OUR AWESOME UNIVERSE

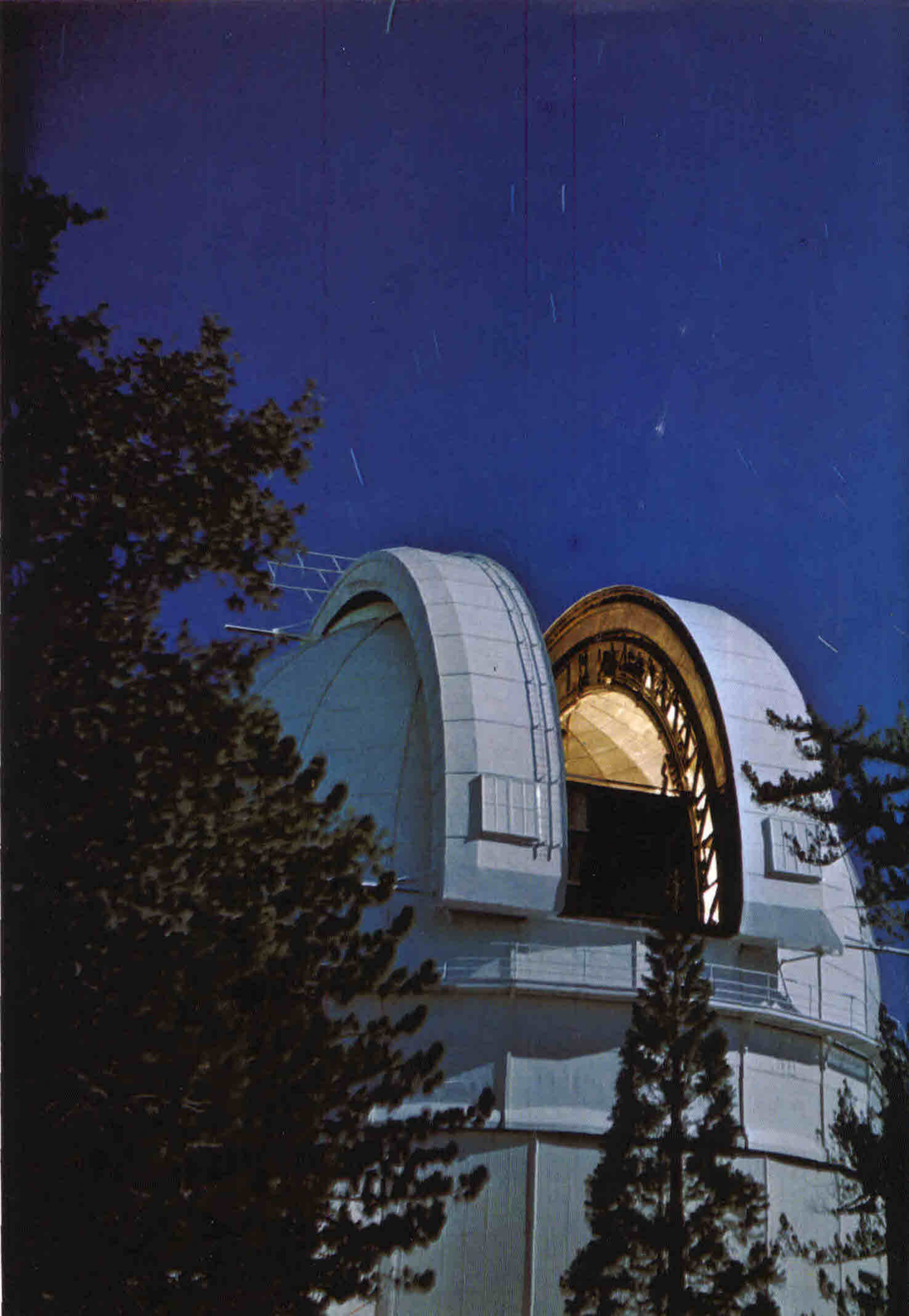
About Our Cover

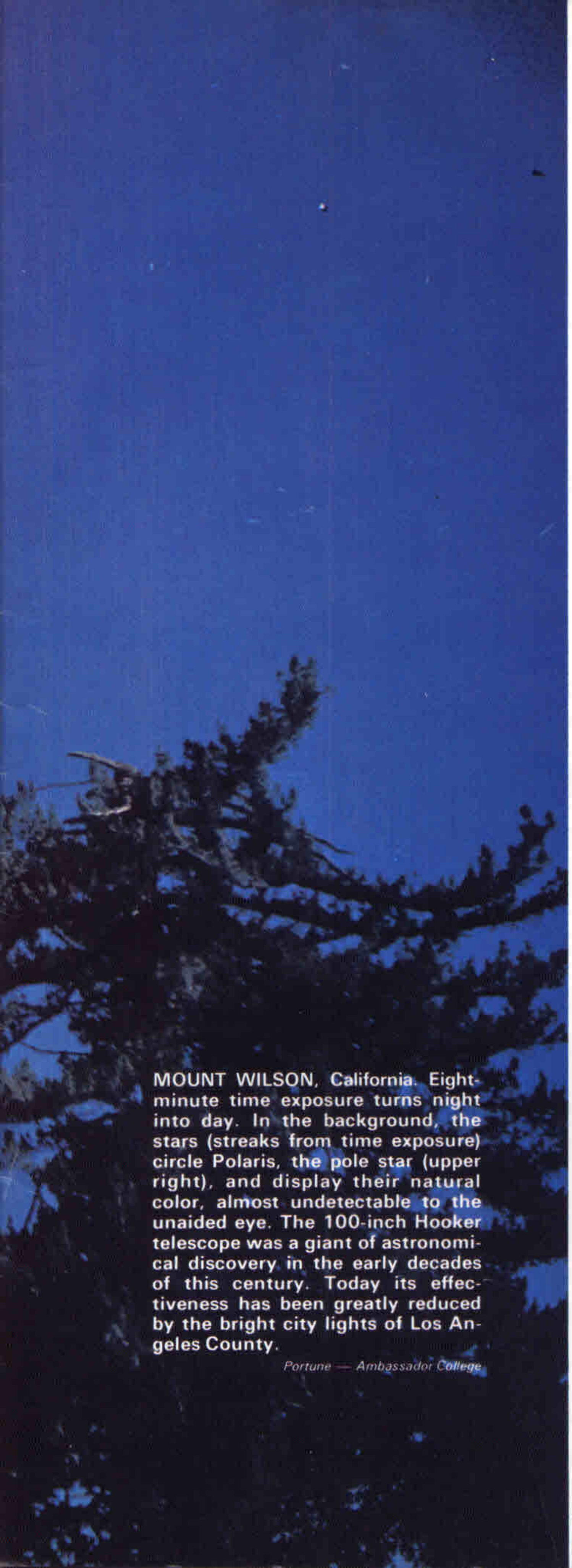
The great Eta Carinae nebula glows with the red light of hydrogen. Visible from the southern hemisphere, it lies at a distance of about 8,800 light-years from the earth. It was photographed by Gaston Araya at Cerro Tololo Inter-American Observatory in Chile on the 24-inch Curtis Schmidt telescope. In the center of the nebula is the slow supernova Eta Carinae. Invisible to the naked eye today, in 1843 it became as bright as Canopus, the second brightest star in the sky. At the upper left (near title) is the bright orange stellar giant u Carinae. In the upper right is the star cluster NGC 3293, a group of at least 130 stars as young as 8 million years.

Photo Courtesy Kitt Peak National Observatory

OUR AWESOME UNIVERSE

The grandeur and splendor of the universe has always challenged the mind of man. It taunts him with the unknown. Where did it all come from? Why does it exist? Is there any purpose behind it? Is our existence the result of intelligence or are we mere cosmic orphans adrift on the ocean of time and space? Many do not know. Yet answers are available.





MOUNT WILSON, California. Eight-minute time exposure turns night into day. In the background, the stars (streaks from time exposure) circle Polaris, the pole star (upper right), and display their natural color, almost undetectable to the unaided eye. The 100-inch Hooker telescope was a giant of astronomical discovery in the early decades of this century. Today its effectiveness has been greatly reduced by the bright city lights of Los Angeles County.

Portune — Ambassador College

WHEN MAN looks up to the starry heavens on a clear night, somehow he innately senses that the universe is no accident. But most of us go to and fro over this earth, busy with our little affairs, serenely indifferent to the real significance of the vastness of time and space. We take little note of the majestic canopy of stars stretched over our tiny planet.

Seldom do we ponder such questions as: *What* is the universe? *Where* did it all come from? *When* did it begin? *Who* made it? Is planet earth unique in the universe? Is man alone in the universe? Or do alien minds on a distant planet plumb the night pondering the same questions?

Over the past few decades, the efforts of science have made available to mankind an impressive reservoir of information about the universe. Never has man known more about the heavens, yet less about *why* he exists. This booklet presents, in brief, a panorama of both "what" and "why," bringing into focus meaning that has somehow eluded humanity since the dawn of civilization.

A Mind-Stretching Perspective

Before daring to step into the arena of origins — one should first appreciate the immensity of space and the awesome power of its elements. The first and most obvious disadvantage confronting any seeker-of-truth is the vastness of scale. For sheer size alone the universe is impossible to conceptualize. Despite the apparent simplicity of a starry night, the universe is a master at hiding the evidence.

One science writer provided the following description:

> **Suppose we make a scale model where the distance from the earth to the sun . . . is just under one quarter of an inch. Now take a dime [or a half new penny] out of your purse [or pocket]. On the scale of our model the orbits of the four inner planets Mercury, Venus, Earth, and Mars fit comfortably on this coin with the orbit of Mars represented by the circumference. . . . The orbit of Neptune, the outermost large planet, will be fourteen inches across. . . .**
>
> **. . . And on the scale of our model where will the nearest star be? Exactly ONE MILE**

AWAY from the dime. This is the closest star. The center of our star system or galaxy would be over SIX THOUSAND MILES [or the air distance from Los Angeles, California to London, England] from the dime, and the millions of other galaxies very much further away.[1] (Emphasis ours throughout booklet.)

Even on this vastly reduced scale the size and immensity of the universe is truly "mind boggling."

The Awesome Power of the Sun

We spend our lives on a natural Spaceship Earth — a massive sphere approximately 8000 miles in diameter. Although it seems "suspended in space," the earth weighs in at six thousand million, million, million tons!

Dominating our skies is that life-giving orb we know as the sun. It is a blazing nuclear furnace over 100 times the diameter of the earth — comprised of sufficient matter to make up another 300,000 planets like our own.

The *total* [emphasis theirs] energy the Sun emits in a SINGLE SECOND would be sufficient to keep a one-kilowatt electric fire burning for 10,000 million million years. Put in a different way, the energy the sun emits in one second is greater than the whole amount of energy the human species has consumed throughout its ENTIRE HISTORY.[2]

But only a tiny fraction (about one two-billionth) of this two thousand million, million, million, million ton orb's energy falls on the earth. But, even considering this, the solar energy penetrating to the earth's surface exceeds the entire annual energy consumption of all the world's industries by more than 30,000 times![3]

Our sun, for all its seemingly massive size, is itself surrounded by a solar system that extends outward into space for a staggering 3,700 million miles. Within this vast area are nine planets, 32 moons, thousands of asteroids, millions of comets, and innumerable dust particles and molecules. Even so, our solar system is but a tiny fleck of cosmic driftwood in an infinitesimal corner of the universe.

Our Awesome Universe

Compared to the entire stellar panorama, our sun and its solar family of planets are but inconspicuous pin-pricks of light lost in a flowing sea of stars we call the Milky Way. The dimensions of this vast starry cluster defy comprehension — several thousand million million miles! It rotates in space like a giant pinwheel with star-studded arms spiralling out from its center. Somewhere along one of these galactic "extremities" is our insignificant sun and its nine tiny planets.

Yet even our gargantuan galaxy (including thousands of millions of stars) is virtually lost in the total population of space. Far beyond our Milky Way, the universe abounds with additional thousands of millions of galaxies.

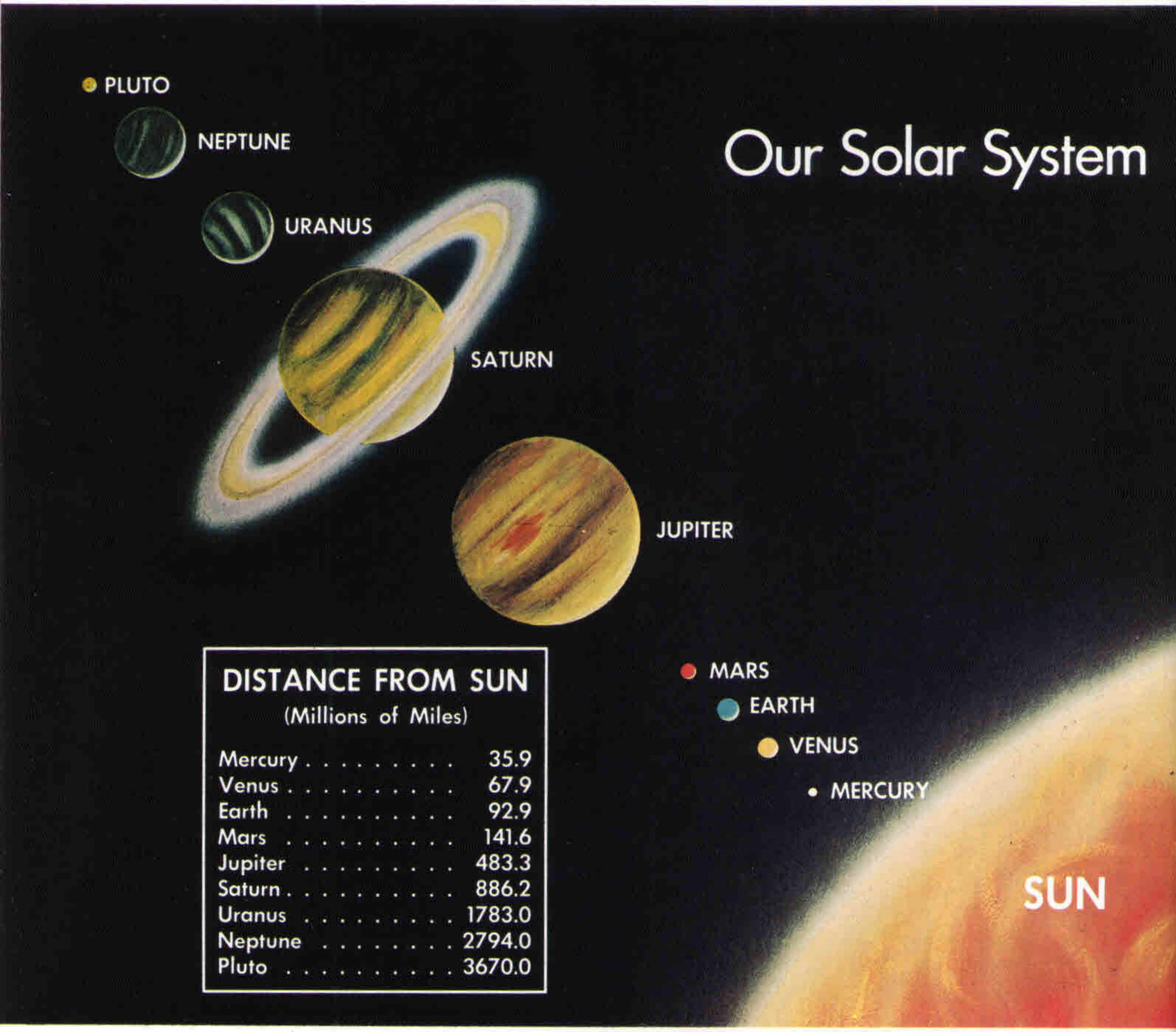
Taking an estimate of the grand total of all the stars in the known visible universe, we arrive at the staggering sum of 1,000,000,000,000,000,000,000 or more. There is also the very real possibility that the universe extends far beyond the limits of present astronomical observation. No matter how we describe the universe, it is absolutely *awesome*.

Man has always wondered if all this could be accidental. Did our universe simply "come into being" sometime in the distant past? Or have all the billions of stars and dramatic forces that gov-

Bright southern portion of the Filamentary or Veil Nebula in Cygnus, the remains of a star that exploded some 50,000 years ago. Left: A spiral galaxy, M 81 in Ursa Major, a remote cluster of stars perhaps 100,000 million in number. Upper right: Another spiral galaxy, the Whirlpool Galaxy, M 51 in Canes Venatici.

American Stock Photos; Upper Right: H. Armstrong Roberts

Our Solar System



DISTANCE FROM SUN
(Millions of Miles)

Mercury	35.9
Venus	67.9
Earth	92.9
Mars	141.6
Jupiter	483.3
Saturn	886.2
Uranus	1783.0
Neptune	2794.0
Pluto	3670.0

ern them always been here? And is there a fundamental reason why the universe exists?

Ancient Theories

Throughout man's recorded history, scholars have continually pondered the meaning of the cosmos, trying to discover answers to the age-old questions: Where did everything come from, and what was its meaning?

During the time of Christ, Diodorus of Sicily related how many thinkers of his day considered the universe to be eternal and self-existent with no definite beginnings. In Plato's day the universe was thought to have resulted from purely natural happenstance.

After the classical Greek period, little scholarly thought was given to the matter of beginnings until about the 18th century. At that time Immanuel Kant formulated a hypothesis for the origin of the solar system. Kant's idea was later developed by the French astronomer LaPlace and became popularly known as the Nebular Hypothesis. Simply stated, it postulated that our sun and

(Text continues on page 16)

A Journey into Space

WHEN WE travel on earth, we usually judge distance in terms of *how long* it takes us to get to a certain place. The same is true in space. Let's consider an imaginary cosmic trip to the sun — and beyond!

To begin, we climb into a space vehicle capable of flying at the speed of a modern commercial jet plane. After take-off we find ourselves winging along through space at the speed of 650 miles per hour — almost the speed of sound. In 15 days we reach the cold, barren, pock-marked wastes of the moon. After a quick check of our navigational instruments, our course is reset for our next destination — the sun. How long would it take us to get there?

FOURTEEN YEARS!

Obviously, that's much too long, so we increase the speed to Mach Three, or *three times* that of sound — 2250 miles an hour. Now our trip to the sun takes a "mere" five years.

Upon reaching the sun, we turn our spacecraft toward the outer reaches of our solar system. But we'd better forget about going. At our present speed of Mach Three, we'll never make it. It would take us over *one hundred years* just to reach the planet Saturn.

So quickly additional power units are activated in our imaginary space vehicle. Soon our speed has increased to 20,000 miles an hour — five times that of recent Apollo spacecraft. Another five long years are consumed as we plod on toward Saturn. Gradually the painful fact begins to dawn on us that by the time we reach Saturn we will have been travelling in space for over 10 years and will still not be out of our own solar system.

Drastic measures are necessary if we're going to complete our journey into outer space. Now, we're ready for a new kind of ride — our spaceship will now travel through space at the speed of light. (Of course, it's totally imaginary!) The speed of light is approximately 186,000 miles per second. That means in a year light travels approximately six million, million miles! Had we begun at this speed, our trip through the solar system would have required only a few hours.

On to the Stars

But the sun and planets are virtual "neighbors" and we want to travel beyond them to some of the "nearer" stars. So we program our inertial navigation computer to take us to Alpha Centauri — the nearest star to our own solar system.

As the outermost planet, Pluto, slowly recedes from view, we settle into our normal spacecraft routine — eagerly anticipating our arrival at Alpha Centauri. We eat supper at the regular time and engage in a few rubbers of bridge with the rest of the crew. Later on at our regular bedtime we lapse into a peaceful sleep, weary with the events of the day.

The next morning the first thing we do is to check with the navigator on how much longer it will take to reach Alpha Centauri. Our face drops when we hear his reply — FOUR AND ONE HALF YEARS! Incredulous, we ask him to recheck his figures. Surely, travelling at a breathtaking 186,000 miles per second, our trip to the nearest star should take much less time. But the navigator confirms his original calculations.

Visibly shaken, we begin to reconsider the possibility of reaching some of the more prominent stars in our immediate neighborhood. "What about Sirius, the brightest star visible to us?"

"We'll get there in eight and a half years," the navigator replies.

Almost desperate, we quickly thumb through our space almanac looking for other nearby candidates. Our finger lands on Rigel, a prominent star in the constellation Orion. The inertial navigational range finder comes back with a set of dis-

The Horsehead Nebula in Orion. The head is a cloud of interstellar dust illuminated nearer to us than the background of the hot gas which glows by radiation from nearby stars.

American Stock Photo

turbing figures. "Time to Rigel — 900 years." We can't even get one tenth of the way there — even if we live to a ripe old age of 90. The realization seizes us that we may have to abandon our mission completely.

The discouraging picture brightens considerably, however, after consultation with our flight engineer. He informs us that a recently installed "warp-drive" energy converter will enable us to rocket through space faster than the speed of light! (Again — strictly fiction because Einstein's theory of relativity shows that this is impossible. The purpose of this imaginary journey is simply to illustrate the immensity of space. It obviously would not represent realistic conditions, especially traveling at velocities approaching the speed of light. At these speeds realistic mass, time, and velocity relationships become rather involved and are governed by Einstein's theory of relativity.)

With the new power unit our speed soars to warp-100, or 100 times that of light. We reach Rigel in less than 5½ years.

Continuing with our planned itinerary, the next leg of our journey will be an exploratory trip to our home galaxy — the Milky Way. We point our spaceship toward its central hub where the concentration of stars is so thick that from our vantage point they appear as a single glowing mass. But once more our navigator comes up with a set of disturbing figures. Traveling at "only" warp-100, 100 times the speed of light, it will still take an exasperating 300 years to reach the center of our galaxy.

Undaunted, we shove our electronic throttle forward until our spacecraft is now moving at a dizzying warp-10,000 (10,000 times the speed of light). With satisfaction we note that the galactic center now lies only three "short" years away.

Approaching the center of the Milky Way, our attention is quickly riveted to the brilliant blaze of lights radiating from formations of densely packed ball-shaped bunches of stars known as globular clusters. Careful observation of these clusters reveals that their individual stars are gyrating back and forth "like gnats in a swarm."[1] We desire to alter our course slightly in order to more closely observe these fascinating groups of stars, but we quickly abandon the idea when our resident astronomer warns us that the combined light emitted by these stars is so intense that once inside their formation we would in all likelihood be instantly blinded.[2]

Toward the Distant Galaxies

Our progress through the Milky Way continues. At the colossal speed of warp-10,000 (1,860 million miles per second), it still takes us another five years to arrive at the outer edge of our galaxy. And as we burst out of its confines, our journey through *known* space has barely gotten off the ground.

Outside the Milky Way, we're confronted by billions of other galaxies similar to our own. We recall that current estimates hold that the universe may be teeming with upwards of one thousand million of these star-laden conglomerates. Our resident astronomer points out that we can better understand the "galactic population density" by imagining a piece of the sky the size of the bowl of the constellation — the "Big Dipper." Seen from the earth, 50,000 individual galaxies, he continues, have been discovered in just such an area of the sky.[3]

A feeling of frustration creeps over us. At this rate we will never complete our cosmic journey. But our flight engineer again comes to our rescue and informs us that our energy converter will allow us to make one more velocity increase — to warp-one million! With renewed confidence we set course for one of our nearest galactic neighbors — the Andromeda Nebula — a vast stellar array similar to the Milky Way.

Still, there is a growing feeling of restlessness as we realize that even at one million times the speed of light it will still take us two years to reach the Andromeda.

As our spaceship plunges on into the remoteness of the cosmos, the Milky Way rapidly recedes into the background. We are now able for the first time to grasp something of its overall dimensions and appearance. Shaped like a giant illuminated pinwheel revolving in the blackness of space, its diameter is a staggering 587 million million miles. No wonder it took so long to cross its boundaries!

At this point we remember that our solar system is located about three fourths of the way out on one of its revolving spiral arms. But we must search in vain for our sun and its nine planets among this vast host of stars, for, as our astronomer informs us, the sun is merely a rank-and-file yellow dwarf star much too dim to be seen from outside the Milky Way.

Continuing on toward the Andromeda, we ponder the incredible fact that millions of other galaxies populate the universe. Many of them, we know, are organized into even larger celestial formations aptly termed "supergalaxies." Such supergalaxies consist of tens of thousands of individual galaxies — a "gigantic system of galaxies . . . perhaps 40 million light-years across . . . and a few million light-years thick."[4] Perhaps, we muse, our Milky Way is a mere "satellite" of some far-distant supergalaxy.

Our train of thought is interrupted as the navigator reports that the spaceship is approaching the outskirts of Andromeda. Regretfully we realize that this neighboring galaxy will have to be the limit of our cosmic journey. Beyond Andromeda, deep in outer space, lie the mysterious quasars, pulsars and radio galaxies. But we have long since abandoned hope of reaching them. Their distances are well up into the hundreds and thousands of millions of light-years. Such an undertaking would be prohibitive even for our *imaginary* superpowered spaceship!

Somewhat dejected by the disappointing prospect of having to return home, we begin preparations for our return to the earth with our hopes of conquering space now considerably dimmed. Twenty-five years have elapsed since we blasted off from the surface of the earth, and even though we rocketed through space up to a million times the speed of light, we never made it out of our immediate galactic neighborhood.

In the words of one author, we now realize that an ant determined to crawl across the United States has more chance of accomplishing its task than man trying to cross the universe!

Men sometimes speak of conquering space. Perhaps *intrude* into it would be a better way to state it, because the universe is truly immense.

FOOTNOTES

[1]Donald H. Menzel, *Astronomy* (New York, 1970), p. 63.

[2]Fritz Kahn, *Design of the Universe* (New York, 1954), p. 163.

[3]*Science Digest*, "Universe Bigger Than Believed," March 1957, p. 19.

[4]Gerard de Vaucouleurs, "The Supergalaxy," *Scientific American* (July 1954), p. 35.

The Crab Nebula, M1 in Taurus, hot bed of astronomical interest. It is the remains of a supernova seen and described by the Chinese in A.D. 1054. Its central illumination is due to high-speed electrons, oxygen and other elements. The red-orange filaments are glowing hydrogen and nitrogen gas. At the arrow is the recently discovered pulsating star (pulsar) which mysteriously flashes some 30 times a second. Some astronomers believe it is a super-dense neutron star that actually rotates that fast.

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Stellar Magnificence

THE INDIVIDUAL stars which populate the universe are awesome all by themselves. To the casual viewer on a clear night, most of them might seem quite similar in appearance. In reality, vast differences exist among the various members of the stellar population.

Stars are primarily classified by the type of light-rays they emit or by the *color* of their radiated energy. At one end of the stellar light spectrum are the ultraviolet giants with sizzling surface temperatures about 50,000° F. (Our sun is a "mere" 10,000° F.) Because of their high temperatures, these blue powerhouses give off most of their radiation in the invisible ultraviolet range of the light spectrum. Their energy consumption is prodigious. Rigel, for example, a blue giant 800 light years away, pumps out power at 40,000 times the rate of the sun. When you consider that our sun, a mere yellow dwarf, is using its hydrogen fuel at the rate of 4.5 million tons a second, Rigel's energy consumption becomes gargantuan by comparison.

In stark contrast to the "big blues," are the relatively "cool" red dwarfs. These pint-sized nuclear generators are the most common type of star in the cosmos and have surface temperatures in the range of 3000° F. to 5000° F. They are difficult to detect because of their low luminosity and because most of their energy is produced in the infrared region of the light spectrum.

By comparison to our sun, the red dwarfs are energy misers. Wolf 359, one of the faintest stars known, has a diameter of only 3% the size of our own sun, and faintly emits only about one fifty-thousandth as much energy. Kruger 60B, another nearby red dwarf, is approximately one eighth the size of the sun, but radiates only four ten-thousandths as much light.

In between these two extremes is a wide variety of orange, yellow, and white stars with varying degrees of mass and brightness.

A Friendly Star

It is more than significant, however, that our sun lies about half way up the scale of star types — both in terms of size and luminosity. As a yellow star, with a radius just under a million miles, the sun generates its energy predominantly in the visible part of the spectrum. If it didn't, life as we know it on the earth would be impossible. On the one extreme, light from a hot blue star, being predominantly ultraviolet, would render most forms of life that we are familiar with impossible. The smaller red stars would also be unable to support any reasonable biosphere because of an inadequate supply of visible light.

In this respect, Sir James Jeans, the famous British astronomer, drew an interesting contrast in order to illustrate some of the vast differences that exist among various members of the stellar population:

> **If the sun is represented by an ordinary candle, Wolf 359 and L 789-6 [two of the faintest stars discovered] are both something less than fireflies, while S Doradus [a star 300,000 times as bright as the sun] is a lighthouse — and the supernovae are cities on fire. If the sun started to emit as much light and heat as S Doradus, the temperature of the earth and everything on it would run up to about 7000 degrees, so that both we and the solid earth would disappear into a cloud of vapour. On the other hand, if the sun's emission of light and heat were suddenly to sink to that of [red dwarf] Wolf 359, people at the earth's equator would find that their new sun only gave as much light and heat at mid-day as a coal fire two hundred yards away; we should all be frozen solid, even the earth's atmosphere being frozen solid around us.[1]**

Multiple and Variable Stars

Another fortunate fact about our solar system is that it has but one star. Most of the stars are found in multiple star groups of two's, threes, fours and more. The proportion of stars that are "multiples" is surprisingly high. Various sources estimate that as many as three quarters of all the stars in the universe are multiple systems. We don't usually appreciate this fact when we look up into the heavens, because of the close proximity of multiples to one another.

Alpha Centauri, the nearest star to our sun, is actually a system of three stars. The two main stars of the trio are similar to our sun; one slightly larger and more luminous, the other cooler and smaller. Both are orbited by a tiny red dwarf star called Proxima Centauri.

Sirus A, the brightest star in the sky, is another good example. It is nearly twice as hot as our sun and roughly 1½ times its diameter. Its companion, Sirius B, is a faint, white dwarf star only one ten-thousandth as bright as its companion, Sirius A.

Some double stars, or binaries, are so close that their mutual attraction causes huge eruptions of tidal gas to pass back and forth between the two stars. Other binaries appear to vary in brightness because they periodically eclipse one another.

Another class of variable stars known as Cepheids have been observed to undergo periodic fluctuations in their brightness without the help of an eclipsing partner. Some of these quick-blinking stellar lighthouses have flare-up intervals of only a few hours duration. These variations are thought to be produced by a "panting" action due to expansion and contraction of the star's skin.

Stellar Oddballs

While stars may vary radically in size and the amount of light they radiate, they all follow similar patterns of aging and development. All of them are essentially giant nuclear furnaces that generate energy by converting hydrogen into helium by the same basic process used in the hydrogen bomb. In the course of this hydrogen-helium conversion process, matter is transformed into energy according to Einstein's well-known equation $E = MC^2$. This accounts for the stupendous light and heat radiated by all stars.

But like any energy source, stars have only a limited amount of fuel. As it burns, the star is continually depleting its stock of hydrogen and at the same time building up a deposit of helium "ash." Eventually these "wastes" grow to the point where the internal forces of the star are thrown out of balance. The star is then rudely jolted out of its previously tranquil state and rapidly balloons in size as the rate of its fuel consumption dramatically increases. At this point a normal star like our sun would become what is termed a "red giant." More massive stars would end up in the "supergiant" category.

A Perspective of Giants

Some of these abnormal stars are immense. For example, Epsilon Aurigae, the largest known star so far observed in the universe, has a diameter approximately *2000* times that of the sun. This red colossus, were it to replace our sun at the center of the solar system, would extend out past the orbit of Saturn! It has an unbelievable diameter of 2,500 million miles. Antares, another familiar super-giant, has a diameter "only" 450 times that of the sun. Compared to Epsilon Aurigae, it is "junior" sized. But placed in the center of our solar system it would nevertheless consume the orbit of Mars.

Yet for all their size, the red giants are in reality a lot of hot air — literally! Under the right circumstances one can actually "see through" them, because their constituency is so thin. Astronomers in one case have actually been able to observe another star through the transparent layers of one of these tenuous red giants. Their matter is so rarefied that it is comparable to the best vacuum man can produce in the laboratory.

Pricking the Balloon

A red giant in its super-bloated state can't exist that way forever. This phase of a star's existence is relatively short compared to the long "normal" phase when it was consuming fuel at a more leisurely pace. As the star's temperature continues to rise because of the pressure exerted by gravitational energy, the helium ash in its core itself becomes fuel in a new but less efficient type of nuclear reaction. The waste products of this new combustion process also provide fuel for yet another "weightier" type of reaction. This chain of events, according to astronomers, eventually leads to the formation of heavier elements such as magnesium, neon, silicon and oxygen. But eventually a point is reached (with the formation of iron) where the elements become too heavy to trigger any further reactions. Consequently, more and more of the nuclear fuel is exhausted until the star finally collapses under the increasing pressure of its internal gravity.

At this point scientists believe the following events occur depending on the size of the star. Smaller stars simply contract and die away as they use up their remaining fuel, becoming white dwarfs in the process. When the residue of their fuel is exhausted, they cease their active existence and become burned-out black cinders floating in space.

Larger stars (greater than 1.4 times the mass of the sun) share a less placid fate. Instead of meekly flickering out, they die with a roar, producing the spectacular phenomenon called by astronomers a *nova*. The forces unleashed in this type stellar degeneration are so titanic as to be beyond earthbound comparisons.

A nova is in theory brought on by a rapid collapse of the star as the flickering nuclear fires can no longer stand up under dwindling fuel supplies and the crush of gravity. This suddenly produces temperatures that can exceed a thousand million degrees Fahrenheit. This, in turn, detonates a massive thermonuclear explosion of gargantuan proportions. It's as if a whole star had been converted into a gigantic hydrogen bomb. In fact, one source estimated the energy released by one such explosion was equivalent to one trillion trillion (British: billion, billion) hydrogen bombs (1 followed by 24 zeros!).[2]

Astronomers call the largest of this type of stellar bombast a supernova. One writer described it like this:

> **The huge thermal energy . . . is thereby converted into radiation so intense that the visible light coming from the exploding star is almost as bright as that which comes from an entire galaxy of 100 billion [thousand million] ordinary stars . . .**
>
> **If the mass of material in the outer layers of an exploding star is about equal to the mass of our sun . . . the energy released per second in the explosion is comparable to the energy output of our sun over a billion [thousand million] years.**[3]

A Star Is Born

Out of such a cosmic catastrophe emerge the shattered remnants of the old star, but in a radically altered state. The gravitational forces responsible for the explosion in the first place now hold the remaining stellar material in such a tenacious grip that it is compressed into extremely high densities. Theoretically, if the explosion isn't too violent, the stellar remains become configured as a white dwarf star.

White dwarfs are Lilliputians even compared to a medium star like our sun. Most of them are roughly equivalent to the earth in terms of size and diameter, but are stellar heavyweights when it comes to density. Sirius B, a well-known white dwarf, is only twice as big as the earth, yet has approximately the same mass as the sun. In other words, it's about 12,000 times heavier than the earth. On Sirius B, the Empire State Building would be shrunk to the size of a pin and yet have the same weight.[4]

On a white dwarf, a pea would weigh more than a truck, or as one author stated, "a ping-pong ball filled with its substance would have the mass of several elephants."[5]

And yet for all this compression, the white dwarf is quite spacious when compared to its smaller cousin, the neutron star.

Neutron Stars — Dynamic Bantams

Scientists theorize that if a supernova explosion is particularly violent, the stellar remains will condense even further than the white-dwarf stage to form what has become one of the most fascinating discoveries of modern astronomy — the neutron star. By comparison even the white dwarfs are huge. Imagine squeezing all the matter of the sun down into a tiny sphere about 10 miles in diameter and you have the approximate density of a neutron star. Densities are on the order of a thousand million tons per cubic inch. This is equivalent to *"all the people in the world compressed into a single raindrop."*[6]

That ping-pong ball that had the mass of several elephants on a white dwarf would now "have the mass of a large asteroid such as Juno, a minor planet 118 miles across."[7]

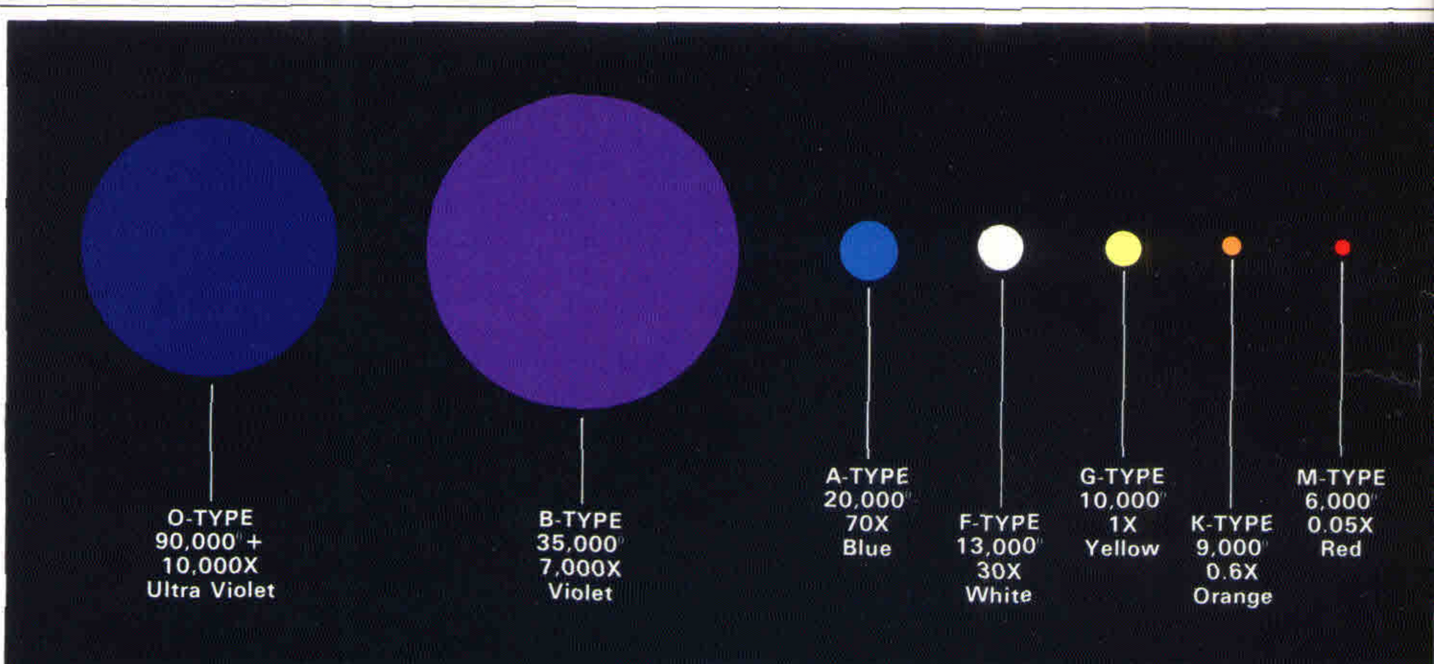
Incredible densities like this cannot be achieved unless the atomic structure of the matter involved is fundamentally altered. The gravitational force exerted in a neutron star is so strong that it can theoretically overcome the normal repulsive forces that exist between electrons and protons within the atom.[8] This impaction of atomic particles essentially removes much of the "open space" that formerly existed between the nucleus of the atom and its electrons. Result: superdense matter.

Beacons in the Sky

Up until the late 1960s astronomers had postulated the existence of neutron stars, but never had they found any observational evidence of one in the universe. However, in 1967 and 1968, radio astronomers in Cambridge, England discovered the first of a series of small new celestial objects which they called pulsars — because of a series of strange, and at first baffling radio pulses that they emitted. Subsequent investigation revealed that neutron stars were undoubtedly the source for these pulsars. The clincher was the discovery of a pulsar in the Crab Nebula, the remnants of a

Stars around the celestial north pole reveal their color in a three-hour time exposure. To the naked eye they seem almost *colorless. Starlight is too faint to fully* activate the eye's color-vision cells.

Lorton — Ambassador College



supernova explosion first observed by the Chinese in 1054 A.D.

Astronomers quickly realized that the radio pulses were due to the rotation of the neutron stars. The frequency of the pulse was found to match the rotational speed. The neutron star in the Crab Nebula, then, was determined to be revolving at the incredible speed of 30 times a second — a rotational velocity comparable to that of a modern electric generator! And essentially that's just what the neutron star is — a giant, self-propelled stellar dynamo, radiating energy into outer space. The total energy production of the Crab pulsar is something on the order of 10^{31} watts (1 followed by 31 zeros!). "It would take the radiation from 100,000 stars like the sun to match this power output."[9] The same author pointed out that "in the time interval of a single pulse — about 1/30th second — the Crab pulsar pours out as much energy in X rays *alone* as our sun emits at *all* wave lengths over a period of 10 seconds."[10] But this stellar dynamo, whirling in the heavens like a superpowered lighthouse, is more than just an ordinary electrical and optical generator. According to astronomers it also hurls out highly charged electrons and protons, in a similar fashion to a man-made atomic particle accelerator.

The Ultimate in Stellar Collapse

Yet even the neutron star/pulsar is not the grand-daddy of stellar energy bundles. Theoretically it is possible for the collapse of a star to be *so* violent, that it passes beyond the neutron stage to become what astronomers call a "black hole." Even the name sounds sinister. But the black hole is everthing its name implies. It's so "uptight" with its matter and so dense that nothing but gravity can theoretically escape its clutches once inside its sphere of influence. That's why it is black. No light escapes from its surface.

A black hole is thought to be no more than four miles in diameter, or roughly a third as large as neutron stars. You might liken it to a giant celestial vacuum cleaner. It absorbs everything in its vicinity. One author put it this way: "Light shot at it falls in. A particle shot at it falls in [never to reemerge]. . . . In these senses the system is a black hole."[11] Although there are indications that black holes do exist, none have definitely been observed to date. Hopefully, if we ever do discover them, it will be from a safe distance — *or else.*

What bizarre and yet magnificent wonders the universe contains!

NORMAL STARS — The size of normal stars, how hot they are and their color depend on how much hydrogen fuel each star started its stellar life with. Light weight stars are cool and red. They have only enough fuel to burn slowly and dimly. Larger stars can support a more intense reaction and burn hotter and yellow. Larger stars still burn hotter, brighter and more bluish. The heaviest stars of all burn so intensely that their radiations are almost entirely in the ultra-violet range. Our sun is a modest yellow G-2-type star with a surface of 9700 °F., a diameter of 864,000 miles which gives off its maximum radiations as visible light. Illustration shows relative diameters and colors. Also listed are the surface temperatures (°F) and the brightness (times our sun).

FOOTNOTES

[1] Sir James Jeans, *The Universe Around Us,* 4th revised edition (New York, 1960), pp. 179-180.

[2] Fred Hoyle, *Frontiers of Astronomy* (New York, 1955), plate XXIX.

[3] Seymour Tilson, "Pulsars May Be Neutron Stars," *IEEE Spectrum* (February 1970), p. 55.

[4] Fritz Kahn, *Design of the Universe* (New York, 1954), pp. 60, 61.

[5] Roger Penrose, "Black Holes," *Scientific American* (May 1972), p. 38.

[6] Malvin A. Ruderman, "Solid Stars," *Scientific American* (February 1971), p. 24.

[7] Penrose, p. 38.

[8] Theoretically, when electrons and protons are driven together neutrons would be formed. Hence the name "neutron star."

[9] Tilson, p. 49.

[10] Tilson, p. 50.

[11] Remo Ruffini and John A. Wheeler, "Introducing the Black Hole," *Physics Today* (January 1971), p. 34.

its family of planets condensed out of a cloud of gas. The concept remained in vogue until the 19th century when it foundered on the rocks of advancing astronomical knowledge.

In more recent times, sophisticated instrumentation has enabled scientists to become much more aware of the immensity of space. As a result, theories merely for the origin of our tiny solar system have faded from the limelight of scientific speculation in favor of ideas concerning the origin of the entire universe.

Modern Theories

Serious scientific thinking on the origin of the universe began in the late 1920s. Astronomers then discovered that the cosmos was apparently rapidly expanding, in analogy like a giant inflatable rubber balloon. This led to the formulation of the "big-bang" theory. Today it is the most generally accepted model for the origin of the present universe.

Credited primarily to the late Russian-born astrophysicist, George Gamow, the big-bang theory stipulates that the universe had its beginning in a massive primordial cloud about 10,000 million years ago. In this cloud was an extremely hot, dense "soup" of the fundamental particles that now make up all the matter we observe in space. As originally conceived by Gamow, there was a giant explosion that formed — within minutes — all the elements of the universe. Since that time all the matter now condensed into stars, planets, etc., has been rushing outward into space in a giant expansion.

However, as time went on it became apparent that the initial big-bang could not totally account for the existence of many of the heavier elements found in the universe. In addition, little can or has been said concerning what initial force or energy was responsible for producing the super-hot temperatures and densities found in the initial "soup" of fundamental particles.

Current cosmological thinking now holds that the chemical elements were produced by nuclear reactions that are occurring in the interiors of most stars. But support for this theory primarily rests on limited earthbound laboratory observation and theoretical calculation — not on actual observation. There remains some uncertainty of what actually takes place deep inside stellar interiors.

An alternate to the big bang, although now more or less fallen from favor, is the steady-state theory. Steady-state proponents, as did many Greek thinkers centuries earlier, suggest that we are living in an eternal, never-ending universe that has always been here and always will be. There is no need for an initial creation process because, somehow, new matter has continually been created in order to maintain a balanced, stable universe.

Although considered to be a very attractive answer by many scientists for a number of years, steady-state thinking eventually ran into some awkward difficulties.

First of all, science has no observational evidence for new matter coming into existence naturally in space, although in the laboratory it has been possible to change energy into minute atomic particles in high-speed particle accelerators. Secondly, it is a well-established observational fact that the universe is undergoing an irreversible energy "rundown." Eventually it will figuratively "run out of gas." This is why steady-state thinking has speculated that new matter (and thus new sources of energy) are somehow slowly, constantly coming into existence.

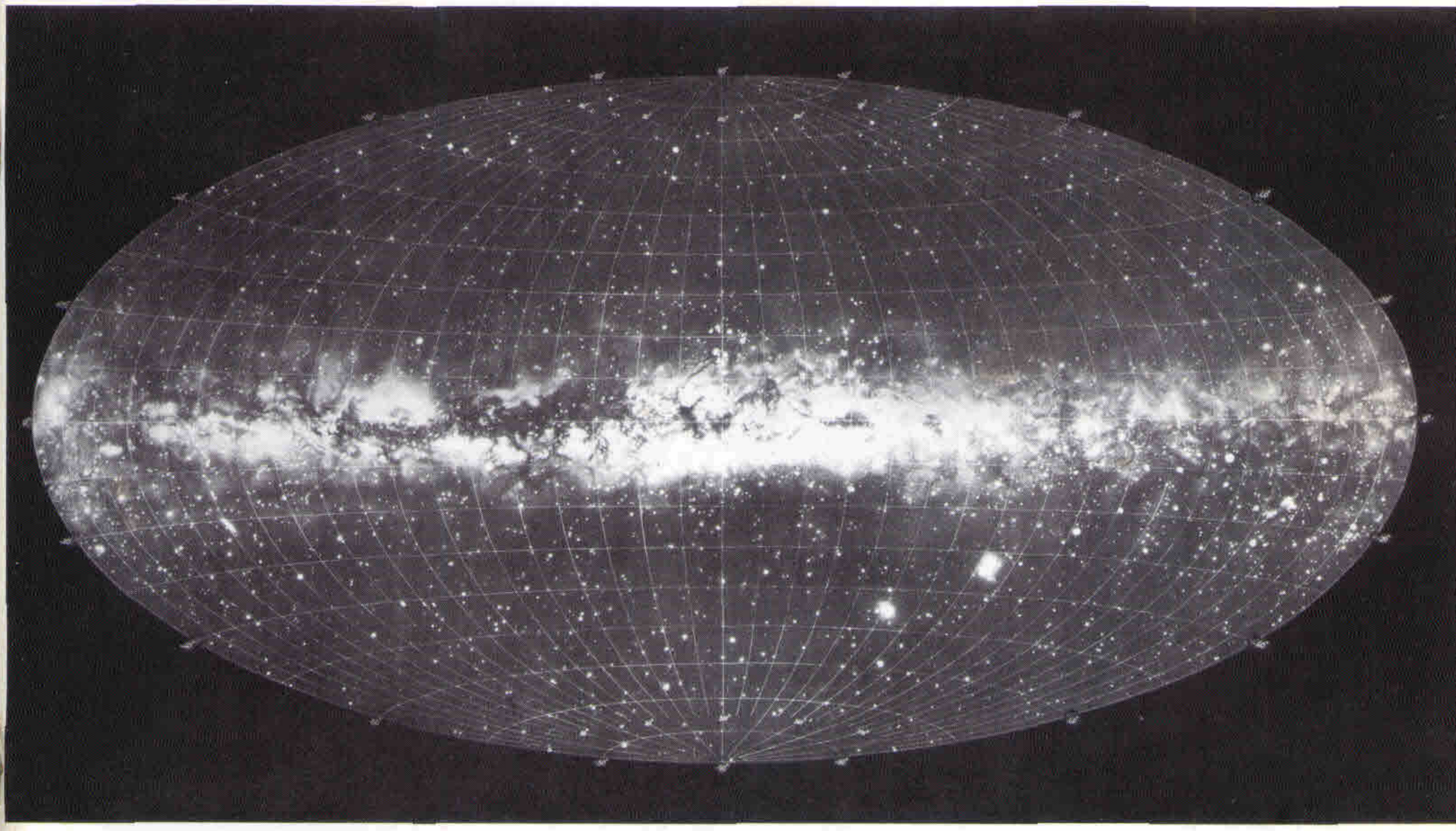
A third concept has been suggested that solves some of the gaps in the big-bang theory. Known as the oscillating-universe theory, it incorporates major aspects of both the big-bang and steady-state theories.

This concept suggests, like the steady-state theory, that the universe has always been here. But throughout time all the matter in space has alternately collapsed inward to form the giant cloud of the "big-bang" theory, only to explode again and begin rushing outward. In this way the universe has eternally oscillated between expansion and contraction. At present we are merely in one of the expansions.

Ultimate Origins Missing

And so, scientists continue to look for solutions. All of the great observatories are busy trying to determine which model, steady state, big bang, or a synthesis of the two, best fits the rapidly growing body of astronomical knowledge. Yet in all of it, most scientists recognize that they are not actually addressing the really important question of where the universe came from originally. All current investigation is aimed at establishing what happened once all the laws, matter, space, time and energy were already in existence. As the late astronomer Harlow Shapley said a few years ago:

> **We appear, therefore, to be rather helpless with regard to explaining the origin of the**



OUR GALAXY — the Milky Way. Never entirely visible to a single observer because we live within it, this reconstruction of our galaxy was created by two Swedish artists who spent years dotting in 7000 individual stars from photographs and painting in the nebulous areas. *Observatorium Lund Sweden*

universe. *But once it is set going,* we can do a little better at interpretation . . . . With bold advances in cosmogony we may in the future hear less of a Creator and more of such things as "antimatter," "mirror worlds," and "closed space-time."

Before his conclusion, though, he reflected:

Finality, however, may elude us. That the whole universe evolves can be our reasonable deduction, but just why it evolves, or from where, or where to — the answers to these may be among the unknowable.[4]

Robert Jastrow, director of the Goddard Institute for Space Studies, adds:

. . . Science offers no satisfactory answer to one of the most profound questions to occupy the mind of man — the question of beginning and end.[5]

James A. Coleman, professor of science and popular science writer, says:

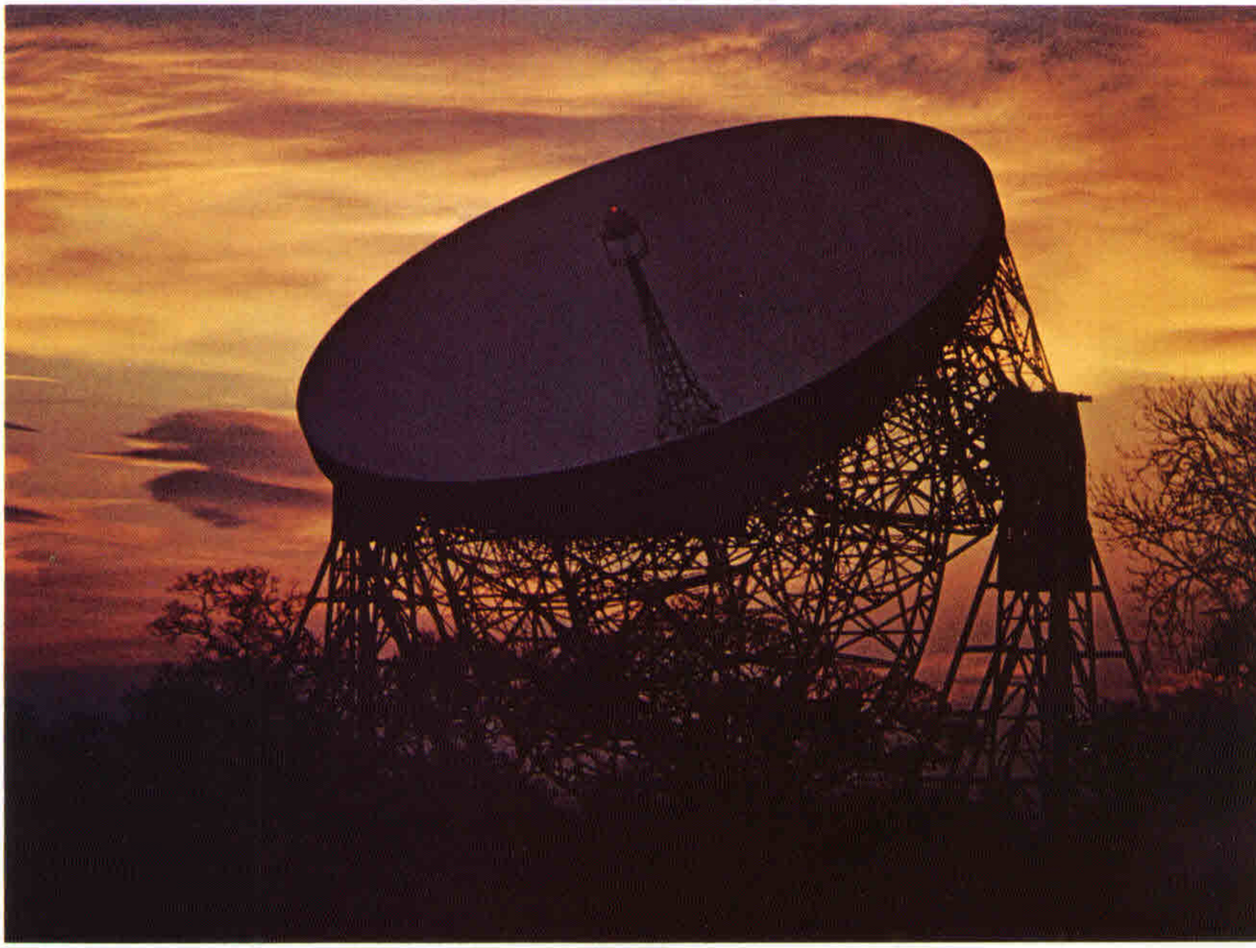
Modern cosmology and cosmogony, like other branches of science, are concerned with investigating the laws of the universe. They do not attempt to answer questions relating to an Original Cause — that is, where the laws of the universe came from or how they came into being.[6]

Fred Hoyle even feels that asking such questions as "Where did matter come from?" is meaningless.

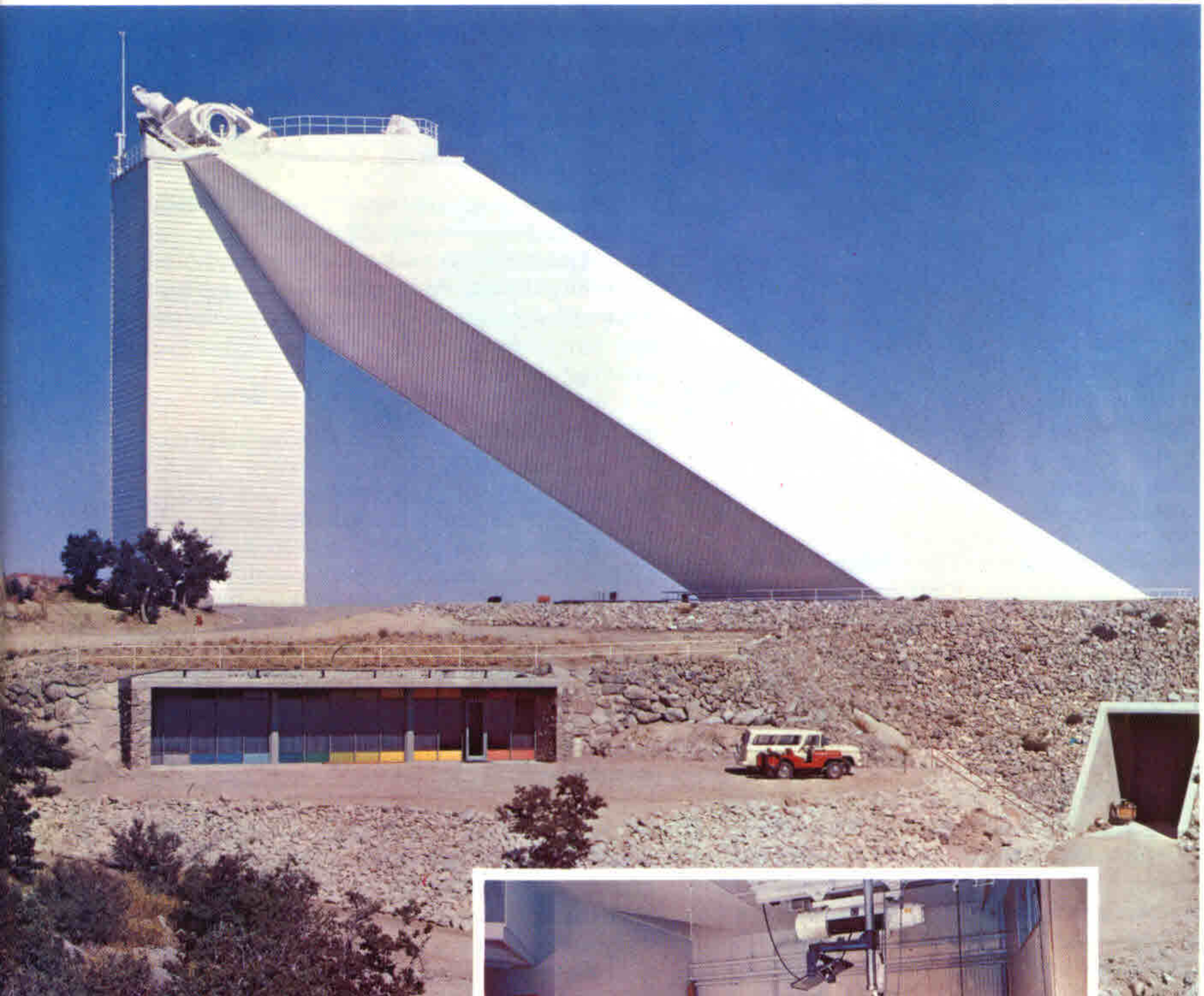
Why is there gravitation? Why do electric fields exist? Why is the universe?

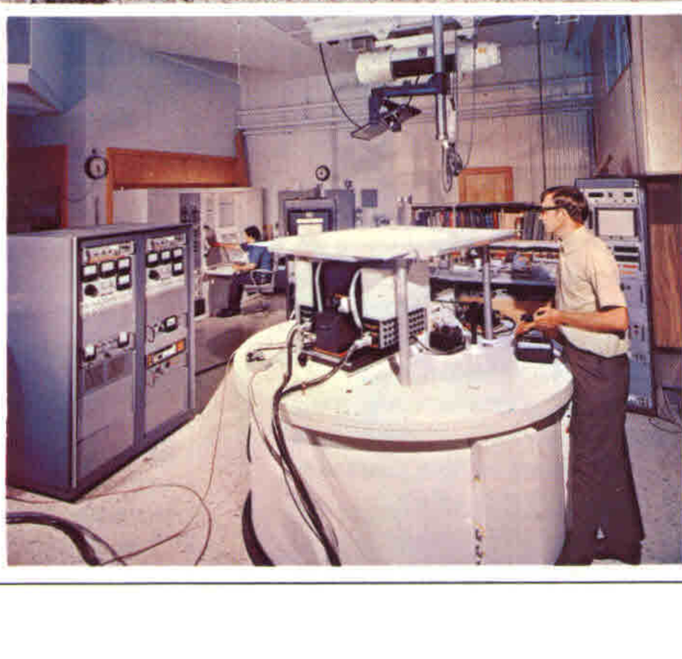
If we ask why the laws of physics . . . we enter into the territory of metaphysics — the scientist at all events will not attempt an answer . . . we must not go on to ask why.[7]

(Text continues on page 25)



Famous Eyes on Space





Three of astronomy's "big eyes." Upper left, England's Jodrell Bank, 250-foot steerable radio telescope. Left, 200-inch Hale optical telescope at Mount Palomar in California. Right, exterior and interior of the solar telescope at Kitt Peak, Arizona. Giant sophisticated instruments like these are dedicated to pushing the frontiers of man's knowledge ever farther into the immensity of deep space.

Upper left: Beardsmore — Ambassador College; Left: Portune — Ambassador College; Right: Kitt Peak National Observatory.

Modern Theories on the Origin of the Universe

PRIOR TO the 1920s relatively little was known about the structure of the universe outside of our own galaxy. Until that time there were no telescopes powerful enough to enable astronomers to probe the depths of space. But with the advent of the 100-inch reflecting telescope on Mt. Wilson, the curtain began to rise on the heavens beyond our Milky Way.

As the flood of new data came pouring in through the lenses of these newly constructed glass giants, astronomers began to engender a host of new theories to explain what they saw.

A Primordial Explosion

The first major theory to come out of this cosmological revolution was the big-bang hypothesis. The earliest version was introduced by the Belgian scientist Abbé Georges Lemaître in 1931. He postulated that the universe originated from a single stupendous primeval "atom" which he termed a "cosmic egg." This atom was so unstable that it disintegrated in a catastrophic explosion that sent its shattered fragments rushing outward into space.

However, Lemaître's theory failed to account for all the various elements currently found in the universe. And more fundamental weaknesses were: "How could a huge atom like this form, and where did it come from?"[1]

Most astronomers have admitted that Lemaître's theory has only historical value.

The more prominent "big bang" theory is the one put forth by George Gamow and others. In his hypothesis, Gamow speculated that the universe began with a huge primordial superheated cloud containing a "soup" of all the fundamental particles within one vast "atom." Temperatures in the cloud were on the order of several million degrees Fahrenheit. About ten thousand million years ago, there was a giant explosion. Within approximately 30 minutes all the particles in the exploded cloud combined to form all the elements in the universe. Hydrogen came into existence. Then came helium, beryllium, boron — and all the rest. The newly formed matter eventually cooled and condensed to form the galaxies, stars and other stellar phenomena which astronomers now see rapidly expanding into outer space.

Lithium Fizzles the Big Bang

As logical as all of this sounds, the Gamow big-bang theory runs into difficulties as early as the formation of the *third* element in the periodic table of 92 natural elements. Lithium, coming after helium in the classical periodic table of elements, is so unstable that it immediately reverses the reaction and breaks down into helium. Since lithium could not be formed by this type of reaction, it would prevent the big bang from proceeding to the next higher element in the periodic table. Consequently the formation of all the known elements from such an explosion would be impossible.

> **. . . There was a tendency to reject the above model [Gamow's Theory], and to make the half-joking remark that "Gamow's theory is a wonderful way to build up the elements all the way up to helium." Recent developments have indicated that this statement should be taken seriously.**[2]

Gamow's ten thousand million degree "soup" sounded good, but unfortunately "when Gamow and his collaborators got down to detailed calculations they met a snag that proved insuperable."[3]

Ralph Alpher and Robert Herman, Gamow's colleagues, discussed the problem:

> **The process could not go beyond helium . . . and even if it spanned this gap it would be stopped again at mass 8 . . . . This basic objection to Gamow's theory is a**

great disappointment, in view of the promise and *philosophical attractiveness of the idea.*[4]

Even if the big-bang reaction were possible, a more serious problem still remains: Where did the initial matter come from? Gamow himself admits that he takes the existence of matter for granted: "The story *begins*... with space uniformly filled with an unbelievably hot and dense gas...."[5]

Change in Theory

Gamow's fundamental concept of how the elements were formed has since been discarded by many leading cosmologists. They now feel that the elements were initially synthesized by nuclear reactions that apparently took place in the interior of stars.

The most basic and familiar of these reactions is the fusion of hydrogen atoms into helium, the same process that man has harnessed in the hydrogen bomb. When a star exhausts its supply of hydrogen, it theoretically would then use its helium in a "weightier" type of reaction that would produce yet a heavier element such as carbon or neon. Carbon and neon would in turn become fuel for yet another round of element-producing reactions. However, this chain of events can go no further than iron in the periodic table, so astronomers have postulated that the heavier elements were formed by a process known as "neutron capture."

In fact, four different types of reactions are necessary to complete the cycle of nuclear synthesis within the stars, and even then there are still shortcomings. For instance, certain light elements (deuterium, beryllium, boron, lithium) cannot be produced in stellar interiors, so cosmologists theorize that they were formed by a specialized process on the surfaces of stars. Also the relative abundance of elements observed in various parts of the universe does not always agree with expected results.[6] Another difficulty lies in the synthesis of helium. Cosmologists aren't in agreement on how it was formed. As one scientist put it:

Astronomy can therefore not yet claim to have settled this question [helium synthesis] which is so important for the nuclear origin of helium and the general understanding of the universe.[7]

Even assuming that these and other difficulties are ironed out, there is still one fundamental weakness to this whole approach of how the elements were formed. It is based on what theoretically *could* occur — not on a positive knowledge of what actually happened.

The Oscillating Theory

The oscillating universe theory was formulated to fill in some of the missing dimensions the big-bang theory seemed to lack. Unlike the big bang, it postulates that the universe has existed for an infinite length of time, and that presently observed outward expansion of the galaxies (presumably caused by a "big bang") is merely one phase of a type of continual motion.

According to this theory, matter in the universe cannot continue to expand indefinitely, but will eventually slow down and collapse under the pull of gravity, until it is dense enough to detonate another big-bang explosion. In this way the universe will alternately expand and contract in between each big bang.

Gamow again explains:

The Big Squeeze which took place in the early history of our universe was the result of a collapse which took place at a still earlier era, and the present expansion is simply an "elastic" rebound which started as soon as the maximum permissible squeezing density was reached.[8]

Gamow went on to say: "... Nothing can be said about the pre-squeeze era of the universe."[9]

It is claimed that the composition of the universe before the "Big Squeeze" was obliterated by the "bang," so we don't know what this pre-squeeze universe was like nor what laws governed it.

Most astronomers, however, admit that there is no known force in the universe — including gravity — strong enough to so dramatically reverse the motion of out-rushing galaxies. One author expressed it this way:

The question we have to answer . . . is what can have made the contraction slow down, cease, and change to expansion . . . we ask why the collapsing cluster of stars should slow down, stop, and then fly outward again.

At present, we have no answer: no physical mechanism which would reverse the contraction has yet been discovered.[10]

The oscillating-universe theory also has problems with the second law of thermodynamics. This law states that the universe is irreversibly proceeding from a state of order to one of disorder and dissipation. But the oscillating theory would somehow allow the universe to periodically "recharge" its batteries during its contraction phase instead of continually running down. This type of "perpetual motion" universe — like the fabled machine — just isn't possible.

Steady-State Cosmology

The big-bang theory dominated the field of cosmological thinking until the late 1940s. But by that time some leading astronomers had become dissatisfied with certain of its implications and proceeded to develop an opposing model of the universe known as the steady-state theory.

Originated by British cosmologists Hermann Bondi and Thomas Gold in 1948 and later expanded by Fred Hoyle, the steady-state theory maintains that the universe never really had an initial start. Instead, the creation process has gone on continuously throughout time.

Underlying the steady-state theory is a fundamental uniformitarian philosophy. One text puts it this way:

> **In the theory of continuous creation there is no necessity for any recourse to an Original Cause because the creation process is assumed to be an every-day process . . . .**
>
> **What, they ask, is so sacred about creation?**[11]

Steady-state advocates claim that new matter (hydrogen) is being spontaneously created out of nothing! They claim the amount could never be calculated or observed physically, so there is no way to scientifically prove if such a miracle is really occurring.

Laws of Thermodynamics

If the steady-state model is true, it would be in perpetual contradiction to one of the fundamental laws of physics. The idea of a continuous creation of matter violates the law of conservation of matter and energy. This law, known as the first law of thermodynamics, states that matter and energy can be transformed in various ways but cannot be created or destroyed.

Steady-state theorists reply however, that:

> **The universe, taken as a whole, constitutes a closed system within which the energy leaving the system in the matter disappearing over the edge is exactly counterbalanced by the energy introduced in the form of created matter.**[12]

They claim that the *total* energy of the universe remains constant even though new matter and energy are continually being created.

But the second law of thermodynamics sheds further light on the question of the "eternity" of the universe. This law demonstrates that the universe tends to "run down," or progress from a state of greater order toward a state of greater disorder and randomness. All processes in nature that we can observe are accompanied by an increase in what is known in thermodynamics as *entropy*. As the entropy of any system increases, the amount of available energy to do work decreases.

The second law of thermodynamics shows us that the amount of energy available for useful work in the universe is steadily decreasing and will eventually be all used up. The same total amount of energy will continue to exist, but more and more of it will be transformed into an unusable state.

This can easily be illustrated by examining any typical energy converter — such as the gasoline engine. The usable energy in the gasoline is transferred into heat, power, motion, etc. But this transformed energy, although it still exists in various states, is no longer available in a usable form. In addition, more total energy went into producing the gasoline (oil in its natural state) than was expended in the combustion process. In short, more energy went into the production of the gasoline, than we can get out of it.

Now, let's apply both the first and second laws of thermodynamics to the total universe. The first law says that the total energy level in the universe is constant. The second law says that of the total energy, more is constantly becoming unusable. Consequently, there is a limit to how long the available energy in the universe will last. The process cannot go on indefinitely, or the universe would figuratively "run out of gas." This means it is impossible for the universe to have existed for an infinite period of time as the steady-state theory maintains.

The aging process of stars is another good example. In the course of its nuclear combustion a star gradually builds up an accumulation of degenerate nuclear waste which is subsequently re-used, but in a less efficient type of fusion process. Ultimately when the residue material, through a progressive series of nuclear reactions, reaches a certain atomic weight, the energy conversion process can go no further and the star dies.

For stars that undergo a more catastrophic aging process, much of their energy is dissipated in a climactic "supernova" explosion. The residue star, whether neutron or white dwarf, simply calls on the last dregs of its stellar energy in order to actively maintain itself. But these prolific energy producers eventually flicker out and die as well.

The foregoing simply demonstrates that the energy of the universe is being consumed in an irreversible one-way downhill process. According to Sir James Jeans, the noted British astronomer:

> **Energy cannot run downhill forever, and like the clock weight, it must touch bottom at last. And so the universe cannot go on forever, sooner or later the time must come when its last erg of energy has reached the lowest rung on the ladder of descending availability, and at this moment the active life of the universe must cease. The energy is still there, but it has lost all capacity for change; it is as little able to work the universe as the water in a flat pond is able to turn a waterwheel.**[13]

Lincoln Barnett, the author of *The Universe and Dr. Einstein,* likewise stated:

> **All the phenomena of nature, visible and invisible, within the atom and in outer space, indicate that the substance and energy of the universe are inexorably diffusing like vapour through the insatiable void. The sun is slowly but surely burning out, the stars are dying embers, and everywhere in the cosmos heat is turning to cold, matter is dissolving into radiation, and energy is being dissipated into empty space. . . . And there is no way of avoiding this destiny. For the fateful principle known as the second law of thermodynamics, which stands today as the principal pillar of classical physics left intact by the march of science, proclaims that the fundamental processes of nature are irreversible. Nature moves just one way.**[14]

Barnett went on to say:

> **. . . If the universe is running down and nature's processes are proceeding in just one direction, the inescapable inference is that everything had a beginning; somehow and sometime the cosmic processes were started . . . .**
>
> **Most of the clues, moreover, that have been discovered at the inner and outer frontier of scientific cognition suggest a DEFINITE TIME of Creation.**[15]

All roads of scientific evidence, then, point toward a time of definite beginnings, the steady-state theory notwithstanding.

With the discoveries of quasars, radio galaxies, and other evidences of large scale variations within the universe, the weight of scientific opinion has shifted decidedly against the steady-state theory. Under mounting observational pressure, Fred Hoyle announced in late 1965 his "radical-departure hypothesis." Hoyle retained the idea of continuous creation but allowed for deviations from a steady-state situation in "local" areas of the universe. And since, he says, we cannot see out beyond our local "bubble," it is difficult to prove or disprove the theory from an observational standpoint.

Matter and Antimatter

Recent speculation about the strange substance called "antimatter" has given rise to another cosmological theory. The antimatter concept was originated by Swedish physicist Oskar Klein and later expanded by Hannes Alfvén, an astrophysicist also from Sweden.

Essentially "antimatter" consists of atomic particles which are exactly the opposite in composition to the electrons and protons we are familiar with. Normal matter as we know it consists of positively charged protons and negatively charged electrons. "Antimatter," on the other hand, contains *negatively* charged protons (antiprotons) and *positively* charged electrons (positrons). Particles of matter and antimatter cannot coexist because they would mutually annihilate each other if they were to collide.

According to the antimatter theorists, the universe began with a thin cloud of what is known as *ambiplasma,* consisting of both matter and antimatter. As the cloud contracted due to gravitational forces, the particles of matter and antimatter began to mix and started the annihilation process. This resulted in the generation of intense heat and nuclear energy which tended to counteract the contracting effect of the gravitational forces. As the annihilation process increased, it forced the ambiplasma to expand and ultimately resulted in the formation of three separate regions of the universe: an area of regular matter, one of antimatter and a buffer zone in between.

The separation of matter and antimatter is crucial to the success of such a formation process. Galaxies, stars, etc., could not be formed if the two types of matter remained in close proximity because mutual annihilation would result.

As Hannes Alfvén, one of the leading proponents of the antimatter theory, stated:

> **One stumbling block is that separation [of matter and antimatter] on a large scale demands transportation of koinomatter [regular matter] particles over huge distances away from the particles of antimatter. Considering the time and the forces available, it is unlikely that the transporting mechanisms could cope with such a task.**[16]

Alfvén did go on to say that separation could occur with a modest start and proceed from there. However, he concluded this particular section by stating:

> **. . . All these processes have still to be analyzed in depth; until then, our discussion cannot be more than loosely speculative.**[17]

As with the other theories, we ask where did the original matter (ambiplasma in this case) come from? Alfvén also commented on this question:

> **We do not venture to say how the cloud of ambiplasma [what Klein's theory starts with] originated . . . we simply assume the existence of the cloud and go on to show that by gravitation it would begin to contract very slowly.**[18]

(We might also add, he is assuming the existence of a contracting gravitational force as well.)

There's a fundamental reason why scientific theory cannot adequately account for the existence of the universe. It involves a missing dimension that is noticeably absent from scientific speculation. It is introduced and explained in the main text. When all the dust — or antimatter, ambiplasma, and super-eggs clears, we are left with *no scientific answer* to our original question — "Where does it all come from?"

FOOTNOTES

[1]William Bonnor, *The Mystery of the Expanding Universe* (New York, 1964), p. 115.

[2]A. G. W. Cameron and Stephen P. Moran, "Relativistic Astrophysics," *Science* (September 29, 1967), p. 1517.

[3]Bonnor, p. 113.

[4]William A. Fowler, "The Origin of the Elements," *Scientific American* (September 1956), pp. 87-88.

[5]George Gamow, *The Birth and Death of the Sun* (New York, 1952), p. 203.

[6]W. David Arnett, Carl J. Hansen, J. W. Truran and A.G.W. Cameron, ed., *Nucleosynthesis* (New York, 1968).

Lawrence H. Aller and Dean B. McLaughlin, ed., *Stars and Stellar Systems: Stellar Structure,* Vol. VIII (Chicago, 1965).

Albrech O. S. Unsöld, "Stellar Abundance and the Origin of the Elements," *Science* (March 7, 1969), pp. 1015-1025.

[7]Donald D. Clayton, "The Origin of the Elements," *Physics Today* (May 1969), p. 29.

[8]George Gamow, *The Creation of the Universe* (New York, 1961), p. 29.

[9]Gamow, *The Creation of the Universe,* p. 30.

[10]Bonnor, p. 121.

[11]James A. Coleman, *Modern Theories of the Universe* (New York, 1963), p. 194.

[12]Coleman, p. 165.

[13]Sir James Jeans, *The Universe Around Us,* 4th revised edition (New York, 1960), p. 279.

[14]Lincoln Barnett, *The Universe and Dr. Einstein* (New York, 1948), p. 99-100.

[15]Barnett, p. 103.

[16]Hannes Alfvén, *Worlds-Antiworlds* (San Francisco, 1966), p. 85.

[17]Alfvén, p. 85.

[18]Hannes Alfvén, "Anti-Matter and Cosmology," *Scientific American* (April 1967), p. 109.

Ancient Theories

Diodorus of Sicily, writing about the time of Christ, tells us:

"Now as regard the first origin of mankind, two opinions have arisen among the best authorities both on nature and history. One group, which takes the position that the universe did not come into being and will not decay, has declared that the race of men also has existed from eternity, there having never been a time when men were first begotten; the other group, however, which holds that the universe came into being and will decay, has declared that, like it, men had their first origin at a definite time.

"When in the beginning . . . . the universe was being formed, both heaven and earth was indistinguishable in appearance, since their elements were intermingled: then, when their bodies separated from one another, the universe took on in all its parts the ordered form in which it is now seen" (*Diodorus Siculus,* Book 1, section 6).

Plato wrote:

"Fire and water and earth and air, they [the philosophers and scientists of the ancient world] say, all exist by nature and chance . . . . and by means of these, which are wholly inanimate, the bodies which come next — those, namely, of the earth, sun, moon and stars — have been brought into existence . . . . in this way and by these means they have brought into being the whole Heaven and all that is in the Heaven, and all animals, too, and plants — after that all the seasons had arisen from these elements; and all this, as they assert, not owing to reason, nor to any god or art, but owing, as we have said to nature and chance" (*Dialogues,* Laws X, section 889).

But is it really meaningless for an astronomer to ask why?

Harlow Shapley made this pointed observation:

Now we ask the grand questions: "What is the ancestor of the hydrogen atom?" [the assumed starting point of the universe] and "What is the destiny of the metagalaxy?" [universe]. We ask the questions — [but we] get no reply![8]

Lincoln Barnett, writer of science books for the layman, tells us:

Cosmologists for the most part maintain silence on the question of ultimate origins, leaving that issue to the philosophers and theology.[9]

Another author, Dean W. Wooldridge, is a little more emphatic.

But what *is* [emphasis theirs] gravity, really? What causes it? Where does it come from? How did it get started? The scientist has no answers . . . Science can *never tell us* WHY the natural laws of physics exist or where the matter that started the universe came from. It is good that our ancestry INVENTED the concept of the supernatural, for we *need it* if we are to answer such questions.[10]

Dr. Jesse L. Greenstein, astrophysicist at California Institute of Technology, said in regard to the origin of the universe: "It is a terrible mystery how matter comes out of nothing. Could it have been something outside science? We try to stay out of philosophy and theology, but sometimes we are forced to think in bigger terms, to go back to something outside science."[11]

The Missing Key

If our knowledge of the universe and our place in it is to have a comprehensive foundation, we must begin to recognize that science does not provide all the answers. What it does provide is of course important. But no matter how noble and precise the efforts of science may indeed be, there is a limit to how far science can go.

Science is physical. Any conclusions drawn on scientific investigations can also only be physical. That is not to demean science. But if man expects

(Continued on page 30)

How Old is the Universe?

IN THE last several decades the lay public and scientists alike have witnessed numerous changes in the estimated age of the universe. At the beginning of the 20th century astronomers thought the universe to be millions of years old. Since that time, estimates have jumped into the billions (thousand millions) of years. But just how much do scientists know? To find out, let's briefly examine the background of some of the figures currently in vogue.

Prior to the 1920s little was understood concerning the structure and size of the universe as a whole. Until that time optical telescopes had been too weak to enable astronomers to determine whether some of the distant celestial formations were single stars, nebulae, or galaxies.

The first major clue in unravelling some of these cosmic puzzles came in 1912 when an assistant at the Harvard Observatory, Henrietta Leavitt, discovered that variable stars, known as Cepheids, fluctuated according to how bright they were. Other astronomers such as Ejnar Hertzprung and Harlow Shapley were quick to realize the implications of Miss Leavitt's discovery. In effect, it meant that the Cepheid variables could be used as a type of cosmic yardstick to gauge the distances of various celestial formations.

Using the Cepheid discovery, Shapley was able to establish the form and dimensions of our home galaxy, the Milky Way. Once the Milky Way was mapped, astronomers focused their attention on the many stellar formations that appeared to be outside its confines. Cosmological opinion was sharply divided on this issue. Many astronomers felt that the distant nebulae and novae that were in question were not so "distant" after all, but were located inside the boundaries of the Milky Way.

The controversy that followed was suddenly and dramatically ended in 1925 when Edwin Hubble of the Mount Wilson Observatory surveyed the heavens for the first time with the newly constructed 100-inch telescope — then the largest in existence. Hubble discovered that the distant celestial formations were indeed "island universes" located deep in the vast reaches of outer space, far beyond the confines of our own galaxy.

Hubble went on to analyze the light emitted by these distant galaxies and found that virtually all of them were moving away from us at colossal speeds. The "red shift" observed in their light spectrum indicated that many were rapidly receding at tens of thousands of miles a second. This meant that the universe was apparently expanding like a giant rubber balloon.

Hubble then calculated how long this expansion would have been going on and came up with an estimated age of the universe at 1.8 thousand million years! But in short order even this figure was shown to be too low.

Geologists, using radioactive minerals, independently derived an age for the earth of about 4.7 thousand million years. But how could the earth be older than the universe? Further investigation in the 1950s revealed an error in one of Hubble's assumptions which when corrected pushed his estimate up to the currently accepted figure of about 10 thousand million years. This figure has been generally accepted by scientists and astronomers since that time.

Another method cosmologists have used to measure the age of the universe resulted from the discovery of background microwave radiation by two Bell Telephone Lab engineers in 1965. Cosmologists theorized that this radiation was the residue of the big-bang fireball which supposedly occurred millions of years ago. By comparing the energy level of this radiation with the assumed energy level in the fireball, they were able to calculate how long it has been since this hypothetical explosion occurred. Their solution basically agreed with that of other cosmologists who had estimated the age of the universe using Hubble's red shift principle.

But this observational data on the age of the universe is far from being conclusive. In the first place, scientists have yet to confirm whether the wave-length patterns of the background radiation conform to theoretical expectations. Secondly, background microwave measurements made outside the earth's atmosphere in 1968 were about 30 times higher than those initially measured. And more important still is the fact that this method of estimating cosmic age is based on two giant assumptions: 1) that there was a big bang, and 2) even given a big bang, that its initial temperature or energy level is correctly known.

A Young Universe?

Other observational methods used by astronomers pose further questions concerning cosmic age. One such method is based on observation of groups of stars known as globular clusters. The larger more densely populated clusters give evidence of having existed for as long as 25 thousand million years, while, on the other hand, many smaller clusters appear to be vastly younger. Theory predicts that the stars of these smaller, less densely populated clusters ought to have long since wandered off from their stellar moorings, eventually resulting in the disintegration of the cluster. Since the universe obviously still possesses many such stellar units, this would suggest a younger age.

Astronomers have found additional indications of youth in what are believed to be recently formed stars, the T-Tauri variables. T-Tauris may be so young that they have not even entered into normal active existence as a star. This would make some of them as young as a mere few thousand years old.

And still another indication of a possibly young universe exists in the many hot, fast-burning stars visible in the night sky. These "super blues," as they are sometimes called, are consuming their hydrogen fuel like nuclear spendthrifts. They would have long since expended their supplies had they been formed thousands of millions of years ago.

In attempting to reconcile some of these vast age differences, cosmologists suggest that the universe might possibly have experienced a progressive re-generation cycle where new stars were, and possibly still are, being formed. This would seemingly account for the wide diversity of apparent ages that are currently in evidence among various members of the stellar population. But while this is a convenient way to dispose of the problems in theory, observational evidence for such a process has been disappointingly lacking so far.

It should be fairly obvious that scientifically estimating the age of the universe is currently a fairly speculative business. No one really knows yet how old the universe is. And interestingly enough, these age estimates, whether "young" or "old," in no way conflict with the biblical account of creation. The 6000-year age for the earth often erroneously associated with Genesis 1 has been arrived at because of a fundamental misinterpretation of the biblical account. When properly understood, the Bible leaves a great degree of latitude for both the age of the earth and the universe.

The great nebula in Orion. A recent photograph taken at Stonyridge Observatory in California. The 30-inch reflecting telescope and observatory facilities were built entirely on an amateur basis, showing the potential of astronomy to enthusiastic individuals.
Thomas and Cram

Life in Outer Space?

STARING INTO the starry blackness of night, men have long wondered if mankind is alone in the universe. Astronomers believe the odds are that many other planets like the earth exist in the remoteness of space revolving around stars similar to our sun. With so many billions upon billions of stars in the heavens, it seems only logical that life too could exist beyond the earth — some of this life perhaps even superior to ours.

But are the chances for life in outer space actually as plentiful as many people assume? Or have we overlooked a few pertinent facts?

The Right Star

All life on earth, as biologists well know, ultimately derives its vital forces from energy that once originated in the sun. Therefore, one fundamental prerequisite to any potential life-supporting system is the right type of star or sun. Not just any run-of-the-mill star can qualify as a suitable candidate.

Astronomers have noted that stars show a remarkable range of size and type. They have in fact created a type-scale that categorizes them from huge, hot, fast-burning blue stars down to the tiniest red dwarfs scarcely the size of our earth. Our sun falls almost exactly in the middle of the scale — a G-type yellow star.

When beginning to consider a star as a potential sustainer of life, one immediately recognizes that only middle-sized stars like our sun are capable of giving off the optimum type of radiation. Stars toward the hot-blue end of the range disqualify themselves because they emit a lethal proportion of ultraviolet and higher-energy radiation. In a contrasting manner, stars near the cool-red end of the scale give off too little visible radiation to be suitable. This leaves, as one research showed, only about 13 percent of all stars in an optimum category.[1]

Of this 13 percent, we would have to eliminate another three fourths, which belong to multiple star groups.[2] A planet orbiting a double or multiple star group would most likely have an orbit far too eccentric and irregular to maintain an adequate temperature range to reasonably support life. In addition, because multiple-star systems normally consist of different types of stars (white and red, yellow and red, etc.) any hapless planet would be bombarded with a wide variety of radiation too irregular for the support of life forms as we know them.

With the multiple-star groups removed from consideration, we're left with only 3 percent of the stellar population as potential supporters of life.[3]

Suitable Planet Needed

But we need more than just a suitable star. It also takes the right-sized planet at the right distance from that sun.

Smaller planets fail the test due to their inability to retain an atmosphere. Larger, more massive planets fall into the other ditch because they tend to retain the heavier, more lethal gasses such as methane and ammonia.

In addition to all of this, we also need the following: The planet must receive an even amount of radiation from its sun. That means a near circular orbit. To keep surface temperature from varying too far outside a life-supporting range, the planet must have a rotational period about a maximum of every 100 hours. Also required is an optimum distance from planet to sun, and the right tilt of the planetary axis to ensure an even distribution of temperatures. An extreme tilt of the axis, or an inadequate rotational speed, would result in intolerable heating in some areas and bitter cold in others.

So while probabilities for all of these factors combined are difficult to calculate, it is interesting to realize that the real chances of life in outer space could actually be far lower than usually suggested. This becomes even clearer from the following evidence.

Our Unique Planet

As it turns out, our earth, the only known life-supporting planet in the universe, "defies the odds" in a number of other areas that are sometimes overlooked in figuring the chances for the occurrence of life. One of our biggest "long shots" is water. For instance:

> **. . . In the universe as a whole, liquid water of any kind — sweet or salt — is an exotic rarity . . .**
>
> **For contrary to common belief, the liquid state is exceptional in nature; most matter in the universe seems to consist either of flaming gases, as in the stars, or frozen solids drifting in the abyss of space. Only within a hairline band of the immense temperature spectrum of the universe — ranging through millions of degrees — can water manifest itself as a liquid.**[4]

Water and plenty of it is the very life blood of our existence here on earth. And our earth is lavishly and possibly uniquely bathed in it.

Not only is the existence of H_2O on the earth unique, but the fact that it exists in a liquid state. How do you calculate the probability of the "coincidence" of life as we know it and the liquid state existing in the same temperature range? The answer is, you don't. As Lincoln Barnett, the author of the article "The Miracle of the Sea," stated: *"It is surely no accident* that life as we know it exists only within this same tenuous temperature band."

But that's not all.

The Correct Atmosphere

Our terrestrial atmosphere is quite different from what one would normally expect in the universe.

> **The signal fact is that rare gases [argon, xenon, etc.] are present here in only small amounts, much smaller than those known elsewhere in the universe. At the same time, oxygen, nitrogen, carbon dioxide and water vapor are present in much greater abundance than elsewhere . . .**
>
> **These [analysis of meteorites] show that the rare gases are present here in only a few millionths to a billionth of their cosmic abundance.**[5]

This would account for something like a million-to-one probability factor since that's how rare such gases are compared to the rest of the universe.

The same uniqueness holds true for our solid elements. Ninety-nine percent of all the matter in the universe is of the two lightest elements, hydrogen and helium. All other elements put together account for only 1% of the total. Yet hydrogen makes up only about 0.9% of the earth's composition, while helium appears only in miniscule amounts within the earth's crust. On the other hand, oxygen, silicon, aluminum, and iron which make up less than 1% of the universe account for over 85% of the earth's composition. These proportions are wholly non-typical and totally exceptional to our planet.

The list of such unusual factors actually has almost no end. And even if we were to assume that a proper planetary environment was achieved, this does not automatically guarantee that organisms will be found living in that environment. The odds for that are infinitesimally smaller yet.

Though some would say that any such estimates are overly simplified and scientifically meaningless, remember that it is on the same basis that scientists confidently tell the public that life in space is scientifically probable. So at least, these factors do serve to illustrate the point that very precise and exacting conditions are required before even the simplest living organism would be able to survive. And knowing what we do about our planet, with its optimum conditions for supporting life, its ideal size, tilt, and rotation rate, its unique composition of elements with its superabundance of water, all powered and energized by a stable, middle-range star that emits its energy dominantly in the visual range — does it follow, then, that life on earth was formed by a *cosmic accident?* Not without a lot of wishful thinking.

[1]Isaac Asimov and Stephen H. Dole, *Planets for Man* (New York, 1964), p. 147.

[2]David Bergamini and the Editors of *Life, The Universe* (New York, 1962), pp. 112, 125. V. A. Firsoff, *Life Beyond the Earth* (London, 1963), pp. 256, 257.

[3]While astronomers may give lower figures on the percentages of stars that are multiples, the *overall* proportion of stars that are suitable for a life-supporting system is still listed in the vicinity of one to five percent.

[4]Lincoln Barnett, "The Miracle of the Sea," *Life* (February 9, 1953), p. 58.

[5]Helmut E. Landsberg, "The Origin of the Atmosphere," *Scientific American* (August 1953), p. 82.

to gain a knowledge of ultimate purposes, he must recognize as do many scientists the absolute need of additional knowledge from an outside source.

There are many important issues in man's real world that are based on criteria beyond the physical and scientific world. Any truly educated man needs to avail himself of the evidence of this intrinsic fact.

That is why man by science alone is unable to totally ascertain how the universe came into being.

We humans, no matter how brilliant, cannot know the whole answer by science alone. No man was on the scene when the universe began. And we can't return to that time. Therefore, if our knowledge of beginnings is to have comprehensive meaning, it must not disregard the evidence of divine REVELATION.

The biblical record describes a Personage who claims to have answers of how to make the story complete. He says He is the Creator of human beings, the Originator of the universe. He claims power to intervene in the affairs of men and nations.

In Genesis 1:1 we are told by *revelation* — "In the beginning God created the heavens and the earth." This is frankly the only answer available that rests on authority. The solutions of science offer only ignorance of ultimate origins. God's Word is the only way to complete the picture.

The Patriarch Job understood this:

> **He [God] is wise in heart, and mighty in strength . . . which alone spreadeth out the heavens . . . which makes Arcturus, Orion and Pleiades (Job 9:4-9).**

Again, through the Prophet Isaiah, God reveals Himself as the supreme architect of the universe.

> **To whom then will ye liken God? . . .Have ye not known? Have ye not heard? . . . It is he that sitteth upon the circle of the earth, and the inhabitants thereof are as grasshoppers; that stretcheth out the heavens as a curtain, and spreadeth them out as a tent to dwell in (Isa. 40:18, 21-22).**

This same God promised Abraham in Genesis 22:17 that his seed would be "as the stars of the heaven, and as the sand which is upon the sea shore." Clearly God was not speaking of a small, localized universe consisting of only a few thousand stars.

God's Word, then, has the foundation — the beginning — of why the universe is here and where it came from.

David tells us that the existence of the universe demonstrates God:

> **The heavens declare the glory of God; and the firmament sheweth his handywork (Psalm 19:1).**

The Bible is full of statements declaring emphatically that God created the universe; that He made man, our earth and the eco-systems around us. The truth of this awesome universe's true origin only comes clear to the man with the willingness to consider biblical revelation, and the courage to place himself in harmony with the laws of the Creator God. □

1. Peter Millman, *This Universe of Space* (Cambridge, Ma., 1962), pp. 15-16.
2. Fred Hoyle, *Astronomy* (Garden City, New York, 1962), p. 232.
3. *Encyclopaedia Britannica*, "Solar Energy, Utilization of," Vol. 20 (Chicago, 1970), p. 854.
4. Sol Tax, ed., *The Evolution of Life: Evolution After Darwin*, Vol. I (Chicago, 1960), p. 33.
5. Robert Jastrow, *Red Giants and White Dwarfs* (New York, 1967), p. 57.
6. James A. Coleman, *Modern Theories of the Universe* (New York, 1963), p. 197.
7. Fred Hoyle, *Frontiers of Astronomy* (New York, 1955), p. 342.
8. Harlow Shapley, *Beyond the Observatory* (New York, 1967), p. 30.
9. Lincoln Barnett, *The Universe and Dr. Einstein* (New York, 1948), p. 105.
10. Dean Wooldridge, *The Machinery of Life* (New York, 1966), p. 4.
11. Los Angeles *Times*, July 30, 1961, Vol. LXXX, Section E, pp. 11, 15.

Why Were You Born?

If man is at all sensitive to the REALISM of the universe around him, he cannot ignore the fact that human beings could not be the result of freak chance spawned from mindless matter, but the unique creation of a greater intelligence than his own.

The only logical answer that really satisfies all the demands of what man encounters is that man was designed, his environment was planned, and therefore there is a definite *reason* for man's existence.

What is man? Why is man? What is this vast universe all about? The answers are clearly revealed by the One who made man. They are revealed in the Instruction Book that goes along with the product.

Are you willing to at least take a look?

Here is a book that asks the BIG questions: What is man anyway? What is his purpose and ultimate goal? Why is he here? Where did he come from? This book — the Bible — asks: "What is man, that thou art mindful of him? or the son of man, that thou visitest him?" (Heb. 2:6.)

The God who speaks in this book doesn't leave man without an answer. He reveals: I have made man a little lower than the angels, but I have given him a measure of glory and honor. I have made him to have DOMINION OVER THE WORKS I HAVE MADE (verse 7).

This passage of scripture continues: "Thou hast put ALL THINGS in subjection under his [man's] feet. For in that He [God] put ALL in subjection under him [man], He left NOTHING that is not put under him" (verse 8).

It is therefore right for man to look out into the vastness of the creation with its endless scope and contemplate dominion over it. God intends it that way.

But, it ought to be clear by virtue of the limitations of his physical makeup and the vastness and fathomless distances of space that he is simply not equipped in his present *form* to have dominion over ALL that he sees "out there."

Again, God does not leave man without an answer.

Continue with verse 8: "But NOW we see NOT YET all things put under him [man]."

Yes, man's present capacities and conditions are *not adequate* for a job that big. Man has done too wretched a job on his own planet to be allowed, now, to spread his unsolved problems, lusts and vices around the universe.

Parallel with his premature efforts to move out into the universe, the degeneracies and problems on earth have proliferated. It is now possible by several different means to annihilate all human life from the face of planet earth. God is not going to permit this kind of leadership and rulership to permeate His creation.

Soon God must intervene in world affairs and enforce peace and order here on earth. Then men will learn the kind of life God wants spread throughout His creation.

Mankind will undergo a change once these lessons are learned. God will impart to men sonship in the Family of God (I John 3:1-2).

Men, transformed, will then be ready for the purpose for which God originally created them — to have dominion over the works of His — God's — hand.

If you would like to understand more of the magnificent plan of the great God whose purpose is being worked out here on this "good earth," write for your free copy of our booklet titled *Why Were You Born?*

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