry involve fusing genesis-units in pairs around a central helium core to produce a rather two dimensional structure. The fourth and fifth stages involve forming successive layers on top of this structure. Whether a composite atom has one, two, three, four or five layers will have an influence on how it bonds with other atoms in the absorption and emission of light. The role any individual genesis-unit performs in the interplay of influences within the atom will depend on its precise position in the structure and the orientation of its V-B polarity relative to the rest of the structure. The position and orientation of a unit can be identified using a unique combination of parameters, just as the Pauli exclusion principle states that electrons can be uniquely identified by the four quantum numbers that we discussed in the last section. From our point of view – even though we reject electrons – it makes perfect sense to accept this principle as mirroring the fact that each genesis-unit in a composite atom will have a unique role in the way that it contributes to the overall symmetry of the structure.

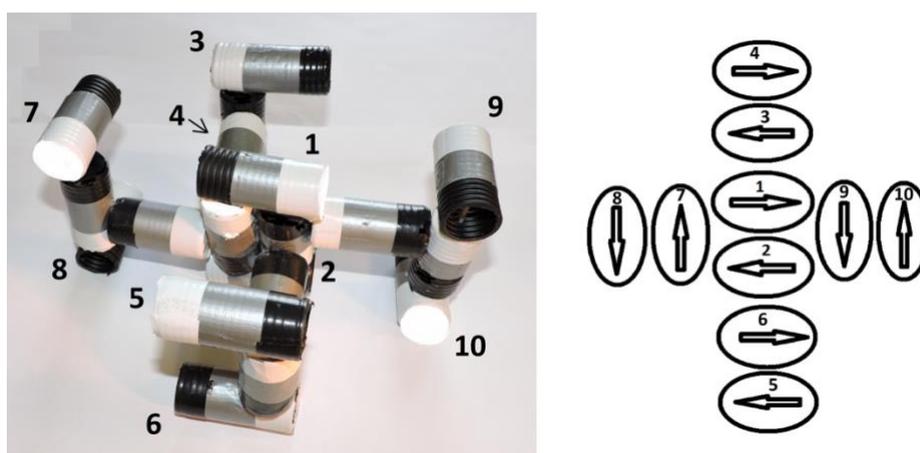


Figure 1.24 Neon. 3-D model to the left whilst the diagram on the right shows the alignments of the V-B components in the proactive genesis-units

If we take the elements up to argon, there are four structural features of the position of the genesis-unit within the composite atom. These features are the *layer* in which the genesis-unit is to be found (corresponding to the principal quantum number of the standard approach), the location of the genesis-unit on a particular arm of the cross (this corresponds to the notion of the subshell), the orientation of that “subshell” with respect to the helium atom at the core of

the structure, and the *alignment of the V-B axis* of the genesis-unit relative to the genesis-unit that it is paired with (corresponding to magnetic spin).

Let us see the numbers associated with the proactive genesis-units in the neon atom. Genesis-units 1 and 2 are located in the inner core of the atom. Their layer (corresponding to the principal quantum number) is 1. They are not located on the arm of a cross, so the second quantum number will be 0. Similarly, their orientation relative to themselves can be assigned the value 0. They have an opposite V-B alignment so their “spins” can be assigned the standard values $+1/2$ and $-1/2$. Thus their quantum numbers are $(1,0,0,+1/2)$ and $(1,0,0,-1/2)$ respectively.

Genesis-units 3 and 4 are on the second layer so their principal quantum number is 2. They are located on the top arm of the cross to which the value 1 will be assigned. Their orientation is the same as that of the core genesis-units, so this value will again be 0. Thus their quantum numbers are $(2,1,0,-1/2)$ and $(2,1,0,+1/2)$ respectively. The arm on which genesis-units 5 and 6 are located will be assigned the value 2. Their numbers will therefore be $(2,2,0,-1/2)$ and $(2,2,0,+1/2)$.

Units 7, 8, 9 and 10 are also on the second layer, and the arms on which they are located will be designated with the values 3 and 4 respectively. All of these units are oriented orthogonally to the core units in the atom, so this value will be assigned the value 1. Thus the quantum numbers for units 7, 8, 9 and 10 will be $(2,3,1,+1/2)$, $(2,3,1,-1/2)$, $(2,4,1,-1/2)$ and $(2,4,1,+1/2)$.

The number of possible layers in any element from hydrogen to argon is 4. From that point onwards, a second cross begins to form and the new composite atoms now have a double layer. Perhaps it would be simplest to assign the value 5 to the inner pair of proactive genesis-units in the second layer of potassium (the element which follow argon in the periodic table). From argon to krypton, using this convention, four new “layers” are added to the composite atom, and four again between krypton and xenon, and so on. We will require more than twenty layers if we are to assign quantum numbers to all the elements in the table.

This is in contrast to the Bohr model of the atom in two contrasting senses. Firstly, the standard method of working out the electron configuration of atoms will typically have *lower* principal quantum numbers than our model. For example, the standard electron configuration for lead (number 82 in the table) has only 6 principal energy levels, whereas our model has fifteen layers for that metal (three superimposed crosses with 4 layers each, and a fourth superimposed cross of 3 layers). Secondly, the Bohr model allows that an electron can be energised so that it jumps through a potentially infinite number of energy levels. This highlights one of the major ways in which our approach to the atom diverges from the Bohr model: it is not the case that “genesis-units” are roughly analogous to “electrons” in everything but name. When we are discussing the *electronic configuration* of an element, there is a sense in which the layers of our model are analogous to the energy levels of the Bohr model. But when we come to the absorption and emission of light, we shall see how this entire discourse of electrons jumping through energy levels can be made redundant by our much simpler account of optical phenomena. The notion that electrons could be raised through a potentially infinite series of energy levels was already a stark warning that there was something seriously implausible about the Bohr model of the atom. In our model of light, as we shall see further on, elements remain as they are with the same number of layers, regardless of how much light they have absorbed.

As we have outlined earlier in this chapter, elements are formed by a weaving process in which cross-like structures develop outwards from a helium core. Each cross will have four arms. Thus the second quantum number will have four possible values between 1 and 4.

The third quantum number refers to the orientation of the plane of the V-B axis of the unit to the plane of the V-B axis of the core pair of units. Here, we are not interested in the actual *direction* that a particular unit is pointing in (that direction is represented by the fourth

quantum number - magnetic “spin”), but only the *plane* in which the axis lies. In three dimensional space, only three planes are possible relative to the plane of the core units. Thus the third quantum number has value from 0 to 2, where 0 represents the plane of the core units.

In the case of neon, the proactive genesis-units all lie in just two of the three possible planes. In other elements, such as carbon, all the units lie in the same plane. Figure 1.25 shows the stable isotope of boron, ^{10}B (the most common form of boron is ^{11}B). Genesis-unit 5 lies in a different plane to any of the proactive units in neon and would be assigned the value 2. In order to make carbon from this isotope of boron, two genesis-units would have to be fused to the ends of genesis-unit 5, both of which would lie in the same plane as the core units and consequently have a third quantum number with value 0.

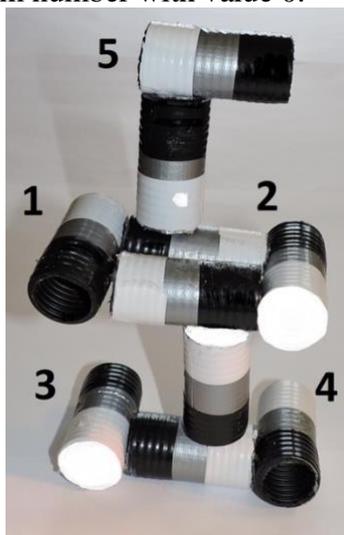


Figure 1.25 Boron revisited. The third quantum number of the core units is assigned the value 0. Genesis-unit 5 lies in a different plane and the value 2 is assigned to its third quantum number.

That takes us to the fourth quantum number. Whenever we speak of the property of magnetic spin, we are speaking of the *relative* orientation of something with respect to the alignment of something else. Within each pair of proactive genesis-units, only two possible V-B directions are possible, and they will always line up opposite to each other.

Sometimes the Pauli exclusion principle is presented as if it had some role in explaining why the electron shells have the capacities that they do, but it is not at all clear how a mathematical formalism that *describes* empirical data can hope to *explain* that same data. Nature does not adhere to mathematical regularities for the sake of regularities. Nevertheless, it must be said that the exclusion principle does point to a fact of nature that has genuine causal consequences. When atoms are being formed, it often happens that new genesis-units are fused coercively onto a pre-existing structure (such as the genesis-unit fused to helium to form lithium). This process does not aid the equilibrium of the structure, but the *next* genesis-unit added to lithium will naturally take up a position that will restore equilibrium. During this ongoing process of evolution, genesis-units will be appended in this two-fold pattern. An odd unit will be fused that will reduce equilibrium, and then the pair will be completed to restore equilibrium. Each new pair will take up a position with respect to the whole in such a way as to reciprocate the many causal influences within the atom in as complete a way as possible. This is what the exclusion principle is pointing to: the process by which this tapestry of equilibrium is woven, with each new unit contributing uniquely to the overall state of the atom.

1.7 WHICH APPROACH HAS THE GREATER EXPLANATORY POWER – THE STANDARD FRAMEWORK OR THE GENESIS-UNIT MODEL?

Earlier, the reader was requested to follow our line of reasoning with patience. The genesis-unit model still has much need of development. We have not seen how it deals with the empirical evidence that is usually interpreted as indicating the existence of the “electron”; nor have the new understandings of electricity, magnetism and the transmission of light been yet presented. The project has only just begun, but at this point it is still possible to evaluate its relative capacity to explain the structure of atoms, the arrangement of the atomic table and the patterns of chemical bonding exhibited by the elements. Whether an explanation is considered a *good* one depends on many factors such as its simplicity and coherency, its ability to predict unexpected phenomena, and a host of other characteristics of good explanation, the relative merits of which have been debated since Robert Boyle's list of such criteria appeared in the seventeenth century. Here we will dwell for a moment on the simplicity and coherency of the genesis-unit model.

The starting point of the model is the postulation of a simple polarity within the hydrogen atom. On the basis of this polarity, we can describe how composite atoms are formed, and why they exhibit the properties that determine their position in the periodic table. The progression from simple hydrogen atoms to more complex structures is driven by a *single* dynamical influence: namely, the propensity of genesis-units to reciprocate the electrostatic influences of other units. Consider how this contrasts with the complexity of the standard model. Here, electrons are postulated to be in orbit around a nucleus composed of particles that somehow adhere together despite the enormous forces of mutual repulsion that ought to prevail between them. To explain the unlikely cohesion of the nucleus, a new force is postulated, carried by hypothetical particles with some properties that, in principle, cannot be observed. The very survival of the atom, on the standard view, is so improbable that we would be forgiven for wondering if this theoretical framework makes any significant contact with the physical world at all. Can it really be the case that such a host of improbable particles and forces are conspiring together to form a stable and enduring entity, the ground of real things?

By contrast, the genesis-unit model postulates a single dynamical influence. And this influence has enormous empirical support, once we perform a simple re-examination of electrical and magnetic phenomena, apart altogether from the structure of the periodic table and patterns of chemical bonding. It will become clearer as we go along how properties such as magnetic spin cohere perfectly with the postulate that the primitive V-B polarity is at the root of the atom, dictating how each genesis-unit aligns itself with others. Composite atoms are formed by genesis-units progressively being fused to a pre-existing structure. The way that each new genesis-unit aligns itself in the composite atom is determined by the role it plays in reciprocating the electrostatic influences of the units already present. In comparison, the valence electron approach to atomic structure has to do a lot of huffing and puffing to account for the arrangement of the periodic table. Under the standard model, a myriad of rules need to be invoked to explain why atoms have the electron configuration that is claimed for them. And the problem with some of the rules is that they lack genuine explanatory capacity. We assign unique quantum numbers to each electron in the atom, and this practice helps us to discern the characteristics of any given electron. But *why* each electron in the “cloud” must have a unique set of quantum numbers is not explained. It almost seems sometimes that we are being asked to believe that electrons conform themselves to numerical regularities just for the love of numbers. Once we appreciate that each genesis-unit plays a unique *structural* role in the electrostatic equilibrium of an atom, then we can see why it might possess a series of unique numbers that determine its electrostatic position with respect to the whole. And the numbers testify that there is nothing indeterminate or cloudlike about this position.

The genesis-unit account of chemical bonding is also simpler and more coherent than the standard approach. The usual explanation of the formation of methane is a classic example of the current theory in action (see Figure 1.26). Each methane molecule is composed of one

carbon atom and four hydrogen atoms. The single electron allegedly possessed by each hydrogen atom is supposedly found on the first shell, which can only hold a maximum of two electrons (according to the expression describing how shells are filled, 2^n , where n is the number of the shell in question). The carbon atom is said to have four electrons on its third and outer shell, a shell that can hold up to eight ($2^3=8$). Each hydrogen atom attains a “share” in an electron from the carbon atom, thus attaining the extra electron needed to fill its shell. The hydrogen atoms also donate their electrons to the joint “pool” and in this way the carbon atom gains the four electrons required to fill its outer shell. The result is a stable molecule composed of atoms whose outer electron shells are full.

Ionic bonding occurs when an atom that lacks electrons in its outer shell receives an electron (or electrons) from an atom (or atoms) with electrons “to spare”. The electrons in the outer shell of an atom are known as the “valence electrons,” and atoms are considered to have a tendency to form bonds that bestow on them a full or closed outer shell. This is a general overview of how such molecules are formed, even if it does not do justice to the many developments that have taken place in the field throughout the twentieth century and the detailed mathematical analysis provided by the contemporary theory of molecular bonding. However there can be little doubt that contemporary theory is driven by the qualitative picture of the planetary model and the belief that atoms have a tendency towards closed outer shells.

The shortcoming of this approach is that gives us no clear idea *why* the atoms strive for full outer shells. Neither does it tell us how this striving actually plays itself out in physical terms. What is it about the hydrogen atom that impels it to “share” an electron with carbon? Is this tendency towards attaining a full outer shell emanating from some unknown causal dynamics in the nucleus? A further difficulty with the whole notion of sharing is the problem of understanding how an entity (the electron) that allegedly has the potential to undergo wild fluctuations in its position can be *shared* in any meaningful sense with another atom whose electrons exist in similar far-flung states.

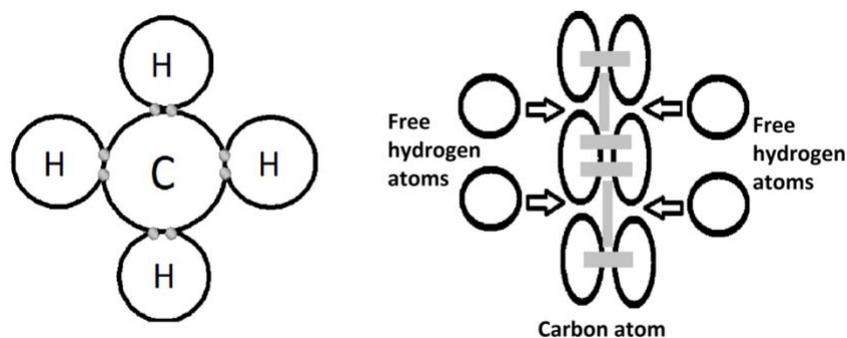


Figure 1.26 Methane. To the left we have the standard picture of the methane molecule. To the right is the genesis-unit model of the bond

The genesis-unit model is able to describe chemical bonding in very simple and coherent terms. Atoms have greater or lesser electrostatic equilibrium depending on how their genesis-units are arranged. The pattern of the units in certain atoms will prompt them to bond with other atoms in such a way as to attain greater electrostatic equilibrium. Atoms with symmetrical configurations will tend to be have the electrostatic influences of their constituent genesis-units reciprocated by other units within the structure. Elements with a protruding unit on one side will tend to bond with elements that have a corresponding “hole” on one side. There is no mystery as to why these bonds occur because they are driven by the pure electrostatic influences of the individual genesis-units within the composite atoms. We do not need to wonder why four hydrogen atoms would have a tendency to “share” their electrostatic

capacities with a single atom of carbon. If we examine the structure of carbon as depicted to the right of Figure 1.26, it becomes apparent how the presence of four new genesis-units would confer greater symmetry and thus greater electrostatic equilibrium on this atom.

The periodic table expresses, in a sort of tabular or numeric form, certain truths about the properties of atoms and their bonding patterns. Hopefully this chapter has done enough to show that the planetary model of the atom is not the only way to visualize a physical structure of matter that could give rise to these periodic properties. Despite the prominent visual role played by the planetary picture in the electron shell account of atomic bonding, a distilled version of the theory can be produced in which the notion of electron energy levels disappears altogether. Little attention has been given to the line of thought, developed in various quarters during the course of the twentieth century, stating that the relationships expressed by the periodic table are purely numerical, and the term “electron” could be replaced by another term without any negative repercussions for our understanding of how atoms bond together. Our real knowledge in this field is largely numerical in nature, and these numbers do not point unambiguously to a unique physical realisation such as the planetary model. Indeed, before the electron was hypothesized at all, it was already understood that the bonding tendencies of the various elements depended on the group they occupied in the periodic table. Instead of saying, as we do now, that “carbon has four valence electrons that it can share in covalent bonds with other atoms”, we can simply substitute for the word “electron” any other property or structure within the atom that we hypothesize to be responsible for bonding of this sort. In our model, that equivalent structure is the proactive genesis-unit.

It is also highly plausible to claim that the patterns of fusion exhibited in the formation of atoms should be mirrored by the chemical bonding patterns between atoms of different elements. The electrostatic “hooks” or lack of them that facilitate or hamper atomic fusion should naturally give rise to the same bonding pattern at the level of the chemical behaviour of the elements themselves.

Moreover, our attempt to characterize each new element largely in terms of its number of proactive genesis-units fits in with the work of Moseley and others. Even though lithium, for example, has an atomic weight of *seven* atomic mass units, just *three* of these units exert significant electrostatic influences beyond the interior of the atom itself. Carbon might weigh *twelve* atomic mass units, but only *six* of its genesis-units are proactive. Therefore it comes as no surprise that the diffraction of x-rays by a sample of lithium should show a mathematical regularity in relation to the number three and the extent of diffraction by carbon should be in relation to the number six. It is the polarities in the proactive genesis-units that is responsible for the diffraction, after all. The binding units have their electrostatic capacities reciprocated from within the atom, and thus cannot diffract the x-rays, just as our model would expect.