The Phases of Matter

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Meditation 1

The Current or Old Atomic Hypothesis

This hypothesis put forward the idea that if one continued to cut up material matter there would come a cut making both parts are still the same but then neither of these parts could be cut into smaller parts without changing them completely.

John Dalton of Cumberland proposed this for elements and molecules. He suggested that as a result elements would only combine in whole (integer) numbers with themselves or with other elements. There would be no fractions. Thus water would be a combination of hydrogen and oxygen but the number of atoms of hydrogen in the molecule of water would be a whole integer number. It could be 1, it could be 2, it could be 3 or any other integer number. It could not be ½ or ¼ or ¾. At the time that was a great advance. Dalton concentrated on gases, but there were problems when it came to the solid phase because it seems that for some compounds there was definitely a formula like $UO_{2.05}$. This contradicted the idea. Of course it could be a mixture. However, in the gas phase this problem did not arise. Today atoms are thought of as the smallest units of the elements, but Dalton thought of them as also being the smallest units of molecules.

In the New Atomic Hypothesis presented in this paper, Dalton's concept is extended to all types of matter, hence it applies to elements, molecules, viruses, bacteria, cells, plants, animals and also to human beings and nations.

Definition of an atom from the Concise Oxford Dictionary:[1] "Body too small to be divided; *physical atom,* supposed ultimate particle of matter; *chemical atoms*, smallest particles in which elements combine with themselves or each other; minute portion, small thing [Greek, *indivisible*]."

Definition from the Oxford Dictionary of Science:[2] "The smallest part of an element that can exist. Atoms consist of a small dense nucleus of protons and neutrons surrounded by moving electrons. The number of electrons equals the number of protons so the overall charge is zero. The electrons may be thought of as moving in circular or elliptical orbits (see *Bohr Theory*) or, more accurately, in regions of space round the nucleus."

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1 3rd edn (eds H.W. & F.G. Fowler). Oxford: Clarendon Press (1944).

2 5th edn. Oxford: University Press (2005).

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Meditation 2

Phases or States of Matter

Definition of **Phase** from the Oxford Dictionary of Science: "A homogeneous part of a heterogeneous system that is separated from other parts by a distinguishable boundary. A mixture of ice and water is a two phase system. A solution of salt in water is a single phase system."

Definition of **State of Matter** from the Oxford Dictionary of Science: "One of three physical states in which matter can exist, i.e., solid, liquid or gas. Plasma is sometimes regarded as the fourth state of matter."

Definition of **Liquid Crystal** from the Oxford Dictionary of Science: "A substance that flows like a liquid but has some order in its arrangement of molecules. Nematic crystals have long molecules all aligned in the same direction, but are otherwise randomly arranged. Cholesteric and smectic liquid crystals also have aligned molecules, which are arranged in distinct layers."

Definition of **Liquid** from the Oxford Dictionary of Science: "A phase of matter between that of a crystalline solid and a gas."

Definition of **Fluid** in the Concise Oxford Dictionary: "(Substance) consisting of particles that move freely among themselves and yield to the slightest pressure (including gases, liquids and the assumed pervasive imponderable media of electricity, etc.)."

Table 1. The Nine States of Matter derived from the New Atomic Hypothesis.

Name of the phase	Directions of geometrical order	Size	Density	Notes
Solid	3	small	large	many allotropes
Smectic	2	small	large	monomolecular thickness
Nematic	1	small	large	monomolecular threads. Includes the cholesteric phase
Eutectic	0	small	large	Rather like liquid drops but they do not unite with other eutectic drops
Liquid	0	infinite	medium	drops of liquid join together to make an ocean
Multimer	0	small but with a wide range of sizes	medium to low	This phase is the basis of the cloudy phase of matter
Gas	0	large	low	a very elastic phase that obeys the empirical formula $PV = RT$
Plasma	0	very large	very low	an ionized phase which does not readily mix with the gas phase
Solar wind	0	very very large	very very low	highly ionized

Meditation 3

Some New Definitions Related to the New Atomic Hypothesis

ATOM

This is the smallest unit of any matter: if it were cut into two neither part would be the same as each other or the original particle of matter from which they were obtained. This includes a wide range of objects, many of which have separate names of their own. Thus ATOM is a wide-ranging term in the New Atomic Hypothesis. It includes, starting from the smallest and invisible particles:

Electron and neutrino

Proton and neutron

Atom of an element and molecule of a compound

Viruses of all types

Bacteria of all types

Single cells of plants and animals and the symbioses of the few organisms (e.g., coral, lichen) that are both plants and animals combined

Whole plants and whole animals (a rose tree and an elephant)

Human beings (especially when they are part of a community)

Nations and sects (difficult to study as part of the New Atomic Hypothesis).

Nucleus

This is the central core of any ATOM. It is the chief controller of what happens within the boundary of an ATOM. Because there are many types of ATOM there are many different types of nucleus.

Cloud

The clouds we see in the sky give some idea of the function of a cloud in an ATOM. Clouds are made up of particles of matter controlled by the nucleus in some way and they determine the *volume* of the ATOM.

In the ATOM of an element the nucleus is of protons and neutrons but the cloud is of electrons. Atoms of elements appear to have a volume but it is quite difficult to define or determine the volume of a single atom.

In the ATOM of a human being the brain is the nucleus (or is it the heart?) and the mass of cells in the being is the cloud, which has a material boundary at the skin. Clearly this cloud is very complex indeed.

All ATOMS in the New Atomic Hypothesis have a nucleus and to detect them (ATOMS) they also have a cloud.

Boundary

This is the outer limit of the cloud of an ATOM. But just as it is difficult to put an exact boundary on a cloud in the sky, and it is impossible to see the boundary of an atom of an element, so it is difficult to define or determine exactly the place of the boundary in an ATOM. In a human being it could be defined as the skin, which is the material boundary for visible light; however, if we use X-rays then the boundary is the bones of the skeleton! If we use sound waves to detect the boundary then the individual human could be quite extensive. Thus there is not just one boundary for an ATOM, and each boundary has its own particular characteristics.

Resonance

The Oxford Dictionary of Science defines it as "An oscillation of a system at its natural frequency, as determined by the physical parameters of the system". Resonance is associated with vibrations of all types, it is associated with *harmony and unity*. It applies to electromagnetic waves and also to sound waves and the internal oscillations within solids, crystals, liquids and gases.

Order

The Concise Oxford Dictionary defines three types of order: 1, rank, row or class; 2, sequence or arrangement; 3 mandate, but in the New Atomic Hypothesis order applies to the first two and not to the last definition. Order can be simply number, in particular integer number; order can be direction, as in three directions of geometrical order in a solid crystal. Order can be a particular frequency of oscillation; order can be a particular combination of atoms of elements in a molecule; the same number of atoms can have two different orders in a molecule. For example, $C_6H_4O_2NCl$ can be either orthochloronitrobenzene or parachloronitrobenzene or metachloronitrobenzene according to the order of the atoms in each of the different molecules. A large drop of liquid may contain 10^6 molecules of water, but a larger drop may contain 10^8 molecules of water; usually this would be considered to be the same order but in some instances it is clearly a different order by a magnitude of 100.

Degrees

The Oxford Dictionary of Science defines three different concepts: 1, unit of a plane angle equal to 1/360 of a complete revolution; 2, a division on a temperature scale; 3, the power to which a variable is raised. It then defines **Degrees of Freedom** as the number of independent parameters required to specify the configuration of a system. In the New Atomic Hypothesis **Freedom** is replaced by **Order** because the latter can be measured whereas the former cannot, it is always a limitation (constraint) on the amount of order in a system. Degrees are the steps undertaken to produce any measurement of some type of order.

All these concepts are combined within the framework of the New Atomic Hypothesis to yield the unit of matter called NENDOREC, which is an acronym for **N**uclei with an **E**qual **N**umber of **D**egrees of **O**rder **R**esonating within an **E**lectron **C**loud boundary (to be discussed further in Meditation 6).

Meditation 4

Action at a Distance

Gravity is a reaction between two (or more) *masses* at a distance. All the calculations assume that gravity between two objects (e.g., Earth & apple; Earth & Moon; or Sun & Jupiter) *travels* at an infinite velocity. Let us consider three types of action at a distance for different types of matter; namely sound, electromagnetic radiation (e.g., light, X-ray, infrared, microwave) and gravity.

First, sound. Sound waves travel quickly, they react with objects at a distance provided the objects can vibrate. They travel at different speeds in different media; for example, 344 m s^{-1} in air; 1461 m s^{-1} in liquid water; and 5000 m s^{-1} in steel. They do not travel in the plasma phase of a vacuum or space, hence we cannot hear any noises from the Moon or the Sun. Sound waves transmit energy, a vibrating violin string can be used to destroy a tumbler by resonant vibration. Sound can be reflected or absorbed by matter.

Second, electromagnetic waves. Electromagnetic waves (light) travel very fast and they react with objects at a distance provided that these objects have shells of electrons that can vibrate. They travel at different speeds in different media, they can travel through the plasma phase of space at 3×10^8 m s^{-1} and through air on Earth at about the same speed. They travel at a lower speed through liquid water and transparent glass. Light can be reflected and absorbed by matter. Light is energy, it is transmitted from one electronic structure of some matter to the electronic structure of other matter, it does not heat gas or plasma but does heat dark liquids and nonreflecting solids. Light from the Sun encounters a lot of plasma and gaseous matter but it does not heat them up, whereas light from the Sun heats up rocks and walls. Until Römer explained his observations on Jupiter by assuming that light (electromagnetic waves) had a finite velocity, light was thought to have an infinite velocity.

Third, gravity (waves?). Gravity reacts with objects of mass (i.e., is the nucleus of an atom and not the electronic shells) at a distance. It passes through all known media. It is not known to be reflected by matter, but could possibly be absorbed by matter. Because we know that sound and light have finite velocities and also a known variety of frequencies, then it is reasonable to *assume* that gravity could also have a finite velocity and a range of frequencies. This could account for the anomalies observed in satellite movements mentioned in astronomical papers. The velocity of sound is not constant, the velocity of light is not constant (despite assertions in many physics textbooks!), the velocity of gravity is unknown but is likely to be greater than the velocity of light because it is associated with the nucleus of an atom rather than its electronic shells.

Too many mathematicians and physicists are looking for a magic formula rather than for the fundamental, basic, building blocks of the world around us.

Meditation 5

States of Matter

In 1957 the Windscale nuclear pile caught fire. In 2001 there was an explosion in a blast furnace in South Wales where the 2000 ton furnace lifted vertically about one foot. In 2006 there was a spillage of gasoline in a storage depot in Buncefield, near Hemel Hempstead, and this led to an explosion followed by a very extensive fire. In 2006 there was an incident in a park in Chester-le-Street (County Durham) where a plastic structure with people inside weighing 4 tons lifted vertically into the air and then drifted about 100 yards before being caught on a pole.

Each of these incidents involved a state of matter behaving in a manner that had not been anticipated by quite competent scientists who were fully acquainted with the current teachings of the three states of matter, namely solid, liquid and gas. Each of these incidents will be studied in detail later.

In 1964 at Sellafield (formerly called Windscale) investigations into the manufacture of mixed oxide fuels of plutonium oxide and uranium oxide for fast breeder reactors, advanced gas-cooled reactors and pressurized water-cooled reactors were undertaken. During these investigations it became clear that the current concept of three states of matter was defective and that there were more than three distinct states of matter, which could be classified in order of decreasing density as follows:

1. A solid state of matter with three directions of geometrical order. It has many allotropes. Its basic units are finite and generally very small, often called grains in metallurgy.
2. A smectic state of matter with two directions of geometrical order. Its basic units are finite and generally very small. It also has many allotropes.
3. A nematic state of matter (including the cholesteric state) with only one direction of geometrical order. Its basic units are finite and generally very small. It cannot have any allotropes.

4. A eutectic state of matter with no directions of geometrical order but like the other states above has a finite measurable size for its basic units.
5. A liquid state also with no directions of geometrical order but which could be infinite in size. The liquid state of water on Earth is seen in the oceans. Its density is slightly less than the corresponding eutectic state of matter. It was found that water was not an anomalous liquid, this will be explained later.
6. A multimer state of matter with finite particles, which have no directions of geometrical order. This is one of the most commonly observed states of matter because the clouds in the atmosphere are examples. Clouds cannot be made of superfine droplets of liquid water or superfine particles of solid ice crystals, simple experiments can easily show that this concept is in error even though it is found in most meteorological textbooks. There are many allotropes of this state of matter.
7. A gas state that is the air we breathe, and it obeys the *empirical* equation $PV = RT$. It has a much lower density than the liquid state and it is very elastic. It exists on Earth between sea level and the tropopause boundary of our atmosphere.
8. A plasma state of matter that is like an ionized gas that does *not* obey the empirical equation $PV = RT$. It has a much lower density than the gas state. It is found in vacuum, it is found in thunderclouds, it is found in the many layers of ionized "gases" above the troposphere from the stratosphere to the boundary of the magnetosphere. The density of the positive ions is similar to the density of a gas but the negative ions have a very low density.
9. A solar wind state of matter where the density is very very low. Only the positive ions can be detected but the negative ions are the component with the really low density. It creates the tail of our magnetosphere but is best visualized shaping the tails of comets.

The addition of energy to any state can change it into a state of lower density with totally different properties.

Meditation 6

Solid State of Matter

Let us first look at the definitions given in the recognized Oxford dictionaries and then consider where they are defective and how by examination of solids that we know only too well find there can be better methods of explaining the observations.

The Concise Oxford Dictionary:

Solid. Of stable shape, not liquid or fluid, having some rigidity, not hollow, without internal cavities or interstices.

Oxford Dictionary of Science:

Solid. A state of matter in which there is a three dimensional regularity of structure, resulting from the proximity of component atoms, ions, or molecules and the strength of the forces between them. True solids are crystalline (see amorphous). If a crystalline solid is heated, the kinetic energy of the components increases. At a specific temperature called the **melting point**, the forces between the components become unable to contain them within the crystal structure. At this temperature, the lattice breaks down and the solid becomes a liquid.

Oxford Dictionary of Science:

Crystal System. A method of classifying crystalline substances on the basis of their unit cell. There are seven crystal systems. If the cell is a parallelepiped with sides *a*, *b,* and *c* and if α is the angle between *b* and *c,* β the angle between *a* and *c,* and γ the angle between *a* and *b* the systems are:

7 **triclinic** $a=b=c$ and $\alpha\neq\beta\neq\gamma$
6 **monoclinic** $a\neq b\neq c$ and $\alpha=\gamma=90°\neq\beta$
5 **trigonal** $a=b\neq c$ and $\alpha=\beta=\gamma\neq 90°$
4 **hexagonal** $a=b\neq c$ and $\alpha=\beta=\gamma=90°$
3 **rhombic** (or **orthorhombic**) $a\neq b\neq c$ and $\alpha=\beta=\gamma=90°$
2 **tetragonal** $a=b\neq c$ and $\alpha=\beta=\gamma=90°$
1 **cubic** $a=b=c$ and $\alpha=\beta=\gamma=90°$

Oxford Dictionary of Science:

Amorphous. Describing a solid that is not crystalline; i.e., one that has no long range order in its lattice. Many powders described as "amorphous" are in fact composed of microscopic crystals, as can be demonstrated by X-ray diffraction. Glasses are examples of true amorphous solids.

The **New Atomic Hypothesis** reviews the data of the solid state of matter in a different way. The solid state is the most ordered state of matter on Earth. It is, however, necessary to reject certain commonly accepted concepts of the solid state: there are no perfect single crystals; lattice defects do not exist; atoms are not generally spherical. The ionic structure of NaCl salt crystals shown in many textbooks is defective.

The most common form of the solid state is a powder, frequently a very fine powder. The simplest of all powders is that of solid helium at 0 K to 2.1 K, which is so fluid, so amorphous, and so cohesive that it is frequently called liquid helium II; at other times it is called a quantum liquid, or even a Bose–Einstein liquid. It is, however, simply a fluid of solid helium as a very fine powder. It is very elastic but under pressure it becomes rigid. This is rather like any powder when subjected to high pressure; it was the basis of manufacturing right cylindrical pellets of mixed oxide fuel for fast breeder reactors, there the powder was compacted in a die in a hydraulic press before being subjected to high temperature, sintering at 1600 °C.

Solid neon is not well documented.

Solid argon provides us with more clues about the solid state. A lump of solid crystalline argon near to 40 K, its melting point, flows down under its own weight, it is not rigid; but at 1 K the same lump is so fragile that it crumbles into a powder. This illustrates two aspects of the solid state of matter: 1, the lower the temperature the smaller the particles of the powder; and 2, the higher the temperature the larger the particles and the more plastic and also more cohesive.

Another illustration of these aspects of the solid state is seen in the steel industry. Ingots of steel can be cast and then annealed, then the grain size can be measured using microscopy. The annealed ingots can be rolled at the annealing temperature or at room temperature. Those rolled at the annealing temperature produce grains that are elongated but roughly the same size as the original grains in the cast and annealed ingot. Those rolled at room temperature produce fine-grained particles and there is no sign of the large grains after annealing. This is because the basic particle size is smaller at low temperatures and larger at high temperatures.

Nuclear fuel (UO_2) irradiated at higher temperatures (1400 °C) is observed to have the fission products on the grain boundaries but if the same fuel is irradiated at lower temperatures (800 °C) the fission products accumulate within the grains, where the gases mark the subgrains that were difficult to detect before irradiation. It was this fact that was overlooked when the Windscale pile was heated to release the Wigner energy in the graphite. The helium gas within the lithium went to the grain boundaries, but at the higher temperature the grains were larger and more plastic so expanded and burst the cans containing them open, exposing the lithium to the cooling air and setting the pile on fire.

Another example of the increasing size of the basic unit of solid matter is seen in gold, which melts at 1064.43 °C. It has been observed that fine dust particles of gold “appear” to melt at a lower temperature, but actually they just spherodize like a drop of liquid and below 1064 °C change into the eutectic state of matter. This state persists until the temperature is 1064 °C when true melting occurs. At present there is no way of distinguishing between the eutectic state and the liquid state of gold in the 900 to 1064 °C region.

In the solid state the nuclei of the atoms are more three-dimensionally complex at lower temperatures and although they have a considerable degree of order there is no evidence for a lattice as shown in most textbooks. This is particularly true of helium. Consider the solid state as being like a platoon of soldiers in Trooping the Colour. They work together as a unit but they are not holding hands.

The solid state of matter has many allotropes that exhibit different orders, some are geometrical like triclinic, monoclinic, tetragonal, orthorhombic and cubic as given in the dictionary definition above, but there are other orders that are much more complex, like magnetism and elasticity. Solids that have multiple allotropes show that the more complex allotropes (triclinic) are stable at lower temperatures but these frequently change into the less complex allotropes (e.g., cubic) at temperatures nearer the melting point. It is a curious fact that the more complex allotropes of any material are less dense than the less ordered simpler allotropes of the same material. In most cases this is of no importance but it is vitally important in the case of the allotropes of water where we know that ice is less dense than liquid water. What is not commonly known is that water is actually an alloy, or a mixture of different allotropes of water.

Single crystals as depicted in Bragg’s theory of the solid state can be infinite in size but they do not exist. Single crystals are simply the tiny units of solid matter lined up in the same orientation. Because they are all in the same orientation it is very difficult (almost impossible) to detect the boundaries of the small units. One of the easiest ways to demonstrate this is to irradiate a single crystal of uranium metal; it rapidly becomes distorted because the fissions develop high temperatures locally so the basic units change and practically melt, they release fission product gases, then they rapidly cool again in a different orientation so the “single crystal” is no longer in the same orientation and it distorts. Single crystals are not single. They are simply a huge number of tiny units of solid matter with the same orientation.

Lead provides us with another aspect of the units of the solid state of matter. A piece of lead has a grain size that can be measured. The lead can then be hammered and it is found that the grains have been broken down into smaller grains. But, left at room temperature these grains gradually amalgamate to form grains of the original size. This is room temperature annealing. Cooling decreases the unit size but often it cannot be seen, battering reduces the unit size and even though it can be seen annealing takes place and these grains grow again.

Next we look at diamond and graphite. Both are made of carbon atoms with a different crystalline structure. There is a minimum size of diamond powder below which it is not diamond, and there is a minimum size of graphite powder below which it is not graphite. However both remain in the solid state of matter but we know nothing of the powder below the minimum size of diamond and graphite, unless it is buckminsterfullerene.

The next crystal that exemplifies the solid state of matter is the snow crystal, which is hexagonal and planar. It is part of a snow flake but its hexagonal symmetry illustrates the dynamic character of crystals because when a snow crystal is examined under a microscope and it begins to melt it does so at 24 points at once and then the process stops for a while and starts again. The crystal resonates and this is true of all crystals. It is the basis of the electronics industry.

All these, and many more, observations and experiments lead to the postulation of a new atomic unit of matter, which has the following characteristics:

Nuclei with an
Equal
Number of
Degrees of
Order
Resonating within an
Electron
Cloud boundary.

Thus, experiments show that the solid state of matter consists of **NENDOREC**s. Solids consist of thousands of these units, which have the following characteristics:

1 They have boundaries
2 They resonate
3 They are of finite size
4 At low temperatures they are small, highly ordered and rigid
5 At high temperatures (near the melting point) they are larger, less ordered and plastic
6 The more complex the crystal structure of the allotrope the lower the density.

One curious and very important observation is that although at lower temperatures the density of an allotrope increases, when the allotrope changes from a simple (e.g., cubic) allotrope to a more complex (e.g., triclinic) one there is a marked decrease in density, even though it is the more stable allotrope at the lower temperature. This is clearly seen when metallic tin is cooled below 18 °C.

Meditation 7

The Smectic State of Matter

The Oxford Dictionary of Science defines:

Liquid crystal. A substance that flows like a liquid but has some order in its arrangement of molecules. **Nematic crystals** have long molecules all aligned in the same direction, but otherwise randomly arranged. **Cholesteric** and **smectic** liquid crystals have aligned molecules that are arranged in distinct layers. In cholesteric crystals, the axes of the molecules are parallel to the plane of the layers, in smectic crystals they are perpendicular.[3]

In many ways this smectic state of matter is easier to understand than other states because it is just one molecule thick for the particles, which have a finite size. The molecules are anisotropic. It is a cohesive powder of molecular plates, like confetti or a pad of notepaper. The particles have two directions of geometrical order, so $c = 1$ and a and b are the unit sizes of the anisotropic molecules that form this state of matter.

Each molecule can be represented as a match in a matchbox. They can take up regular arrays so that the least ordered arrangement is square, a lesser order is oblong and a lesser ordered state is rhombic. This is when α is not 90°; with this system it would appear that there could be an infinite number of allotropes, but in reality there is for each molecule (compound) a limited number.

Particles of any one allotrope of the smectic state of matter are smaller and more rigid at low temperatures and larger and more plastic (or flexible) at higher temperatures.

The allotropes of the higher temperatures in a compound in the smectic state tend to be square, $a = b$ and $\alpha = 90°$, the least ordered state. The allotropes at lower temperatures tend to be rhombic where $a \neq b$ and $\alpha \neq 90°$.

Although we can always picture states as being pure, we know that in reality nothing is pure. Pure gold is not quite pure if we have the means of detecting the impurities. I have seen pure gold with only parts per (U.S.) billion of plutonium oxide as an impurity, but this impurity can be detected and it does influence the rest of the gold.

Some impurities can make the basic unit of the smectic plate (the NENDOREC) larger and other impurities can make the basic unit smaller at any particular temperature. Take a pure basic particle of one million anisotropic molecules in a square array, add to it ten impurity molecules and the new basic particle could be 10 million molecules! Add to it a different impurity and the new basic particle could be only 100,000 molecules in size. These effects can only be determined by experiment.

The effect of impurities applies to all other states of matter, especially the solid state of matter in metals where we know "impurities" can make iron into steel or a steel into stainless steel. Impurities can change a malleable iron into a brittle iron, all of which have been studied empirically. "Theory" has to be backed by experiment at all times.

The crystalline character of the smectic state is rather like the soldiers in the Trooping of the Colour, there is order, there is flexibility but the soldiers are not holding hands so there is no lattice. Likewise the molecules are ordered so that there "appears", by X-ray analysis, to be a lattice. The difference between this crystallite and the soldiers is that the former molecules have harmony and the molecules are within a boundary. The soldiers have harmony under instruction but they can break ranks because they have no boundary.

In summary, the smectic state of matter is an assembly of monomolecular thin crystallites. These crystallites are smaller and more rigid at low temperatures and larger and more flexible at higher temperatures. The size of these crystallites can be changed by impurities. The crystallites are very fluid but *they are not liquid at all*.

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3 Liquid crystals are more accurately called fluid crystals. Fluid crystals are not liquids, but they are erroneously called "liquid crystals" in most science books dealing with these chemicals. The error appears to have arisen as a mistranslation of the original German term "flüssige Kristalle".

The crystallites, being platelike, make the fluid oily or waxy.

Like the solid state of matter the more complex (rhombic) allotropes will be less dense than the simpler (square) allotropes of the same compound.

Cholesteric molecules can be in the smectic state but frequently they are in the **nematic** state as explained in Meditation 8. The so-called cholesteric state of matter has frequently been confused with the smectic state because both produce "oily" results. Hence the Oxford Dictionary of Science equates cholesteric with smectic whereas cholesteric is a specialized form of the nematic state of matter.

Meditation 8

The State of Matter with one direction of geometrical order. It has two distinct names; the Nematic State of Matter or the Cholesteric State of Matter

The nematic state of matter is made of a fluid of particles of anisotropic molecules in a one-directional order. These anisotropic molecules are like matchsticks where $c \gg a$ and b and $a = 1$ and $b = 1$. Thus when they are aligned together they make a flexible tape (or thread), which has only one direction of geometrical order and that order is length. It is shorter and more rigid at low temperatures and longer and more flexible at high temperatures. It is these tapes that respond to electric fields because the individual molecules are anisotropic.

The cholesteric state of matter is also made of a fluid of particles of anisotropic molecules in a one-directional geometrical order. These anisotropic molecules are plate-like cholesteric molecules; that is, $c \ll a$ and b, where $a = 1$ and $b = 1$. These molecules when stacked together make tubes, shorter tubes at low temperatures and longer tubes at high temperatures, hence they are confused with the smectic plate particles (also of anisotropic molecules). At present we have no means of measuring the number of molecules in each tube. Likewise we have no means of measuring the number of molecules in the nematic particle tapes.

The table below lists comparisons between these three states of matter and it is extended to the fourth state of matter, which has no directions of geometrical order but also has a finite size for its amorphous particles or droplets. This is the eutectic state of matter. Eutectic means nearly liquid.

Cholesteric and smectic states of matter are often confused together because of their similar physical appearance. Nevertheless cholesteric and nematic are truly similar because they each have only one degree of geometrical order.

Table 2. Solid to Eutectic States of Matter.

Degrees of geometrical order	Shape of molecule	Shape of NENDOREC particle	Type of matter	Common name of state of matter
3	Angular	Angular	Crystalline or amorphous	Solid
2	Plates or rods	Plates	Oily fluid crystal	Smectic
1	Plates	Tubes	Oily fluid crystal	(Cholesteric)
1	Rods	Tapes (threads)	Fluid crystal	Nematic
0	All types—rods, plates and angular	Spherical	Drops	Eutectic

Two facts should be noted because they appear to be contradicted in some experiments: As the temperature (energy) is raised SOLID changes to SMECTIC and this changes to NEMATIC and then to EUTECTIC and finally to LIQUID. At each stage there is a *decrease* in density. But within any one state of matter, as it cools the allotropes at the lower temperature are more complex (i.e., monoclinic or triclinic) and also lower in density! Each state/allotrope boundary can be measured but there is no way of predicting them from first principles. Thus, as a triclinic solid changes to a cubic solid there is an *increase* in density. But as soon as this cubic solid changes into smectic plates there is a *decrease* in density! Although ice (hexagonal water) changes into liquid water, with an increase in density, this apparent anomaly is only apparent, because all matter follows the above observations.

Meditation 9

The Eutectic State of Matter

The Oxford Dictionary of Science defines:

Eutectic mixture. A solid solution consisting of two or more substances and having the lowest freezing point of any possible mixture of these components. The minimum freezing point for a set of components is called the **eutectic point**. Low-melting-point alloys are usually eutectic mixtures.

Metallurgy for Engineers, p. 78:[4]

As a rule, one constituent forms a continuous matrix in which the other constituent is dispersed. The dispersed constituent may consist of spheres, rods, plates and angular shapes but all tend to be fine in the centre of the grain, thus giving rise to the "colony" effect, seen in Fig. 30,[4] which shows a copper–silver eutectic of the globular type.

The eutectic state of matter is the most frequently observed state of matter! It includes living matter so there are billions of allotropes. When eutectic (living) matter changes either to the liquid state or to the solid state (ice) the living state becomes the dead state. Life has either frozen to death or has simply rotted away.

The eutectic state is involved in all melting processes; viz., solid → eutectic → liquid; but freezing is liquid → eutectic → solid; it is found by experiment that sometimes melting point is not the same as freezing point.

The eutectic state in metallurgy illustrates the finite size of the drop (grain). First the mixture separates out one component of the alloy leaving the eutectic state as "liquid" but when this drop freezes it produces a stripy pattern within the eutectic grain. This is because the components of the alloy have continued to deposit within the grain as separate components, but this time within the confines of the former grain (drop). As in all metallurgical processes the rate of cooling determines the exact pattern that is observed.

Many studies of liquid crystals (fluid crystals) found that there appeared to be another state between the crystalline fluids and the isotropic liquid state, sometimes called the blue state. However it was difficult to study and often appeared to be like the liquid state but with a much increased viscosity. These observations accord with the eutectic state being finite drops, with no directions of geometrical order (i.e., amorphous) and very cohesive.

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[4] E.C. Rollason, *Metallurgy for Engineers*, 3rd edn. London: Edward Arnold (1963).

Meditation 10

The Liquid State of Matter

Oxford Dictionary of Science:

Liquid. A phase of matter between that of crystalline solid and a gas. In a liquid the large scale three-dimensional atomic (or ionic or molecular) regularity of the solid is absent but, on the other hand, so is the total disorganization of the gas. Although liquids have been studied for many years there is still no simple comprehensive theory of the liquid state. It is clear, however, from diffraction studies that there is a short-range structural regularity extending over several molecular diameters. These bundles of ordered atoms, molecules, or ions move about in relation to each other, enabling liquids to have almost fixed volumes, which adopt the shape of their containers.

A Textbook of Theoretical & Inorganic Chemistry:[5]

Pure Liquids. While the recently introduced X-ray methods of crystal analysis have thrown much light on the nature of the solid state, and while the kinetic theory has done much the same for gases, our knowledge of pure liquids (as distinct from solutions) is still rudimentary. That the molecules in the interior of a liquid are in motion is shown by the fact that two mutually soluble liquids placed in contact diffuse into each other until the system is homogeneous. The kinetic theory accounts for the difference between the liquid and the gaseous states by assuming that in the former the molecules have been brought so close together that the intermolecular attraction is sufficient to overcome the tendency of molecules to leave the system. Surface tension is caused by the inward pull of the body of the liquid on the surface molecules. Only molecules with exceptionally high velocities are able to overcome this attraction and break through the surface, and the vapour pressure at any temperature is a measure of the number of molecules for which this is possible. As the temperature is raised the concentration of molecules in the vapour phase approaches the concentration in the liquid phase; when these two concentrations become equal the surface tension is reduced to zero, the liquid–vapour interface disappears, and the *critical temperature* is reached.

While there is little doubt that the kinetic view of evaporation is correct, not much else is certain. Ignorant as we are of the law of force between molecules in close contact we cannot calculate the mean free path or the volume of the molecules. Even the determination of the molecular weight of pure liquids is a problem of much difficulty. In this section we shall confine ourselves to a short discussion of this problem and to an account of some recent experiments, which tend to show that certain types of molecules at least are at the surface arranged in a regular fashion.

The New Atomic Hypothesis has a different view on the liquid state of matter, which is a real puzzle to today's scientists who believe in Bragg's theory of solid state lattices and the kinetic concept of balls flying about randomly in space corresponding to gases. These are standard ideas that have been taught for years in schools and universities. The many theories of liquids published in books have either broken lattices or are compressed gases, but they are mutually incompatible.

A NENDOREC hypothesis based on resonating units with ordered (but not lattice) atoms, or molecules within an electron cloud that has a boundary finds that the molecular particles in

[5] By F.A. Philbrick and E.J. Holmyard. London: Dent (1935).

liquids are spherical. They are like marbles in a plastic bag that is its outer boundary, free to move but not able to escape. The bag fits the shape of any container that could hold it. There are certain points to notice about liquids that could never be understood by the concepts of broken lattices or compressed gas:

1. There are many mutually immiscible liquids. A simple example is mercury–water–petrol. It has been found that there are 12 mutually immiscible liquids that can be shaken together and then they separate out into 12 layers by density.
2. Liquids are potentially infinite. Drops of rain fall to Earth to make streams, streams unite to make rivers, rivers flow under gravity to congregate into seas and finally these join together to form the oceans of the world. The liquid state of matter has no limit except in the quantity of molecules available to join together.
3. Liquids can freeze to solids via the eutectic state of matter.
4. Liquids can change into the gaseous state of matter via the multimer state either during evaporation or when boiling.
5. Egg timers (hour glass type) work with sand (solid state of matter) but do not work at all with liquid water, or any other liquid. This shows quite clearly that liquids are not powders.
6. Many people have suggested that liquid water is a mixture (or alloy) of different molecular units of $(H_2O)_n$.
7. Grains in metal alloys are rather like liquids with a finite boundary.
8. Liquids that are miscible do not readily mix if they are sufficiently different. For example cold water does not readily mix with hot water, river water (like that of the Amazon) does not readily mix with salty sea water.
9. Liquid water is essential to living matter but living matter has not the same n.m.r. spectrum as river water.
10. Liquids can become turbulent and acquire different properties.
11. Drops of liquid water in spacecraft can be moved like a bag of marbles. It is clearly not like a powder.
12. Liquids on hot surfaces often gather together as a ball bouncing on the surface. Mercury liquid readily forms drops that run around in a glass dish.
13. Liquids are generally easily fragmented into little drops, like raindrops or a dripping tap.

When scientists thought that Jupiter was a wandering star, they gave it a special name “planet” because it was not like the fixed stars. Planets were anomalous stars to those scientists. But when Copernicus, Galileo and others suggested that planets were satellites of the Sun, scientists ridiculed them. Galileo suggested that they did not emit light of their own but reflected the Sun’s light, like the moon, hence they were not stars at all. Planets were no longer anomalous stars. Today’s scientists think very sincerely that water is an anomalous liquid. This is because the current theories of liquids are erroneous. The New Atomic Hypothesis (based on NENDORECs) finds that water is not only the most abundant liquid on Earth but it is also the most normal liquid, illustrating aspects of all liquids. Some of these aspects are not readily seen in most other liquids.

All liquids are alloys (i.e., mixtures) of molecular units that are spherical in shape and they are in a potentially infinite electron cloud with a definite boundary. Because the molecular units are of at least two types some are more complex than others (and hence have a lower density) that are simpler (and hence have a higher density). The lower density units freeze at a higher temperature than the higher density units but the unit that actually freezes out depends on the ratio of the total masses of the two units in the liquid. The density of the real liquid, an alloy of A and B, will be the weighted average density of pure liquid A and pure liquid B. Hence, as in water, the solid A, which is more dense than the pure liquid A, can be less dense than the real liquid (alloy) because the real liquid is rich in pure liquid B, which, although it is less dense than solid B, has a much greater density than solid A. The molecular units in a liquid are frequently in dynamic equilibrium with one another.

If allotrope A is more complex than allotrope B then allotrope A will tend to be in greater abundance at lower temperatures because allotrope B can in those circumstances change to allotrope A. Nevertheless if allotrope B is still the predominant component of a liquid it will freeze out the allotrope B as the solid state and allotrope A will revert to allotrope B in the remaining part of the real liquid. Solid A will be less dense than solid B but solid A will be more dense than pure liquid A. Solid B will be more dense than pure liquid B.

Liquid water

Liquid water is an alloy of three molecular units:

$(H_2O)_2$: rod-like molecules in a high density spherical shell
$(H_2O)_4$: tetrahedral-like molecules in a fairly high density spherical shell
$(H_2O)_6$: hexagonal plate-like molecules in a low density spherical shell.

With these components water then becomes a normal liquid. Empirical formulae can be determined for its various properties; for example, freezing point, boiling point, viscosity, compressibility, velocity of sound, refractive index.

Consider the following experiment with a beaker of water about 2/3 full. Into it is placed a drop of carbon tetrachloride about 1 mm in diameter, then another drop of trichloroethylene coloured with a green dye, again about 1 mm in diameter, is placed close by and the two drops are moved to meet each other. They touch and immediately amalgamate, but just watch it very carefully—the liquids do not readily mix at first.

The following scenario is an analogy of the liquid state of matter as found by experiment and using the principles found in the New Atomic Hypothesis.

There are enough soldiers to fill completely Horseguards Parade in London. They are all wearing tracksuits, but most of them have tunics over the tracksuits, in addition a few have busby hats as well. They have no orders except to stay on the parade ground. Occasionally one wearing a busby takes it off and another tunicked soldier puts it on. Also occasionally a tunicked soldier, not wearing a busby, takes off his tunic and one of the soldiers only in a tracksuit puts it on.

When the temperature falls a little, more busbies are issued and soldiers put them on, when the temperature rises a little not only are busbies returned but also some of the discarded tunics are removed from the parade ground.

Thus there is general turmoil on the parade ground and it changes with the rise and fall in temperature. Sometimes there are more busbies present, sometimes there are more tracksuits visible.

However, if the temperature falls sufficiently more tunics and busbies are issued. Those wearing busbies gather together with just a few non-busby wearing soldiers with them, so this group splits off from the rest of the soldiers. Nothing of this splitting off of a platoon can be seen externally until an order is given to form rank and file. The soldiers of this platoon with busbies form into files but the soldiers without busbies are excluded. These files form on the edges of the parade ground, they become visible because they are ordered in rank and file, they are a neat lot. This process can continue as more busbies are issued and other platoons form into rank and file with a different orientation. The files are a bit higgledy-piggledy, rather like the grains in cast metals. This process can continue until all the soldiers in the parade ground have received busbies and formed into rank and file. This represents the changing of a liquid into first the eutectic globule and then into the crystalline particle. Each file has its own orientation but if an order is given it is possible for the whole parade ground to take up one orientation facing the Admiralty Buildings. This is highly ordered and the individual platoons would be difficult to identify. It is like a single crystal in which it is difficult to identify the basic units within; like a liquid crystallizing out the more complex higher melting point allotrope.

However, it could be that the soldiers in tunics decide to form platoons and split off from the rest of the soldiers in the parade ground. Then they agree to form rank and file and become visible units. To get equilibrium more tunics are issued and some busbies are removed. So the process repeats itself until the whole parade ground is filled with soldiers in tunics without any busbies present. This is like where the less complex allotrope is crystallized out of a liquid.

Alternatively, we can increase the temperature and the busbies are removed from most soldiers and more tunics are discarded so that the track-suited soldiers predominate. These gather together and form platoons. Again there is nothing to see that they have formed their own platoon. But then the gate into St James's Park is opened and a platoon slips out leaving the others behind with an excess of tunicked soldiers. These lose some tunics to get the correct balance as before. The platoon that has escaped into St James's Park now brings out flags on long poles and proceeds to swirl them around, so the platoon fills the whole of St James's Park. These soldiers are only in contact at the periphery of their flagged area. This small platoon, which occupied a small area in Horseguards Parade, now occupies the whole of St James's Park! This is the liquid state splitting off into the multimer state and then changing into the gaseous state of matter.

Recapitulation:

Liquids are always alloys—different types of soldiers

Liquid components are always in equilibrium—changing tunics and busbies

Liquids can split into eutectic or multimer droplets—platoons forming but not being identifiable.

In many ways the liquid state of matter is simple:

1. It comprises hard molecular spheres in an electron cloud with a boundary that can be potentially infinite.
2. It is always an alloy, even when it is only one type of molecule there are still spheres of different allotropes.
3. These allotropes are in dynamic equilibrium and the ratio is temperature dependent. In addition the ratio is also modified by any soluble impurities.
4. Near the freezing point the electron cloud breaks down into eutectic state drops.
5. Near the boiling point the electron cloud breaks down into multimer state drops.

Meditation 11

The Multimer State of Matter

Oxford Dictionary of Science:

Cloud. A mass of minute water droplets or ice crystals held in suspension in the atmosphere that appears as an opaque drifting body. The droplets or crystals are formed by the condensation of water vapour in the atmosphere in the presence of condensation nuclei—minute particles such as smoke or salt. A number of cloud classifications have been devised; that most commonly used is based on cloud appearance and height. The high clouds (above 5000 metres) comprise cirrocumulus, cirrostratus, cirrus (mares' tails) clouds; the medium clouds (approximately 2000 to 5000 metres) comprise altocumulus and altostratus; and the low clouds (below 2000 metres) are nimbostratus, stratocumulus and stratus. Some clouds with great vertical development cannot be confined to these height categories, these are cumulus and cumulonimbus clouds.

The multimer state of matter is the second most commonly observed state of matter, but it has not hitherto been recognized as a separate, and very important, state of matter. The units of the multimer state are similar to polymers but the adherence of the molecular units in the multimer state is weaker than in chemical polymers.

The most commonly observed allotropes of the multimer state are clouds, which we see almost every day. Despite the assertions of the Oxford Dictionary of Science, quite simple experiments demonstrate that clouds are not superfine drops of liquid water nor are they fine particles of ice crystals.

The multimer state is similar to the eutectic state, being a finite number of molecules within a boundary. The multimer state is less dense than the liquid state and is denser than the gaseous state. The multimer state occurs not only in clouds but is present in high pressure gas. Argon gas under pressure contains not only monomers that obey the empirical formula $PV = RT$ but also argon multimers, Ar_2, Ar_3, Ar_4 etc., which cause the real gas to deviate from the ideal $PV = RT$. When CO_2 gas is introduced in small quantities into the argon gas the multimers of argon, vanish and are replaced with $(CO_2)_n$ multimers. This is because the latent heat of vaporization of argon is less than the latent heat of vaporization of CO_2. So using Le Chatelier's principle the argon multimers revert to argon monomers and are replaced by CO_2 multimers.

The multimer state in air, when it cools, can change into the liquid state, which are raindrops. If clouds were already liquid water it would be almost impossible to form raindrops from over 10^6 cloud-type droplets as suggested in meteorological cloud physics books. However, multimers are large enough to form raindrops, but because there are many allotropes there are many sizes of raindrops. Rapid cooling of the multimer particles in the atmosphere produces the solid state—snowflakes made up of many planar hexagonal snow crystals. Each type of cloud allotrope gives a distinctive snow crystal pattern. Liquid water (i.e., rain) when it freezes gives hailstones, these are quite different from snowflakes, as is well known.

The multimer state particles of water in air are clouds. These show that these allotropes are very low density because even when there is no updraught they still float in air. This was observed by Wordsworth![6] Just as a log has almost the same density as liquid water so these clouds have about the same density as the air at the level at which they are seen floating.

[6] In his poem entitled "Daffodils".

It is also found that the surface area of these multimer particles is very large compared to the liquid state drops, so that in steam boilers there is a point where the rate of heat transfer suddenly increases by a factor of 10 to 100 fold, this is called nucleate boiling.

This large surface area to volume ratio of the multimer state has many consequences in the oil industry, in the design of heat exchangers, in the combustion of gasoline in engines, and in the explosion of gasoline vapour at Buncefield, near Hemel Hempstead.

Table 3 gives the essentials of the eutectic, liquid and multimer states of matter.

Table 3. Essentials of the eutectic, liquid and multimer states of matter.

Name	Directions of geometrical order	Density	Size	Fragility	In meteorology
Eutectic	0	> liquid low range of densities	Finite, usually small or microscopic	Tough	Insects and birds
Liquid	0	This is the standard	Potentially infinite	Fragile, easily broken into drops	Raindrops
Multimer	0	< liquid, often with a very wide range of densities	Finite, these can be very large indeed	Very fragile and flexible. Cannot be seen microscopically	Clouds

The multimer state can change into the liquid state if it is cold or can change into gas if it is heated. Real gases are always alloys and contain some multimer state molecules within the gas. Real liquids are always alloys and easily create multimer particles on hot surfaces in contact with the liquid. It is the formation of the multimer state on hot surfaces that gives the singing noise in kettles, the singing ceases and changes to rumbling when boiling commences. This is when the multimer state changes to the gas state, liquids *never* change directly into the gas state, this will sound strange but it is true! However, the multimer state can change to the gas state explosively as was seen at Krakatoa, Chernobyl, Port Talbot and Scunthorpe, each resulting in the death of people close by.

Although not mentioned in science books the multimer state of matter is the second most observed state of matter, seen in the kitchen, in fog, in mist, in cloud, and in industrial boilers and accidents.

The six states of matter mentioned above, solid, smectic, nematic, eutectic, liquid and multimer, are usually visible, but the next three states of matter occupy great volumes and are usually (always?) invisible so that the boundaries are very difficult to detect. One example is the tropopause, another is the boundary of a comet. But there is one that can be seen if care is taken, but usually scientists have not taken adequate care with their observations and have invented the term *critical point,* or *critical temperature.*

When a sealed tube of a liquid like carbon tetrachloride is heated to its so called critical temperature the meniscus flattens and then disappears! But if it is carefully observed, especially using collimated light beams and magnifying equipment, it will be seen that there is a lens of multimer state matter between the liquid below and the gas above. Partington's textbook[7] lists

[7] J.R. Partington, *An Advanced Treatise on Physical Chemistry*, vol. 1, § Supposed anomalies of the critical point. Longmans (1949–54) [vols 1–5]).

many experiments that showed that there was something wrong with this *critical temperature* concept but he dismisses them as poor experimenters with dirty equipment. You can repeat these experiments and you will find that the liquid state does exist above the *critical temperature*, the gas state also exists and so does the multimer state, indeed the critical point *is* a thermodynamic triple point for the liquid state—the multimer state—the gas state. This is one of the many places where the New Atomic Hypothesis based on the NENDOREC concept differs from the Bragg and kinetic concepts.

Meditation 12

The Gaseous State of Matter

Oxford Dictionary of Science:

Gas. A state of matter in which the matter concerned occupies the whole of its container irrespective of its quantity. In an ideal gas, which obeys the gas laws exactly, the molecules themselves would have a negligible volume and negligible forces between them, and collisions between molecules would be perfectly elastic. In practice, however, the behaviour of real gases deviates from the gas laws because their molecules occupy a finite volume, there are small forces between molecules, and in polyatomic gases collisions are to a certain extent inelastic.

If the above definition was genuine then there would be no air on Earth, it would all vanish into space, likewise the Sun would also vanish if it were all gas as many astronomy books inform us. The New Atomic Hypothesis proposes that every molecule in a gas *has* volume and every molecule obeys the *empirical* equation

$$PV = RT \tag{1}$$

where P is pressure, V is volume, R the universal gas constant and T is temperature.

Real gases are mixtures of gas molecules and multimer molecules, it is the latter that cause the apparent deviation from $PV = RT$.

Dalton called gases "elastic fluids" to separate them from liquids that were inelastic fluids. This suggested that molecules in gases had considerable volume and were elastic so that they could transmit sound, like liquids (water at 1461 m s^{-1}) and solids (steel at 5000 m s^{-1}) but at a slower speed (air at 344 m s^{-1}). If the kinetic theory were correct it would be impossible to transmit sound in a gas.

Gases are transparent, but chlorine, bromine and iodine vapours appear to be coloured gases because they contain many multimers that absorb light. At high temperatures when there are only a few multimers present they too are colourless.

Gases have mass and so a pile of gas molecules is under more pressure at the base of the pile than at the top. This is best seen in climbing high mountains where the pressure at the top of the mountain is less than the pressure at the base of the mountain. Air in the atmosphere is like a pile of bricks, the one at the bottom has the pressure of all those above it pressing it down.

Gases are insulators. A furnace was constructed with insulating bricks and operated under argon. Then when the argon was replaced by helium the insulation was so much decreased that the power input to maintain the same temperatures had to be increased by 30%. Furnaces where the insulating gas was hydrogen needed an even greater input of power.

Gases in the atmosphere do not absorb heat because they are transparent. Air is not heated by the Sun; land, vegetation and sea are heated by the Sun and these heat the air in contact with them. Clouds (multimer state) can also heat the air.

Real gases are all alloys, they are mixtures of gas molecules (which are very large in volume compared to the corresponding liquid molecules) and multimers (which do not obey the empirical equation $PV = RT$).

Gases do not readily mix if they are of a different order. For instance, hot gases float over cold gases as in convection, and CO_2 gas is so dense compared to air that it sinks to the floor and displaces the air upwards. It is reputed that a mixture of helium gas and xenon gas in a bottle will segregate if left to stand. In Calder Hall reactors the gases from the hot channels did not mix with the gases from the cold channels in the top dome (as was calculated from the mean free path concept of the kinetic theory) but had to pass half way down the heat exchangers before they were adequately mixed.

Gases are sticky. A moving gas jet will pull other gases along with it, gases move the surface of the sea and they affect solid surfaces. These have been studied in aerodynamics where numerous empirical equations have been developed to assist in the designing of aircraft.

Because sound has a velocity in gas, when an object moves through the gas at a speed greater than the speed of sound a shock wave is developed and the energy in the shock wave can do considerable damage. The shock wave from Concorde would have done so much damage as it flew over the UK that flights above the speed of sound were prohibited. The shock wave from Thrust 2, the supersonic car that broke the sound barrier, almost destroyed the microlight plane that was filming the event.

The gases round the Earth are mainly found from sea level to about 15 km (8 km at the poles and 18 km at the equator. Because there is less insulation over the poles they are cold and icy, because there is less insulation over the top of Kilimanjaro it is also cold and icy). The tropopause is the limit of the normal atmosphere, because this is where the gas changes from an alloy of gas plus multimer to another alloy of gas plus plasma. Below the tropopause is the troposphere, above the tropopause is the stratosphere and this extends to the ionosphere as the percentage of the plasma state increases. This ends at the boundary of the magnetosphere.

There is another difference of considerable importance between gases and the six states of matter from solid to multimer, namely that $PV = RT$ is independent of the gas molecule, it is the same for hydrogen, argon and xenon. Pressure and temperature are interrelated in this gaseous state of matter and hence we have adiabatic effects. This is most noticeable in compressors, where the rapid compression of the gas increases its temperature. This is the usually observed phenomenon. But, just occasionally one encounters a rapid rise in temperature that causes the pressure to rise as in atomic explosions, the pinking in internal combustion engines and at the Buncefield explosion a few years ago, where the rapid rise in temperature caused an increase in pressure that crushed cars in the vapour cloud.

Thus, gases are monomers that have mass, volume and elasticity. They obey the formula $PV = RT$. Real gases contain either multimer state molecules at high pressures or plasma state molecules at low pressures.

Gases surround the core of the Earth to a height of 15 km, gases surround the core of the planet Venus to a height of 50 km, gases surround the core of the planet Jupiter to a calculated height of about 10,000 km, gases surround the core of the Sun to a calculated height of about

100,000 km. This difference in insulation results in different surface temperatures: Earth about 20 °C, Venus over 200 °C, Jupiter over 600 °C (the Great Red Spot) and the Sun at 6000 °C. The calculation that the Sun's temperature is 1,500,000 K is based on the kinetic concept.

As you will see from the above notes the New Atomic Hypothesis implies a totally different scientific analysis of gases from Maxwell's kinetic theory. It is as different as a satellite or planet (Jupiter or Venus) is from the wandering stars of Aristotle.

Hence, meditate on the definition from the Oxford Dictionary of Science given below. Is it correct?

Kinetic theory. A theory largely the work of Count Rumford, James Joule and James Clerk Maxwell, that explains the physical properties of matter in terms of the motions of its constituent particles. In a gas, for example, the pressure is due to incessant impacts of the gas molecules on the walls of the container. If it is assumed that the molecules occupy negligible space, exert negligible forces on each other, it can be shown that the pressure P exerted by one mole of gas containing n molecules each of mass m in a container of volume V, will be given by:

$$P = nmc^2/3V \tag{2}$$

where c^2 is the mean square speed of the molecules. As according to the gas laws for one mole of gas $PV = RT$, where T is the thermodynamic temperature and R is the molar gas constant, it follows that

$$RT = nmc^2/3\,. \tag{3}$$

Thus, the thermodynamic temperature of a gas is proportional to the mean square speed of its molecules. As the average kinetic energy of translation of the molecules is $mc^2/2$, the temperature is given by

$$T = (mc^2/2)(2n/3R)\,. \tag{4}$$

The number of molecules in one mole of any gas is the Avogadro constant, N_A; therefore in this equation $n = N_A$. The ratio R/N_A is a constant called the Boltzmann constant, k. The average kinetic energy of translation of the molecules of one mole of any gas is therefore $3kT/2$. For monatomic gases this is proportional to the internal energy (U) of the gas, i.e.

$$U = N_A 3kT/2 \tag{5}$$

and as $k = R/N_A$

$$U = 3RT/2\,. \tag{6}$$

For diatomic and polyatomic gases the rotational and vibrational energies also have to be taken into account.

In liquids, according to the kinetic theory, the atoms and molecules still move around at random, the temperature being proportional to their average kinetic energy. However, they are sufficiently close to each other for the attractive forces between the molecules to be important. A molecule that approaches the surface will experience a resultant force tending to keep it within the liquid. It is, therefore, only some of the fastest moving molecules that escape; as a result the average kinetic energy of those that fail to escape is reduced. In this way evaporation from the surface of a liquid causes its temperature to fall.

In a crystalline solid the atoms, ions, and molecules are able only to vibrate about the fixed positions of a crystal lattice; the attractive forces are so strong at this range that no free movement is possible.

Meditation 13

The Plasma State of Matter

The Oxford Dictionary of Science:

Plasma (in physics). A highly ionized gas in which the number of free electrons is approximately equal to the number of positive ions. Sometimes described as the fourth state of matter, plasmas occur in interstellar space, in the atmospheres of stars (including the Sun), in discharge tubes, and in experimental thermonuclear reactors. Because the particles in a plasma are charged, its behaviour differs in some respects from that of a gas. Plasmas can be created in a laboratory by heating a low pressure gas until the mean kinetic energy of the gas particles is comparable to the ionization potential of the gas atoms or molecules. At very high temperatures, from about 50,000 K upwards, collisions between gas particles cause cascading ionization of the gas. However, in some cases, such as a fluorescent lamp, the temperature remains quite low as the plasma particles are continually colliding with the walls of the container, causing cooling and recombination. In such cases ionization is only partial and requires a large energy input. In thermonuclear reactors an enormous plasma temperature is maintained by keeping the plasma away from the container walls using electromagnetic fields. The study of plasmas in known as plasma physics.

The plasma state of matter exists on Earth in two distinct areas, first in high vacuums (mainly in laboratories) and second in the stratosphere out to the magnetosphere boundary.

The plasma state of matter consists of positive ions and a negative component. In conventional concepts the negative component is a free electron but in the New Atomic Hypothesis it is a negative ion particle. Mass spectrometry has shown that there are positive ions and negative ions that respond to magnetic and electric fields. It was soon found that mass spectrometers detecting positive ions were better than those attempting to detect negative ions. In the gaseous state of matter molecules have volume, considerable volume when compared to the liquid/solid states of matter. Hence it is not surprising that in the plasma state there is a considerable increase in volume over the gaseous state. In this case it is the negatively charged plasma ions that have an increased volume but the positively charged ions are roughly the same size as the corresponding gas molecules. The mass spectrometer illustrates this; modern mass spectra are now based on the positively charged ions in the spectrographs.

A mass spectrometer at UKAEA Harwell was set up to produce plutonium isotopes for further examination. Its positive beams would be collected like the U^{235} beams at Oak Ridge in World War II. However, the Harwell project was soon halted—was this because they had not anticipated that the negative plasma would be ejected by the vacuum system? Like so many failed scientific experiments the results were not available to other workers.

Thunderstorms also illustrate the same effect of the negative ions being of considerable volume. Under certain atmospheric conditions thunderstorms develop, there is a rapid rising of air, but it is not hot air, in fact it is very cold air but it is highly ionized. It has both positively and negatively charged ions which rise to the level of the tropopause, there the positively charged ions are trapped in the typical anvil cloud. The negatively charged ions, having much lower density, pass into the stratosphere. The positive ions accumulate and discharge occasionally as lightning. The idea that thunderclouds are hot air rising, because there are more in tropical regions of the globe, is wrong. Inside a thundercloud it is very cold—parachutists have been frozen to death in them.

Thus all the indications are that the plasma state of matter is found at low pressures, especially in vacuums, and there are two types of charged particles: one particle with a volume about the same as that of the gas particle and the other particle with a volume considerably greater than the gas particle.

Air in the stratosphere consists of gas molecules plus plasma molecules. As we go higher into the mesosphere the plasma molecules become relatively more numerous and the gas molecules diminish. The process continues into the thermosphere at a height of 100 km where the density is only 2×10^{-7} kg/m^3. Just as the air in the troposphere is segregated into three significant layers with different multimer clouds within them, so is the plasma-rich air round the Earth segregated into three layers as seen in Table 4 below, and there are many more known above these layers.

Table 4. Characteristics of the atmosphere.

Divider	Main divisions	Sub-divisions	Height above the Earth / km	Density / kg m^{-3}	Mixture
	Troposphere	Lower	2	1.2	Gas + multimers
		Middle	6		Gas + few multimers
		Upper	15	6×10^{-1}	Gas + plasma
Tropopause					
	Stratosphere	?	40	2×10^{-3}	
Stratopause					
	Mesosphere	?	80	8×10^{-6}	
Mesopause					
	Thermosphere	?	120	1×10^{-7}	Very rich in plasma

It is very easy to see that the kinetic concept of matter does not explain the above observations. However most studies on plasma refer to temperature and it is therefore important to meditate upon the meaning of temperature.

Oxford Dictionary of Science:

Temperature. The property of a body or region of space that determines whether or not there will be a net flow of heat into it or out of it from a neighbouring body or region and in which direction (if any) the heat will flow. If there is no heat flow the bodies or regions are said to be in **thermodynamic equilibrium** and at the same temperature. If there is a heat flow, the direction of the heat flow is from the body or region of higher temperature. Broadly there are two methods of quantifying this property. The empirical method is to take two or more reproducible temperature-dependent events and assign **fixed points** on a scale of values to these events. For example, the Celsius temperature scale uses the freezing point and the boiling point of water as the two fixed points, assigns the values of 0 and 100 to them respectively, and divides the scale between them into 100 degrees. This method is serviceable for many practicable purposes but, lacking a theoretical basis, it is awkward to use in many scientific contexts. In the 19th century, Lord Kelvin proposed a thermodynamic method to specify temperature, based on the measurement of the quantity of heat flowing between bodies at different temperatures. This concept relies on an absolute scale of temperature with an absolute zero of temperature, at which no body can give up heat. He also used Sadi Carnot's concept of an ideal frictionless heat engine. This Carnot engine takes in a quantity of heat q_1 at a temperature T_1 and exhausts q_2 at T_2 so that $T_1/T_2=q_1/q_2$. If T_2 has a value fixed by definition, a Carnot engine can be run between this fixed temperature and any unknown temperature T_1, enabling T_1 to be calculated by measuring the values of q_1 and q_2. This concept remains the basis for defining **thermodynamic temperature**, quite independently of the nature of the working substance. The unit in which thermodynamic temperature is now expressed is the Kelvin. In practice thermodynamic temperatures cannot be measured directly; they are usually inferred from measurements with a gas thermometer containing a nearly ideal gas. This is possible because another aspect of thermodynamic temperature is its relationship to the internal energy of a given amount of substance. This can be shown most simply in the case of a monatomic gas, in which the internal energy per mole (U) is equal to the total kinetic energy of translation of the atoms in one mole of the gas (a monatomic gas has no rotational or vibrational energy). According to kinetic theory, the thermodynamic temperature of such a gas is given by $T = 2U/3R$, where R is the universal gas constant.

Temperature has an empirical scale, Celsius (°C) is the one most frequently used nowadays. The absolute Kelvin scale (K) has the same degrees as Celsius but its zero is about 273° lower than 0 °C.

Temperature is energy with dimensions $\mathbf{ML^2T^{-2}}$ but it is clearly not related to total energy, as suggested by the kinetic theory, because when melting occurs a solid gains energy but it does not gain any temperature energy. Likewise when a liquid boils it gains energy but the temperature remains constant. At the triple point solid–liquid–gas three states of matter have the same temperature and the same pressure. Pressure is energy per unit volume.

In the New Atomic Hypothesis temperature energy is related to the electron cloud and the pressure energy is also related to the electron cloud. Thus temperature and pressure do not apply to α particles but they do apply to solid helium, liquid helium and to helium gas. A single atom can be either solid or liquid or gas depending on how much energy there is in the atom.

When solid changes to a liquid it is the order of the nuclei within the electron cloud that changes. The solid particle has three directions of geometrical order and is finite in size. The liquid has no direction of geometrical order and is potentially infinite in size. Between these two states of matter is the eutectic state, which has no direction of geometrical order but has a limited size, its particles have a finite size for their electron clouds. Yet all three states can be at the same temperature, that is the melting point. The order of the electron clouds of each state is the same but the order of the nuclei within the electron clouds is different for each state of matter.

Thus temperature and pressure are related to the energy of the electron clouds of particles (NENDORECs) of the seven states of matter; solid, smectic, nematic, eutectic, liquid, multimer and gas but when two gas particles change into a positive and a negative plasma particle it is difficult to see that the electron cloud energy of these charged particles will have any energy that can be attributed to an empirical scale of temperature. Thus, to speak of a plasma at a particular temperature is meaningless in the New Atomic Hypothesis.

To recapitulate, plasma is a mixture of charged particles, some positively charged with a volume like a gas particle and others negatively charged with a huge volume compared to a gas particle.

Plasma, like gas, is sticky and this has been demonstrated in two incidents. The space shuttle Columbia returning to Earth had some heat-resisting tiles missing and the plasma state in the stratosphere heated it up and tore it apart. In the solar system the comet Shoemaker–Levy 9 broke up as it entered Jupiter's plasma zone. The comet Hale–Bopp was visible from the Earth for a few months, it had a white tail of multimers round the core blown outwards by the solar wind, but there was also a blue tail of ions in a plasma envelope that was invisible—its direction was governed by the magnetic field of the Sun. When Halley's comet passed between the Earth and the Sun it would have been possible to sample the tail, but that did not happen because it was swept aside by the magnetosphere of the Earth. This shows, as it did with gases, that plasma states of different degrees of order do not readily mix with other plasma states.

The magnetosphere boundary shows that the solar wind, also a type of plasma or ionized gas, must be something quite different and special.

Meditation 14

The Solar Wind

Oxford Dictionary of Science:

Solar wind. A continuous outward flow of charged particles from the Sun's corona into interplanetary space. The particles are controlled by the Sun's magnetic field and are able to escape from the Sun's gravitational field because of their high thermal energy. The average velocity of the particles in the vicinity of the Earth is about 450 km s^{-1} and their density at this range is about 8×10^6 protons per cubic metre.

The solar wind is perhaps the state of matter that we know least about. It is the most voluminous in the solar system, extending from the Sun's surface to the limits of the satellite Pluto. It has such a low density that it was thought to be empty space; that is, there was nothing there at all. But it has shown itself to be a wind flowing away from the Sun because a comet's tail always points away from the Sun. It is also known to be ionized so it is rather like a plasma state of matter, but it must be regarded separately because it does not mingle with our own magnetosphere nor does it get mixed up with the comet's tails. It is like a stream flowing past a rock; it is like the wind passing over the wing of an aeroplane.

All the indications are that it is a highly ionized plasma that is different from the plasmas round the Earth, from the stratosphere to the magnetosphere boundary, which is about 60,000 km above the Earth's surface facing the Sun (it is higher in other directions). This compares with the aurora borealis at 100 km above the Earth's surface as determined by John Dalton in his book on meteorology.[8]

The solar wind has two components; one small positively charged particle the same size as gas particles or slightly smaller but with multiple positive charges on each particle. These can penetrate the magnetosphere boundary and are likely to be associated with the aurora borealis. The other particle of the solar wind has a huge volume, much greater than the volumes of the plasma states round the Earth, it will have negative charges on it. These voluminous particles will not pass through the magnetosphere boundary, they will only react with its surface. It is like

[8] J. Dalton, *Meteorological Observations and Essays* (2nd edn). Manchester: Harrison & Crosfield (1834).

the effect of wind on the surface of a liquid. Wind affects waves but it does not penetrate the liquid water in the wave.

The positive ion particle is like the positive ions in a mass spectrometer. It is detectable. The negative ion particle is like the negative ions in the vacuum of a mass spectrometer, described by Aston as unpredictable (his work was mainly empirical when designing and operating mass spectrometers).

Rather than speculate on this voluminous state of matter it would be better for all those using artificial satellites to know of its existence and view their own deviations from the predicted orbits as being possibly due to the effect of this solar wind.

At Chester-le-Street in 2005 a plastic structure lifted vertically in calm hot weather. The designers, the police and the Health and Safety experts attributed the event to a sudden gust of wind that lifted the 4 ton structure into the air and so the designer was prosecuted for being careless. It was much more likely that on the hot sunny day charges developed[9] and formed plasma, very low density, inside or on the surface of the structure and this then lifted it into the air.

Thus the solar wind is a plasma but it is sufficiently different from the earthbound plasmas that it should be considered as a distinctly separate state of matter.

Meditation 15

Changes of State

Changes of state are basically changes in order; that is, solid to smectic to nematic to eutectic to liquid to mutimer to gas to plasma. The only states that can be omitted from the sequence are smectic and nematic if the molecules of the nendorec are not of the right kind. Smectic and nematic states are only possible with rodlike molecules or with platelike molecules, leaving for practical purposes the following state changes:

Solid to eutectic to liquid to multimer to gas—for normal pressure systems;
For very low pressure systems it is possible to go on to the plasma state.
Melting is solid to eutectic to liquid. It is never solid to liquid.
Freezing is liquid to eutectic to solid. It is never liquid to solid.

Because all liquids are alloys of two different isomers then the melting point can be significantly different from the freezing point. Depending on the two isomers in the liquid state it is possible to have two different freezing points for some liquids, one freezing point for one isomer and another freezing point for the other isomer. But a solid isomer can only have one melting point.

The kinetic concept of matter engenders numerous anomalies but the New Atomic Hypothesis of matter does not have an anomaly with two freezing points for some liquids, or with the freezing point being different from the melting point in some cases.

Solids cannot be superheated because they always change into the eutectic state first, but liquids can be supercooled sometimes.

Boiling is liquid to multimer to gas. It is never liquid to gas directly.

9 It is known that plastic balloons can generate charges and this means that they cannot be used with hydrogen.

Condensation is gas to multimer to liquid. It is never gas to liquid directly.[10]

When we see boiling we see huge bubbles of gas forming near the heating surfaces, this is because the heating surfaces change the liquid state into the multimer state so that there are a large number of molecules in a cluster (multimer) and these have a very high heat transfer coefficient so that they accumulate a lot of heat rapidly and then *they* change into the gas state where each molecule has about 1000 times greater volume than the molecule in the liquid or the multimer state. Hence the huge bubble instead of lots of invisible gas bubbles. This change of state requires a lot of energy, called latent heat of vaporization, and as a result in a small zone some of the liquid state will cool to provide the energy for the volumetric expansion of the gas state in that zone. So when a liquid boils it cools! This cooling cannot be measured because it occurs in such a small zone that immediately receives energy from the surrounding zones. This remarkable process means that the temperature is stabilized and we call it the boiling point. It is fixed because it is the multimer-to-gas change that takes place at a lower temperature than the liquid-to-multimer state change. As soon as the liquid changes into the multimer state it immediately becomes the gas state of matter and at a lower temperature for a fraction of a second.

This type of process is also true for the melting process where the solid changes *on the surface* into the eutectic state and this eutectic state immediately changes into the liquid state, this requires energy called latent heat of fusion so the surface temperature in that small zone falls and then it gains heat from the surrounding solid and the surrounding liquid.

Once again it is not possible to measure this fall in surface temperature directly, though some scientists have tried to do so. However, there is one way of demonstrating the fall in temperature by mixing two solids in powder form. Orthonitrochlorobenzene has a melting point of 32 °C and paranitrochlorobenzene has a melting point of 63 °C. If these two powders are mixed at 25 °C the temperature of the mixed powders immediately falls to 17 °C, which is the temperature of the melting point of the so-called eutectic mixture of these two compounds. Thus the mixing of these two different powders results in a temperature fall to 17 °C. If the two powders are at a temperature of 10 °C then the temperature remains 10 °C, but at 25 °C the temperature of the mixture falls immediately to more 17 °C and remains there until all the powders change to the liquid state and then the temperature rises to 25 °C (room temperature).

A more common example of this phenomenon is the addition of salt to ice resulting in a lowering of the temperature of the mixture. This was used frequently before refrigeration was common.

So we have the remarkable phenomena, which are not readily measurable, that:

When a solid melts its surface temperature falls!

When a liquid boils the surface temperature of the bubble falls!

So now we can combine these two processes into one process called sublimation, which is defined in the Oxford Dictionary of Science as:

Sublimation. A direct change of state from solid to gas.

This is incorrect! In the sublimation process the solid state changes *on the surface* to the eutectic state, this immediately changes to the liquid state, which immediately changes to the multimer state, and this immediately changes to the voluminous gas state. The latent heat of sublimation is the sum of the latent heat of fusion plus the latent heat of vaporization. When a

[10] Condensation is much more difficult to understand and it will not be discussed further.

solid sublimes it melts on the surface, this can be seen as a glazed surface, unlike the normal crystalline surface. The surface temperature falls but this cannot be measured.

The sublimation of a solid isomer is rather more complex because the liquid on the surface becomes an alloy of two isomers or even three. The solid isomer sublimes into an altogether different gaseous isomer of the same molecule. It is much more complex than you would expect at first sight, but one thing is quite certain, namely that sublimation is *not* the direct change of a solid to a gas.

There are two significant changes of state that will be examined in the next Meditation. They are the so called *critical temperature* and the critical point, and also the *triple point* where three states are in equilibrium at the same temperature and pressure.

Meditation 16

Critical and Triple Points

Oxford Dictionary of Science:

Triple point. The temperature and pressure at which the vapour liquid and solid phases of a substance are in equilibrium. For water the triple point occurs at 273.16 K and 611.2 Pa. This value forms the basis of the Kelvin and the thermodynamic temperature scale.

Critical state. The state of a fluid in which the liquid and the gas phases both have the same density. The fluid is then at its critical temperature, critical pressure and critical volume.

Critical temperature. The temperature above which a gas cannot be liquefied by an increase of pressure.

Critical pressure. The pressure of a fluid in its critical state, i.e. when it is at its critical temperature and critical volume.

Critical volume. The volume of a fixed mass of fluid in its critical state, i.e. when it is at its critical temperature and critical pressure. The **critical specific volume** is its volume per unit mass in this state; in the past this has often been called the critical volume.

Boiling point (b.p.). The temperature at which the saturated vapour pressure of a liquid equals the external atmospheric pressure. As a consequence, bubbles form in the liquid and the temperature remains constant until all the liquid has evaporated. As the boiling point of a liquid depends on the external pressure, boiling points are usually quoted for the standard atmospheric pressure (760 mmHg = 101.325 Pa)

Melting point (m.p.). The temperature at which a solid changes into a liquid. A pure substance under standard conditions of pressure (usually 1 atmosphere) has a single reproducible meting point. If heat is gradually and uniformly supplied to a solid the consequent rise in temperature stops at the melting point until the fusion process is complete.

Freezing point. This is not defined.

Evaporation. The change of state of a liquid into vapour at a temperature below the boiling point of the liquid. Evaporation occurs at the surface of the liquid, some of those molecules with the highest kinetic energies escaping into the gas phase. The result is a fall in the average kinetic energy of the molecules of the liquid and consequently a fall in temperature.

Condensation. The change of a vapour or gas into a liquid. The change of phase (state) is accompanied by the evolution of heat.

Sublimation. A direct change from solid to gas.

Figure 1 shows the standard state of matter diagram.

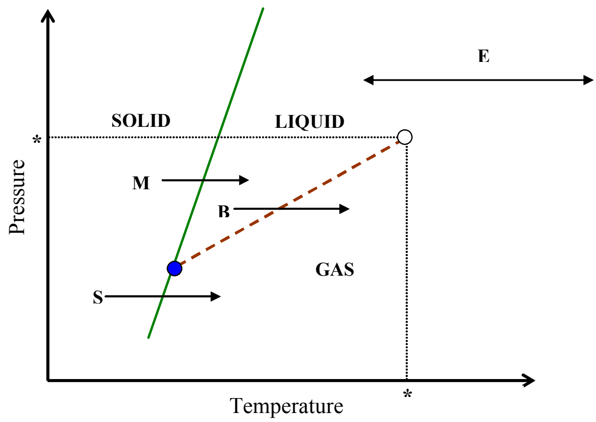

Figure 1. Standard state of matter diagram. **M** is the melting process. This is solid direct to liquid. **B** is the boiling process. This is liquid direct to gas. **S** is the sublimation process. This is solid direct to gas. **E** is the supercritical process. There is no latent heat above the critical temperature. The solid line is the melting state of change line; the dashed line is the boiling change of state line; the solid disk is the triple point; the open circle is the critical point. Asterisks denote critical parameters.

The critical point has always intrigued scientists. It was the basis of the van der Waals equation and many others attempting to explain deviations from the empirical $PV = RT$ and the compression of a gas to yield a liquid (which, it was asserted, was not possible above the critical temperature). With the New Atomic Hypothesis the critical point is no longer a mystery, it is simply another thermodynamic triple point where three states of matter are in equilibrium with each other at the same temperature and pressure. At this critical point the three states of matter are

Liquid–Multimer–Gas

If we extend the boiling point line from the critical point to higher temperatures and pressure we get a new diagram (Figure 2). To this we add a line (dashed in Figure 2) for the multimer-to-gas change of state line and extend this back into the liquid zone. This new diagram helps us to understand that boiling is the change of state from liquid to multimer to gas and *not* liquid direct to gas as given in the definition in the Oxford Dictionary of Science.

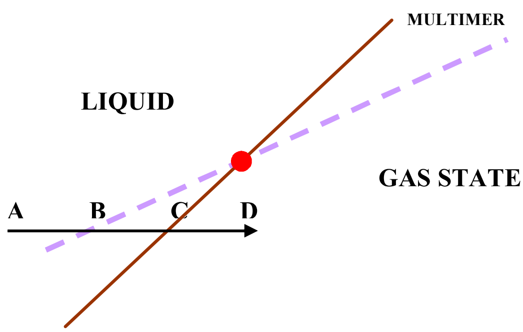

Figure 2. States of matter diagram including multimer (see text).

When a liquid is heated at **A** it is quiet and convection occurs within the liquid. As more heat is added the temperature rises to **B** and then it starts to sing, this is because the multimer state is formed but it is not stable so it reverts to the liquid state and this results in the vibrations that we hear as singing. The temperature continues to rise until **C** is reached, the singing ceases and bubbling on the heating surface is considerable, giving a rumbling sound. At **C** the multimers cannot revert to the liquid state but heat has to be added for the multimers to change into the gas state, which has a very high volume per molecule. So boiling is when a liquid changes into the multimer state and the multimer state is already in the gas state zone of our chart, being at a higher temperature than **B**.

The liquid state is a mixture of two allotropes and the gas at **C** is a mixture of gas and multimer states. The gas state molecules obey $PV = RT$ but the multimer molecules do not obey $PV = RT$, hence the deviation from the so-called ideal gas.

The temperature remains at **C** until all the energy has been given to convert all the multimers into the gas state of matter. The transition is liquid to multimer to gas and this energy is called the *latent heat of vaporization*. This can be measured but the latent heat of liquid to multimer and the latent heat of multimer to gas cannot be measured, only the sum of these two latent heats can be measured. If the Steam Tables are examined carefully it would be found that the latent heat of liquid to gas (water to steam) is constant and independent of pressure (as was found by Dalton and Callendar) but the arrival of the van der Waals equation distorted the figures to make it seem that at this magical critical point there was no latent heat, whereas in truth it is just the same as the value found by experiment at atmospheric pressure!

Latent heat is a measure of the change in the order of the nuclei of the liquid NENDORECs to the order of the nuclei in the NENDORECs in the gas state, it has nothing to do with the energy of the electron clouds and therefore nothing to do with temperature or pressure. Where there is a *change in order* from one state of matter to another then there is a change in the internal energy.

Above the critical point there are three states of matter. The liquid state changes to the multimer state and then at a higher temperature the multimer state changes into the gas state, and the increase in internal energy from the liquid state to the gas state is the same latent heat as before. This was found experimentally in the supercritical boiler at the Drakelow C power station near Burton-on-Trent in Nottinghamshire.

At the critical point there are three states of matter, liquid, multimer and gas. Each state has the same temperature and the same pressure (this is energy related to the electron cloud but not the nuclei within the cloud boundary), but each state has a different volume, small for the liquid molecules, larger for the multimer molecules and very large for the gas molecules. Each has a totally different total energy that cannot be related to temperature or pressure.

Hence the notion that there is a measurable critical volume as defined in the dictionary is meaningless because it depends on the ratio of the numbers of molecules of each state that are present.

At **B** we have evaporation without boiling, this continues to **C** when evaporation is accompanied by boiling. In both cases cooling of the remainder of the liquid occurs, this is because latent heat has to be supplied to convert the multimer into the gas state, which has a greater internal energy. It is measurable at **B** but hardly noticed at **C** because of the turbulence due to boiling within the liquid.

The critical point could be renamed the **multimer point** because it is where the multimer state appears on the state of matter diagram.

The critical point and the boiling phenomenon have been studied extensively, but to the best of my knowledge the melting line and its equivalent "critical" point have not been studied but they must exist in the right conditions.

Melting is solid to eutectic to liquid (Figure 3) and the melting line is the solid to eutectic state change, where the eutectic is already unstable so as soon as the solid reaches the point **C** on the green line there is a halt because energy (latent heat) is required to change the nuclear order of the solid state into the nuclear order of the liquid state. This could have occurred at **B** but it was not stable. The surface of the solid cools on melting!

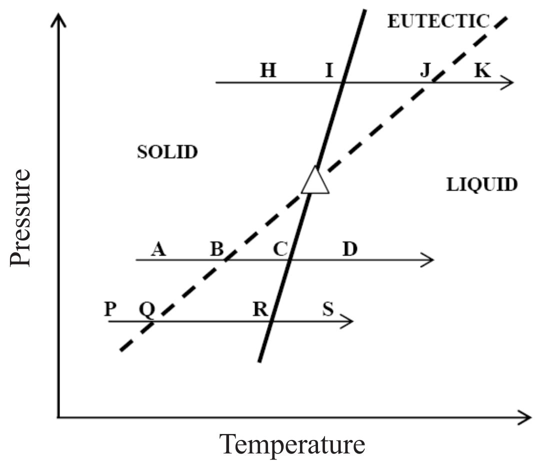

Figure 3. Melting point diagram. The line **R**, **C**, △, **I** is the change of the solid phase to the eutectic phase. The line **Q**, **B**, △, **J** is the change of the eutectic phase to the liquid phase. **C** is the melting point of the solid **A**; **R** is the melting point of the solid **P**; **J** is the true melting point of solid **H** though it will have "appeared" to melt at **I**.

The reverse process of freezing is much more interesting because a liquid can supercool below **C** to **B** and still be stable at **B.** At **B** the liquid changes to the eutectic state, that is it splits up from being a potentially infinite fluid to being a fluid of amorphous particles or droplets. It gives out energy (latent heat) and this raises the temperature back to **C** but it cannot go above **C**. Hence **C** (the melting point) of one allotrope is the freezing point for the same allotrope. There are, however, quite a number of organic compounds where the allotrope melts at one temperature **C** but the other allotrope freezes at a different temperature **R.** This is because all liquids are mixtures of allotropes. This gives the impression that some solids have one temperature for melting and another temperature for freezing.

The point △ on Figure 3 is the equivalent of the critical point on the boiling line. It could be called the **eutectic point.** Above this point solid changes into eutectic at **I,** which is stable, and then the temperature rises to **J** where the eutectic changes into the liquid state. Both the eutectic and the liquid state may be alloys and it will certainly be difficult to distinguish between them. This is melting without a definite melting point, it happens in many alloys but I have seen no evidence for it in pure compounds and elements.

Sublimation is where a solid changes into the eutectic state and then immediately all the other states are unstable so it changes into liquid to multimer and then to gas. It is a study in itself because it is a surface phenomenon with a fall in surface temperature to release latent heat to the gas.

These studies show that the critical point is a triple point, there is an equivalent point on the melting line and the triple point is actually a point where there are five states of matter in equilibrium. These are solid, liquid, and gas as before but additionally eutectic and multimer states are also in equilibrium (see Figure 4).

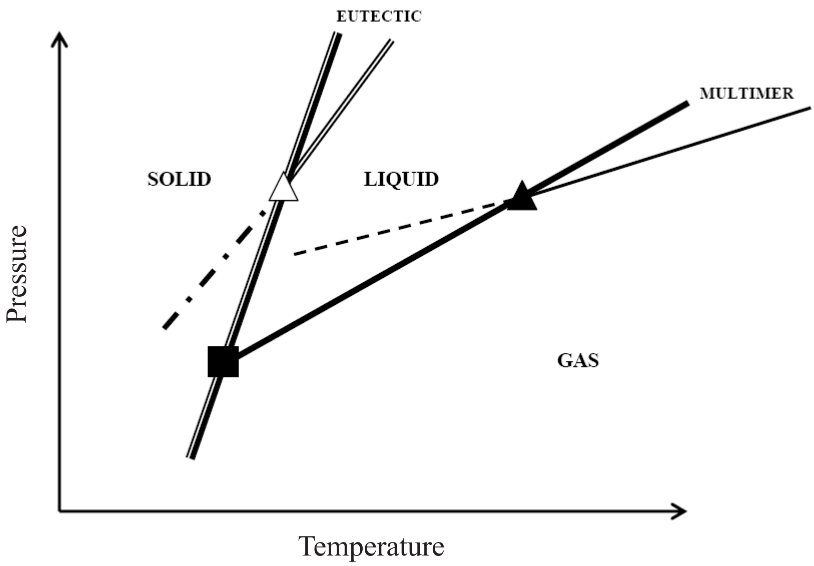

Figure 4. The state of matter diagram based on the New Atomic Hypothesis. ▲, multimer triple point for liquid–multimer–gas (formerly critical point); △, eutectic triple point for solid–eutectic–liquid (not previously specified); ■, conventional triple point for *five* states of matter in the New Atomic Hypothesis: solid–eutectic–liquid–multimer–gas. The changes of state lines are: ═══, solid to and from eutectic; ═══, eutectic to and from liquid, continued as – – – -; ▬▬, liquid to and from multimer; ___, multimer to and from gas, continued as – – –. It is the existence of the pecked lines of change of state of matter that make melting and boiling points precise for pure compounds.

Definitions redefined[11]

Triple point

This is a point where five states of matter are in equilibrium. They are, in order of decreasing density, solid–eutectic–liquid–multimer–gas. They have the same temperature and pressure energies but their total energies increase from solid to gas.

[11] Based on the New Atomic Hypothesis. Compare with the definitions from the Oxford Dictionary of Science quoted at the beginning of this Meditation.

Critical state
There is no such state of matter, what was considered to be the critical state of matter is a mixture of the liquid, multimer and gas states of matter. The molecules in each of these states have different volumes, it is small for the liquid state, larger for the multimer state and very much larger for the gas state.
Critical temperature
This is the temperature of the triple point for the following states of matter: liquid–multimer–gas.
Critical pressure
This is the pressure of the triple point for the following states of matter: liquid–multimer–gas.
Critical volume
This has no meaning in the New Atomic Hypothesis, because each molecule has a volume depending on its state of matter, its temperature and its pressure.
Boiling point
This is the temperature at which a liquid changes to the multimer state. If this is below the triple point of the liquid–multimer–gas then bubbles form on the heating surface or within the liquid state. It is usually quoted for standard atmospheric pressure. If the liquid changes to the multimer state above the triple point then there is no boiling within the liquid state but as the temperature rises latent heat has to be given to convert the liquid into first the multimer state and then into the gas state. Latent heat of vaporization is constant and independent of the pressure at which the change takes place.
Melting point
The temperature at which solid changes to the eutectic state. If it is below the temperature and pressure of the triple point for solid–eutectic–liquid the eutectic state changes into the liquid state and there is a fall in temperature on the surface of the solid until all the solid has changed state, first to the eutectic and then immediately it is formed to the liquid state. It is a fixed point for a fixed pressure, but unlike the boiling point changes in pressure do not have a great effect. Solids cannot be superheated, whereas liquids can be supercooled.
Freezing point
This when a liquid changes into the eutectic state and releases heat so that it rises in temperature, but it cannot exceed the melting point temperature of the same allotrope. Liquids can, therefore, supercool. Because liquids are alloys of two (or more) allotropes the freezing points of the two allotropes will be different. If a solid has melted at one temperature and then changed to a different allotrope it will appear to freeze at a temperature different from that of its melting point. When a solid appears to have a melting point that is different from its freezing point it is not anomalous.
Evaporation
This is when a liquid changes to the multimer state below the boiling point. The multimers on the surface change to the gas state but this requires an input of energy for the latent heat, this is extracted from the liquid so its temperature falls. Evaporation takes place only on the surface of a liquid so there are no bubbles. Latent heat is also required for boiling but the fall in temperature of the multimer state and the liquid state cannot be measured. Hence this fall in temperature during evaporation is a good confirmation of the New Atomic Hypothesis.

Condensation

The change of state from gas to liquid via the multimer state. The latent heat is released into the multimer state and then to the liquid, raising its temperature. The temperature of the liquid cannot exceed the boiling point at the pressure of condensation. Occasionally the cloudy nature of the multimer state is seen during condensation in distillation experiments. Rain (liquid water) is invariably associated with the condensation of clouds, which are the most commonly observed form of the multimer state.

Sublimation

Occurs when a solid melts on the surface and the liquid immediately boils, cooling the surface layer. The changes of state on the surface are solid → eutectic → liquid → multimer → gas. The reverse process is used for purification of some chemical compounds.

Meditation 17

Types of Matter on the Earth

1. States of Matter
2. Atomic Matter
3. Subatomic Matter
4. Subnuclear Matter
5. Molecular Matter
6. Living Matter
7. Human Matter
8. Other Societies
9. Classification and Evolution

The nine headings above are really individual meditations on the world around us. Each will be discussed with the idea that readers can then expand the topic themselves. The writer uses the concept that all matter on Earth is a NENDOREC, that it has an integer number of nuclei that are orderly in some way, these are resonating in harmony within a fluid that has a boundary. NENDORECs cannot be split, therefore they are atoms in the true sense of the word.

NENDORECs have been given many different names such as a meson, an atom, a molecule, a crystallite, a grain, a virus, a bacterium, a hedgehog, and a nation. Your own body is really the best example of a NENDOREC, it has your DNA nuclei, it works in harmony, it has a boundary, and its fluid is mainly water in the eutectic state.[12]

But some things are not NENDORECs even though they have some of their characteristics, a building, a nest, a field, an aeroplane, a book, a dinner or a dress, so let us meditate on the nine items one by one.

1. States of matter have been discussed and we find that there are nine states of matter. These form the basics of all the matter on Earth. Thus everything can be studied and put into one of these categories.
2. Atomic matter referring to the elements that are found on Earth, there are about 92 elements and if we look at the isotopes we find that there are about 250 different

[12] If the water changes to ice then you have frostbite, if the water changes to liquid water then you are dead!

isotopes. Just a few isotopes have the same atomic weight but a different atomic number. The strange thing is that it appears that isotopes with an odd atomic weight are related to only one element, whereas isotopes with an even atomic weight can be related to more than one element. Atomic matter contains a small nucleus with most of the mass and an electron cloud surrounding it. The nucleus would appear to be the dominating feature of an atom or isotope of an element.

3. Subatomic matter in the nucleus seems to consist of protons and neutrons bound closely together. It is rather strange that the nucleus has all the positive charge and the electron cloud has all the negative charge. This would appear to be a rather unstable form of matter, but maybe there will in the future be a better understanding of the nature of the charges within the nucleus and the cloud. The nucleus is more than likely to be based on an octahedron made up of tetrahedral units of one neutron and one proton, in addition there are spare neutrons and these not only make up the mass to the measured mass of the isotope, but they also fill in the spaces left between the [neutron + proton] tetrahedral units. Hence these extra neutrons are string-like in character. Hence it appears that there are only three basic units in the nucleus of an atom, protons associated with neutrons, string neutrons, and the electrons in the cloud round the nucleus.
4. Subnuclear matter is made up of units with which we have little direct knowledge. Experiments with high energy atom machines like CERN show that mesons are some of these units and it takes about 10 of them to make a proton or a neutron. 10 is a reasonable number because it is like the nucleus of neon where there is a double unit followed by eight [neutron + proton] units. The present claims of the nuclear physicists of many subnuclear particles is not substantiated by the reasoning of a NENDOREC hypothesis.
5. Molecular matter is made of atoms and is generally split into two distinct subjects of inorganic chemistry and organic chemistry. There are millions of different molecules but all these can be classified. The organic molecules are basically of two types based on the carbon atom, the first type is the aliphatic molecules and the second type is the aromatic type based on the benzene carbon ring. The carbon nucleus consists of six [neutron + proton] units and these can be arranged in two very distinct ways. There can be a helium unit surrounded by 4 [neutron + proton] units in tetrahedral form, this gives the pattern for diamond structures and all the aliphatic molecules. Alternatively the nucleus of the carbon atom can be 6 [neutron + proton] units in a planar hexagonal form and this leads to the graphite type structures and the benzene ring structures. Thus these simple units lead to a vast number of different molecules. The largest of these molecules are the polymers like polythene and viruses, which seem to replicate themselves under the right conditions. This replication is also found in freezing of liquids into solid crystallites. Thus there are a vast number of molecules but there is order and there is not an infinite number of possibilities.
6. Living matter is based on two essential components on Earth. The first is water in the eutectic state, thus the units of living matter are not infinite and most are made up of individual cells that are working together in resonance. The second component is

carbon-based molecules of the DNA type. These control and organize the water into a resonating unit, often this is a cell. This cell can amalgamate with food and enlarge itself until it becomes unstable. Then it undergoes an internal transformation developing into two similar units that separate by splitting into two almost identical units. This is the basis of growth, often best seen in the growth of an embryo. There are once again a vast number of possibilities but there is not an infinite number. In biology they are usually separated into two divisions, plants and animals, it is generally recognized that on Earth plants are influenced by the Sun and animals depend on plants for their existence.

7. Humans are a special type of animal, and there appear to be only a few types, Mongoloid, Negroid, Caucasian, and Australoid. Humans are different from all other animals because they have the capacity to communicate on a wide range of topics to enable them to work and serve each other on Earth. They can now leave books so that future generations can learn what they have discovered. Yet humans cannot live forever, they have many limitations, they are often greedy, they kill not only pests and weeds but they also exterminate buildings of the past and also domestic animals. They are quite different from the rest of the living world.
8. There are however other species that have a mutual dependency on each other and they can teach humans a great deal how to live and work harmoniously together. Bees, ants, elephants and whales are just some of these but talking is basically unique to the human race.
9. Classification is carried out by humans, it has been practised for many thousands of years. Generals have counted their troops, they have arranged their troops into different categories. Mendeleev classified the elements into a periodic table, many others have classified the elements in slightly different ways. Aston classified the isotopes of the known elements. Linnaeus classified plants and animals. Howard classified the clouds by their appearance. The census is another way of classifying the people of a nation. However, there is a concept of evolution that tries to say how it all began, “Once upon a time” becomes “A milliard years ago” in these evolutionary beliefs, they are all imaginary stories based on some simple observation that is then expanded into a belief that there has been a natural driving force on Earth. All evolutionary stories are myths whether they are ancient like the Greek myths or recent like the Natural Selection or Big Bang myths of the 20th century.

Thus you can look at the things about you and you can study them in many ways, you can classify them and you can even make up stories about how they came into being. Fossils are interesting but you must first determine exactly how they were formed on Earth. Was it really millions of years ago? Why is the mantle of the Earth so thin compared with the total depth of the solid part of the Earth? Geology is the study of rocks but are the methods used for determining the age of the rocks as sound as they should be? There are many types of matter on the Earth but it is only humans who seem to have the ability to classify them. Humans exploit them to build up their form of civilization and have done so for many centuries.

Meditation 18

Measurement of Matter

Previously we have discussed matter and its classification. We have restricted the discussion to the Earth and noted how changes can be made when the pressure and temperature are changed to cause solid matter to melt, or liquid matter to evaporate and boil. In this Meditation a study is made of various measurements and what they actually mean. These are:

1 Mass, length and time
2 Order
3 Radiation and vibration
4 Resonance.

Mass, length and time

On Earth mass is known because all matter is associated with the nuclei of the atoms of elements. Each of these atoms has a dense nucleus that interacts with the mass of the Earth; that is, the total amount of matter on the Earth. We call this the pull of gravity. It is an ever-present force between matter. We have always assumed that it is immediate, it is not like sound where it takes time for a pulse of sound energy from one piece of matter to pass to another piece of matter. We hear the sound of thunder from a lightning strike some seconds after we have seen the flash of light. We have assumed that gravity is like neither sound nor light because it has an infinite velocity.

Light takes time to reach our eyes from the Sun, we see the Sun as it was about nine minutes ago. But for gravity we assume that it is immediate, it does not have a velocity; that may not be true, for which one gains an inkling when one studies the dichotomy of Venus and the erratic orbit of Mercury round the Sun. There appears to be no barrier to gravity. Electromagnetic waves, especially light can be absorbed, sound can be absorbed, β-particles from radioactive elements can be absorbed and so can α-particles and γ-rays. But there appears to be no barrier to absorb gravity. Gravity is one thing on Earth that we know something about, the reduced gravity on the Moon is understandable and so is the weightless condition in space travel. But we really have no idea on the effect of mass on the visible surface of Jupiter and even less of an idea on the invisible solid surface of the core of Jupiter, which is covered by an atmosphere that could be 10,000 km deep (the Earth's atmosphere is 15 km deep). Gravity and its effect on mass is an anisotropic force and anisotropy can (and does) have remarkable unpredictable effects. This is illustrated in anisotropic pressure (tension) causing metals to cease being elastic and anisotropic temperatures in nuclear fuel causing massive grain growth in seconds.

There are two major differences between the New Atomic Hypothesis and the currently taught atomic hypothesis. In the latter matter and energy are reputedly interchangeable, governed by the formula $E = mc^2$ and mass changes with velocity by the formula $m_v = m_o(1-v^2/c^2)^{-1}$. In the New Atomic Hypothesis the mass of the nucleus is constant and it cannot be converted into energy. The nucleus of an atom has energy quite separately from its mass. Mass is not related to its velocity. The old laws of conservation of mass and conservation of energy apply to the New Atomic Hypothesis.

Length (**L**) is easy to define, it can be cubit, foot, metre etc. but the main quality that we notice is actually volume, which is $\mathbf{L}^3$. We notice volume more than any other dimension of matter. That is why we measure our petrol and diesel in litres because volume is generally easier to use than mass. We note the volume of a pinhead, the volume of an egg, the volume of a balloon and the vastness of space.

Velocity is $\mathbf{LT}^{-1}$, it involves length and time. The energy of a moving object is $\mathbf{ML}^2\mathbf{T}^{-2}$.

Time is related to the regularity of a wave passing a point. It can be a light wave but usually we use the rotation of the Earth to define day, hour and minute. We relate the year to the orbit of the Earth round the Sun. It is clear that mass can be related to the mass of the nucleus of a proton and a multiple of that mass. But length and time are purely human inventions based on observations like the circumference of the Earth, the rotation of the Earth and the orbit of the Earth round the Sun.

There are many types of energy. One of the simplest is a moving mass where the energy is related to the mass and the velocity of that piece of matter under study. In this case the energy is $E = \frac{1}{2}mv^2$. Energy can be converted into heat as was found by Rumford in his boring experiments, it was also seen in the return of space shuttles, where the velocity of the shuttle was reduced in the ionosphere and in the case of Columbia the heat melted its structure and it disintegrated. Energy can be obtained from moving electrons in metal wires. Energy can be obtained from the nucleus of a radioactive atom when it disintegrates. Energy can be obtained from the fission of nuclei. The energy from the disintegration of the isotope ^{238}Pu is quite remarkable, it can be used to power batteries by means of a thermocouple. If ^{238}Pu oxalate is prepared, it soon (within days) becomes plutonium oxide, indicating that locally the plutonium oxalate has been over 600 °C even though the thermocouple in the material showed that it was only 30 °C. If ^{238}Pu oxide is placed between two pieces of stainless steel and the sandwich is compressed they can be welded together, showing that locally temperatures must have been greater than 1000 °C. If this plutonium oxide is placed on some plastic like PVC it soon burns the surface. Even ^{239}Plutonium oxide will char polythene in about a year if it remains in contact with it.

But there is one form of energy that is so universal that scientists tend to forget that it is just energy, this energy is temperature, which should therefore have the dimensions of energy $\mathbf{ML}^2\mathbf{T}^{-2}$ but it is frequently given the dimension θ, which is somewhat misleading. When a solid melts its temperature remains constant whilst there is some solid state present and when all the solid is changed into liquid the temperature rises again. During the period when the temperature is constant heat is being absorbed into the nuclei and these change from having three directions of geometrical order to a spherical shape that has no direction of geometrical order, that is the liquid state of matter.

Scientists who were studying this change of state invented the concept of **entropy**, which is expressed in the following formula:

$$\Delta S = \Delta Q/\theta \qquad (7)$$

where S is the entropy of the change and Q is the change in energy that is measured as latent heat. But because Q is energy and θ is also energy then S is simply just a number. It has no dimensions. Whenever entropy is used it has to be converted back into energy terms, it has no meaning of its own, it is just a number created by a mathematical formulation.

The difficulties of entropy can be seen by studying its definition in the Oxford Dictionary of Science: Symbol *S*. A measure of the unavailability of a system's energy to do work; in a closed system an increase in entropy is accompanied by a decrease in energy availability. When a system undergoes a reversible change the entropy (*S*) changes to an amount equal to the energy (*Q*) transferred to the system by heat divided by the thermodynamic temperature (*T*) at which it occurs. $\Delta S = \Delta Q/T$. However, all real processes are to a certain extent irreversible changes and in any closed system an irreversible change is always accompanied by an increase in entropy. In a wider sense entropy can be interpreted as a measure of disorder; the higher the entropy the greater the disorder. As any real change to a closed system tends towards higher entropy, and therefore higher disorder, it follows that the entropy of the universe (if it can be considered a closed system) is increasing and its available energy is decreasing. This increase in the entropy of the universe is one way of stating the second law of thermodynamics.

Whereas entropy is claimed to be a measure of disorder the New Atomic Hypothesis deals with ORDER as something that can be measured. Mass is an order, length is an order, time is an order, direction is an order, half-life is an order. ORDER is what scientists can potentially measure or classify if they try to do so. No scientist can measure randomness nor can he measure disorder. Nor can one measure the freedom that is simply lack of some degree of order, freedom is always defined in terms of order.

In the New Atomic Hypothesis, which is the study of NENDORECs, the concept of resonance is most important. A unit is not stable unless it is in resonance. We see red light because it has a wavelength of 4×10^{-7} m and we have receptors in our eyes that also resonate with that wavelength. A stable isotope has a nucleus in resonance, an unstable isotope has a nucleus that is not quite in resonance and in conjunction with other similar nuclei it develops beats and these release energy in the form of an α-particle or a β-particle or a γ-ray of energy in order to try to gain equilibrium and resonance. This can take a long time as illustrated by the term of some half-lives. However resonance applies to all matter, it applies to solid grains, it applies to molecules, to multimers in clouds and all living matter. When resonance ceases then death of the NENDOREC happens, usually by splitting into smaller NENDORECs.

Meditation 19

Relativity and Quantum Theory

One of the important aspects of science is to repeat experiments or observations to make sure that the first observation was correct or whether it needed to be modified. The Moon eclipses the Sun about every two years, some eclipses are more observable than others. Some are in places difficult to access and some are not observed because clouds cover the Sun at the vital time, which is typically only two minutes for a total eclipse. This happened to me when I went to Cornwall to observe the total eclipse in 1999. But one eclipse gets a mention in the Oxford Dictionary of Science because it confirmed that Einstein's relativity theory was better than Newton's theory of gravitation. This was the eclipse of 29 May 1919. The dictionary states "This led Einstein to conclude that, in general, rays of light are propagated curvilinearly in gravitational fields. By means of photographs taken of stars during the solar eclipse of 29 May

1919 the existence of the deflexion of starlight around the Sun's mass was confirmed". This, however, does not tell the full story because these observations were repeated on many subsequent eclipses and the new results did not agree with the first claims. The other thing that was not borne in mind was that in 1919 two telescopes were used for the experiments, one was a 12 inch reflector telescope and the other was a 3 inch refractor telescope. Due to undue haste the optics of the 12 inch telescope were distorted by the heat of the Sun's rays, so it produced no results. The whole basis for the claim that Einstein's relativity theory was correct was based on the one 3 inch telescope and when many years later the plates were re-examined they too were found to have been misinterpreted. In effect there is nothing to support Einstein's theory! But leading scientists still believe it to be correct. The photographing of star movements continued from 1922 to 1960, when it was decided to discontinue the experiments because they were not producing significant results and they were quite expensive.

This failure of scientists to properly check their work is not uncommon. If you read Andrews' paper[13] on the so-called critical state of matter you will observe that he found evidence for the liquid state of matter above the critical temperature but this has been ignored by those who believe in the critical state of matter. For many years scientists believed that there were canals on Mars but this has been shown to be false. When the Titanic sank observers said that it broke into two pieces before it sank but the evidence produced to the court of inquiry was that it sank in one piece. It was over 90 years later that new observations showed that the Titanic had actually broken into two pieces before it sank. The Piltdown man was taken as clear evidence that Darwin's theory of natural selection by evolution was correct, and it took many years before somebody decided to re-examine the skull only to find that it was a fake. It must be remembered that Hitler based many of his ideas on the belief that the Arÿan race was, as Darwin stated, the peak of humankind. Hitler told the Hitler Youth that "In this world the Laws of Natural Selection apply. Nature has given the strong and the healthy the right to live."

Experts can come to the wrong conclusions if senior persons have already been misled. A classical example was in World War II when a body was placed off the Spanish coast carrying false information, which it was hoped would reach the German High Command so that they would not reinforce Sicily before the planned invasion by Allied troops. It worked and the paragraph below is taken from Ben Macintyre's book *Operation Mincemeat*:[14]

One by one, Hitler's key advisers were being drawn into the deception, either by access to the documents themselves, or through independent "confirmation", as the same intelligence arrived by other routes: Canaris, Jodl, Kaltenbrunner, Warlimont, von Roenne. By 20 May, Mussolini "had come round to the same view." A collective willingness to believe seems to have gripped the upper reaches of the Nazi war apparatus, driven by Hitler's own belief. It takes a brave man to stand up to the boss in such circumstances. The men surrounding Hitler were not made of such stuff.

It takes a brave man to confront the managers of Sellafield. Those who tried to do so were either sacked or demoted [the writer came into the latter category]. A lady once asked a senior

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13 T. Andrews, The Bakerian Lecture: On the continuity of the gaseous and liquid states of matter. *Phil. Trans. R. Soc.* **159** (1869) 575–590.

14 London: Bloomsburg (2010).

manager if the Pile could catch fire. The manager gave an emphatic reply, “Certainly not”. Two days later the Pile did catch fire but the lady’s question did not get published.

Einstein attributed the bending of light during an eclipse to his gravitational field but others, who were discredited, thought that it could be due to refraction in the outer atmosphere of the Sun. In 1919 the scientists had no idea that space contained the solar wind and the slightest refraction would be possible in the 93 million miles of this state of matter. The effect would be magnified for X-rays that have a much shorter wavelength than visible light. This bending of X-rays gives the impression that the Sun is not only heterogeneous but also that the X-rays come from outside the corona of the Sun; we must be very careful that we are not deceived. So now we turn to another of Einstein’s postulates.

Einstein postulated that in order to explain the photoelectric effect it was necessary to have light not only as a wave but also as a particle called a photon, which had no mass. This particle could then interact with matter and eject an electron. If light were a wave then this could not happen because there would not be enough energy in the wave when it reached the atom. However, Einstein did not realize, and still today scientists do not realize, that if a wave interacts with matter then the atoms, many millions of them, work together and by resonance they emit one electron from the millions that have been irradiated. In the New Atomic Hypothesis with its basic units of NENDORECs light is always a wave and it is never a particle. Photons do not exist!

Einstein studied two forms of relativity, Special and General. The former was the one where he made many predictions, which have now proved to be false but are still taught as being correct in so many universities. General relativity was a real puzzle to Einstein because he tried to apply mathematical formulae to it. It is best expressed in words “It should be possible to formulate the laws of the physical universe so that they apply in all frames of reference.” The New Atomic Hypothesis uses this principle for its examination of matter. All matter has mass. All matter has volume. All matter has vibrations, radiations and resonance. All matter has a boundary. All matter has nuclei or a nucleus. It applies to helium atoms, it applies to DNA molecules, it applies to water and to elephants. Size cannot be infinite. A pebble is small, even though it contains millions of atoms. The Earth is bigger than a pebble but it is much smaller than the Sun. Yet if we look at the Sun it is tiny when we consider just the solar system, of which it is the central nucleus. All matter is relative, that is General Relativity. Einstein tried in vain to put it into mathematical terms.

Leaving Relativity we turn to Quantum Theory. The Oxford Dictionary of Science states that a quantum is “The minimum amount by which certain properties, such as energy or angular momentum, of a system can change”. The Concise Oxford dictionary gives “Amount; share, portion; required, desired, or allowed amount.”

Quantum is often used to indicate strange events in physics that are not easily understood using Newtonian physics. These events include superfluid helium being classified as a quantum liquid, but the New Atomic Hypothesis shows that superfluid helium is a powder, very fluid but very much a solid state of matter. Other quantum events are the jumping of electrons from one orbit in a Bohr model of the atom to another and thus giving out radiation of light at a fixed energy. In the New Atomic Hypothesis all isotopes have resonances for their electron clouds, so that although two different isotopes can have very similar chemical properties, their spectra can be seen to be different as was studied by F.W. Aston and described in his book on Mass Spectra and Isotopes.[15]

I like to consider that quantum simply means unique, whether it is a radiation, or a shape or a dimension. Water is a quantum liquid, it is not an anomalous liquid. If it were anomalous then you would know immediately that the theory that you were using was erroneous, no matter who supported that theory. That was Galileo's problem when he considered that planets (wandering stars as they were known at that time) were simply satellites of the Sun, just like the Earth itself. Even today people talk of sunrise and sunset, which indicates that the Sun is moving, whereas in reality it is the Earth that is rotating. Aristotle and his supporters believed that the Sun moved and hence in their universe there was the possibility of sunrise and sunset, which followers of Galileo denied.

[15] London: Edward Arnold (1933).