CHAPTER 2 - SETTING UP AND USING MODELS

I. HOW TO SET UP MODELS OF THE PAST.

Science deals with present events and processes. This is not to say that it can never perform investigations relating to the past. For instance, a paleontologist might dig up an unknown type of bone. By looking at previously discovered bones, he decides that it is probably from a new type of dinosaur. Based on the anatomy of other known types, he draws a sketch of what he thinks the complete skeleton will look like. He publishes his work, along with his conclusion that the animal had bad breath and a nasty disposition.

Part of his work is scientific. He and others can test his hypothesis about the skeletal structure by digging up more bones. (An idea does not have to be right in order for us to use the scientific method - just testable.) However, there is no way to test the animal's breath or temper. The paleontologist has left science and gone to storytelling.

Visual # 2-1

Likewise, there are some aspects of the initial disorganization / initial complexity controversy for which we can devise tests, and others for which we cannot. As we have noted, there is no way we can test the identity or motivation of whoever or whatever started the whole process. Neither is there any scientific way we can find out details such as the names of the first humans, what they wore, or what they liked to eat. However, all is not lost. Using the ideas of initial disorganization or complexity, we can make testable predictions about things that would have occurred under one set of conditions but not the other, and vice versa.

Any comprehensive model of origins must deal with at least four major areas:

Visual # 2-2

(1) How matter and energy came into existence.
(2) How they developed from their initial condition to the present state.
(3) How life began.
(4) How it developed from its beginning to its present state.

Visual # 2-3

We can make testable predictions about a great many aspects of each of these. We cannot prove beyond a shadow of a doubt whether initial conditions were disorganized or complex, but we can see which model fits better with what we observe in the universe around us.

Following are just a few of the hundreds of predictions which follow logically from the initial complexity and initial disorganization models. These are grouped according to the four major topics above.

II. FIRST PREDICTION: ORGANIZATION OR DISORGANIZATION?

When we consider creation vs. evolution in terms of initial complexity vs. initial disorganization, one prediction becomes immediately obvious. It applies not just to the four major areas above, but to every branch of science.

A. INITIAL COMPLEXITY.

Visual # 2-4

Initial Complexity begins with the postulate that the universe began in a complex, organized condition. This leads us to believe that there has been a steady decrease in complexity throughout the universe. Thus, we expect to find a built-in tendency in matter and energy toward deterioration. Though there may be temporary local exceptions, we are looking for an overall trend.

B. INITIAL DISORGANIZATION.

Initial Disorganization leads us to believe that there has been a steady increase in complexity throughout the universe. There may be exceptions, but there should be an overall trend - a built-in tendency in matter and energy toward increasing organization.

C. ACTUAL OBSERVATION.

Visual # 2-5

Throughout nature, scientists have discovered a a universal trend toward deterioration known as the Second Law of Thermodynamics. (Remember, a scientific law does not make anything happen; it simply describes what *does* happen.) The Second Law tells us that unless forced to do otherwise by some external influence, energy tends to flow from greater concentration to lesser concentration. In other words, the universe is becoming less organized rather more so. In the language of physics, its *entropy* is continually increasing.

As the name "thermodynamics" suggests, the Second Law specifically applies to the flow of heat energy. However, since energy can be converted back and forth between different types (electricity to light, kinetic to heat, etc.), it applies to other forms of energy as well. In addition, since every chemical bond in the universe contains a certain amount of stored energy, the Second Law implies that the molecules held together by this energy also tend to fall apart as the energy escapes. Nature tends to move away from concentrations of energy toward equilibrium. Something may delay the energy from spreading out, but there is still a tendency for it to do so.

The Second Law specifically applies to *isolated* systems, those that do not allow energy or matter to move in or out. However, the principle of entropy increase applies equally well to *open* systems, those in which energy is allowed to enter or leave.

1. CONDITIONS NEEDED FOR ENTROPY DECREASE IN OPEN SYSTEMS.

Visual # 2-6

While the term "Second Law" applies specifically to isolated systems, the tendency toward increasing entropy applies to living cells as well as everything else.

a. Supply of Usable Energy. There must be a supply of energy coming into the system from outside – not just any type of energy, but energy in a form usable by the system.

As an example of an open system, consider a newborn baby. It needs energy to grow. However, it would not do any good to set off a bomb next to it. That would be the wrong kind of energy. The specific type of energy the baby needs is chemical energy from food.

b. Conversion Mechanism. There must be a mechanism to convert the supply of energy into a form usable by the relevant parts of the system. We can pile lobsters and steaks around a baby but they won't do it any good. Its digestive system is not yet mature enough to break them down into the proteins needed. Until it develops a proper conversion mechanism, the baby has to drink milk. It even needs a conversion mechanism to process the milk.

c. Pre-Existing Information. There must be a preexisting source of information guiding the increase in organization. Even with food and a digestive system, a baby needs a building plan – DNA – to put together new cell structures. Without DNA it will not grow. If the DNA is defective the child will be deformed or dead.

d. Entropy Increase at the Energy Source. Any open system is part of a larger system that also includes the energy supply. In order for entropy to decrease in the smaller system, it has to increase at least as much at the energy source. For example, a teenager uses a hamburger as fuel for growth. The hamburger came from a cow that ate plants that took in energy from the sun. The plant, cow, and teenager temporarily decrease in entropy as they grow, but the sun's entropy increases at least as much as theirs decrease. There is always a cost.

There is not a single documented case of either an open or closed system spontaneously increasing in organization apart from these conditions.

2. THERMODYNAMICALLY FAVORABLE VS. UNFAVORABLE PROCESSES.

Some processes are spontaneous, that is, they happen with no outside influence. Others require some sort of external influence. The difference has to do with the flow of energy.

Visual # 2-7

In any chemical process, whether in an open or closed system, there is an interaction between energy (enthalpy -- the heat absorbed or released by the process) and entropy. Chemists use the equation **$\Delta G = \Delta H - T\Delta S$** to describe this interaction. (The Greek letter delta, Δ, is used to represent a change in condition of the reaction.) ΔG stands for the energy absorbed from or released to the universe, ΔH stands for the enthalpy change, T stands for the temperature in Kelvins, and ΔS stands for the entropy change. If entropy increases, ΔS is positive; if it decreases, ΔS is negative.

Only when ΔG is negative, that is, when energy is released to the universe, does a process occur spontaneously. This can happen under three conditions:

a. ***Energy released, local entropy increases.*** If the process releases heat (negative enthalpy change ΔH) and the local entropy increases (positive $T\Delta S$) then both factors will be negative, giving a negative ΔG.
b. ***Enough local entropy increase to offset energy absorbed.*** If the process requires heat (positive enthalpy change ΔH) but the local entropy due to $T\Delta S$ increases more than enough to offset it, then subtracting the larger $T\Delta S$ still gives a negative result.
c. ***Enough energy released to offset local entropy decrease.*** If the local entropy decreases (negative $T\Delta S$) but the process releases more than enough heat ΔH to offset it, then the more negative ΔH still gives a negative result.

Entropy allows simple components of cells such as amino acids to come together spontaneously because they are *thermodynamically favorable*, that is, ΔG is negative in the above equation $\Delta G = \Delta H - T\Delta S$.

The more complex components of living things such as proteins and DNA are thermodynamically very *unfavorable*. (ΔG is positive in the above equation.) Entropy prevents these components from coming together spontaneously. They only come together if forced to do so by external circumstances. There must be a source of usable energy, a conversion mechanism, preexisting information, and a greater entropy increase at the energy source.

Because living cells meet all of these conditions, they can decrease in entropy for a while. Nevertheless, since they consist of matter and energy far out of equilibrium with their surroundings, they eventually fall prey to entropy and die. Thermodynamically unfavorable reactions stop abruptly. The tendency toward increasing entropy takes over and they begin to decay into simpler, more thermodynamically favorable substances.

3. INFORMATION VS. ORDER.

Visual # 2-8

Some advocates of the simple-to-complex idea say that the tendency toward entropy must not be universal, because order can increase in such cases as water turning to ice. The problem is that they are confusing information with order.

Life is orderly, but this is because of the information (assembly instructions) stored in DNA. Initial Complexity says that it was put there at the beginning of life; Initial Disorganization says that it must have been gradually added over millions of years. Now compare this to ice. When water freezes, the crystal structure does not gain any extra information. Whether liquid or solid, water is not a straight molecule with an oxygen atom in the middle of two hydrogens. Instead, as described by VSEPR (Valence Shell Electron Pair Repulsion) theory, the two unshared pairs of electrons on the oxygen atom deform the water molecule to about a 109° angle. Its shape is somewhat like Mickey Mouse ears with oxygen (negative) as the head and the two hydrogens (positive) as the ears. Ice crystals form as water molecules slow down enough for the positive hydrogen ends of the water molecule to link together with the negative oxygen ends. When this happens, the crystals form according to the structural information already present in the hydrogen and oxygen atoms.

This is not a violation of the principle of entropy. The decrease in the entropy of the water molecules as they link into crystals is offset by the greater amount of heat released to the universe. (See the third case above.) The overall entropy of the universe increases.

We can illustrate the difference between order and information as follows. Suppose we take a random assortment of 113 letters:

Visual # 2-9

VTERABUTSHEOLHGFOEHNWYTEHTSVDHEAONTIEVHL
STEHIDVOAVLDEHTUOIORSPEGELORSBOHILEDOERTO
NATBOELIMSOEAFRLINSTHENGNIHTVEGW

If we put them in alphabetical order it comes out like this:

Visual # 2-10

AAAAA BBB DDDD EEEEEEEEEEEEEEEEFF GGGG
HHHHHHHHHHH IIIIII LLLLLLL M NNNNNN OOOOOOOOOOOO
P RRRRR SSSSSSS TTTTTTTTTTT UU VVVVVV WW Y

The arrangement is orderly but it doesn't mean anything. However, when these same letters are arranged in a specific way, they say

Visual # 2-11

FOR GOD SO LOVED THE WORLD THAT HE GAVE HIS
ONLY BEGOTTEN SON THAT WHOSOEVER BELIEVETH IN
HIM SHOULD NOT PERISH BUT HAVE EVERLASTING LIFE.

This arrangement contains not just order but a great deal of information.

In order for a collection of matter and energy to form a living cell with all its complex parts, it must contain not just order but a vast amount of information. The information determines the specific pattern in which the cell's atoms are arranged into amino acids, proteins, DNA, and the like. This kind of specified complexity is exactly the opposite of what happens when chemicals are left to themselves.

4. CHAOS THEORY.

Visual # 2-12

In order to try to explain how information could arise despite the tendency toward increasing entropy, some look for support to Ilya Prigogine, Nobel Prize winner for his work in chaos theory. Prigogine received his award for devising a mathematical model which showed that under chaotic conditions, temporary local areas of order could occasionally develop. However, this has nothing to do with evolution.

a. Lack of Experimental Verification. This is only a mathematical model. Such a process has not been observed in nature. It's one thing to say something *can* happen, but quite another to say that it *does*.

b. ***Lack of Relevance.*** Evolution is supposed to involve the entire universe. It requires something far more comprehensive than Prigogine's model, which deals with chaos on a microscopic scale.

c. ***Instability.*** Since evolution requires a series of events to build one upon another, evolutionary changes would have to be stable. Those in Prigogine's model are not. The local areas of order are transient and break down quickly.

D. SUMMARY OF ORGANIZATION VS. DISORGANIZATION.

No scientist was present to observe the beginning of the universe. However, the concept of Initial Complexity leads us to predict the Second Law of Thermodynamics, verified through centuries of observation and experimentation. On the other hand, the concept of Initial Disorganization requires that we discard this law and look for some unknown process instead. Initial Complexity requires us to believe that the laws of nature were superseded only once, by an intelligent designer; Initial Disorganization requires us to believe that they have been violated countless times, whether by random chance or by deliberate action of the designer.

Visual # 2-13

It is not the job of the science teacher to force students to choose whether they believe in initial disorganization or complexity, but we can help them develop the type of thinking skills used in science to determine which of these options seems more more reasonable.

III. SECOND PREDICTION: ORIGIN OF MATTER AND ENERGY.

A. LARGE SCALE - THE UNIVERSE AS A WHOLE. *(Physics and chemistry.)*

1. INITIAL COMPLEXITY.

The initial complexity model and the theistic version of initial disorganization both lead us to believe that matter and energy came into existence because of an influence outside of the physical universe. (Who or what it might be is a question outside the realm of science and should be reserved for classes dealing with philosophical matters.)

Visual # 2-14

We would expect that natural processes by themselves could not cause new matter/energy to come into existence or old matter/energy to go out of existence.

2. INITIAL DISORGANIZATION.

The atheistic initial disorganization model leads us to believe that matter and energy came into existence through purely natural processes. We would expect that these processes could produce similar results at any time, and that matter/energy could probably go out of existence the same way.

3. ACTUAL OBSERVATION.

Remember that a scientific law does not make anything happen, but merely describes what happens. The Law of Conservation of Matter and Energy, also known as the First Law of Thermodynamics, has been confirmed for centuries. It tells us that matter and energy cannot be created or destroyed by any known process, that is, the total amount of matter and energy in the universe is constant. This naturally leads to the question of what caused the matter and energy of the universe to come into existence in the first place.

Visual # 2-15

a. The Eternal Universe Model.

Why could the universe could not be infinitely old? Remember that the Second Law of Thermodynamics tells us that the entropy (randomness) of an isolated system, such as the physical universe, continually increases. Working backward through time, there would have had to be a point at which the entropy of the universe was zero. Before that point, known natural laws would not apply. There had to be a beginning.

Visual # 2-16

b. ***The Quantum Universe Model.***

Many believe that the universe began when matter and energy popped into existence from nothing in the form of an almost infinitely dense point known as a *singularity*. This is then supposed to have exploded in a "big bang" which eventually evolved into the present universe.

Visual # 2-17

Where did the singularity come from? The First Law tells us that no known natural process could have produced it. However, some try to get around the First Law by appealing to quantum physics. This deals with particles that are smaller than atoms and have very little mass, such as protons, neutrons, and electrons. Large groups of them behave in an entirely predictable way. However, the behavior of individual particles can only be predicted in terms of probability, e.g., there is a 70% chance that a specific electron will have a particular energy or be in a specific location. Sometimes these tiny particles do not do what we think they are most likely to. They can behave in ways that seem bizarre.

Some physicists such as Hans Dehmelt and Stephen Hawking believe the universe began in a bizarre quantum event (Freeman, 1991, 56). They say that the singularity popped into existence by an unknown natural process, a quantum fluctuation from nothing that produced the "positive" universe in which we live and a "negative" one we cannot detect. Positive plus negative equals zero, so our universe is half of nothing.

This idea appeals to the infinitesimal size of the hypothetical singularity to try to apply quantum principles. However, it requires us to ignore its unimaginably large mass, consisting of all the matter in the universe. We can only ignore this mass if we discard all the observations of physics so far. Every experiment ever performed has shown that quantum unpredictability vanishes for objects consisting of large numbers of atoms. We must overlook the singularity's tremendous mass to try to make it obey the rules of quantum physics.

The quantum fluctuation hypothesis is a fascinating piece of storytelling, but it is not part of science. There is no way to test it. In addition, it goes against almost everything we've learned about physics.

c. ***The Oscillating Universe Model.***

Another proposed explanation for where the singularity came from is the "Oscillating Universe" model. Some try to get around the First and Second Laws of Thermodynamics by saying that matter and energy must have existed forever and have oscillated through an infinite number of "big bangs." Each big bang was supposedly followed by an eventual "big crunch" as it collapsed into another singularity. This exploded again, evolved into another universe, collapsed again, and so on. However, such a concept contradicts many of the observed laws of science.

i. ***The Law of Gravity.***

Visual # 2-18

Gravity would have to pull the whole universe back together each time.

The law of gravity can be written as $F_{grav} = \frac{Gm_1m_2}{d^2}$ where *G* is the universal gravitational constant, m_1 and m_2 are the masses of the objects, and *d* is the distance between their centers. The attraction between two objects decreases by the square of the distances between their centers. For example, if the distance doubles, the gravitational attraction is only one-fourth as strong.

Most astronomers believe the universe is between 7.5 and 15 billion light years across. It would take a tremendous amount of matter to produce enough gravity to pull it all back together. Try though they might, scientists have been able to detect only a tiny percentage of the matter needed (Gott & Rees, 1975. 365-376). There is nowhere near enough matter for the universe to collapse back on itself once, let alone an infinite number of times.

ii. Contradictory to Big Bang Cosmology requirement of 4-Dimensional Space.

As far as we can tell, we live in a 3-dimensional universe that can be measured in terms of length, width, and height.

Visual # 2-19

From our perspective on earth, the overall distribution of matter in the universe seems roughly the same in any direction. This might imply that the earth is somewhere close to the center of our 3-dimensional universe. However, because this might in turn imply that there is some special purpose to this planet, atheists say that the universe should look much the same in any direction, no matter where you look from (Humphreys, 1994, 86-99).

How could this be? After all, if you are standing at the edge of the universe and look toward the center you will see a great deal of matter, while if you look the other direction you will see nothing at all. Those who believe in the concept of Initial Disorganization respond that the rest of us don't understand - there is no edge. They say that the universe must be four dimensional so that it curves back on itself. According to this belief, light follows the curvature of space so that if you look far enough in any direction, you will see the back of your head.

This belief is based on the axiom we saw in Chapter One that says absolutely every physical phenomenon must be explainable by physical causes. In order for the universe to seem the same in any direction no matter where we look from, we must think of space in ways contrary to our experience. The axiom of four-dimensional space is necessary in order for the mathematics of a big bang to work. There is no way to test it. It must simply be taken by faith.

Visual # 2-20

As we saw above, the Oscillating Universe model requires gravity to pull all the parts back together. However, this is incompatible with the Big Bang concept. If there really was a four-dimensional big bang, there would be no center for gravity to pull toward. The universe would not collapse into another singularity.

iii . 2nd Law of Thermodynamics.

Even if there were enough matter to make the universe come back together, the Second Law tells us that the process could happen only a finite number of times, because a certain amount of heat energy would escape and be forever lost every time the universe went through a bang/crunch oscillation.

Though the amount of energy in the present universe is enormous, it is a finite quantity. Since the sum of any two finite numbers is always a finite number, no matter how many times we add the energy lost in an oscillation to the present amount of energy in the universe we still get a finite quantity. Yet if the universe had gone through an infinite number of oscillations it would have lost an infinite amount of energy. This is a physical and mathematical impossibility.

The universe had to have a beginning. The Oscillating Universe attempts to push it farther into the past, but it cannot avoid it. In fact, few scientists believe in an oscillating universe any more.

Visual
2-21

d. The Steady-State Universe Model.

Recognizing that an infinitely old universe would have long since reached 100% entropy and lost all its useful energy (the Second Law), some have speculated that new matter and energy must be continually coming into existence from nothing. Since we have never seen such a thing happen it is supposed to take place out in deep space where we can't observe it.

Those who believe this do so not for scientific reasons but because they want to do away with the need for a creator. They must discard the First Law of Thermodynamics, based on centuries of observation, in favor of an unobservable model. This is religion, not science.

The steady-state model has largely fallen out of favor. Even its former champion, astronomer Sir Fred Hoyle, has abandoned it in favor of a big bang operating under some sort of cosmic intelligence. He now calls himself a "non-Biblical creationist."

4. SUMMARY - LARGE SCALE ORIGIN OF MATTER AND ENERGY.

- There is no known process by which the matter and energy of the universe could come into existence in a complex condition.
- There is also no known process by which the matter and energy of the universe could come into existence in a disorganized condition.

Either model, Initial Complexity or Initial Disorganization, must be accepted by faith. There is no reason to require students to believe one or the other. What is most important from a scientific perspective is that they understand what the two models say.

B. ORIGIN OF MATTER AT THE ATOMIC SCALE - THE CHEMICAL ELEMENTS.

All known matter consists of atoms. It is commonly estimated that there are probably around 10^{80} of them in the universe. By analyzing the light from distant stars using *spectroscopic analysis*, scientists have estimated that about two percent, or 10^{78}, are atoms heavier than hydrogen. This is about a million billion billion billion billion billion billion billion billion atoms of elements other than hydrogen.

Visual
2-22

> Spectroscopic analysis: Each element has a different arrangement of electrons, causing each to emit a different spectrum of colors when heated (e.g., by a star). Scientists can analyze the colors emitted by a star to determine what elements are present in it.

We already saw that there is no known natural process that can cause matter to come into existence. For the sake of argument, though, let us suppose that all the hydrogen atoms in the universe began to exist through some unknown process. The question is whether natural processes could combine the hydrogen atoms into the 10^{78} atoms of more complex elements.

Visual
2-23

Atoms are composed of protons, neutrons, and electrons. Protons and neutrons are found in the *nucleus*, while electrons are located in *orbitals* around the nucleus. (An orbital is not a physical object, but a region of probability where the electron is likely to be.) The number of protons in the nucleus (the atomic number) determines which element the atom belongs to.

There are 90 known naturally occurring elements, ranging from the simplest, hydrogen (atomic number 1), to uranium (atomic number 92). Two more elements, atomic numbers 43 and 61, are not known to occur in nature but have been produced in the lab.

Since protons are positively charged, they repel each other. Two or more protons cannot stay together unless they are held in place by a mysterious force called the *strong nuclear force*. Neutrons contribute to this force in some way we do not understand. The number of neutrons determines the stability of every atom with two or more protons.

When we add the number of protons and neutrons, we obtain the *mass number*. This is often written as a dash and a number after the name or symbol of the element, such as hydrogen-2 or H-2, carbon-14 or C-14, and so on. The mass number tells us which *isotope* the atom is. Different isotopes have different degrees of stability, that is, they hold together more strongly. For instance, all uranium nuclei eventually decay into lighter elements but U-238 does it much more slowly than U-235. Thus, it is considered more stable.

1. INITIAL COMPLEXITY.

Visual # 2-24

Visual # 2-25

Since the universe is deteriorating, it must have come into existence in a more complex condition than it is now. With few exceptions, all the naturally occurring elements from hydrogen to uranium should have been present from the beginning. We would expect that natural processes would not be sufficient to assemble complex elements, especially those with very high atomic numbers, from simpler ones.

2. INITIAL DISORGANIZATION.

In the instants after a hypothetical singularity exploded in a big bang, the only particles of matter would have been protons, neutrons, and electrons. Since the protons would have been separated from each other as they came into existence, the only element present in the big bang would have been hydrogen, which has one proton. Heavier elements must have been produced by processes such as fusion and neutron capture either during the big bang or later, perhaps in the interior of stars.

Since so many of the universe's atoms are composed of heavier elements, these processes must be fairly common. It should be relatively easy to produce heavier elements by combining lighter ones.

3. ACTUAL OBSERVATION.

If we accept the idea that the universe began in the big bang, it is logical to wonder how the original nuclei with one proton each combined to have two, three, and so on all the way up to 92.

a. Big Bang Synthesis.

If the other chemical elements built up from the H-1 (protons) that would have been present in the big bang, there would have had to be a series of atoms with gradually increasing mass numbers. Scientists using sophisticated devices called *particle accelerators* have smashed together every possible combination of protons and neutrons at close to the speed of light to see what would result. They have been able to produce many isotopes, as shown below.

Visual # 2-26

Visual # 2-27

STABLE ISOTOPES

Name of Isotope	Atomic Number	Mass Number	Protons	Neutrons
hydrogen-1	1	1	1	0
hydrogen-2	1	2	1	1
hydrogen-3	1	3	1	2
helium-3	2	3	2	1
helium-4	2	4	2	2
NONEXISTENT		***5***	1	4
NONEXISTENT		***5***	2	3
NONEXISTENT		***5***	3	2

Periodic Table of the Elements

(IUPAC data)

1 H Hydrogen 1.01																	2 He Helium 4.00
3 Li Lithium 6.94	4 Be Beryllium 9.01											5 B Boron 10.81	6 C Carbon 12.01	7 N Nitrogen 14.01	8 O Oxygen 16.00	9 F Fluorine 19.00	10 Ne Neon 20.18
11 Na Sodium 22.99	12 Mg Magnesium 24.31											13 Al Aluminum 26.98	14 Si Silicon 28.09	15 P Phosphorus 30.97	16 S Sulfur 32.07	17 Cl Chlorine 35.45	18 Ar Argon 39.95
19 K Potassium 39.10	20 Ca Calcium 40.08	21 Sc Scandium 44.96	22 Ti Titanium 47.87	23 V Vanadium 50.94	24 Cr Chromium 52.00	25 Mn Manganese 54.94	26 Fe Iron 55.85	27 Co Cobalt 58.93	28 Ni Nickel 58.69	29 Cu Copper 63.55	30 Zn Zinc 65.41	31 Ga Gallium 69.72	32 Ge Germanium 72.64	33 As Arsenic 74.92	34 Se Selenium 78.96	35 Br Bromine 79.90	36 Kr Krypton 83.80
37 Rb Rubidium 85.47	38 Sr Strontium 87.62	39 Y Yttrium 88.91	40 Zr Zirconium 91.22	41 Nb Niobium 92.91	42 Mo Molybdenum 95.94	43 Tc Technetium [98]	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.91	46 Pd Palladium 106.42	47 Ag Silver 107.87	48 Cd Cadmium 112.41	49 In Indium 114.82	50 Sn Tin 118.71	51 Sb Antimony 121.76	52 Te Tellurium 127.60	53 I Iodine 126.90	54 Xe Xenon 131.29
55 Cs Cesium 132.91	56 Ba Barium 137.33	La-Lu 57 71	72 Hf Hafnium 178.49	73 Ta Tantalum 180.95	74 W Tungsten 183.84	75 Re Rhenium 186.21	76 Os Osmium 190.23	77 Ir Iridium 192.22	78 Pt Platinum 195.08	79 Au Gold 196.97	80 Hg Mercury 200.59	81 Tl Thallium 204.38	82 Pb Lead 207.2	83 Bi Bismuth 208.98	84 Po Polonium [209]	85 At Asttine [210]	86 Rn Radon [222]
87 Fr Francium [223]	88 Ra Radium [226]	Ac-Lr 89 103	104 Rf Rutherfordium [261]	105 Db Dubnium [262]	106 Sg Seaborgium [266]	107 Bh Bohrium [264]	108 Hs Hassium [277]	109 Mt Meitnerium [268]	110 Ds Darmstadtium [271]	111 Rg Roentgenium [272]	Cn Copernicium [285]	Nh Nihonium	Fl Flerovium	Mc Moscovium	Lv Livermorium	Ts Tennessine	Og Oganesson

57 La Lanthanum 138.91	58 Ce Cerium 140.12	59 Pr Praseodymium 140.91	60 Nd Neodymium 144.24	61 Pm Prometheum [145]	62 Sm Samarium 150.36	63 Eu Europium 151.96	64 Gd Gadolinium 157.25	65 Tb Terbium 158.93	66 Dy Dysprosium 162.50	67 Ho Holmium 164.93	68 Er Erbium 167.26	69 Tm Thulium 168.93	70 Yb Ytterbium 173.04	71 Lu Lutetium 174.97
89 Ac Actinium [227]	90 Th Thorium 232.04	91 Pa Protactinium 231.04	92 U Uranium 238.03	93 Np Neptunium [237]	94 Pu Plutonium [244]	95 Am Americium [243]	96 Cm Curium [247]	97 Bk Berkelium [247]	98 Cf Californium [251]	99 Es Einsteinium [252]	100 Fm Fermium [257]	101 Md Mendelevium [258]	102 No Nobelium [259]	103 Lr Lawrencium [262]

Only elements with atomic numbers below 93 are know to exist in nature.

STABLE ISOTOPES (continued)				
Name of Isotope	Atomic Number	Mass Number	Protons	Neutrons
NONEXISTENT		***5***	4	1
helium-6 *	2	6	2	4
lithium-6	3	6	3	3
helium-7 *	2	7	2	5
lithium-7	3	7	3	4
NONEXISTENT		**8**	1	7
NONEXISTENT		**8**	2	6
NONEXISTENT		**8**	3	5
NONEXISTENT		**8**	4	4
NONEXISTENT		**8**	5	3
NONEXISTENT		**8**	6	2
NONEXISTENT		**8**	7	1
beryllium-9	4	9	4	5
boron-10	5	10	5	5
boron-11	5	11	5	6
carbon-12	6	12	6	6
carbon-13	6	13	6	7
carbon-14	6	14	6	8
nitrogen-14	7	14	7	7
nitrogen-15	7	15	7	8
oxygen-16	8	16	8	8
oxygen-17	8	17	8	9
oxygen-18	8	18	8	10
etc.				

* Even though Helium-6 and helium-7 have been produced, the ratio of protons and neutrons makes them unstable so that their nuclei fly apart very rapidly.

Notice that there are no known stable isotopes of any element with mass numbers of five or eight. Physicists have tried every possible combination of protons and neutrons, only to find that any nucleus with either of these masses falls apart almost instantaneously (Fowler, 1956, 85). Since the big bang would have been expanding at extremely high speeds (some say faster than the speed of light), the chance of any two particles hitting together would have been much less than in a particle accelerator, where they are deliberately aimed at each other. Thus, there is no known process by which a big bang could use hydrogen to produce elements heavier than helium-4. Even if an unknown process could somehow get past mass number 5 to produce lithium-6 or lithium-7, it would stop again at mass number 8. Scientists have smashed together two of the most stable nuclei, He-4, only to find that the resulting nucleus falls apart instantaneously.

Visual
2-28

This is no trivial problem. No less an authority than Dr. George Gamow, who persuaded much of the scientific community to believe in the big bang, admitted that it is an unsolved problem for all the big bang models (Gamow, 1956, 154) Even if a big bang could temporarily smash together atoms with mass number 5 or 8, they disintegrate so fast that the explosion, expanding close to the speed of light, could not hold them together long enough to use them as building blocks for heavier elements.

Why make such a big deal out of these two numbers? Because our observation indicates that perhaps 99% of the matter in the universe consists of two isotopes, H-1 and He-4. In order to make all the rest of the elements in a Big Bang, we need to find ways to combine these two.

- If we put together two H-1 atoms, nothing happens. Two protons do not stick together unless there is at least one neutron present.
- If we smash together a H-1 and H-2, the resulting He-3 is extraordinarily rare, comprising only about 0.000138% of all the known helium (Gammel, 1998).
- If we smash together a H-1 and a He-4, the resulting nucleus has mass 5, which falls apart instantly.
- A He-4 smashed into another He-4 would produce a nucleus with mass 8, which also refuses to stay together.

There are no other possible ways to combine two of these nuclei. Using the raw material available throughout the universe, we are blocked at every turn from putting together any of the heavier elements.

In summary: Scientists starting with hydrogen have never been able to produce any stable element heavier than lithium-7. Every experiment that has produced very heavy radioactive elements (Lawrencium, Nobelium, etc.) has started with heavy elements such as uranium, not with hydrogen or helium. There is no known way to produce heavier elements starting from hydrogen.

b. Synthesis in Stars.

Visual # 2-29

Some have proposed that the elements heavier than lithium must been produced in the interior of stars by nuclear fusion. In fact, most courses in astronomy tell students that a star spends most of its life performing nuclear fusion, thereby turning hydrogen into helium. At the end of a star's hydrogen-burning phase, it is supposed to go into a "helium flash." During this hypothetical process, one of two things is supposed to happen: either two helium nuclei combine to form beryllium-8 (the unstable one that falls apart instantly), which for some unknown reason stays together long enough to combine with another helium-4 to form carbon-12, or else three helium nuclei fuse directly in a "triple-alpha" process to form the carbon-12. Somewhere in the process, some of the carbon-12 nuclei are supposed to capture yet another helium nucleus, resulting in oxygen-16.

There are at least three problems with this scenario: (1) the process goes against what we've discovered about the instantaneous decay of nuclei with atomic mass 8, (2) it has never been observed – indeed, even if it did happen it could not be seen from outside the star (Seeds, 1999, 251), and (3) atomic nuclei are so small (less than 1/100 of a picometer, or less than 10^{-13} m in diameter) that the chance of getting two to collide is extraordinarily small, let alone three at the same time. There is no evidence that it ever actually happens. It is simply a made-up story, invented to try to explain how to get past the mass-8 problem.

c. Synthesis in Supernovae.

Textbooks are full of many other hypothetical steps leading up to elements as heavy as iron (atomic number 26). For instance, carbon atoms are supposed to have combined into heavier elements which later decomposed, and so forth. Such processes would require temperatures measured in the hundreds of millions of degrees, hundreds or thousands of times hotter than what a star's normal conditions appear to be. As a result, many believe that most of the heavier elements, especially

Visual # 2-30

those heavier than iron, must have been formed when massive stars exploded in supernovae. These elements were scattered throughout space by the explosions, then recycled as gravity pulled the same clouds that had just exploded back together into new stars. The cycle has continued for billions of years, eventually producing all the elements found in nature.

Some of the problems with this scenario:

i. *Presence of metals in all stars.*

According to the initial disorganization model, the very earliest stars formed after the Big Bang but before the first supernovae took place. These should have been metal-free, consisting of nothing but hydrogen and helium. Since the most distant stars and galaxies were supposedly formed just a few hundred million years after the Big Bang, the light we now see from them should have been sent in our direction before any supernovae had time to take place. These should be the metal-free stars we are looking for. Yet it is common knowledge that while there are metal-poor stars, there are extremely few – if any at all – claimed to be completely metal-free.

ii. *Problems with recycling elements.*

The force of gravity drops off by the square of the distance between the center of two objects, as seen in the formula for the Law of Gravity where *d* represents the distance.

$$F_{grav} = \frac{Gm_1m_2}{d^2}$$

Stars contain a great deal of matter in a relatively small area, resulting in strong gravitational attraction and keeping the star together. However, as the distance from the center of the star doubles the gravitational force is only one-fourth as strong; a distance five times as great results in one-twenty-fifth the force; a hundred times farther results in one ten-thousandth the force, and so on. Now imagine that a star that was previously a few million miles across blows up in a supernova. In a short time its mass is spread over hundreds of billions of miles. The force of gravity between the atoms would be so weak that they would never come together to form a new star, but would just keep spreading through space.

iii. *Required conditions.*

Visual # 2-31

In order for the observed abundance of metals in stars to have come from supernova explosions, there would have had to be a first supernova some time after the big bang in order to produce the first heavy elements. This would have sent atoms of heavier elements spreading through space. In order for those atoms to then come back together into a new star, another supernova would have to takes place relatively close by, perhaps only a few light-years away. The shock wave from the second would have to collide with the material from the first, pushing it back together. Later, a third supernova had to create a shock wave that pushed the second back together, and so on.

Students should consider whether it is reasonable to believe that hitting an expanding cloud with a shock wave coming from trillions of miles away will make the cloud condense into a ball. They should also consider whether it is reasonable to believe that this process has happened to every single star we have ever observed.

4. SUMMARY - ORIGIN OF MATTER AT THE ATOMIC LEVEL.

Advocates of Initial Disorganization have proposed many scenarios about the origin of the elements found on earth and in space, but all of them are purely theoretical. There is no direct observation to support them, only a desire to find an a way to explain the elements without admitting that they could have been brought into existence in an already complex condition.

Remember that the number of atoms in the known universe is estimated at about 10^{80}, or a “1” with eighty zeroes behind it. Astronomers estimate that about 99% of the atoms are either Hydrogen-1 or Helium-4. This means that about 10^{78} (a million billion billion billion billion billion billion billion billion) atoms are NOT hydrogen or helium.

Visual # 2-32

- Those who follow Initial Complexity have to believe in one unexplainable event when matter and energy, including the heavier elements, were called into existence by a direct creative act.
- Those who follow Initial Disorganization must believe that an unexplainable event took place every time one of these atoms was formed – at least a million billion billion billion billion billion billion billion billion times.

Which is more reasonable?

Either way, known natural law is completely inadequate to account for the origin of matter and energy at the scale of the universe or at the level of atoms. Something outside the realm of known natural processes has to be responsible.

IV. CHAPTER SUMMARY.

Whether in a complex or disorganized state, there is no known process that could bring matter and energy into existence on either a large scale (the whole universe) or a small scale (atoms). Whether things went from complex to simple or simple to complex, something outside the realm of known natural processes has to be responsible for the origin of matter and energy.