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Man Reaches for the Stars

or

Is Interstellar Flight an Improbable Fiction?

By George Draper

Man's fascination with the heavenly bodies began in a time laden with the dust of forgotten centuries. The Babylonians and Egyptians, advanced races of their time, left evidence of their preoccupation with stars and planets on clay tablets, in burial chambers, even in the configuration of their pyramids. Stonehenge, constructed of massive stones at enormous expense of manpower and time, stands as mute evidence of the measured and thoughtful response of earlier man to the heavens and the seasons. It is a calendar, in stone.

In nearly all the primitive societies the earth and sky evolved as a pair of gods or goddesses long before there was any understanding of astronomy as a Science.

In ancient Egypt the sky was Nu and was represented as a female figure bent over Seb, the earth, with her feet on one horizon and her fingertips on the other. Nu and Seb were separated by Shu, the god of air or sunlight. The sun's daily journey was represented by the god Ra journey was represented by the god Ra seated in a boat moving daily in a chosen course from east to west.

The Egyptians thought the earth was a flat platter with a corrugated rim. This platter floated on the waters of the underworld, or the abysmal regions

Since the Egyptians were literate, we know from their records that when they looked up into the vault of heaven, they felt a kind of "welling-up" of the soul, and a realization of their insignificance, a mood as yet not uncommon, when we contemplate the immensity of the universe.

Man then, as now, felt the necessity of making some kind of sense out of the spectacle of wheeling stars.

Concepts, which have changed with startling rapidity in recent years, contrast with some static concepts which bridged more than a thousand years. Let us begin in the year 1300, at the nearer end of the bridge in time.

In that year Dante wrote the Commedia. Since he was a careful and scholarly writer, his description of the universe gives us an excellent of the universe gives us an excellent summary of the cosmological ideas of his time, a time of rediscovery of the surviving Greek thought.

This is the view presented by Dante. The earth was thought to be a motionless sphere at the very center of the universe. Only half the earth was populated: it was assumed that there was no land mass in the Southern hemisphere. This was not determined from exploration, but from scripture. St. Paul, in Romans 10, had stated that the preachers of the gospel 'went into all the earth, and their words unto the end of the earth.' Since no preacher had gone into the southern hemisphere, obviously and quite logically there could be no habitable land in the area. In Dante's view, purgatory was located down in the southern hemisphere.

The stationary earth was encircled by nine transparent spheres. Eight of these carried the sun, moon, all the planets, and the stars, while the ninth, the *primum mobile*, furnished the

powe
The ninth sphere was the Heaven, completel
of space. Outside that was Heaven, completel
beyond description.

Hell was a conical cavity inside the earth, with Lucifer at the apex of the cone, at very the center of the earth.

Everything above the moon was perfect. All the heavenly bodies moved in perfect circles at an unvarying rate of speed. Perfection applied only to the heavenly bodies, however, for below the moon was imperfection. Everything below was subject to change, to decay, and to death .... even the material of which the earth was made was inferior to that of the heavens.

The mechanics were based on models developed by Aristotle and Ptolemy 1600 years earlier.

The real <u>heart</u> of the concept, though, was the picturing of the behavior of purely physical objects as though

they were living things. Dante, like Aristotle, envisioned the world and its whirling satellites as organisms. In addition, Dante believed the heavenly they were living things. Dante, like Aristotle, envisioned the world and its whirling satellites as organisms. In addition, Dante believed the heavenly bodies to be moved by the love of God. In their conscious striving to imitate God's perfection, they orbited the earth in exact circles because such perfect circles represented perfect motion.

Although this seems wholly strange and irrational to us, it was the accepted approach to physics, the conventional view of that time, termed an *organismic* view. It was later that men came to perceive the world as a *mechanism*.

The wedding of Greek science and medieval theology was not performed by Dante: it was accomplished by St. Thomas Aquinas in his *Summa Theologica* and appropriated by Dante.

St. Thomas felt a deep need to reconcile the most acceptable science of his day, that of Aristotle, with the teachings of the Christian church; and he set forth a skillfully combined blending of religion, astronomy, and physics, which appeared to his contemporaries to hold together logically..

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In his view, the pattern of contemporary society was reflected in the workings of the heavens: its very pattern was that of feudalism. At the top of the nine different orders of angels, tending the primum mobile, all the stars, and the sphere of Saturn, were the cherubim, seraphim, and thrones, at the

lowest level Venus, Mercury, and the moon were tended by the princedoms, archangels, and angels.

This cosmology was essentially a religious structure, and has been described aptly as "a cathedral of the mind." In it, man had supposedly been fashioned in God's image and set down at the exact center of a universe that pivoted around him, a universe that was deeply concerned with his affairs.

This total synthesis of religion and science, which was an honest attempt by St. Thomas to meet the truth of science with the ultimate truth of religion, was simply too successful; science was trapped in the net of religion and made for more than three centuries a mute prisoner of theology. His logical statement in De Unitate Intellectus, "It is philosophically impossible for divine faith to profess what the reason must regard as false," was the reason must regard as false," was twisted from its simple, original, logic, to a religious doctrine barring any other approaches or reasoning, and in that sense was applied in the trial of Galileo in 1633.

Galileo was a disciple of Nicholaus Copernicus, a Canon of the church who, in 1543, challenged the idea that the earth was stationary in the publication De Revolutionibus Orbium Coelestium. He placed the sun in its proper place, very near the center, and made the earth travel around the sun and rotate on its own axis.

Actually, Copernicus was reviving an earlier concept. Almost two thousand years before, in the fourth century BC, Heracleides of Pontus taught that the earth rotated on its own axis, and that the heavens were stationary. In the following century Aristarchos of Samos taught that the earth both rotated on its axis and traveled around the sun. Unfortunately, these ideas were unpopular, and were discarded for nearly two millenia.

Copernicus wrote in Latin. The public was not impressed. Astrology, not astronomy, was their interest. Martin Luther reacted to the book. He not astronomy, was their interest. Martin Luther reacted to the book. He had nothing but scathing criticism for the unorthodox view of Copernicus, and the church felt no threat at the time.

Later, however, when Galileo began to make popular the ideas of Copernicus and began to insist that the earth really *did* move, the Church roused itself to action, and in 1616 *De Revolutionibu* was placed on the *Index of Prohibited Books*, from which it was not removed until 1822.

Copernicus was followed by Johannes Kepler, a German astronomer who, using a multitude of accurate observations made by Tycho Brahe in Denmark, and employing a superb, intuitive mathematical insight, performed calculations covering hundreds of pages and proved that Mars moved, not in a circle, but in an ellipse with

the sun at one focus. Also, he proved that the speed of the planet in its orbit was not constant, but varied in a manner that could be both understood and calculated.

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Kepler's discovery demolished the time honored theory of perfect transparent spheres. Ten years later he formulated another law of planetary motion, when he determined that the square of the time which a planet took to orbit the sun was proportional to the cube of its distance from the sun. This was the type of mathematical harmomy for which he sought all through his life.

He was not satisfied with the traditional explanation of why planets move. Rather than ascribe this to a moving spirit (anima motrix), Kepler stated that there was an external force (*vis*) which pushed the planet in its path. His idea was that this was a magnetic force which emanated from the sun, an idea later pursued by Einstein. This was a complete break from the old animistic ideas, and prepared the way, both intuitively and mathematically, for Isaac Newton to stand on Kepler's broad shoulders and formulate a new and scientific world mode

This was a time of startling discoveries. In 1609 Galileo Galilei trained the thirty power telescope, which he had made himself, on the heavens, and saw wonder never before beheld by human eye. In a tiny book *The Starry Messenger* Galileo told of mountains on the moon, thousands of stars never before seen, even tiny satellites circling around the planet Jupiter.

In 1632 Galileo wrote, in Italian, and published, a book setting forth clearly the particular merits of the Copernican (heliocentric) as opposed the orthodox Archimedean (geocentric) model. As is now well known, the Church reacted violently to this heresy, and turned Galileo over to the Inquisition in 1633. Threatened with the rack, at the age of 70, Galileo was compelled to recant, to acknowledge that this Satanic heliocentric concept was wrong, and even then he was kept under house arrest, and condemned to silence, for the rest of his life.

On the stage next came Isaac Newton, an unbelievably gifted mathematician, inventor, and scientist. Among his diverse contributions to reasoning man was the <u>Philosophiae Naturalis Principea Mathematica</u>, perhaps the greatest single work in all of Scientific literature. It showed that all the known motions of the Earth, moon, planets, and comets, even the rise and fall of the ocean tides, could be both explained and calculated precisely in terms of the laws of motion and of a period of transition from the medieval world to a new age of reason and enlightenment.

In light of the discoveries, it began to appear necessary to develop a different and much more abstract view of God. Newton, philosopher as well as mathematician stated that "God is always and everywhere. He constitutes duration and space. He exists in a manner not at all corporeal, in a manner utterly unknown to us." This represented a radical departure from the old anthropomorphic view.

With Newton, a rational cosmology had emerged, but by no means a complete one. His view mainly concerned itself with the solar system. In fact, Newton said little about the stars except that they of necessity were at great distance from each other, otherwise they would "fall on each other."

The first clue to the distance of the stars came from the reasonably accurate measurement by the French in 1672 of the distance to Mars and consequently to the sun, made by simultaneously observing the planet Mars from France and French Guina. Their 300 year old measurement, 138 million kilometers, is close to our know with the knowledge that the sun was a star, the time had come to take the measure of objects that were distant suns. How large were they? How far away?

There were no rules. How should it be done? Could one measure the

diameter and compare it to the sun's diameter, or should one compare brightness of the star and the sun? This appeared logical. Galileo tried with a silk cord, suspended vertically. Placing the cord between himself and the bright star Vega, he moved backward until the cord no longer completely obscured the star. His measurement showed that if Vega were the same size as the sun it should be 400 times as far away. We know that his measurement was wrong; the diameter of Vega is actually 1500 times smaller. We also know that his method was not a valid method, for even the closest and largest stars do not appear as more than pinpoints of light when viewed through a 200 inch telescope. Size cannot be determined in a direct visual manner.

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A third method – the accurate one, involves the annual orbiting of the sun by the earth. Relative to the sun the earth moves, in six months, about 186 million miles. As the earth travels about the sun the position of the nearby stars, relative to the more distant stars, should show an annual change. Given the distance of a star, through trigonometr it is easy to calculate by how much its apparent position in the sky will appear to change. The change, related to the extreme positions of earth in its orbit, is called the annual parallax of the star and, even for the closest stars, is less than one second of arc.

To visualize one second of arc, consider the moon, which is, in diameter, about 30 minutes of arc. Divide the moon into thirty slivers; each sliver is one minute of arc. Now, take this sliver and divide it into 60 equal slivers. Each is one second of arc, but, the angle measured to the nearest star is only 3/4 of a second. Other stars are more distant, and their angles are considerably smaller.

What is 3/4 of a second of arc? If one lets the circumference of a penny represent the orbit of the earth, i.e., 186 million miles the miles away, or more than half the distance to Pembroke. On the same scale the Earth would be invisible, the sun, in scale, if not illuminated, barely visible. These are

the dimensions of space.

Not until the first half of the nineteenth century did improvements in astronomical instruments make such measuremen possible. In 1838 F.W. Bessel, an astronome scanning the skies from Königsburg, measur the distance to the star Cygni as 660,000 times the distance to the sun, or about 60 trillion miles. Scientists, having discovered the vastness of extra solar space, invented a new unit for astronomical distance, the light year. On that scale, the distance to 61 Cygni was 10 light years. Another convenient unit was the parsec, a shortened form of parallel second, which meant simply that distance which would represent annual displacement from parallel lines of one second. The distance of a parsec is 3.258 light years, or, another illustration, equivalent displacement to the diameter of a dime at a distance of three miles.

Recognition that our solar system is part of a galaxy came from a professional musician who took up

astronomy
Herschel, an Englishman, on a clear evening in 1781, peered at the sky through his homemade telescope and discovered what he thought was a comet. It wasn't a comet: it was the planet Uranus.

Shortly after this discovery Herschel gave up his career in music

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and devoted the remainder of his life to making telescopes and searching the sky. He wanted to discover "the construction of the Heavens."

Together with his sister Caroline, Herschel made an incredible number of observations, with the purpose of mapping the distribution of stars by employing different power telescopes, then computing how far they extended.

This undertaking produced a chart of our own galaxy. Herschel estimated its diameter at 7,000 light years, its thickness about 1/4 as much.

In concept he was right: in distance he was much too conservative. A recent figure places the diameter at 100,000 light years, however the central bulge is only 400 light years. Contained in this galactic disc are well over 100 billion stars. The sun is about two-thirds of the way out has spiral arms and rotates about its center once every 200 million years.

Herschel and his sister saw through their large telescopes what appeared to be fuzzy stars. He called these nebulae, and thought they might be "island universes", about which Immanuel Kant had speculated.

It remained for the 100-inch telescope at Mount Wilson, California, to show that the two great nebulae in Andromeda and Triangulum were composed of stars, that they were actually

galaxies similar to our own.

The distances were too great to measure by the annual parallax method: this is good only to about 160 light years.

Edwin Hubble settled the question of distance in 1924, using the 100 inch telescope, and two Cepheid variable stars, one in each galaxy. This type of star is a "standard candle". By determining period and brightness, distance is revealed. The distances were stunning. Triangulum was 720,000 light-years Andromeda 900,000 light years. These galaxies are approximately the size of our own.

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Strangely, everywhere Hubble looked he saw galaxies scattered in space. He estimated that there must be at least 100 million galaxies in the range of Mt. Wilson, and that the faintest of the galaxies were more than a billion light-years away.

Even that was not to be the end, for now radio astronomers claim that they can see even farther. They have discovered <u>quasars</u>, which they believe are the most distant objects possible for man to detect. Some of these are 10 billion light-years away.

Thus, knowledge of the cosmos has increased in exciting, exponential fashion, and the overwhelming nature of this information is such that we scarcely know what to think of it or what to do with it.

Its very nature demands from thinking man some kind of response, physical or philosophical. The response should certainly enhance, and not dispel, man's conviction that he is unique, and that he is important.

In all of the bright splendor of the universe, perhaps the only living and sentient observers of its vastness dwell on the crust of this one friendly planet under its thin canopy of air, warmed by one isolated G Type sun out of the universe's billions upon billions of stars. If this is our view, then man was not altogether wrong in placing Earth at the center of the cosmos, and feeling the sense of his own importance.

I believe that, in all probability, this is true. I believe, in my deepest self, that man is unique, that the life forms of earth are unique in all the universe.

Increasing knowledge perhaps demands also, in an insistent way, as a magnet pulls steel to itself, that man brave the interstellar voids and explore our near astral neigbors.

Already man has accepted the challenge of near space, our own solar habitat. It appears sterile, excep But what of the stars? Do planets orbit them? Might one of them be suitable for Earth's animal life? No doubt the planets would be barren. Still, if we could get there, and find out, what a

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marvelous adventure that would be!

The problems in getting there are staggering in scope, and fit into four principal categories, which still overlap to some degree. They are:

1. Distance
2. Temperature
3. Unknown Hazards
4. Motivational Requirements

The problem which leaps instantly to mind is <u>distance</u> to a nearby G Type star. From approximately five to twenty-five light years are involved. Travel at full light speed would convert both vehicle and crew into pure energy, according to Einstein, thus one must settle for a slower journey. The trip to α Centauri, 4.2 light years away, would be the shortest possible journey. To illustrate the distance difficulty, let us relate speed assumption to time required.

½ Light speed	8.4 years

5.0 million miles per hr.	56.3 years
1 million miles per hr.	2820 years
50,000 miles per hour	56,400 years
18,000* miles per hour	157,000 years

(* speed needed to orbit the earth)

The time is for a one way trip, and to the nearest star.

Allied with the extreme distance

would be the need for provisions for this lengthy trip. A self sustaining ecological arrangement might be employed, for continuous production of food, but enormous quantities of energy would be required for heat and radiance.

A manned vehicle would need to be extremely large, possibly 10 miles or more in length, and its outer hull would have to be sufficiently strong and rigid to prevent collapse from inward pressure. Even the slightest leakage of life sustaining oxygen would be disastrous. It would be necessary to construct the star craft in space, because of its size.

The trip, like the construction of the great cathedrals, would require a span of many, many generations. The concept of a space ark comes to mind.

Motive Power Required

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All existing systems of propulsion are inadequate. It appears that something similar to nuclear, or ionic, propulsion, will be required. Very soon, in 1986, Halley's comet is scheduled to return, and an unmanned probe of the comet has been discussed using ion propulsion. It should be mentioned that ion propulsion would be insufficient to lift any vehicle out of the earth's gravity, but would be an excellent means for continuous acceleration, in this way solving another problem of manned interstellar travel, that of sustained artificial gravity.

Continuing with the categories, the second classification is <u>temperature</u>.

Stepping out from the sun through the planets, surface temperatures are as follows: the sun 11,000° F, Mercury 750° F, Venus 600° F, Earth 70° F, Mars 0° F, Jupiter −200° F, Saturn −240° F But the cooling has just begun. In deep space, the temperature is near 0° Kelvin, which is −459° F, or −273° C, plus 3° C representing residual radiation from the "big bang" of creation, accordin to Jimmy Wooldridge.

Here is a problem of monstrous proportions facing the interstellar voyager. To heat the craft, to maintain more than a tiny portion of the total volume of the vessel under heat, would be enormously wasteful of energy. Even a wall temperature of 100°K returns only 1% of the total energy radiated from a test heated body at 300° K (about room temperature). But, in deep space, the temperature is not 100°, but 3°K. To attempt any type of ecological system, reprocessing wastes, growing food, would, as stated before, require both earth-like temperatures of 80-90° Fahrenheit, and solar type radiation. The growing of plants would be indispensabl as a means of converting carbon dioxide back to oxygen. Massive amounts of energy would be required.

Too, low temperatures cause

extreme alterations in the structural properties of materials. Rubber loses its elasticity and shatters, metals become brittle and lose bonding strength. Selective shrinkage of hull or compartment walls at weld points could rupture these walls. shrinkage of the functioning could render it a piece of space junk.

We think we have an energy problem on Earth. Consider, though, what separation from the Earth, and from the sun's warmth and power, would produce in terms of multiple problems in a matter of hours, and the interstellar dilemma comes into focus.

Under the heading of Unknown Hazards, we must list the possibility of collision with uncharted interstellar objects. In a supposedly expanding universe with enormous amounts of empty space there may be objects which have never been attracted to and trapped in orbit by stars, but continue in the endless wheeling pattern of the galactic stars. An encounter at ultra high speed would atomize the star craft. In fact, one scientist has calculated that if a space-ship traveling at 85 percent of the velocity of light should collide with a single interstellar particle, 21 billion calories of kinetic energy would be generated. This would be enough energy to vaporize 10 tons of iron! Even if the materials could withstand this fantastic amount of energy, the radiation produced by the flow of interstellar hydrogen past the ship would probably destroy all animal life aboard.

Already in the more prolonged earth orbital flights bone marrow deterioration and skeletal structural damage has been observed, this in only a few weeks of weightless orbiting.

Fierce bombardment by cosmic rays may present a problem for which there is no solution.

Consider, too, the necessity for critical determination of speed and entry pattern into a solar system of unknown masses, dimensions, and orbital speeds, and the hazards in entering the system.

Finally, there is the problem of Personal Motivation. How can qualified volunteers be obtained? This would be a personal one way trip. The success of the mission would be multiple generations away. Think what it would mean to leave Earth — never to return, and to commit ones progeny to a cold and cheerless trip through sunless space without ever breathing the warm fragrant air of Earth or rejoicing in its beauty!

Add to this the necessity for international cooperation over a period of a century or more,

and the sharing in an astronomical total of expense.

All of this appears a thinking of the unthinkable and a game at posing the impossible and unattainable. Perhaps it is.

Yet — when we consider the enormous advancement of science, which is really man's acute perception of himself and the nature and dimensions of his surroundings, one hesitates to say that such a venture is a complete impossibility. In all the history of man we live in the most astounding and exciting of times, when nothing is dismissed as impossible: a venture simply takes a little more understandin a little more time — perhaps one hundred — perhaps five hundred years, but we are going there eventually.

And what shall we find?

Let me share my view with you. Wherever we go, there will be a vast

And what shall we find?

Let me share my view with you. Wherever we go, there will be a vast wasteland of sterile planets. Perhaps some, through terraforming, can become habitations for man. There will be long and lonely journeys to desert globes, for we need not expect to find life.

You may not share this opinion. My daughter doesn't. After giving my views to her at the kitchen table one evening, she came back with this comment:

"Somehow, somewhere, someone out there near a distant star is sitting at a table discussing the same subject we are. A father is telling his daughter that they are unique, that there is no other life in all the universe."