104.5^{o} and 180^{o}: Two Critical but Unsung Cosmological Constants

Allen R. Utke

Abstract

"Our finely-tuned Cosmos", as characterized by a series of numerous, interrelated, intricately-balanced, mathematical, cosmological laws, principles, forces, fields, equations, and constants, is usually one of several major themes to be found today at the heart of any discussion of the relationship of science and religion. And, within that theme, the late 20^{th} century renascence of natural theology and the argument from design, are usually key sub-themes.

However, "the new cosmological story" now being told by increasing numbers of people in the science/religion community, and elsewhere, is invariably being told today predominantly from the pointed perspectives of "the new physics", astronomy, biology, neurological sciences, and genetics. Inexplicably, the role of chemistry, the oldest of the sciences, is usually underemphasized or even absent in that new story.

The author of this paper, a chemist, views such "oversights" as being extremely unfortunate. For, he contends that chemistry also has a major, contributory story to tell, and thus a key role to play, in defining the unfolding nature of "our finely-tuned cosmos".

In the paper, in support of such provocative contentions, the author begins by succinctly summarizing "the new cosmological story" as it is usually being told today. He then identifies what he maintains are usually "the missing chemical dimensions in that story, dimensions involving the critical but largely-unsung roles of electron configurations (patterns), the periodic table, chemical periodicity, chemical bonding, and the roles of carbon (C), water (H_2O), and carbon dioxide (CO_2) in the formation and sustaining of life in the Cosmos. After briefly explaining how "the missing chemical dimensions" can be added, to dramatically-expand and enhance" the new cosmological story", the author offers some personal observations and conclusions about what the contributory role of chemistry in that story may mean.

Biography

Dr. Allen R. Utke is Emeritus Professor of Chemistry at the University of Wisconsin Oshkosh. However, over the last 38 years or so, beyond his accomplishments in chemistry, he has extensively centered his professional activities, whenever and wherever possible, on using an interdisciplinary (re)unification of scientific, religious, philosophical and futuristic thought to help mold and even save the future. Overall, Dr. Utke's accomplishments as an interdisciplinary scholar have included authoring three international books, 22 articles, and 40 papers (many in foreign countries); developing 14 new interdisciplinary courses; making 80 radio and television appearances and giving more than 600 professional and public presentations; receiving two distinguished teaching awards, extensively based on his interdisciplinary teaching and research; and being the 1999-2000 President of the International Society for the Study of Human Ideas on Ultimate Reality and Meaning, centered at the University of Toronto. In 1995 and 1996, Dr. Utke received three Templeton Foundation Awards for the development of the first science/religion course and first science/religion speakers series at his university, and for the article titled "Michael Faraday's Concept of Ultimate Reality and Meaning", judged to be one of

the best recently-published articles on science and religion. Dr. Utke is co-chair of the LSI granted Synodical Task Force on Science and Religion, a project of the Evangelical Lutheran Church in America (ELCA), East Central Synod of Wisconsin.

INTRODUCTION

"Our finely-tuned Cosmos", as characterized by a series of numerous, interrelated, intricately-balanced, mathematical, cosmological laws, principles, forces, fields, equations, and constants, is usually one of several major themes to be found today at the heart of any discussion of the relationship of science and religion. And, within that theme, the late 20th century renascence of natural theology and the argument from design, are usually key sub-themes.

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[Note: The material to now be presented is extremely-complex. By necessity, the author will thus have to present it in a broad, over-simplified way. The reader therefore may wish to challenge the author to develop, document, and/or defend part or all of what is said.]

COSMOLOGY WITHOUT CHEMISTRY?!

In brief, "the new cosmological story", as it is usually being told today, begins with a non-visualizable, holistic "singularity" (a source of "oneness" and Super Reality) comprised of infinitely-dense and hot energy and/or light, no larger than a marble and possibly smaller than an atom, of unknown origin(s), which for some unknown reason(s) exploded in an unimaginable "Big Bang" about 13.7 billion years ago.

Within the first second after the Big Bang, the singularity instantly "inflated to trillions of trillions of times its original "size", before then continuing to expand and cool at a much slower rate. Simultaneously, the singularity "fractured" and formed a cosmic reality system comprised of "frozen" space; time; energy; a hot "soup" made up of numerous positive and negative, large and small, matter and anti-matter "particles", a la $E = mc^2$; four forces, including gravity, able to bind all forms of matter and anti-matter together; overarching cosmic tendencies toward forming both

complementary cosmic disorder (entropy) and order (negentropy); and numerous, overarching, interrelated, intricately-balanced, finely-tuned, mathematical, cosmological laws, principles, forces, fields, equations, and constants which, overall, defined and controlled the origins, nature, and unfolding of the new Cosmos.

By the end of the first second after the Big Bang, as the result of a series of complex processes, most of the large "particles" in the "particle soup" had disappeared, as had all of the anti-matter, and the remaining "particle soup" consisted of six kinds of negative and positive "quarks", and negative electrons and other leptons (structure-less "particles"). In the next three minutes after the Big Bang, with further cosmic expansion and cooling, the six quarks became three "up and down" quarks, which then combined in two different combinations to form a "particle soup" comprised of positive protons, neutral neutrons, and negative electrons, the three sub-atomic components of all yet-to-appear atoms.

By the end of the first three minutes after the Big Bang, with further cosmic expansion and cooling, the positive protons and neutral neutrons in the most recent "particle soup" combined to form a new "opaque particle soup" comprised of the first three elements to form, 77% hydrogen, 23% helium, and minimal lithium nuclei, and negative electrons.

About 300,000 years after the Big Bang, when the temperature of the expanding Cosmos finally dropped to 5500^{o}F, (half the temperature of the surface of the sun), the "opaque particle soup" suddenly disappeared as hydrogen nuclei combined with one electron each, helium nuclei combined with two electrons each, and lithium nuclei combined with three electrons each to form gases of the three elements comprised of "complete" *atoms*, with electrons *"orbiting"* around the nuclei. The "foggy" cosmos thus cleared, becoming the "transparent" Cosmos we experience today. In the presence of "dark matter", gravity then progressively coalesced the three gases into clouds, stars, "filaments" of stars, and galaxies.

In both larger, hot stars and also in cooler small stars, the former "particle soup" of positive nuclei and negative electrons reformed. However, all stars then became "stellar furnaces". In small stars, the hydrogen nuclei present "burned" (fused) to produce more helium. In large stars, hydrogen, helium, and lithium nuclei "burned" to produce 89 more varieties of larger elemental nuclei, before increasing nuclear instability stopped the process. Subsequent supernova explosions in large stars, and subsequent cooling of the debris, produced clouds of "stellar ash", comprised of recombined "complete" *atoms* of all 92 elements, with electrons *"orbiting"* around nuclei, throughout the cosmos. On cooled planets such as the earth, around second generation stars such as the sun, the 92 varieties of "complete" atoms began to combine in myriads of ways, via the formation of chemical bonds, to form millions of *molecules* and thus new forms of matter, including water (H_2O) and carbon dioxide (CO_2), the two molecules at the heart of the formation of life in the cosmos.

THE MISSING CHEMICAL DIMENSIONS

The author maintains that the first of two major missing chemical dimensions in the new cosmological story" just summarized comes into focus whenever a "particle soup" of positive elemental nuclei and negative electrons is cooled enough to coalesce and form "complete" atoms of elements, for example, at 300,000 years after the Big Bang, after supernova, in cool interstellar space, on a cooled planet, etc. For, at that time, a chemist knows that there is far more to

the story than to simply say that the incorporated electrons that result in a "complete" atom "orbit" around the nucleus! The second major missing chemical dimension comes into focus when atoms form molecules, via the formation of chemical bonds. For, chemists know that chemical bonds must obviously involve outer, orbiting electrons! Overall, it should be obvious that at these two points in "the new cosmological story", the story shifts from an emphasis on the formation and nature of atomic nuclei to an emphasis on the nature and behavior of "orbiting" electrons!

The author believes that the clearest way to fill-in the missing chemical dimensions may be to do so historically, beginning about 300 B.C.E. At that time, Democritus in Greece first postulated the existence of "atoms", although the idea never really took hold in history over the next 2100 years or so. However, in 1803 C.E., in England, John Dalton successfully revived the concept, proposing the existence of solid, marble-like atoms which differed in terms of their atomic weights and physical and chemical properties. In 1846, based on the changes in matter produced by the passage of electricity into matter (electrolysis), Michael Faraday suggested that atoms may actually be comprised of smaller positive and negative sub-particles.

In 1869, while studying the physical and chemical properties of the chemical elements known at the time, Dimitri Mendeleev, in Russia, accidentally discovered that when those elements were arranged in terms of increasing atomic weight, each element became a member of one of seven "periodic families", with each family divisible into A and B sub-families in terms of secondary properties. [Note: An eighth "inert" family with no A/B division was later discovered by others.] Mendeleev's discovery later became known as the periodic law. Mendeleev then devised an ingenious way to represent the periodic law graphically. That graph, largely unchanged to this day, became known as the periodic table. In general, Mendeleev arranged all of the known elements at his time in the periodic table in terms of their increasing atomic weights. But, he did so in a vertical as well as a horizontal way. Specifically, he vertically placed two of the seven A sub-families (later knows as groups) to the left of the table and the other five A sub-groups to the right. [Note: The eighth undivided family was later added to the extreme right.] Because they were all collectively related in various ways in-and-of-themselves, he placed all of the B sub-families collectively between two regions of A sub-families, forming a transitional "valley" in the table. He called the seven horizontal lines of elements which resulted in the table periods, and placed two additional periods of elements with similar properties collectively separately below the table. Overall, the periodic table turned out to be essentially rectangular, but with four distinct regions, higher sections to the left and right, a middle transitional "valley", and two periods below. Amazingly, Mendeleev then realized that the extremes in properties among the elements wer found to the left and right in the table, with a gradual change from "group to group" going either direction, with a "pause" in properties in the B sub-groups "valley". Interestingly enough, it would be another 50 years or so before it would be possible to explain why the periodic law and table "worked" in this way. Mendeleev never knew!

In the late 1800's, J.J. Thomsen and others in England discovered the positive and negative sub-atomic particles which Faraday had earlier predicted. They were called protons (positive) and electrons (negative). By 1911, their masses and changes had been determined by George Johnstone Stoney in Ireland, Robert Millikan in America, and others. In 1900, Max Planck in Germany discovered that the energy present in light and electrons, is "quantized" and is thus absorbed and emitted in only certain discontinuous values. To determine those values, he defined a cosmic proportionality constant which became know as Planck's Constant. In 1912, Lord Rutherford, in England, unexpectedly discovered that, contrary to previous thought, protons and electrons are not

evenly distributed throughout an atom but that the protons are to be found in a tiny, control "nucleus", with the electrons orbiting around that nucleus. Rutherford also determined that an average atom is about 10^{-8}cm in size and an average nucleus about 10^{-13}cm in size, making the atom about 100,000 times larger than its nucleus and thus comprised largely of empty space!

In 1913, in America, Niels Bohr claimed that negative electrons do not follow the classical laws of physics, and thus can orbit around the nucleus, in quantized energy levels, forever, without gradually losing their energy and then spiraling into the positive nucleus. He also claimed that electrons stay in their own energy levels unless promoted to higher levels by energy added from outside the atom. However, when they get a chance, they jump back down to their original levels, emitting the energy they previously absorbed, in the form of light.

In 1920, in England, Francis Aston used a new technique involving x-rays, to determine how many protons are present in the nucleus of any atom. That number became known as the atomic number of the element. The number of protons present in an atom also determined the number of electrons present since, overall, atoms are electrically-neutral. Up until this point in the 20^{th} century, electrons had invariably been viewed as if they were definitive particles orbiting the nucleus of an atom. However, in the 1920's, Erwin Shrodinger in Austria, and others elsewhere, began to view electrons as if they were actually standing waves, and thus clouds of negative charge, rather than particles. When the appropriate mathematics was added, this new approach in studying electrons became knows as quantum mechanics or wave mechanics. Solving the extremely-complex equations which resulted, produced values for four definitive quantum numbers which collectively defined the possible address, shape, size and spin of every electron that night be present in an atom!

Quantum mechanics and its conclusions are so complex that they are difficult to even summarize in a paper of this general nature. Overall, it night simply be pointed out that, in what night be described as a "quantum leap", quantum mechanics unveiled a far more complex and finely-tuned electron pattern (electron configuration) present in atoms than Niels Bohr had ever suspected. For Bohr had envisioned a pattern in which electron "particles" could be found in circular shells possibly comprised of circular "s, p, d, and f" sub-shells (possible order within order). However, quantum mechanics discovered a pattern of sub-sub-shells (orbitals) present within s, p, d, and f sub-shells, within shells (complex order within order within order!) And, it was also found that the orbitals, and thus any electrons within them, actually have four different geometrical shapes, depending on what sub-shell they are in. Only s electrons are spherical. The three orbitals in the p sub-shell are dumbbell-shaped at 90^{o} angles to each other. And, the five d orbitals and seven f orbitals are too complex geometrically to mentally-visualize or draw on paper without models. And yet, surprisingly enough, without the geometry included, the overall form of the cosmic electron pattern can be easily visualized or drawn on paper using only three, simple mathematical symbols n, n^2, and $2n^2$, where n is the number (1, 2, 3, etc.) of any major shell.

Once the cosmic electron pattern present in all atoms had been defined, a second "quantum leap" in understanding became possible. For, while electrons and electron patterns were unknown to Dimitri Mendeleev, it was soon clear in the 1920's that they were the fundamental basis of the periodic table and the properties of matter. In that regard, it was soon realized that Mendeleev had not only arranged the elements known in his time by increasing atomic weights but, unknowingly, also sequentially by increasing atomic numbers (number of protons in an atom's nucleus) and thus also

sequentially by numbers of electrons present in atoms. In any atom, those electrons present (1-92) always fill the cosmic electron pattern present in the same orderly way. However, the last electron(s) to be added become either outer s, p, or inner d, f electrons, depending on where the element is in the periodic table, with corresponding shapes. And, as one up to 92 electrons are added to the pattern, certain identical end-results begin to repeat themselves, albeit in different shells. Patterns within the overall pattern begin to develop, and the eight A sub-families, two to the left and six to the right, end up with 1-2 outer s electrons (to the left) and 3-8 outer p electrons (to the right). The B sub-family, transition elements to the left-center of the table end up with two outer s electrons and 1-10 inner d electrons. And the elements in the two periods below the table end up with two outer s electrons and 1-14 inner f electrons.

Actually, the situation is even more complex than just stated, but suffice it to say that the A sub-family elements in any vertical column, and the d and f elements in those regions and vertical columns have the same number of "outer" electrons, albeit in different shells, and thus similar physical and chemical properties because the "surfaces" of their atoms are thus similar. And, it should also be pointed out that as one moves across a horizontal period, from one end of the periodic table to the other, in either direction, from element to element, there is a gradual change from one extreme in properties to the other extreme, with a "pause" among the transition elements.

With an understanding of electron patterns as being the basis of the periodic table in place, yet another "quantum leap" in understanding occurred. For, a series of finely-tuned periodic trends (periodicity) came into focus in the periodic table, trends such as atomic size, attraction for electrons (electronegativity), the energy required to remove electrons from atoms (ionization potential), the

energy released when electrons are added to atoms (electron affinity), etc. For example, atomic sizes generally increase from right to left and from top to bottom in the periodic table.

When one combines the aforementioned three "quantum leaps" in chemical understanding, yet a fourth, almost obvious "leap", perhaps the most important of all, then comes into focus, almost in an epiphany sort of way. For, atoms are endowed with energy that dates back to the Big Bang, are thus endowed with eternal motion, and are thus continually colliding. If they "stick" together when they collide, new particles known as molecules result, and thus new forms of matter. The "stickiness" that holds two different or alike atoms together is often simplistically only referred to as being a chemical bond. However, in reality, any chemical bond which forms is actually the result of an initial, extremely-complex, interplay and then extremely-complex, finely-tuned balance struck between the pre-ordained and pre-determined atomic sizes, electronagativities, and six types of positive and negative attractions involved when the two atoms involved approach each other. [Note: Of course, all such factors and properties were actually the result of the more fundamental finely-tuned, ultimate cosmic laws, principles, forces, fields, equations, and constants that create, mold, control, and sustain reality.] Furthermore, when atoms collide, they obviously do so at their outermost surfaces, just as billiard balls do. And thus, it is the number and geometry of the outer electrons in the atoms forming chemical bonds which ultimately determines the type, size, shape, polarity, geometry, characteristics, and behavior of the molecules which form, and thus determine the properties of the new matter which results. Having said that, the author would contend that the periodic table is thus actually *the* icon of science! For, overall, it is a finely-tuned cosmic blueprint for understanding, explaining, and predicting the formation, existence, nature, and behavior of all matter in the Cosmos!

As a capstone to the historical story of matter just presented, it should be pointed out that in 1932, in America, James Chadwick used an "atom smasher" known as the cyclotron to discover neutrons, thus greatly advancing our understanding of the nucleus, atomic weights, isotopes, radioactivity, etc.

COSMIC CHEMICAL STARS

Hopefully, the author has now made his point that by adding the missing chemical dimensions to "the new cosmological story", usually told today without them, the information content of that story increases significantly. However, the author would also contend that the wonder, mystery, and awe content also dramatically increases. For example, among other things, we are usually told in "the new cosmological story", minus chemistry, that the first ten elements formed in the Cosmos were hydrogen (H), helium (He), lithium (Li), beryllium (Be), boron (B), carbon (C), nitrogen (N), oxygen (O), fluorine (F), and neon (Ne); that those elements and 82 more were distributed throughout the cosmos by supernova explosions; that H, He, C, and O comprise 99% of the Cosmos in terms of abundance; that H, O, C, and N comprise 99% of the elemental composition of life; that C is the "life forming element"; that water (H_2O), carbon dioxide (CO_2), formaldehyde (N_2O), hydrogen cyanide (HCN), and ammonia (NH_3) were critical molecular precursors in the formation of life, DNA, and RNA; and that water (H_2O) and carbon dioxide (CO_2) are the most important molecules of all because they not only help make the formation of life possible but then sustain it. But where is the connecting thread in such facts? And, why are H, N, and O key actors in the cosmic play, but C is the cosmic star? And, why are most of the molecules just listed key actors in the same cosmic play, but H_2O and CO_2 are the cosmic molecular stars?

To answer such questions one need merely invoke an understanding of the periodic table, as outlined previously. First of all, H and He form the top period in the table, and Li, Be, B, C, N, O, F, and Ne form the second period. H and He are unique among all of the elements, for a variety of reasons. For example, H, often called "the odd-ball" element is the most abundant element in the Cosmos by far; is the raw material for forming the other 91 elements; is the only element in which the majority of its atoms contain no neutrons; and is the only element whose properties allow it to be a member of several families in the periodic table, and, overall indicate that it should actually be found somewhere in the middle of the table. He is unique because it is the top element among the unique family of "inerts", the A sub-family to the extreme right of the table with eight outer electrons in their atoms. And so, the first period of elements in the periodic table, comprised of H and He, is collectively unique.

The second period is also unique. In the eighth A sub-family, Ne is an "inert" element. In the first seven A sub-families, the atoms of the top element in each family are the smallest, most electronegative atoms in the family and also have the highest electron affinities and ionization potentials. Also, all of the elements in the first two periods of the table have no d and f electrons in their atoms, unlike all of the elements below. And, while it may not be obvious, the periodic trends in the table (periodicity) confer specific uniqueness in several ways upon H, N, and O in the second period. However, the "mid-points" of those trends actually converge on C, making it the most "usual" element in the table. But, paradoxically, that fact actually turns it into the most "unusual" element in the whole table, uniquely-endowing it with the critical capabilities needed to form life (e.g., form chains and rings of its atoms; form "friendly", covalent bonds with most other atoms, but particularly H atoms; and form multiple, double and triple bonds, not only between its own atoms

but with those of nitrogen and oxygen as well.).

However, C can't form life all by itself. Fortunately, as mentioned previously, the periodic table also bestows specific unique, but also supportive, synergistic physical and chemical properties on H, N, and O! Overall, it's the cumulative properties of all four of these "unusual" elements, as they interact with each other in various ways, and several other elements as well, that allows life to form on the earth, and "probably" elsewhere as well. And, their life-forming uniqueness is the reason that "the four" comprise 99% of the elemental basis for life. As mentioned earlier, various molecules of "the four" can also interact in various, synergistic ways to play key roles in the formation of life, DNA, and RNA. However, water (H_2O) and carbon dioxide (CO_2) are the two "cosmic molecular stars" in that regard. For, they are not only key actors in the formation of life, but in sustaining it as well. Both molecules contain three atoms each, and thus, it should be obvious that other factors beyond molecular type (AB_2), must thus be responsible for their uniqueness and synergistic behavior.

At first glance, those values and their difference do not seem to be all that important. However, if either value were only slightly different, there would be no life in the Cosmos, and we wouldn't be here to state that fact! For, first of all, in the case of H_2O, the 104.5^o bond angle, and two additional pair of unbonded, second shell electrons on the O atom produce "bent" water molecules that have a positive H end and a negative unbonded electrons end, and thus molecules that can act as if they are tiny magnets. Any water molecule can thus potentially loosely bond to up to four other water molecules (with unique, secondary, inter-molecular bonds known as hydrogen bonds) depending on the temperature. And thus, water is a solid below 0^oC, a liquid at room temperature, and a gas above 100^oC. Those characteristics are "just right" to produce a hydrologic cycle on the earth, and possibly elsewhere, which can both produce and sustain life!

The ability of water molecules to collectively bound to themselves is also at the heart of more than 20 more "unusual properties" of water, properties which also collectively are involved in the formation and sustaining of life. For example, water "magnets" comprising liquid water can dissolve more other substances in the Cosmos than any other liquid. Water has therefore often been called "the universal solvent" and it is an ideal medium in which to conduct chemical reactions, in nature, the laboratory, or the Cosmos! In terms of fine-tuning, one molecule in about every 550 million molecules of liquid water spontaneously fracture (self-ionize) at room temperature to form H^+ and OH^- fragments, and this fact is the basis of the pH scale, a scale of acidity and basicity in water and its solutions.

Our discussion of water could be continued almost ad infinitum. However, as mentioned earlier, carbon dioxide is the second molecular star in the cosmic play of life, a star which can also act alone or synergistically with water. In that regard, CO_2 is a gas at room temperature, making it an inexhaustible, mobile source of carbon for life! For example, animals such as ourselves breath in oxygen, and CO_2 out as a waste product, while plants, which animals eat, synergistically breath in CO_2 and breath out oxygen! Water will dissolve CO_2 to form a weak acid known as carbonic acid, a fact not only important in expelling waste CO_2 from our bodies via the blood stream, but in producing carbonation in soda pop as well!

Again, as in the case of water, the role of CO_2 in forming and sustaining life could be discussed almost ad infinitum. Suffice it to say in closing, that, the weak carbonic acid solution present in our

blood forms part of a chemical buffer system that protects us constantly against possible surges in acidity and basicity in the blood that could kill us. And thus, CO_2 helps keep us alive every second we are alive! Overall, even from what little has now been said about H_2O and CO_2, it should now be obvious that, among the countless chemical bonds and molecules that exist, or could exist in the Cosmos, **104.5^{O} in water molecules, and 180^{o} in carbon dioxide molecules, are critical but unsung cosmological constants!**

WHAT DOES IT ALL MEAN?

When most people read or listen to "the new cosmological story", as it is usually being told today, it isn't long before they come face-to-face with a cosmic, conceptual, inferential conundrum. For it isn't long before one realizes, that if a finely-tuned Cosmos, the result of over 300 extremely-complex, intricately-balanced, mathematical cosmic laws, principles, forces, fields, equations, and constants is the *answer*, there must be an ultimate *question*? That ultimate question, of course, should be rather obvious, and it can be asked in a variety of ways. For example, did the Cosmos emerge from a singularity, and subsequent Big Bang, as the result of randomness, chance, and accident, or as the result of potential, plan, design, or a cosmic blueprint present before, in, or after the singularity? Did our Cosmos emerge as the result of prior pre-organization and pre-engineering, or did it self-organize itself, pull itself up by its own energy boot-straps, and then endow itself with life, consciousness, self-awareness, and thought as it unfolded? Is the obvious fine-tuning present the result of chance or a Cosmic tuner? Is the Cosmos a plan or an accident?

The missing chemical dimensions in "the new cosmological story" now being told, certainly dramatically expand and enhance that story in terms of its fine-tuning informational content. But, the chemical additions also dramatically expand and enhance the wonder, mystery, and awe content! The result is an increase in the desire, need, and even compulsion in most people to answer the ultimate question(s) just outlined. However, the author contends that the missing chemical dimensions also lower "the leap of faith" needed to reach an answer! In his own case, until convinced otherwise, the author has long opted for an answer of potential, plan, design, blueprint, designer, and tuner, and he thus endorses the recent renascence of natural theology and the renascence of the argument from design!

REFERENCES

None

The paper is based on the author's accumulated knowledge and understanding as a chemist.