**A Decade of Analysis by A.C. Sturt 2001-2013
of the Systems of the Natural World**

extended to include biology papers on: cell walls and natural selection (26 May 2013)
and stem cells (8 July 2013)

Summary of Papers on www.churingapublishing.com

If the essentials of these analyses are valid, and they certainly form a coherent system in their own right, they suggest changes to the paradigms of physics which have held sway since the early twentieth century. The fundamental outcome is that much of the mystery can be taken out of modern physics by acknowledging the existence of the medium of space. Newton believed it existed, and so did Faraday. It was discarded by Einstein because he did not need it. In its present reinstatement by me, it has the property of susceptibility to electromagnetic induction. From this everything else below flows: new paradigms not only in physics but also in astronomy and cosmology, in fact all parts of the system which is the Universe.

My development of alternative models required an examination of the mathematical basis of equations used in physics, particularly the limitations of the hyperbolic functions used in relativity. Surprising conclusions about the nature of time and space emerged.

Since the systems methodology is universal in application, I also used it on particular biological systems. The results showed that evolution is not so much a theory as a law, like the gravitational attraction between masses and the flow of rivers downhill. As final proof of its versatility, I applied it to an archaeological process, probably the most important change in the history of mankind. This is all part of our Universe of ceaseless change.

   A. Summary conclusions in bullet points

      a. physics papers

1. The fundamental mathematical assumption of the expansion model of the Universe is shown to be wrong. The Universe is a system, the ultimate system. The 'Big Bang' is a lousy system.
2. My alternative model is a Universe regenerated stochastically part by part through collision, fusion, fission and explosion wherever gravitational attraction brings together sufficient mass to reach the critical limit.
3. Explosion reduces the matter to fundamental particles which are then spread throughout the Universe to start the process of agglomeration all over again.
4. This provides the feedback which maintains the system in equilibrium overall. The corollary is that this model is a Universe which is infinite in time and space.
5. In this model nuclei are built in stars, but they are also destroyed in stars, as is being done in particle colliders on Earth. This is the dynamic equilibrium which results in the relative abundances of heavy elements.

6. The electromagnetic frequency of radiation from stars decreases en route from star to Earth, not at the star, which is the assumption of the current Hubble equation. (What colour does a sodium lamp have on Alpha Centauri? And what about the chemistry?)

7. Electromagnetic frequency is proportional to energy as determined by the agreed relationship of Planck, which has its basis in measurement.

8. The magnitude of the decrease is greatest close to the source, where energy and so electromagnetic frequency, are at their maximum. Thus the form of the decrease with distance travelled through space is exponential.

9. The same exponential curve applies to all electromagnetic radiation, whatever its starting value.

10. It is demonstrated how the existence of this Universal exponential can be detected by measurements made on Earth.

11. The exponential constant can then be evaluated by calibrating frequency shifts with those of stars of trigonometrically measured distances. Assuming the Universe is isotropic, this allows distances of all stars to be calculated.

12. The conclusion from the existence of the exponential decline must be that the medium of space exists, because there is nothing else between stars and Earth. This reverts back to the paradigm of physics at the beginning of the 20th century.

13. Reduction of electromagnetic frequency is caused by the interaction of each individual particle of light with the medium of space through which it passes. The medium of space must therefore have the property of susceptibility to electromagnetic induction.

14. The curve of the exponential decrease means that the stars are much closer than currently estimated using Hubble. The most distant visible stars are probably no older than the Solar System, which also indicates a Universe that is infinite in time and space and so steady-state, rather than expanding.

15. In this model the medium fills the whole of space, and it is composed of microgranules which have electromagnetic properties. What fills interstices between microgranules, if there are any, is a matter of conjecture.

16. Microgranules are much smaller than the smallest particles of stuff, which occupy the rest of the Universe. The electromagnetic properties of the microgranules are susceptible to orientation by particles of stuff without the expenditure of energy.

17. It is the orientation of microgranules that transmits all forces acting at a distance between particles of stuff. This includes gravity.

18. The existence of the medium of space provides a new paradigm to account for the increasing force required for acceleration of particles of stuff at relativistic speeds.

19. This is caused by resistance from the medium of space to an accelerating particle of stuff. Resistance increases hyperbolically with the velocity of the particle at the point at which force is applied. This is an alternative to relativity's dilation of time etc.

20. This phenomenon is not unlike the 'stickiness' of the postulated Higgs field in relation to mass.

21. The new paradigm leads to the addition of an Inertial Resistance Factor R to Newton's Second Law no less! The value of R is a simple function derived by transformation to a rectangular hyperbola. (The symbol R was chosen for the lack of alternatives in a crowded field.)

22. I developed a new theory of light as a particulate phenomenon, transmitted through the medium of space by successive reorientation of microgranules to form rotating electromagnetic dipoles or REDs, rather like small whirlpools. Each stretches out to form a helix as it travels through space. This model explains both the wave and particle behaviour of light.

23. The rate of reorientation of microgranules determines the velocity at which REDs progress, and so the velocity of light *in vacuo*, which is why it is Universal and constant.

24. From this I developed a new electrodynamic structure of the atom which does not require Bohr's hypothetical electron orbits.

25. My attention then turned to the composition of the nucleus, starting with the neutron. Reinterpretation of the facts led me to propose that the neutron observed in the laboratory is in fact a proton with an electron in close orbit that rapidly decays.

26. An extension of this concept is that the neutrons which are believed to exist in nuclei do not exist. Their apparent neutrality results from electrons in close orbit around assemblies of protons. These intranuclear electrons together with the extranuclear or orbital electrons are sufficient in number to neutralise the charges on the protons. This gives the atom a new structure.

27. This then led me to propose a new model of the proton itself based on the agglomeration fundamental particles with the size and stuff of an electron, which I called ε-particles. (The symbol was again chosen for the lack of alternatives in a crowded field.)

28. All ε-particles in this model have the same rate of spin, which is immutable. Their axes are randomly orientated, and the orientation of each particle cannot change. The force of agglomeration is derived from their spins.

29. This implies that agglomeration of ε-particles, whether to form subatomic particles or chemical bonds, is by selection from a population of ε-particles by trial and error to find the best fit to the existing structure.

30. From this I proposed a new model of the cosmos (where did all the positrons go?) composed entirely of ε-particles in various stages of agglomeration in a microgranular medium of space.

31. The constant spin of ε-particles is then the origin of all energy in the cosmos, which is why it cannot be created or destroyed.

32. In a steady-state model the 'laws' of thermodynamics cannot be extrapolated from parts of the Universe to the whole. Entropy increases in parts of the Universe when processes are occurring i.e. energy is applied. However, in the system as a whole explosion returns particles of stuff part by part of the Universe to the pristine state in which they are all independent, like particles in a perfect gas.

33. In the ceaseless motion of the Universe, and under the influence of gravitational attraction, they begin to agglomerate again. This is the formation of order, albeit somewhat imperfect.

34. Thus the perfect order which entropy is supposed always to be destroying is in fact a perfect 'gas'. Explosion is the feedback system which maintains the steady-state of the whole. This Universe will not all end in waste and void.

    b.   mathematical physics

1. Algebra uses symbols to represent numbers, because it enables general statements or equations to be made and manipulated. A condition of the transformation is that the symbols can be turned back into numbers at any stage.

2. Mathematical physics uses algebraic equations to describe relationships between physical variables in a general way which facilitates prediction.

3. Variables are assigned numerical values appropriate to the system in question, but they also have qualitative connotations which algebra cannot capture i.e. not just numbers but numbers of metres, numbers of seconds etc. They may even include terms which in themselves are essentially meaningless such as temperature to the power four.

4. When symbols are turned back into numbers, the arithmetical manipulations are limited by these qualitative attachments, a process which is valid because the qualities are retained in the equation in the form of constants.

5. These qualities must be completely separate and independent i.e. 'orthogonal' in mathematical terms, or the magnitudes of the numbers are uncertain, that is statistically 'confounded'.

6. Even if they are orthogonal, the numbers in the equation are valid only because they are numbers of defined intervals of particular variables i.e. numbers of time-intervals or distance-intervals.

7. The reason for reaching this depth of analysis was to reveal the assumptions which underlie relativity, which is couched in terms of time and length.

8. The concept of space-time is problematic, because it confounds two different variables. There is no such thing as time or length, but only numbers of time-intervals and length-intervals. These are defined by the velocity of light *in vacuo* and cannot dilate if variables are to retain any meaning.

9. This is a fundamental argument in favour of a non-relativistic approach to the resistance to acceleration of particles, which is reintroducing the medium of space.

10. Mass is a concept which Newton introduced to enable him to describe the magnitude of forces. It is in effect a constant of proportionality in an algebraic equation. Mass is ultimately defined in terms of numbers of standard time-intervals and length-intervals, and so it cannot vary independently.

11. However, processes certainly occur at different times and in different places. The outputs from one become the inputs for others, and so there are certainly intervals between them, however defined. Otherwise everything would occur simultaneously and in the same location.

12. Intervals can be measured in terms of the number of oscillations in a beam of light of a chosen colour in transit from one system to another. Any colour will do, because they all travel at the constant velocity of light *in vacuo*.

13. The interval is then either the number of wavelengths or the number of oscillations undergone by the beam in transit, because they are bound together. It is the numbers which give the comparison of intervals.

14. Intervals are not reversible in the sense that inputs cannot be sent back to the system from which they originated. The processes which caused the emission from the source will have changed the source during the interval.

The interval decouples the two systems, which is what allows them to operate separately.

15. As a test of the validity of relativity, I devised a clock that cannot possibly dilate under any conditions, because it is based entirely on radioactive decay, and elapsed time is told entirely by numbers of sparks emitted. Numbers cannot dilate by definition. Time dilation needs reconsideration.

 c. biology

1. Bacteria are difficult to characterise because they produce unexpected variants that are viable in their own right, which may be a kind of evolution.
2. All they need is food to grow and reproduce, which they do rapidly. A bacterium may produce a clone of itself in as little as 20 minutes.
3. Szilard found that an isolated bacterium apparently evolved, because it produced new 'species'.
4. My suggestion was that bacteria are just (relatively) sloppy cloners. If the 'clones' are also able to survive in the culture, they may reproduce themselves. They may also produce poor 'clones' of themselves.
5. The result then becomes a mixture of strains of bacteria, many of which have not been encountered before. Hence the problem of characterisation.
6. The same process must also occur during infection, but antibiotics work, even though as stereospecific entities they are tailored to counteract only bacteria of the original 'species'.
7. The corollary is that something else is killing off the variants which the antibiotics have never seen. The only alternative is the immune system.
8. The role of antibiotics is then to restrict the numbers of the original 'species' produced, and give the immune system a chance to respond and finish the job. This requires the immune system in effect to evolve.
9. This analysis gives a more rational account of bacterial systems. They are not 'out to get us'. Other approaches to avoidance and treatment become possible as the threat from bacterial infections grows.
10. On this result it seemed possible to apply the methodology to the much greater system of evolution by natural selection.
11. Entities of the living world can be grouped into species. Within species it can be seen by inspection that there is much differentiation of individuals with trends running in families.
12. Reproduction suggests a possible mechanism of change of the characteristics of species over time.
13. Individuals which are best suited to the particular environment of the time are likely to survive better and reproduce more successfully, which is natural selection.
14. When the environment changes, individuals which are best suited to it prosper relative to the others, and change the character of the species as a whole. That is evolution.
15. There must be a mechanism for creating new species more suited to the environments of their time, because almost all of the species which have existed on Earth are now extinct. Hence the process of evolution by natural selection.

16. The physical environment is a major determinant of evolution, but all individuals are part of the environment of all others. When change occurs, they must all evolve together, predator with prey etc. Hence co-evolution.

17. All this also applies to the evolution of modern man. Numerous variants of our species have been identified in the fossil record. We are just the last to survive.

18. Darwin represented evolution as a tree, which implies that one species gave way to the next and ceased to exist.

19. This cannot be entirely true because the earlier organisms from which life evolved can still be found living on Earth, and in numbers which give them a much greater collective biomass than the animals we see, for instance. It is the higher organisms which have disappeared into extinction.

20. The deficiencies of the tree model are becoming apparent with the continuing discovery of variants of our species which would be successors on the tree, but in fact are now known to have been contemporaries for long periods of time. These have been mainly but not completely separated by geography.

21. I have suggested that the mutations which gave rise to variants occurred at random at different times and in different places on Earth. They arose separately, spread out across the local land mass, which essentially meant continents, but mostly remained separated by geographical isolation. However, they also diffused over time into each other's territories and may even have interbred to a small extent.

22. Given enough time, every individual would have had the same mixture of mutations. However, isolation meant that the process was extremely slow, new mutations kept on occurring at random and environmental change influenced the process of natural selection in different ways in different places at different times.

23. The result would have been differentiation. Different variants arising from different mutations would have been contemporaries, rather than successors on a tree, which is how fossil remains are increasingly being regarded.

24. Most mutation would have occurred where and when there was most suitable territory. This was Africa, the largest continent on Earth and with relatively the most benign environment.

25. Mutation occurs by definition in individuals and spreads through a population by procreation. Its occurrence therefore depends on the number of individuals. Favourable mutations increase the number of reproducing individuals, and so the number of the more successful in their particular physical environment increases exponentially with time.

26. This diffusion mechanism which I have proposed is a new paradigm.

27. Species are characterised by the DNA in their cells. DNA is a polymeric molecule with stereochemical properties that enable it to act as a template for cloning itself, which is the essence of procreation of the species.

28. However, the dynamics of natural selection are that the natural environment differentiates species physically according to their ability to reproduce in changing circumstances. Differentiation is therefore by physical characteristics, not by DNA.

29. Differentiation occurs between species occurs both in DNA and in the physical characteristics which respond to the environment.

30. However, differentiation also occurs within a species between individuals which have virtually the same DNA. Indeed this is the basis of the survival of those individuals which are best adapted. What makes one individual 'better' adapted than another? This is analysis at the level of 'particle' kinetics.

31. There must be a mechanism by which the physically amorphous, chemical template DNA relates to the physical structure which is produced. My proposal is that this arises through interaction between a cell's DNA and its walls. Only the walls have the material properties of tensile strength and resilience to give three dimensional structures.

32. My conclusion is that cell walls must therefore have the physical and stereochemical structures to link all cells in that individual. They are not just semipermeable membranes or containers.

33. This is analysis in effect at the level of particle kinetics. Stem cells are the primordial particles of a living entity.

34. Stem cells become 'committed' to specific organs at later stages of development.

35. The type to which stem cells become committed in laboratory culture has been found to be related to nature of the surface on which they grow. In particular there seems to be a correlation with the tensile properties of the material.

36. Stem cells are defined by what they do, but they are indistinguishable from ordinary cells embedded in tissue. They have much longer lives than other cells, which may die in a month or two.

37. This suggested to me that the property of being a stem cell might be something additional to the functioning of a cell such as a coating which can be transferred from ordinary cell to ordinary cell as it reproduces, so as to give the appearance of being everlasting.

38. Differentiation into types of organs must begin at the earliest stages of growth by some mechanism.

39. What is difficult to envisage in any model is how cells know that they are supposed to be on the left or the right, or indeed the back or the front of the fully grown entity.

40. Such directions must be inherent in the original cells on which the form of the growing entity is constructed, because there appears to be no mechanism for changing them later in its development e.g. heart into left arm.

41. After these directions have been established in the embryo, it is possible to envisage a mechanism by which the entity could be formed on the basis of the successive addition of cells with asymmetric walls.

42. Such directions must apply to all embryos in the earliest stages, because all humans, for instance, have their hearts on the left side. Plants do not have the equivalent because their fine structures are symmetrical about the vertical axis to maximise the effect of the Sun.

43. The only direction of motion which applies to the growth process of all entities is the direction of rotation of the Earth on its axis i.e. they all have the same east. Far-fetched as it seems, this would have to exert its influence at the very moment of conception.

44. There could be a parallel with particle physics and the cosmological model proposed in a separate paper.

    d.   archaeology

My systems methodology was set out in my three books *The Scale and Scope of Economics*, *A Degree of Freedom* and *Democratic Systems*, which covered social as well as scientific areas. My first analysis which went beyond these concerned an archaeological topic, the Neolithic Revolution. This is the term used to describe the change from hunter/gatherer to farming that occurred about 11,000 years ago in populations around the world. The revolution was probably the most significant change which modern man has ever undergone, certainly up to the industrial revolution. The analysis shows the process by which all the institutions taken for granted today, government, law and of course the industrial revolution emerged from the new system. The paper largely stands the test of time 10 years after I wrote it.

    B.   Summary conclusions in paragraphs

    1.   The theory of the expanding Universe.

I began from my assessment that the theory of cosmological expansion was simply wrong. I do not disagree with any of the measurements, but only with their interpretation. It can be seen that the Universe is perpetually changing or evolving at every level of existence from microbes to galaxies. All these changes are the operation of systems, where 'system' is the generalised term for the fundamentals of a process, any process. The definition of a system is that it is composed of subsystems which interact, as do the systems of the natural world. The inverse of this is that subsystems which interact must therefore constitute a greater system, in this context the Universe itself. The model of the 'Big Bang' is not a good system, because it has a magical input and no end.

    2.   A new model of an infinite Universe.

However, there is ample evidence of 'big bangs' occurring in the Universe. The problem of the Big Bang model is that in systems terms, there is no feedback. My much more plausible model is that big bangs occur stochastically wherever sufficient matter agglomerates through gravitational attraction to cause it to explode. This reduces it to small particles and scatters them far and wide to begin the process of agglomeration all over again, but in different compositions in different places. The result is that the Universe is regenerated part by part through collision, fusion, fission and explosion.

This requires a Universe that is infinite in time and space, which is not the model of the past 50 years. It calls into question the alleged evidence of the Big Bang. Such evidence includes the abundance of metallic elements in the Universe, which is thought to represent its age. However, an alternative explanation is implicit in the process of regeneration described above: the abundance of metallic elements is the result of a dynamic equilibrium in which metallic nuclei are being destroyed as fast as they are formed. Processes of destroying heavy metal nuclei have been demonstrated on Earth in particle colliders, and so they could certainly occur elsewhere in the Universe, in stars, supernovae etc.

The other evidence, which is the interpretation of the redshift of light from stars and the microwave background are addressed below. My model still stands.

3. Redshift between stars and Earth.

The first evidence concerns redshift. From a reading of Hubble's own description of his work, he was not sure whether the relationship between the redshift of stars and their distance and velocity was linear, which the current interpretation implies, or whether it was in fact a curve. The decision was made all the more problematic because the measurement he was making is a ratio, which is difficult to interpret mathematically. In any case his major discovery was proof for the first time that there were galaxies outside our own. He went along with the straight line. The idea was that light waves were stretched in some way by the velocity of the emitter by analogy with the Doppler effect in sound.

My simple test of this is to ask what colour of light you would see if you took a sodium lamp to Alpha Centauri. The answer without exception has been sodium yellow, as on Earth. But the electromagnetic frequency of light which we would observe on Earth from the sodium lamp on Alpha Centauri would be shifted towards the red. The only conclusion must be that electromagnetic frequency decreases between the star and the Earth, which is just as well, or we would have velocity-dependent chemistry which was different in every part of the Universe, because electromagnetic frequency and chemical combination both depend on the same electron energy levels. The Periodic Table is literally Universal.

4. A theory of exponential decrease of electromagnetic frequency.

My model proposes that the electromagnetic frequency of light decreases in transit from stars to Earth according to an exponential function. The exponential would be an inevitable consequence of Planck's equation in which the electromagnetic frequency of light is proportional to its energy, and so most energy would be lost when it was at its maximum i.e. close to the star.

5. Validation by observation.

The question is how to demonstrate that the curve is exponential, and if so, how to determine its exponential constant. Such a constant could be used to determine the distance of all sources of electromagnetic radiation, because different colours or frequencies of electromagnetic radiation start at different points on the same curve. You can hardly go half-way to a star to check, but I was able to suggest an Earth-bound solution in a later paper: The Decrease of the Electromagnetic Frequency of Radiation from Stars (24 August 2011). The method was to compare the loss of frequency of light from stars with their distances measured trigonometrically, where this is possible. This should give a curve in which the more distant the stars, the closer their electromagnetic frequencies measured on Earth. With modern instruments this should not be too difficult.

There may also be a possibility of direct measurement. I proposed that ruby laser light sent back from reflectors left on the Moon by astronauts should be checked for

frequency shift. The reason is that the Moon may be just far enough away for a measurable shift to occur, there and back, and it is virtually stationary with respect to Earth, so that any shift could not be attributed to relativistic effects. There are also reports that masers can be reflected from the pole of Mercury, which may give another possibility of measuring frequency shift through an astronomical distance, though with the complications of velocity.

The exponential curve of decreasing electromagnetic frequency means that emissions in every direction from stars are all converging on the same low frequencies at great distances, and so it is not surprising that there is a microwave background in the cosmos. The electromagnetic frequencies may decrease still further to give a background of radio waves. Any observations of structures of the background would then be imposed by phenomena between the Earth and the sources.

This background of electromagnetic radiation also explains Olbers' Paradox, which seems to intrigue astronomers. The sky is dark at night because the Sun is not out. This is not as simplistic as it seems. What we see is by definition visible light. What we see during the day is visible light from the Sun, but we do not see the electromagnetic radiation which it emits at other frequencies, because the human eye does not detect them. What we see at night is visible light from stars, but we do not see electromagnetic radiation which they emit at other frequencies for the same reason. Nor do we see all the radiation that they have produced which was originally in the visible range. It has been redshifted by its exponential decrease below the limits of our detection. If we could see all the frequencies of electromagnetic radiation, the sky would always be seen to be bright, though with what colour is difficult to say.

6. The implications for physics.

The implications of the exponential for physics are considerable. First, the only reason for the decrease of electromagnetic frequency must be interaction with the medium of space i.e. proof that the medium of space exists, and that it has electromagnetic properties, which would hardly be surprising. This finding alone is sufficient to take physics back to the early 20th century paradigm. Newton and Faraday would be delighted.

7. Closer stars in an infinite Universe.

Secondly, the exponential function places all the stars much closer to the Earth, in fact so close that the light from the most distant stars left them about the same time as the Solar System formed, as estimated from radioactive decay. This is evidence that my model of an infinite Universe is much more likely than the Big Bang model. Fred Hoyle would be delighted. Further evidence from a recent informative RAS public lecture on the Herschel telescope may be that distant stars appear to be brighter than expected. My reaction was, perhaps they are just not as far away as we thought. Brightness may be a more reliable indicator of distance than wavelength.

8. Microgranular space.

Following on from that argument, I propose that the medium of space is composed of microgranules, because this is the most obvious explanation of other phenomena. The

microgranules populate the whole of space, and they must be small enough to penetrate even within subatomic structures such as protons. They have the property of susceptibility to electromagnetic induction by particles of matter, which causes orientation of their axes. They interact with adjacent microgranules without the expenditure of energy and influence their orientation.

In their default state the axes of microgranules are stochastically oriented, but they become aligned locally head to tail to form lines between particles of matter by successive electromagnetic induction. These lines are the resultant directions of all the axes of the contiguous microgranules. The directions become increasingly diffuse with the distance from the body from which they originate. It is these lines of microgranules that transmit forces acting at a distance including the strong force, the electroweak force and the electromagnetic force. As they become diffuse, their strength decreases with the square of the distance. These are all the same force acting between particles of matter at different distances, and detected by us in different ways. They are in operation all the time, like gravity, and so what we detect is not force but the change of force as particles of matter accelerate. The rate of propagation of change through space is determined by the rate of reorientation of the microgranules between particles. It follows that this determines the rate of transmission of all changing forces through space, including gravitational, electric and magnetic. The maximum rate of transmission is the same for all forces i.e. the speed of light. This is a characteristic of the medium of space, and it unifies all the forces of physics, which has long been attempted. It is likely that much of General Relativity can be replaced by putting a velocity on the speed of gravitational change.

There remains the question of what is in the interstices between microgranules, because they must surely be spherical. This opens the possibility of some kind of anisotropy at the lowest order of the Universe.

9. Resistance at relativistic speeds.

The existence of the medium of space makes other problems more amenable to rational solution. Thus the resistance to acceleration at relativistic speeds can be explained. Considerable increases in energy are required to accelerate a charged particle to velocities close to the speed of light, until at the speed of light *in vacuo* itself no amount of energy will suffice; that is the limit. Newton's law does not envisage such a phenomenon. All particles which reach such speeds are charged, because there is no other means of accelerating them. Einstein's solution was his Special Theory in which the parameters of time, distance and mass dilate hyperbolically with velocity until they reach their asymptotic values at the speed of light *in vacuo*, which of course was the reason for his choosing the hyperbola.

My solution is that the particle encounters hyperbolically increasing resistance from the medium of space. I incorporated this into the ordinary equations of physics by adding a parameter R to Newton's Second Law of Motion (no less!). Thus in this solution a newton of force is still a newton of force, but the number of newtons required to produce acceleration increases hyperbolically with velocity. The parameter R which expresses this number is a hyperbolic function of velocity. The value of R is surprisingly easy to enumerate using a transformation to a rectangular hyperbola. The function of $1/R$ is then a straight line which cuts the axes at zero

velocity and the speed of light *in vacuo*. This gives the parameter R as the ratio of the speed of light to the difference between the speed of light and the velocity of the particle.

It can be demonstrated that the theory of time-dilation is invalid by using a clock which tells the time but cannot possibly dilate. I devised such a clock based entirely on the principle of radioactive decay, using no conventional measurement of time either in counting the number of 'sparks' or in the exponential constant. If time-dilation was to occur, by definition it would depend on the relation between events, but 'sparks' are completely independent of each other. That is what exponential decay means. Thus there is nothing between sparks to dilate. With such a clock to count the time away, particles would still be difficult to accelerate at relativistic speeds.

In fact separate analyses showed that there is no such thing as time, just time-intervals. Indeed this is a necessary condition of using algebra in Newton's physics and the calculus which depends on it. Some events certainly happen before others, or in the terms of this analysis, some systems precede others, but what this means is that their outputs travel through space and become inputs for other systems. The interval between systems or events is the passage of light, which may be counted as a time-interval or a distance-interval, but more neutrally as the number of oscillations of an electromagnetic emission, which can be treated as a time-interval if the distance interval is given, or vice versa, because their product, the speed of light *in vacuo*, is constant.

So the Second Law of Motion becomes F = mRa and there is no need to dilate anything. Newton's orthogonality between time and space still stands.

10. Light and wave/particle duality.

Newton thought that light consisted of particles, but he applied the mechanics of masses to the problem and could not reconcile his predictions with the measurements. He had to accept the Huygens wave model. Nevertheless, he was remarkably perceptive in linking both the motion of particles of stuff and light particles to the same fundamental phenomenon which is the medium of space. Einstein later proved conclusively that light consisted of particles, but he was unable to explain diffraction, and so he half stuck with the Huygens wave model. He invented the term 'wavicles' to describe the phenomenon, and this soon evolved into the more sophisticated 'photons'. This was the origin of 'wave/particle duality' which has persisted ever since.

My re-introduction of the medium of space in its electromagnetic form suggests an alternative which can account for both the wave and the particle phenomena. Light particles are formed at the level of individual atoms. They are most obviously the result of the acceleration of electrons back into orbit around nuclei after they have been displaced, but they may occur more generally whenever electrons are caused to accelerate, for instance by increasing temperature. My concept is that their acceleration gives rise to electromagnetic induction of microgranules in the medium of space, which causes their alignment. At some point the energy of the electron is such that a string of aligned microgranules separates from the matter and is spun off

into space. This is an equivalent of activation energy in chemical reactions. The act of spinning off suggests a rotational motion, which results both from the velocity of the electron and the curvature of its trajectory. Electromagnetic induction from electrons to microgranules changes the forces of attraction between the electron and other particles of matter, which is energy. As soon as the induction is completed, the kinetic energy of the electron is reduced by a quantum equal to that of the light produced, and it settles back into its stable orbit. Each oriented microgranule passes its orientation on to the next, so that the entire process consists of forming dipoles or orientation of axes. Since this process requires no energy, it proceeds indefinitely until it is stopped by a receptor. The passage of light is therefore the specific reorientation of successive microgranular structures, and the speed of light in vacuo is the rate at which reorientation occurs.

There are two alternative interpretations of this phenomenon. Using Maxwell's relationship, one might be that when a particular energy level of oscillation is reached, electromagnetic radiation leaves the source in the form of successive electric and magnetic layers, each of which generates the other to give a sort of layer effect. This 'slab structure' progresses through space by the same process. This is in effect broadcasting *en masse* on 'wavelengths'. However, the problem then is to reconcile the wave from a single atom with the behaviour of light in bulk. This may be conceivable with long wavelengths which use aerials, but it does not seem compatible with the interference of the much shorter waves of visible light, still less with any kind of Doppler effect. It may be that different 'wavelengths' of electromagnetic radiation are generated by different mechanisms, although the end results are the same.

My model is that each section of the string of oriented microgranules is ejected as it is formed. Successive sections of the string follow immediately until the energy of the electron's changes of motion has been exhausted. They travel together in the same direction as a 'string' with a beginning and an end because they all have the same velocity of propagation. The hexagonal close packing of microgranules suggests that the process of electromagnetic induction progressing through the microgranular structure of space may cause local rotation. The simplest description to describe the result of all the separate motions of generation and transmission is a rotating helix. Such a helix is characteristic of the atomic structure which produced it. It has dipolar characteristics because of the inductive processes by which it is formed and propagated. It would appear to rotate in transit as a result of the continuous induction process. Its essentials are that it has a definite length, a characteristic rate of rotation and the characteristics of a dipole.

I have called such a rotating electromagnetic dipole a RED for short. The RED keeps on going until it reaches a receptor with which its structure can resonate and it becomes absorbed. The result is that the RED has simply been the means of transferring energy from one particle structure of matter to another. The RED has no energy of its own because reorientation of microgranules requires none. It is reorientation at the interface between microgranules and particles of mass which involves energy, because it changes the forces linking the particle of mass to all other particles of mass.

 The problem of diffraction which is the main evidence for waves of light can be attributed to deflections of REDs by one another of the same species because of their polarity. No energy is lost; they simply change direction at the speed of light, and the angles of deflection match those observed in diffraction.

As explained above, energy is not involved as a RED travels through space, but proponents of the linear theory of redshift seem to be alleging that the same energy of light is spread out over a longer distance- or time-interval, because the wave crests are further apart. But the velocity of light is constant for all wavelengths, which has been confirmed by astronomical observation, and so some extra time or distance has crept into the argument from somewhere. If the RED also appears to lose energy, because its electromagnetic frequency is decreasing, this can be explained by its generation of a secondary RED resulting from the same process of electromagnetic induction of microgranules which generated the first. It ought to be possible to detect the secondary by spectroscopy.

Laboratory tests easily show that the intensity of light from a source decreases according to the inverse square of the distance from it. It seems to make sense because the surface of a sphere increases with the square of its radius. If light travels radially in straight lines from a point source, all rays would lie on the surface of a sphere. However, the concept of collisions of REDs suggests that it is more complicated than that. No source can really be a point. The geometry of the source should emit particles of light in every direction from every point on its surface. Therefore, when REDs are in the zone close to the source many will inevitably collide and be deflected off in new directions. They will still obey the inverse square law in the collision zone, but they will not be able to avoid contact with each other and travel unimpeded in straight lines until they are far enough away from the source. Then their intensity will decrease according to the simple model of the surface of a sphere. However, light from stars, and even the Sun, is said to travel in parallel straight lines, which is at odds with the radial model. Why then should it still obey the inverse square law?

The particle theory of light also explains why acceleration of a charged particle of stuff becomes increasingly difficult as its velocity increases; it is losing some of the energy applied to cause acceleration by ejecting particles of light into the medium of space. The higher the velocity, the higher is the electromagnetic frequency of the RED caused by acceleration. It seems likely that the direction in which the RED is ejected from an atomic structure changes as the velocity of the atom increases from, say, dead ahead to more at an increasing angle, because the 'escape' velocity is reached earlier in the orbit of the electron. Newtonian kinetic energy is still valid at all velocities but an increasing proportion of applied energy is ejected to attain the same increase of velocity. The limit is reached at the velocity of light *in vacuo* when it is all ejected without any acceleration being produced.

Such a phenomenon offers the possibility of measuring the absolute velocity of any body through space. Since the velocity of light *in vacuo* has a constant value everywhere and at all times, it has always been possible to use it has a benchmark. The problem is that measurement of velocity at relativistic speeds itself involves the velocity of light, say by signalling the arrival at the finishing post. However, if the above relationship between acceleration of a particle and the electromagnetic frequency of light emitted holds good, it should be possible to find the velocity of a

body by accelerating an electron from it and observing the colour of the light emitted. This analysis applies to acceleration of a single electron, but this is different from a stream of electrons. Electrons in bulk introduce collisions with each other which may slow down the progress of the whole, but cause many other local accelerations, probably distributed normally with the emissions to match.

11. A new structure of the atom.

The discussion of light leads naturally to the structure of the atom which produces it. The concept of atomic structure has not changed since Rutherford first discovered that it had a hard kernel or nucleus at the centre. Negative particles in the form of electrons had already been identified, and there had to be a balancing positive charge to make the atom neutral, but its nature was not known. One guess was that the atom might have a sort of 'plum pudding' structure. Rutherford's discovery settled that question. The atom had a hard nucleus at the centre, because alpha particles could be shown to bounce off it, and the electrons must orbit around it, a bit like the solar system. There was the immediate objection from classical physics that such a structure would be unstable because the electron would radiate away its energy and run the atom down, which it clearly did not. Bohr rode to the rescue with his theory that the electrons were confined to predetermined orbits, though without saying why. However, there was another objection which was that the masses did not add up; the nucleus seemed to contain more protons than matched its charge. The conclusion was that the nucleus must contain other particles with about the mass of a proton but no charge i.e. neutrons. A few years later Chadwick duly discovered the neutron.

There were two problems with these solutions. First, there is no reason why an atom with orbital electrons should grow tired, any more than the Sun grows tired of holding on to the planets, or the Earth holding on to the Moon. It is changes of forces which require energy, and that requires some outside influence. Kinetic 'energy' is only potential until a body collides with another. The classical objection that a moving charge loses energy confuses it with induction, which requires a second, receptive body. The second problem was that the neutron was later found to decompose at room temperature and pressure into a proton and an electron by a process with a half-life of about 10 minutes. It was clearly not a fundamental or even stable particle.

Bohr orbits in effect describe the energy required to lift successive electrons out of orbit around an atom's nucleus. Until that happens they are considered to be bound into prescribed shells of mysterious origins. However, the previous analysis allowed me to start anew with the observation that all electrons are identical. This must be true, because you cannot have different versions of a fundamental particle.

My approach is simply to build up an atom by adding successive electrons. The first would find its own orbit. The second would join the orbit, but in the diametrically opposed position because it would stay as far away as possible from the like charge; they would stay poles apart. The third would try to join at the same distance from the nucleus, but it would be at an equatorial position to avoid the other two, and so on. They would all be identical while seeming to possess their own positions. There would come a point at which all eight electrons would be as close as possible to the nucleus but as far as possible from each other. The next arrival would not be able to join in, and so it would have to orbit further away. It would be more loosely bound.

Additional electrons would go into this outer orbit, until it too was full. I called this an electrodynamic model of the atom.

However, there was one question that neither Rutherford nor anyone else seems to have considered. Why did not the electrons simply settle on the nucleus? Why all this space in between, so that the atom was almost entirely empty space? The easy decomposition of the neutron offered a solution. Neutrons cannot be made on Earth; this requires the extreme pressures and temperatures of stars. Yet they readily decompose in the laboratory, and the decomposition has a half-life, which shows that it is a process involving probability which is taking place. Since the products are a proton and an electron which is a fundamental particle, they must be closely associated rather than absorbed into a single particle. The pressure of the star is forcing them into very close contact without fusing them. I propose that the neutron is in effect a proton with an electron in very close orbit around it, which gives the impression of a neutral particle when we isolate it. This is how they remain frozen in the nuclear structures which are made in stars. When they are released, the orbit of the electron begins to unwind, probably through disturbance by or collision with another particle, or with the walls of the laboratory vessel.

This suggests that neutrons in stars are also protons with electrons in close orbit, not 'attached' to a particular proton but orbiting around and between all of them. Thus the nucleus of the atom is composed of an assembly of protons which are bound together by intranuclear electrons in close orbit around them. The protons try to push apart, because of their like charge. The electrons pull them back together again, which they are able to do because they are much smaller and faster, but the electrons are also trying to avoid each other. The whole nucleus is a pulsating, oscillating agglomerate and the forces binding it together are very large because the distances between charges is very small. It takes the pressures and temperatures of stars to force the particles into such close proximity. The other electrons which are required to make the atom neutral orbit around the nucleus. The number of protons in the nucleus is equal to the number of intranuclear electrons plus the number of orbital electrons.

Why then do the orbital electrons not settle on the nucleus? The answer seems to be that they certainly try, but they are immediately repelled back into orbit by the faster intranuclear electrons which get there first. These are faster because of their tighter orbits.

There is another thought about neutrons, one which is relevant to dark matter. Stars belch out neutrons in the same way as they radiate REDs, and the same processes of collision take place. With neutrons the product would be hydrogen atoms, as protons and electrons shifted into a bigger orbit and loosely recombined. Those that got through unscathed would be travelling slowly, because of the gravitational attraction of the star, and on parallel trajectories. The number of particles in these regions would be very low, no more that half a dozen per cubic metre, and so the chances of collision would be very small. There is no reason why the neutrons should not survive undetected for a very long time, and their number would be constantly replenished by the action of the star. Nevertheless, they would still have mass and exert gravitational attraction. Neutrons might therefore be possible candidates for dark matter, which is also associated with stars.

The idea of electrons in the nucleus is not as unfamiliar as commonly believed. Some conventional nuclear reactions appear to conjure up an electron from nowhere.

12. The proton

After decomposing the neutron and the nucleus, it seemed logical to consider the other subatomic particle, namely the proton. Protons are not fundamental particles. They can even be smashed to pieces in colliders on Earth. The corollary is that they are also synthesised somewhere in the Universe or their numbers would be depleted by now. This must occur in stars. But what is most remarkable is that, while they have about 1836 times the mass of the electron, they have a charge which is exactly equal and opposite.

The question is what kind of process of synthesis can give rise to a particle which is much more massive but has a charge which is not only opposite but so exactly equal. It is most unlikely to be an accident of nature. The only possibility seems to be that the proton is composed of smaller particles, just as atoms and nuclei are composed of smaller particles, and it contains within its structure an anti-electron, which is called a positron. This could account for the apparent dearth of positrons in our Universe. The contribution of the stars would be to force the particles into close proximity in such a way that they formed a stable agglomerate in the form of a proton.

It seems unlikely that the proton is built of assorted building blocks, and so I postulated that they were all the same particles of stuff, including the electron. The term 'stuff' is used to described the matter which obeys Newton's laws of mechanics. I called these building blocks ε-particles to distinguish them from electrons and protons, because electric charge was not used in the analysis.

My first attempt drew on the concept of forces generated by currents passing through parallel conductors. These are forces of attraction or repulsion depending on whether the directions of the currents running through them are the same or opposed. This cannot be directly transposed to ε-particle behaviour, but it suggests that the same might be true of their directions of spin. A model was constructed on the basis of ε-particles separated by a distance but with axes in line i.e. poles towards poles. It was postulated that like particle spin directions would then attract them together and opposite spin directions would repel. The link which carried the force between them would be the microgranules of the medium of space. Lattices of paired ε-particles with opposing spins could be formed stochastically to give a larger particle with the stuff of a proton, but with a single unpaired ε-particle at the centre to fulfil the role of a positive charge. Such a simple model was capable of producing very complex results, but it failed at the level of the atom. Nevertheless, it had the potential for development.

A more realistic model began with a single ε-particle rotating on its axis. Its interaction with the medium of space would cause microgranules to become oriented most at the equator, which was moving fastest, and least at the poles, with a gradation between the two. The orientation would spread around the particle like a toroidal belt, and the effect would decrease according to the inverse-square law as far as infinity. If two such ε-particles with parallel axes were spinning in opposite directions, resonance would be set up through the microgranules between them and the ε-particles would

attract each other. If, however, they were spinning in the same direction, dissonance would occur and they would repel each other. The force between them could be adjusted for deviations of the axes from the parallel.

On this basis I constructed a model of the proton. All the stuff of the Universe is composed of a basic building block, the ε-particle. It is the stuff which obeys the laws of mechanics, momentum etc. All the forces which act at a distance, gravitational, electric and magnetic are determined by the rotation of ε-particles on their axes. The axes of the ε-particles in the Universe are randomly distributed, so that there is no overall direction. These directions never change, and the rate of rotation of each about its axis is the same for all ε-particles. The forces between them bind ε-particles together to form protons, nucleons together to form nuclei, and ε-particles to nuclei to form atoms. They are the same force acting at different distances and transmitted by electromagnetic induction through the microgranules of the medium of space.

The proton grows stochastically by statistical accretion of ε-particles around a single ε-particle on the basis of what maximises the forces between ε-particles in particular locations. At some size additional ε-particles are unable to adhere to the structure because the forces are insufficient, and the process of agglomeration ceases. If the central unpaired particle is rotating one way, we see the agglomerated particle as a proton. If it rotates the opposite way, we see it as an anti-proton. In our particular environment we see a preponderance of protons, but in the Universe as a whole there must be anti-protons to balance. If this model is valid, high speed collisions should produce fragments which are whole numbers of the stuff of ε-particles, and if these are reduced to individual ε-particles, almost equal numbers of electrons and positrons. The particles in a 'species' will not be identical because they will contain a range of axis angles, and so they will show a distribution of deflections in detectors.

Thus in this model of the Universe there are just two components: particles of stuff and the microgranular medium of space through which they interact.

However, the role of electromagnetic radiation complicates the picture. The medium of space establishes forces between particles of stuff through alignment of its microgranules by electromagnetic induction. When particles of stuff move with respect to each other, which they are always doing in a turbulent Universe, the lengths and directions of lines of oriented microgranules between them must continuously adjust, which they do at the speed of light. This changes the forces acting between the particle of stuff and all other particles of stuff, a process which requires energy, but forces which increase when a particle comes closer are balanced by others that decrease when one recedes. The particles may be considered to be moving under their own momentum at constant velocities, and so it does not require the application of force. This may be regarded as the property of inertia or alternatively of mass. However, it is also true that forces from particles cannot all adjust simultaneously because the particles are at different distances, while the rate at which change can be transmitted is fixed by the speed of light *in vacuo*. Thus they cannot balance the whole time, and so the trajectories of particles curve, which I have described as bodies waltzing around each other.

When the movement becomes acceleration, there is another process at work. The orientation of microgranules at the surface of the particle of stuff spins off a RED.

The forces themselves adjust at the speed of light as above. The RED travels through space at the speed of light without consuming energy, because re-orientation of microgranules does not require energy. When the RED reaches a receptor, it resonates with the structures of microgranules around the particle. Since microgranules convey forces between particles of stuff, this changes the forces between these particles, and causes them to respond by accelerating into new positions. This is in effect another way to transport forces between particles of stuff, in this case forces of disruption of the structure of matter rather than the attraction or repulsion of bodies. Work done in changing the positions of all particles of stuff is energy.

This has to be taken into account when using the equation for force $F = mRa$. The force F is not all used in producing kinetic energy, because it does not all produce acceleration. An increasing proportion of applied force at higher velocities is used in spinning off REDs. This is what the Inertial Resistance Factor R represents, and it leads eventually to the absolute limit of the speed of light *in vacuo*.

Physics is not the only science affected by the ε-particle model. The angles of their axes in nuclei affect their orbital particles which are the basis of chemical combination. It can be assumed that atoms and molecules in bulk, which is the main concern of chemistry, adopt common configurations because there are sufficient numbers of ε-particles to find the best fit in any position. However, this may not be true of small numbers of particles, still less of individuals.

13. Cosmic energy

Thermodynamics is very gloomy about the future of the Universe. Entropy is relentlessly increasing, and eventually it will lead to a cold dark cosmos of barren rocks and gases which are unused because their quantities are insufficient in their separate locations to ignite into nuclear reactions. Energy is more hopeful on the face of it, because it is conserved; it never disappears, but only changes its form. However, this form is ultimately low grade heat, which is incapable of initiating further change. All this is inherent in the Big Bang model of the Universe, where the bang ultimately fizzles out. But what about a Universe which is infinite in time and space, as proposed here?

However, the more fundamental question is: what is energy anyway? Energy is commonly described by its sources such as gas, oil, electricity etc, but if all these are equivalent as Joule showed, what is the underlying source which unites them?

The model of the previous paragraph provides a possible solution. The forces of attraction which arise from the spin of ε-particles are ceaselessly pulling them into more stable aggregates, by which is meant structures which maximise the forces in particular locations. Energy is the work done by these forces of attraction. In that sense energy is always being used up, because it is not available to bring about further change. It is not a smooth decline, because there are positions of metastability. In fact our whole world is metastable, because nothing lasts for ever. But these positions are eventually overrun by change, which is inevitable in the infinity of time.

The answer to that lies in the phrase 'regeneration part by part through collision, fusion, fission and explosion'. What saves the day is the process of explosion which

occurs when agglomerates of matter become too large for their structures to sustain, and reduces them to scattered particles. The forces of accretion contain the seeds of their own destruction. This is the feedback which allows the whole process of accretion to begin all over again with renewed energy in an infinite Universe.

14. Bacterial evolution

Particles are a major feature of the preceding analyses. Bacteria are living 'particles', which reproduce by cloning in less than hour. A lecture at the Royal Society described the difficulty of categorising the species of bacteria. It was said that a single, isolated bacterium would evolve on cultivation. In a different lecture it emerged that the human immune system could apparently evolve in a few days to meet a threat, which of course a bacterium could constitute. As evolution is one of the examples in my book on systems A Degree of Freedom, it seemed that there might be some interest in looking at the systems dynamics of their evolution in the same way that I have applied the methodology to physics.

My conclusion was that bacteria do not evolve in the commonly used sense of the word. They are in fact rather sloppy cloners, and produce a small but significant proportion of variants during reproduction in animals. The variants survive and reproduce like the original bacteria. The importance of this is that antibiotics are designed to kill bacteria sterospecifically. Since it cannot be known in advance which variants are going to be produced, something other than the antibiotic must kill them if cure is to be effected. The only alternative seems to be the immune system which failed to prevent the infection in the first place i.e. it must evolve a new defence to meet the threat from the variants. The function of the antibiotic then is to slow down the production of variants by limiting the number of original bacteria until the immune system has learned to cope with the newcomers. The implications of this are considerable, especially since the threat of infection is increasing. It is possible that a similar effect may be observed with viruses, because it has recently been reported that babies who were expected to have HIV remained immune for years of their lives after inadvertent early treatment with antivirals. There were only a few cases and so any causation remains to be proved in proper trials.

15. The co-evolution of species

Bacterial reproduction was a fairly mathematical system for systems analysis, but the interesting results suggested that it might usefully be applied to the much more complex subject of evolution as a whole. In fact the analysis showed that Darwin's and Wallace's 'evolution by natural selection' is a law which is every bit as valid as the second law of thermodynamics. It is no longer just a theory. Everything evolves, not just life but everything in the Universe, as described in previous papers.

The fossil record shows that almost all the species which have existed on Earth have become extinct. There must be some mechanism for producing new species, or by now life would have completely disappeared from Earth. It is unlikely that an individual can change species during its lifetime, and impossible for all individuals to change simultaneously. However, it can be seen by inspection that there is a great deal of differentiation between individuals within a species. Individuals whose

characteristics happen to be best suited to the environment of the time thrive, reproduce more successfully and in due course come to dominate. This is a new species, while it lasts. The environment in which each individual exists is not simply the physical landscape. It includes all the rest of living species. Since this is true of all species, the process of evolution is best described as co-evolution in which every living species evolves together. Many species are dependent on each other for survival as predators and prey, animals and insects, humans and bacteria etc. Nor has the process finished. Species are metastable states.

16. Human evolution – a new paradigm

Human evolution is a case in point. Our perception is that humans are the pinnacle of development, but the discovery of the remains of increasing numbers of different hominins is suggesting that we are really the last surviving variety after two million years of evolution. All evolution is the result of changes in the human genome caused by radiation or by faults in the process of cloning, both of which occur stochastically throughout a population. These changes must occur in individuals, as described above, and then survive the process of procreation through eggs and sperm which is full of mechanisms to filter them out. The stochastic nature of the process means that most changes occur where there are most individuals. Changes which are advantageous in their locations tend to increase the number of individuals which survive, and so they accumulate exponentially. The corollary is that successful changes occur in individuals and then diffuse through the population by procreation.

Diffusion is a new paradigm which is different from the concept of a tree. Each mutation will be different from the others because the length of the genome makes it most unlikely that it could strike twice in the same place by chance. As the mutations spread out, there are areas in which they overlap, so that some individuals will have both. In addition some areas will be isolated from this process, so that their genomes take a different path. Thus at any particular time on Earth there will be many contemporary 'varieties' of hominin, some of which, using the tree model, would have been thought to be predecessors of the others. The difference between them may seem large to us but it amounts to much less than 1%, because this is the difference between man and the ancestral ape from which he descended.

What has eventually decided the outcome is that survival depended on the local environment which varied considerably over the surface of the Earth. This was not simply a question of place, but also of time. The Neanderthals, who were very close to modern man, were caught in northern latitudes when the glaciers advanced across half of Europe. Other hominins and modern man came out of Africa at various times when the contraction of the Sahara permitted it. These chance events allowed some to increase exponentially in numbers, but caused others to suffer decline to the point of extinction.

For reasons that are not clear, modern man then developed the capability to change the rules. He started adapting the environment to his needs rather than suffer the consequences of their changes. He began to use fire instead of fearing it. He developed technology to help his survival. His brain grew in size and his rate of learning increased. None of this was done in isolation; it was co-evolution. The effect

on the development of other species worldwide has been dramatic, but not necessarily to their advantage.

17. Cell walls – the limits to growth

The previous analyses provide a basis on which to speculate about the relationship of DNA, a soluble chemical polymer, to the shape and proportions of the resulting entity. They focussed on what happened to the individual in the species. The methodology in this analysis focusses on the cell as a unit in the structure, a further extension of what may be called 'particle kinetics', as used in physics and chemistry analyses. The results suggest further observations and measurements to substantiate the new concepts which emerge.

Materials structures depend ultimately on tensile strength, which is resistance to deformation, and on elasticity, which is the property of recovering shape after deformation. The only part of a living system that has these properties is the cell wall. Resilience implies cross-linking of macromolecules in the cell wall. If this conclusion is valid, it is possible construct a feasible model as follows:

Structure is certainly related to DNA which determines the general form of the species. The structure of an individual must therefore be the result of an interaction of its DNA with its cell walls. Organs such as heart, liver etc must also have cell walls characteristic of the individual, but they require additional input to differentiate them from each other, and allow damaged cells to be replaced. It is cell walls that form three-dimensional structures. They must be asymmetric, because symmetry would produce diamond-like regularity. Each wall of a cell could differ in area and in 'inside' and 'outside' properties. Back to back cell generation i.e. building a new cell on the wall of another would generate mirror images, but cells separated from the matrix would not necessarily show this because they are free to rotate e.g. under the microscope or in a body.

Cell walls contain information and memory, because they have been observed to regenerate *in situ*. The information and memory must be imprinted on cell walls at the earliest stages of the embryo, and passed on to later cells generated in the growth process. This is the information which determines shape and proportions, the limits to growth, and it may develop from the egg membrane which is the only 'structural' feature at conception. The special properties of stem cells may be that they have walls which are not yet interactive. If this is so, there must be a process of growing the cell wall for division, which also has a bearing on its properties. The cell wall is not simply a semi-permeable membrane or a protective covering, though it may of course perform both functions. If these components also change with the quality and age of the sperm and the egg, it is possible that they may play a part in determining the eventual physical structure of the organism.

In this model, cell walls must be very complex internally if they are to possess both stereochemical and physical attributes. It seems likely that they may be constructed of helices to account for their material properties of extension and retraction; linear molecular strain would not be enough. But they must also have the stereochemical specificity to allow interaction with their individual's DNA. If cell walls contain genetic information, they may also gather mutations like the DNA within the cell,

both those present at the embryonic stage and those produced later. This would probably affect all cells generated from them as a template. The alternative to having information contained within cell walls would be that it is relayed by some mobile entity e.g. in bloodstream. Even then, there would have to be detectors at the cell to receive the required information and communication to the central memory of the system, wherever this was located.

A coherent living entity must have some overall connection which links all structural parts together i.e. the parts must be linked to the whole to function as a system. The obvious conduit for this is the network of all cell walls. The conclusion is that cell walls must therefore have the physical and stereochemical structures to link all cells in that individual; they are not just semipermeable membranes or containers. A living entity then grows to the size which the network of cells, or skin, can accommodate. Similar effects would then occur at the level of the subsystems or organs within the entity. Somewhere in this system there must be a clock by which the processes are synchronised. This would presumably have to be based on the rates of chemical processes within cells, because there is nothing else, unless of course there are also chemical processes going on in cell walls too. Cell walls seem to become less resilient with the age of the individual, which may give a clue. This might also involve oxidation, which is known to reduce the resilience of synthetic polymers because it causes cross-linking of the macromolecules by free radical processes.

There are enough degrees of freedom in this system to allow the differentiation between individuals on which natural selection operates. The criteria of selection vary with the local environment i.e. from time to time and place to place. But natural selection is not trying to 'improve' living entities. What is optimum at one time in any place may not be optimum at a different time. Defunct species might have done very well in environments which occurred after they became extinct. It is a matter of chance. A new species is formed when a line of progeny emerges of individuals with enough coherent new structural features for natural selection to differentiate them as a group from the 'home' species. With the passage of time, individuals in the new 'species' begin to diverge from each other in their turn. Species are not homogeneous through time.

18. Stem Cell Discussion at the Royal Society Summer Exhibition 2013.

It seems to be established that the nature of surfaces is extremely important in determining the function to which stem cells, become 'committed'. In that case if surfaces are a controlling factor in growing stem cells on a plate, this must also apply to stem cells in the embryo, where the only surfaces are the inside of the embryo membrane and the outside of the other stem cells. The corollary would be that stem cells from the embryo may operate differently from stem cells embedded in tissue. The corollary is, if you want to grow 'uncommitted' stem cells, use the lining of an embryo or the equivalent biomimetic film as a substrate. It also seems likely that the influence of the substrate may depend on the particular wall of the stem cell with which it interacts through contact. If you turned over the cell to a different face, you might get a different result. If you carried out the growth in suspension or a stirred medium to avoid contact with surfaces, you might get a different result again.

It is difficult to see why stem cells should live much longer than other cells when they appear to be identical in tissue. If stem cells became 'committed' at the differentiation stage of the embryo, they could be interpreted as meaning that they acquire an additional factor, say a coating, which carries the essence of a stem cell. If this transferred from cell to cell to carry out its 'committed' function, it would always be associated with a young cell. The cell from which the coating was taken would function and die at the usual rate, but the population of stem cells would not diminish, and they would have an apparently longer life. In such a scheme stem cells which are extracted from organs would always be 'committed'. This assumes that the generation, living and death of cells are parts of a different process, which carries on without the stem cell coating. It is also possible that stem cells become 'committed' by contact with the surface of tissue cells which are already differentiated.

Homeostasis is the state in which differentiated dead cells are replaced by the action of stem cells i.e. the number dying equals the number being made. Presumably growth would occur when more were made than died. This implies some sort of process which has a diminishing effect on the difference between numbers being formed and dying when the entity is approaching full size.

There is a problem in understanding how stem cells per se know whether the organ to which they give rise is on the left or right of the body, or for that matter the front or the back. This must start with the cells in the embryo. Somewhere in the process, differentiation begins for unknown reasons. Cells learn one end of a structure from the other, and how to tell left from right of the final mammal. This must be settled at the very beginning, because these are the configurations which are transmitted throughout the growth process to the adult entity. As far as the ends of a structure of cells are concerned a mechanism can be formulated which depends on the anisotropy of the cell walls i.e. different walls of different sizes with different properties, being assembled back to back. They will always finish up with different ends, which become apparent when the baby separates from its mother.

However, it is more difficult to envisage what sort of mechanism could fix the left and right side of a foetus which is twisting and turning throughout its construction. How do our heart cells know that they should form the organ on the left hand side of the body, at least for almost all people, and how do cells know that they should be at the front of the body or the back?

For this I draw on my paper on cosmology that proposes a model in which the stuff of the entire Universe is constructed from an infinite cloud of particles of a single species, which I have called the ε-particle. In this model all ε-particles are spheres which have the same size as an electron but without the charge, and all spin on their axes at the same immutable rate. They are attracted to or repelled from each other by their spins, but that does not concern us here. What is relevant is that the axes of individual ε-particles in the cloud are randomly oriented. There is no preferential direction in the cloud itself, because the Universe can have no bias. However, as soon as an observer is introduced, then in whichever direction you look, half of the particles always seem to be rotating to the left and half to the right. This would still be true if the observer was in a different place; it is just that it would be a different half. It is the observer who determines which direction of spin is which, or in engineering terms provides the degree of freedom against which everything else can be aligned. It

is the spin of the ε-particles which determines what is left and what is right for the observer.

Far-fetched as it may seem, and I can see no alternative phenomenon which would encompass the whole animal world on Earth, the only phenomenon which can provide left and right motion irrespective of the observer is the direction of the Earth's rotation. Velocities and accelerations may be in any direction in space, and change from time to time, and from individual to individual. Magnetic fields can point either north or south, and may flip. Similarly, the axis of rotation provides a direction, but this is not unique because it has both north and south. If the axis were the determinant, you might expect the population to be divided into 'north' and 'south' individuals. By contrast the unique direction which every living entity on Earth has is the east, the direction of rotation which is illuminated by the Sun. The biological model would be that particles of genetic material in the embryonic sac were suspended in a liquid without the constraints of walls to give a degree of freedom, but as genetic strings they took on in some way an alignment parallel to the direction of rotation of the Earth's surface. The west of all living entities would be what they had left behind, and their east would be where they were going. This is not unlike the flow of air on the Earth's surface. As soon as the first structure began to be formed by the embryo's development, this would supply it with a degree of freedom which was fixed, whatever the subsequent orientation of the growing embryo. Everything anisotropic built on this basis would contain the directions of the left or right of the structure i.e. the foetus.

This would be a mechanism which did not apply to plants, because they are isotropic; they do not know left from right, but only gravity i.e. up and down, and the direction of the Sun, which might mean that they have no equivalent of the embryo stage.

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