SCI FI-ARIZONA
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Life As We "Think" We Know It

By
Michael McCollum

There is an old joke defining the Yiddish word *chutzpah* (when pronouncing the first syllable, pretend that you are gargling a bunch of marbles). You have chutzpah if, after murdering your parents, you throw yourself on the mercy of the court because you are now an orphan. Frankly, I never expected anyone to actually try that defense, but the Menendez brothers in California came close to making it work a few years ago.

When it comes to chutzpah, however, the grand champions of all time are the cosmologists. Cosmology is that branch of astrophysics that studies the origins and structure of the universe. No mucking around with little tiny pieces like planets, moons, stars or galaxies for these guys. Their goal in life is to swallow the entire universe in one big intellectual gulp. The thought that we mere mortals can actually comprehend anything as vast as the universe bespeaks a self-confidence bordering on maniacal. Talk about having a superiority complex!

There is one branch of cosmology that impresses me above all others. It is that group of cosmologists who use as their guiding doctrine something called the Weak Anthropomorphic Principle (WAP). Stated simply, the WAP asks the question, "Taking as a given that we are here to ask the question, what must conditions have been like in the early universe in order for human beings to exist?" In other words, what are the required limitations on the laws of physics that allow billions of years of stellar and organic evolution to culminate in *Homo sapiens*, without whom the question would be moot, at least here on Earth. How so? If there were no human beings on this planet, there would be no one around to ask the question.

If cosmologists as a whole suffer from an excess of overconfidence, the Weak Anthropomorphic Principle shows a self-centeredness that is breathtaking in the extreme. Do we really think that the end purpose of the whole grand firmament of stars and galaxies stretching for billions of light years in every direction is us? Well, actually, many of us do. We express our belief quite simply by saying, "In seven days, God created the heavens and the Earth..."

No, the WAP is not merely a scientific way of stating that "God made man in his own image." Instead, the WAP is a rather clever approach to taking a known fact and extrapolating backward in space and time to learn something about the way the universe is constructed. The known fact is that we humans do indeed exist. At least, we think we do. *Cognito, Ergo Sum! I think, therefore, I am.*

And given that we exist, what precursors were required to bring this very desirable event about? Actually, life in general and human beings in particular are the result of a long chain of fairly improbable events; so much so that many people feel that

the whole process could not possibly have taken place without the intervention of a supreme being. To these people, the very existence of humanity is all the evidence they need to prove the existence of God. And, frankly, who is to say that they are wrong?

The opposing view is that such reasoning is circular. For it doesn't make any difference how improbable an event the evolution of human beings is because we are obviously here. Whether the chances were a million, a billion, or a trillion to one against makes no difference. The fact that we are contemplating the problem at all indicates that we have won the lottery.

And in a universe of one hundred billion galaxies, each containing one hundred billion stars, probabilities on the order of a trillion to one against aren't that unreasonable. To understand this point, consider some physical process that is approximately as likely to occur as hitting a royal flush in an honest poker game. The universe is so large that there are several hundred million royal flushes occurring each second throughout the galaxies. How likely is it, then, that at least one intelligent species would evolve on one planet in the whole universe at some time during the 15 billion years since the Big Bang? Obviously, the likelihood is 100% because here we are.

So what are some of the things we can divine from our own existence? For one thing, we can calculate fairly precisely the bond strength between hydrogen and oxygen atoms. We know that the di-hydrogen-monoxide molecule (H_2O, or water) must have a particular strength and that its shape must be bent such that the hydrogen atoms stick to the oxygen to form an obtuse angle (approximately 106 degrees if I remember correctly). How do we know this? Because even a slight change in the hydrogen-oxygen atomic bonds would mean that water would contract on freezing like most other materials. And if water contracted when frozen (becoming denser in the process), all of the icebergs on the planet would sink to the bottom of the ocean and be trapped there, leaving not a drop of fresh water for us to drink. In fact, the Earth would be a desert with nearly all of its water trapped in submerged icebergs in the Arctic Ocean.

What of the strength of the strong nuclear force? Surprisingly, the allowable variation for this fundamental force is very small. Too much strong force and the atomic nuclei would be too compact for the electrons to orbit properly. The chemical reactions, which are the basis for life would not operate and we would all be dead. Too little strong force and atoms would not form at all. Thus, by noting that we exist, we can calculate the necessary value of the strong nuclear force that is required to ensure our existence.

I could go on for hundreds of pages this way, but frankly we don't have the time and I'm not that expert on the details of the WAP. All I do know is that when we think the problem through and do the math, we come up with a universe very like the one we live in. That is good because we would hate to find out that we don't exist after all.

We can take the Weak Anthropomorphic Principle and combine it with another of the basic tenets of science, the Universal Principle (UP). The UP states that the physical laws everywhere in the universe are the same as the ones we are familiar with. There are no regions where the gravitational constant, for instance, is twice what it is where we live. Nor are there any places in the universe where light travels through vacuum at half the speed it does locally.

Which brings us to a bright flash of insight! If the conditions of the universe brought forth human beings, then they might also have brought forth other intelligent species. And since we know how the universal laws of physics shaped our own evolution, we can

assume the same laws acted on all the alien races as well. In other words, we have a basis for estimating what form an alien being might take using the WAP and the UP as our basis for extrapolation.

And while this sort of thing is of interest to exobiologists and astrophysicists, it is a really useful thing to know if you happen to be a science fiction writer.

The Modern Book of Genesis:

In the beginning, God said, "Let there be light, and there was light!" A whole lot of light! Today we call this process the Big Bang, that moment 15 billion years ago when nothingness blew up and became somethingness. The cosmologists claim they can describe the process back to 10^{-22} seconds from Time Zero, which is why I stand in awe of their self-confidence.

At first it was too hot for anything to exist but radiation. After a time, however, the superheated energy cooled and subatomic particles formed. Later, the universe cooled again, allowing these particles to coalesce out into atoms, which in turn clumped together under the force of mutual gravitational attraction to form stars. The stars condensed into galaxies, which in turn formed clusters of galaxies, and then superclusters of galaxies.

None of the stars that formed during this time were our sun. These stars were poor in elements, consisting almost entirely of hydrogen and helium. The heavier elements were absent and the universe was a very simple place. For billions of years, not much happened while the first generation stars cooked up all the elements from lithium to iron in their stellar furnaces.

Then these precursor stars began to run out of fuel. Many of them collapsed inward at the instant their furnaces ran short of hydrogen, collapsed inward and then exploded outward in titanic supernova explosions. These had two beneficial effects. First, they seeded the interstellar medium with all the elements below iron in the periodic table. Secondly, in the instant of death, temperatures within the stars reached levels hot enough to synthesize everything from cobalt to plutonium.

Eventually new stars coalesced from the enriched interstellar gas left over from the dead first generation of stars. These second-generation stars lived and died explosively, too, further enriching the interstellar gas. Then, some five billion years ago, an inconspicuous third generation star coalesced out of the detritus of destruction. We named this tiny star, Sol, or simply call it "the sun." Nor was it alone in the firmament. Nine planets of various sizes also formed from the great gas globule and took on distinctive characteristics determined by how close they circled the central furnace.

The lifeless lump of rock circling in the third position out from the sun had a nitrogen and ammonia atmosphere a few billion years after its formation, and a sea of complex hydrocarbons dissolved in water. The modern term for this mixture is "smog," and the early Earth had a smog problem that makes the worst day in Los Angeles seem like the best in the Rocky Mountains. To this mixture was added energy in many forms -- heat energy from the sun, electrical energy from lightning bolts, impact energy from numerous collisions with the space debris that still cluttered the early Solar System. Slowly the primordial soup began to change color. It grew darker as ever-longer molecules were hooked together by the constant cooking. At some point one of these long amino acid molecules attained the ability to replicate itself and life was born.

It wasn't "life as we know it," of course. For one thing, the Earth's atmosphere in that age was still what we would consider to be highly poisonous. There was no free oxygen, but life flourished anyway. It as a strange anaerobic kind of life, a series of organisms that are now largely extinct save for the gangrene bacteria and a few others.

The reason they are extinct lies in a mutation that happened a couple of billion years ago. There came into existence one particular organism that was a different color from all the others. Where the predecessor life forms were a pale, transparent white, this new organism, still transparent, was tinged with a substance that reflected visible light near the middle of the spectrum. Nor was its color the only thing that set it apart from its neighbors. For this organism exhaled a deadly poison so reactive that it killed everything with which it came in contact. Slowly the atmosphere came to be filled with these poisonous fumes until they comprised nearly 20% of all the free gas molecules on the planet. Today we give these organisms and their deadly byproduct names. We call the organisms "plants" and the corrosive stuff they exhale is called "oxygen."

Because their exhalation byproducts killed virtually every other living thing on Earth, these first plants grew apace, turning the seas a soupy green color. And over millions of years, single cell animals appeared. Living as they did in the highly deadly oxygen atmosphere, they learned to incorporate that oxidizing molecule into their own chemical processing chain. In fact, it soon came to be that the "animals" needed free oxygen (or at least oxygen dissolved in seawater) to survive.

The microscopic organisms grew bigger, grew fins and tails, and eventually crawled out onto dry land. There they prospered, going through many ages until they were nearly as big as a house and covered with scales. For nature, having invented the cockroach, turned to something a bit more ambitious. She created the dinosaur. There things remained for millions of years, and might still remain had it not been for an Act of God.

Some 65 million years ago, a ten-kilometer (6-mile) rock fell from the sky onto what is now called the Yucatan Peninsula of Mexico. That rock arrived moving some 30 km/sec (18 mi./sec). When it hit, it dissipated between 500 million and 1 billion megatons of energy. The resulting cataclysm roiled the seas, burned down the forests, and blackened the skies for years. When it was over, the dinosaurs were dead, leaving in their place small rat-like creatures covered with hair. We call these creatures "mammals," and they are our distant ancestors.

Without the competition of the great reptiles, a competition they could never have won on their own, the mammals thrived. They grew large. Some became elephants, others lions, others apes, and eventually, some became "men." These new humans were not very impressive by the standards of their neighbors. They lacked tooth and claw, and frankly, couldn't have fought off a determined hyena by themselves. As individuals they were largely defenseless and inexpert hunters. In fact, a few million years ago, something chased them out of the trees, their homes, and down onto the savanna where the lions lived.

But they learned to cope. They began to hunt in packs, which in turn caused them to develop rudimentary language for coordinating their attacks. Being basically defenseless, they learned to use tools and make weapons, and this development in turn increased the size of their craniums. Soon they were growing plants rather than gathering them, herding animals rather than hunting them. Somewhere along the way they invented cities and then science. Eventually, billions of years after the Big Bang, one of them scratched

his hairy head with a hairy finger and asked, "What sort of universe must it be if I am here to ask this question?" Humanity, it seemed, had finally developed the Weak Anthropomorphic Principle.

That then is the modern story of Genesis, and every bit as exciting as the ancient version you learned in Sunday school. Whether you ascribe the creation of humankind to an act of God, or the culmination of billions of years of probability theory, you must admit that the process is an intricate one. Still, if it worked once, why not again? In an infinite universe, shouldn't there be an infinite number of similar stories? Let us assume that we are not alone. What are the basic principles that will shape a race of intelligent aliens? Basically, they are the same principles that shaped all of the species on Earth. The UP mandates it.

So before we look at alien possibilities, let us look at the wide variety of life on Earth. That is, after all, where most science fiction writers find their aliens.

The Long, Intricate Process That Culminated In Me!

Back in the 1970s, Erik Von Dannekan and several other authors made a pile of money by postulating that the Earth was visited in ancient times by alien spacecraft. Some of these authors went so far to suggest that we didn't evolve on this planet at all, and that we are the descendants of shipwrecked spacemen. If you just got a blindingly brilliant idea for a science fiction story, namely that the entire human race is descended from two space castaways named Adam and Eve, forget it. It's been done a million times, including a *Twilight Zone* episode starring Richard Basehart about 1960.

While I have no objection at all to writers getting rich, I must say that the idea that we evolved somewhere else strikes me as just plain silly. All we know about life on Earth tells us that we are all relatives of one another. That is the basis for the Gaea Principle, the belief that Earth is one giant organism. (Personally, I think that is silly too, but at least it's better than the Ancient Astronaut Origin theory.) When I say that we are all related, I mean *all of us!* Be the organism human, ape, monkey, equine, bovine, canine, lizard, crustacean, fish, mushroom, or oak tree -- we all stem from a common ancestral base. Oak tree!!?? That's what I said. The only difference between you and an oak tree is the way in which your chromosomes and various amino acids are arranged.

There are several observations that make scientists believe that all life on Earth has a common origin. One that I find most convincing is that we are all left handed (in a manner of speaking). If you have ever taken advanced chemistry, you know that the more complex molecules come in different varieties, called isomers. That is, the chemical formula is the same for the two forms, but the shape of the molecule is different. If this seems a difficult concept to visualize, try a simple experiment. Look at your hands. What you see are two objects that appear to the casual observer to be identical. There are the fat parts from which five digits extend. One of the digits, the thumb, is shorter than the others and fully opposable. Only after a moment do you realize that the two are not identical. In fact, they are mirror images of one another. If you are ever in an accident where both your hands are cut off, the last thing you would want is for the doctor to reattach the left hand to the right wrist, and vice versa.

Isomeric molecules are like that. They are asymmetric (having more atoms on one side than the other, making them lopsided), and in some cases, where you attach a

particular atom makes a difference. For instance, we all have bottles of isopropyl alcohol in our homes. Presumably there is a molecule called propyl alcohol which has the same formula, but which is put together slightly differently.

What has this to do with life on Earth? Simply this. All life on Earth consists only of left-handed isomeric proteins. This is significant because any non-life process that produces organic molecules (such as lightning bolts in the primordial soup of the early Earth's atmosphere) will produce equal numbers of right and left handed isomers. Logically then, there is a fifty percent chance of life on Earth being right handed (chemically speaking) or left handed. Therefore, if the diversity of life on Earth were the result of independent parallel evolution, approximately half the plants and animals would have right-handed organic molecules and the other half would have left-handed molecules. The fact that all of our proteins are left-handed indicates that there was probably one single organic molecule from which we are all descended. (Note: While proteins are all left-handed, sugars are all right-handed. This complicates the picture, but does not change it. Any sugars that form from non-organic processes will be 50% right-handed and 50% left-handed. This could prove quite useful, as we will see next.)

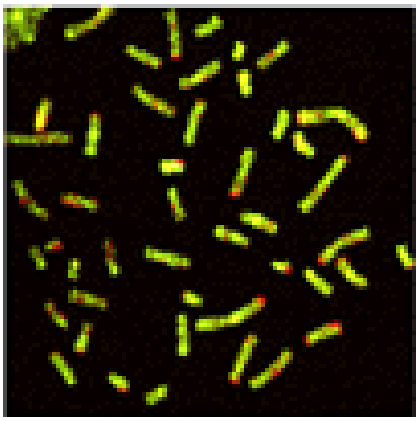
Does this have any practical application in everyday life? You bet! For several years now the chemists have been working on a substance called left-handed sugar. It is the isomer of sucrose, the white powder we keep in our sugar bowls. The chemical name for left-handed sugar is lepto-sucrose (or possibly iso-sucrose, since I am not a chemist). Because lepto-sucrose has an oxygen atom attached at a different place than the regular sucrose, it is sufficiently close to the real thing to fool your taste buds, but totally non-nutritious. In other words, it's sweet, but has no calories, and can be used in cooking such things as calorie free chocolate doughnuts! There, I thought that would get your attention.

As for the relatedness of animals and plants, there is a fact I believe I learned while attending a summer science camp in 1963. I say that I "believe" I learned it because I have never been able to confirm it. If true, however, it points to a strong relationship between the Earth's plants and animals. Animal blood consists of many things, but chief among them is an iron-based molecule called hemoglobin. It is the iron in the hemoglobin that makes blood red. Plants, on the other hand, rely on a magnesium-based molecule called chlorophyll, which they use to turn solar energy into carbohydrates and other "food" molecules. The fact that I believe I learned was that hemoglobin and chlorophyll have almost precisely the same molecular structure, except that everywhere hemoglobin has an iron atom, chlorophyll has a magnesium atom. The thought that both are similar in structure would tend to indicate that one is descended from the other, and ultimately, that animals are the descendents of plants.

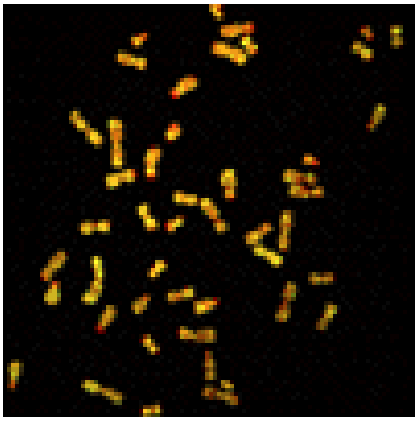
What other things make us believe that human beings and all other life on Earth evolved from a common source? Well, there is Darwin's Theory of Evolution. As I have noted before in this series, many people aren't comfortable with the idea that humans are descended from apes. Actually, of course, the apes and we are descended from a common ancestor.

Obviously, if humans evolved on some other planet, they would have no genetic tie to the apes or any other animal on this planet. Unfortunately for disbelievers in evolution, we have delved quite deeply into the genetic makeup of both humans and apes, specifically chimpanzees. What we have discovered is that our gross physical similarities

are no accident. Chimpanzees (and other apes) have 48 chromosome pairs whereas humans have 46. This would be comforting to the "I'm not descended from no apes!" crowd except that scientists have identified one of our chromosomal pairs as being the fused remains of two ape pairs. Actually, there is only a 2% difference in total nuclear DNA between humans and chimpanzees. No need to take my word for it. See for yourself. Below are two pictures of the chromosome patterns of humans and chimps. The differences appear in red and the similarities appear in green. They look pretty similar to me.



HUMAN DNA



CHIMPANZEE DNA

What other clues are there to the fact that humans evolved on Earth? Well, there are our eyes for one. The degree to which light bends as it passes through a lens is determined by its wavelength. That is one reason why, when you pass white light through a prism, the light comes out spread into a full color spectrum. Thus, it is impossible to precisely focus all of the light onto the retina of the eye. One color will be in sharp focus while all the others will be slightly out of focus.

Physiologists have long noted that the human eye is designed to operate on yellow-green light, the precise shade that comes from having yellow sunlight shine down through the leaves of a forest. Obviously, if we had evolved under either a blue-white or a red star, our eyes would be designed to see in the wavelengths put out by those stars. Since we are evolved to see forest shaded Sol-light, then we have a strong indication that we are at home.

Nor is our vision the only clue to our origins. There are literally hundreds of details about our bodies that strongly suggest that our present star is also our home star. Little details like the relative density of melanin pigmentation in our skin tell us not only which star we evolved under, but also where on the planet our ancestors dwelt. Those who lived near the equator in sunny climes have darker skins, while those who evolved under perpetually cloudy skies in northern climates have lighter skins. This variation in pigmentation that gives us so much social stress is really just a handy environmental adaptation based on the varying amounts of Sol-light that our ancestors were exposed to.

Interestingly, it is only in the last couple of years that we have identified the mechanism that drives skin color. It seems that there is a hormone in both women and

men (not necessarily the same hormone, by the way) that relates to fertility. To properly synthesize this hormone, the body needs a certain amount of ultraviolet light to shine through the skin and illuminate the blood. Too much or too little UV in the blood will make you less fertile, and the degree of UV light that comes through the skin is regulated by the melanin density. This is why people come in different colors, and why the skin color of individuals varies with exposure to sunlight. Too little, and your skin lightens; too much, and it darkens in a process known as "getting a tan." It's all a scheme by your chromosomes to reproduce themselves!

Some Unifying Principles for Terrestrial and Extraterrestrial Living Things

So by observing life on Earth, we can derive some unifying principles that we can apply to designing our aliens. These principles are:

Form Follows Function

Unlike Baroque and Rococo artists, Mother Nature doesn't decorate things for artistic reasons. Whether it is a fish or dolphin slicing the waves, a bird flying overhead, or a pretty girl walking down the street, every single physiological feature has a distinct purpose in nature. The form of an animal, therefore, is determined by its function. If it must slice through dense liquid like a fish, then it will be streamlined like a fish. If it must soar through a thin atmosphere, then it will have large area wings and a lightweight body. In all probability, its bones (if it has any) will be hollow and its strength-to-weight ratio large. If it is designed to bring forth its young alive and provide them with nourishment for months or years, then it will have wide hips and breasts. Granted, they may be arranged differently than human females, but they (or some analogous structure) will exist.

One Intelligent Alien Implies A Whole Mess of Others and A Complex Ecology Somewhere

You see a lot of science fiction stories where the aliens seem to have been created whole from out of thin air a few seconds before the story began. This cannot be. Just as the evolution of human beings started a couple of billion years ago, so too the evolution of aliens. Even if you don't see them in your story, the aliens must have families, a civilization, and an entire planetary ecology at home to back them up. Think of what that means in terms of our own lives. When we go out into space, we will probably take our dogs, cats, parakeets, cockroaches, boa constrictors, mice, rats, and microorganisms with us. So will any aliens your heroes happen to meet.

Look At the Eyes, Stupid!

The aliens have been raiding your outpost for months now and you don't know where they live. You've captured a few alien bodies, but they don't give you any clue to the location of the enemy home world. Hey, look at the eyes, stupid!

As was noted above, our bodies are literal signposts to the location of our home star. We see best in rays cast by a G2-class yellow-dwarf star, we're sensitive to certain types of radiation, and our muscles are precisely designed to withstand a gravitation acceleration of 9.8 meters per second squared (32.2 ft per sec squared). How many more clues to the location of the Earth do you think the aliens would need?

No, when designing an alien, ask yourself what sort of star his race evolved under. If it was a red giant, then give him large eyes about twice the size of ours, with pupils that can open up for good low light vision. If he lives under a blue-white dwarf star, then give him small eyes with needlepoint pupils. Whatever his eyes are like, they must be evolved to see in the wavelengths put out by his parent sun. A big-eyed being with huge pupils that hunts during the day on a world surrounding a B-class blue-white supergiant will not be a threat to your crew of Galactic Rangers. They will all have had their retinas (or whatever they use as a substitute) burned out before they leave the nursery.

Life Is Aggressive

All life is based on aggression. No, I'm not being paranoid, merely stating an obvious fact. Carnivores hunt herbivores to survive and attack any other carnivore that trespasses on their hunting grounds. Herbivores are less aggressive, but not total pacifists either. Why else would an animal that eats grass need those long, sharp horns you find on bulls of many species. Even plants are aggressive, spreading their canopies upward to the sun, smothering everything that operates on chlorophyll that lives below them.

So if your happy crew of space adventurers happens across a race of intelligent aliens, you can expect the sparks to fly. True, the aliens may have evolved beyond their ferocious past, they may have developed along the pathways to eternal peace, but down somewhere in their insides lies a snarling animal anxious to get out.

As a rule, altruism has never been a survival characteristic in the biosphere of Earth. Nor is it likely to be on any other inhabited planet in the universe.

Conclusion

What we have learned in this article will be the basis for the next, in which we will design a few aliens. Remember that life on Earth is complex and amazingly varied, yet built on the same foundation. It is therefore likely that we will find the same situation on alien planets we visit. Still, as we shall see, there is a strong likelihood that intelligent aliens will be built on approximately the same pattern as us. Which is good because it means that Hollywood will be able to continue filling their monster suits with people.

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Michael McCollum, Proprietor
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NOVELS

1. Life Probe - ^{US}$5.00

The Makers searched for the secret to faster-than-light travel for 100,000 years. Their chosen instruments were the Life Probes, which they launched in every direction to seek out advanced civilizations among the stars. One such machine searching for intelligent life encounters 21st century Earth. It isn't sure that it has found any...

2. Procyon's Promise - ^{US}$5.00

Three hundred years after humanity made its deal with the Life Probe to search out the secret of faster-than-light travel, the descendants of the original expedition return to Earth in a starship. They find a world that has forgotten the ancient contract. No matter. The colonists have overcome far greater obstacles in their single-minded drive to redeem a promise made before any of them were born...

3. Antares Dawn - US$5.00

When the super giant star Antares exploded in 2512, the human colony on Alta found their pathway to the stars gone, isolating them from the rest of human space for more than a century. Then one day, a powerful warship materialized in the system without warning. Alarmed by the sudden appearance of such a behemoth, the commanders of the Altan Space Navy dispatched one of their most powerful ships to investigate. What ASNS Discovery finds when they finally catch the intruder is a battered hulk manned by a dead crew.

That is disturbing news for the Altans. For the dead battleship could easily have defeated the whole of the Altan navy. If it could find Alta, then so could whomever it was that beat it. Something must be done…

4. Antares Passage - US$5.00

After more than a century of isolation, the paths between stars are again open and the people of Alta in contact with their sister colony on Sandar. The opening of the foldlines has not been the unmixed blessing the Altans had supposed, however.

For the reestablishment of interstellar travel has brought with it news of the Ryall, an alien race whose goal is the extermination of humanity. If they are to avoid defeat at the hands of the aliens, Alta must seek out the military might of Earth. However, to reach Earth requires them to dive into the heart of a supernova.

5. Antares Victory – First Time in Print – US$7.00

After a century of warfare, humanity finally discovered the Achilles heel of the Ryall, their xenophobic reptilian foe. Spica – Alpha Virginis – is the key star system in enemy space. It is the hub through which all Ryall starships must pass, and if humanity can only capture and hold it, they will strangle the Ryall war machine and end their threat to humankind forever.

It all seemed so simple in the computer simulations: Advance by stealth, attack without warning, strike swiftly with overwhelming power. Unfortunately, conquering the Ryall proves the easy part. With the key to victory in hand, Richard and Bethany Drake discover that they must also conquer human nature if they are to bring down the alien foe …

6. Thunderstrike! - US$6.00

The new comet found near Jupiter was an incredible treasure trove of water ice and rock. Immediately, the water-starved Luna Republic and the Sierra Corporation, a leader in asteroid mining, were squabbling over rights to the new resource. However, all thoughts of profit and fame were abandoned when a scientific expedition discovered that the comet's trajectory placed it on a collision course with Earth!

As scientists struggled to find a way to alter the comet's course, world leaders tried desperately to restrain mass panic, and two lovers quarreled over the direction the comet was to take, all Earth waited to see if humanity had any future at all…

7. The Clouds of Saturn - US$5.00

When the sun flared out of control and boiled Earth's oceans, humanity took refuge in a place that few would have predicted. In the greatest migration in history, the entire human race took up residence among the towering clouds and deep clear-air canyons of Saturn's upper atmosphere. Having survived the traitor star, they returned to the all-too-human tradition of internecine strife. The new city-states of Saturn began to resemble those of ancient Greece, with one group of cities taking on the role of militaristic Sparta...

8. The Sails of Tau Ceti – US$5.00

Starhopper was humanity's first interstellar probe. It was designed to search for intelligent life beyond the solar system. Before it could be launched, however, intelligent life found Earth. The discovery of an alien light sail inbound at the edge of the solar system generated considerable excitement in scientific circles. With the interstellar probe nearing completion, it gave scientists the opportunity to launch an expedition to meet the aliens while they were still in space. The second surprise came when *Starhopper's* crew boarded the alien craft. They found beings that, despite their alien physiques, were surprisingly compatible with humans. That two species so similar could have evolved a mere twelve light years from one another seemed too coincidental to be true.

One human being soon discovered that coincidence had nothing to do with it...

9. Gibraltar Earth – First Time in Print — $6.00

It is the 24th Century and humanity is just gaining a toehold out among the stars. Stellar Survey Starship *Magellan* is exploring the New Eden system when they encounter two alien spacecraft. When the encounter is over, the score is one human scout ship and one alien aggressor destroyed. In exploring the wreck of the second alien ship, spacers discover a survivor with a fantastic story.

The alien comes from a million-star Galactic Empire ruled over by a mysterious race known as the Broa. These overlords are the masters of this region of the galaxy and they allow no competitors. This news presents Earth's rulers with a problem. As yet, the Broa are ignorant of humanity's existence. Does the human race retreat to its one small world, quaking in fear that the Broa will eventually discover Earth? Or do they take a more aggressive approach?

Whatever they do, they must do it quickly! Time is running out for the human race…

10. Gibraltar Sun – First Time in Print — $7.00

The expedition to the Crab Nebula has returned to Earth and the news is not good. Out among the stars, a million systems have fallen under Broan domination, the fate awaiting Earth should the Broa ever learn of its existence. The problem would seem to allow but three responses: submit meekly to slavery, fight and risk extermination, or hide and pray the Broa remain ignorant of humankind for at least a few more generations. Are the hairless apes of Sol III finally faced with a problem for which there is no acceptable solution?

While politicians argue, Mark Rykand and Lisa Arden risk everything to spy on the all-powerful enemy that is beginning to wonder at the appearance of mysterious bipeds in their midst…

11. Gridlock and Other Stories - US$5.00

Where would you visit if you invented a time machine, but could not steer it? What if you went out for a six-pack of beer and never came back? If you think nuclear power is dangerous, you should try black holes as an energy source — or even scarier, solar energy! Visit the many worlds of Michael McCollum. I guarantee that you will be surprised!

Non-Fiction Books

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Have you missed any of the articles in the Art of Writing Series? No problem. The first sixteen articles (October, 1996-December, 1997) have been collected into a book-length work of more than 72,000 words. Now you can learn about character, conflict, plot, pacing, dialogue, and the business of writing, all in one document.

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This collection covers the Art of Writing articles published during 1998. The book is 62,000 words in length and builds on the foundation of knowledge provided by Volume I of this popular series.

14. The Art of Science Fiction, Volume I - US$10.00

Have you missed any of the articles in the Art of Science Fiction Series? No problem. The first sixteen articles (October, 1996-December, 1997) have been collected into a book-length work of more than 70,000 words. Learn about science fiction techniques and technologies, including starships, time machines, and rocket propulsion. Tour the Solar System and learn astronomy from the science fiction writer's viewpoint. We don't care where the stars appear in the terrestrial sky. We want to know their true positions in space. If you are planning to write an interstellar romance, brushing up on your astronomy may be just what you need.

15. The Art of Science Fiction, Volume II - US$10.00

This collection covers the *Art of Science Fiction* articles published during 1998. The book is 67,000 words in length and builds on the foundation of knowledge provided by Volume I of this popular series.

16. The Astrogator's Handbook – Expanded Edition and Deluxe Editions

The Astrogator's Handbook has been very popular on Sci Fi – Arizona. The handbook has star maps that show science fiction writers where the stars are located in space rather than where they are located in Earth's sky. Because of the popularity, we are expanding the handbook to show nine times as much space and more than ten times as many stars. The expanded handbook includes the positions of 3500 stars as viewed from Polaris on 63 maps. This handbook is a useful resource for every science fiction writer and will appeal to anyone with an interest in astronomy.

