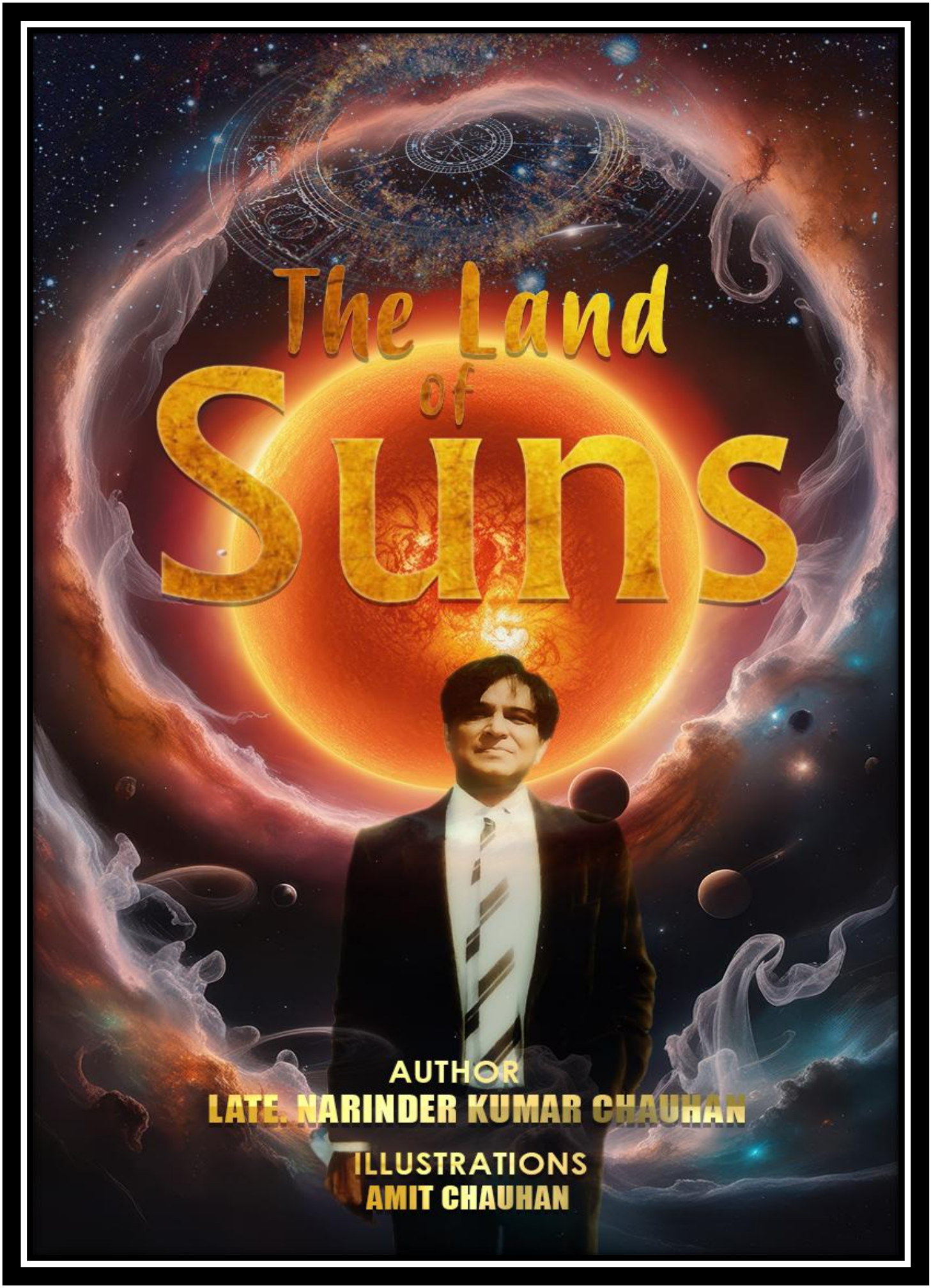
The Land
of
Suns
AUTHOR
LATE. NARINDER KUMAR CHAUHAN
ILLUSTRATIONS
AMIT CHAUHAN

The Land Of Suns

BY

NARINDER KUMAR CHAUHAN

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Artwork & Illustrations: Amit Chauhan

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Summary: Thirty years ago, the late Mr. Narinder Kumar Chauhan penned this book, but due to his untimely passing, it remained unpublished. Now, after three decades, his family has lovingly brought it to life, meticulously updating and refining the original content, and presenting it with entirely new illustrations, design, and artwork. This long-awaited release pays tribute to the author's legacy and brings his vision to a new generation of readers. It is a story of the universe — how the universe began, stars formed and how they shine and die. Also contains information about some of the biggest stars, star galaxies, constellations and our own solar system.

CONTENTS

ABOUT THE BOOK

More exciting than any fairy tale is the story of stars and Planets. It attracts both young and old. Long ago my mother told this story to my children. They were thrilled by it and have never forgotten it. Such was the charm of her story and the timeless wonder of these heavenly bodies.

The original story has been updated and retold in these pages to introduce young readers to the amazing worlds above us. What the heavens contain and how its complex machinery works is, in many ways, a mystery. It is difficult to comprehend that stars are suns and what we see in the sky is a vast land of suns. The enormous size of these bodies and the immense distances which separate them are also beyond the imagination. The information contained in this book may convey their intrinsic nature. Our sun and planets are part of these amazing worlds. It is difficult to imagine that many suns are thousands of times brighter than our sun and the incredible gift we receive from stars when they die. The sky is also adorned with 'heavenly frescoes' that we call constellations. The classical lore associated with their shapes enlivens these distant beacons of light. This story covers these fascinating aspects.

It is hard to fully capture nature's drama in heaven. A small part of it is presented here that may unfold a world of fantasy and delight to the young readers. They may find the narrative entertaining to grasp the basic information which is the objective of this story.

ONE

STARS ARE SUNS

Look at the stars above. That's the land of suns. All the stars you see are actually suns. There are so many stars in the sky that nobody can count. You can see only a few thousand. Many more - millions, billions and trillions are beyond our sight. What is a trillion? If you add six zeros after a one, it makes a million (written as 1,000,000). A thousand million make a billion (i.e., nine zeros after one) and a thousand billion make a trillion. In a trillion, one is followed by twelve zeros

(1,000,000,000,000).

But there are not just a million or billion stars in the land you see above. There are trillions and trillions of them. Some people say there are as many stars as there are grains of sand on all the beaches of the world. Nobody knows the exact number, because that is one place where nobody can ever reach. The stars are not cold as they appear. They are hot suns, very hot, hotter than anything you can imagine. You cannot go even within several million miles from them, even if you find a magic horse to fly on.

Actually we should call our sun a star but we have always called it a sun. We probably do so because it does not look like a star. Being the nearest star, it locks bigger and brighter than all the rest. Even so, it is 93 million miles (150 million kilometers) away. Its heat and light are unbearable. Imagine how hot it would be if we went close to it. The other stars are far too distant, trillions of miles/kilometers beyond the sun. Their heat does not reach us. We can only see their light.

Let me tell you another thing about the stars. They are not solid bodies like our earth, which we can walk on. They are all huge balls of burning gas, mostly hydrogen gas.

There are many stars which are bigger and hotter than our sun. There are also many which are smaller and colder. If you look at the stars carefully, you will notice they are not of the same color. There are red (or orange) stars, yellow stars and white or blue stars. These color show how hot they are and what their surface temperature is. You may have seen when an object (say, a piece of iron) is heated, its color changes as the temperature rises. To begin with, it looks dull red; if we keep heating further, its color changes to red (or orange), then yellow and finally at enormously high temperature (as you may see in welding or industrial processes), it turns to white or blue. This means that red (or orange) stars are not very hot. Medium hot stars like our sun appear yellow. The stars which are extremely hot, the hottest ones appear white or blue.

Two

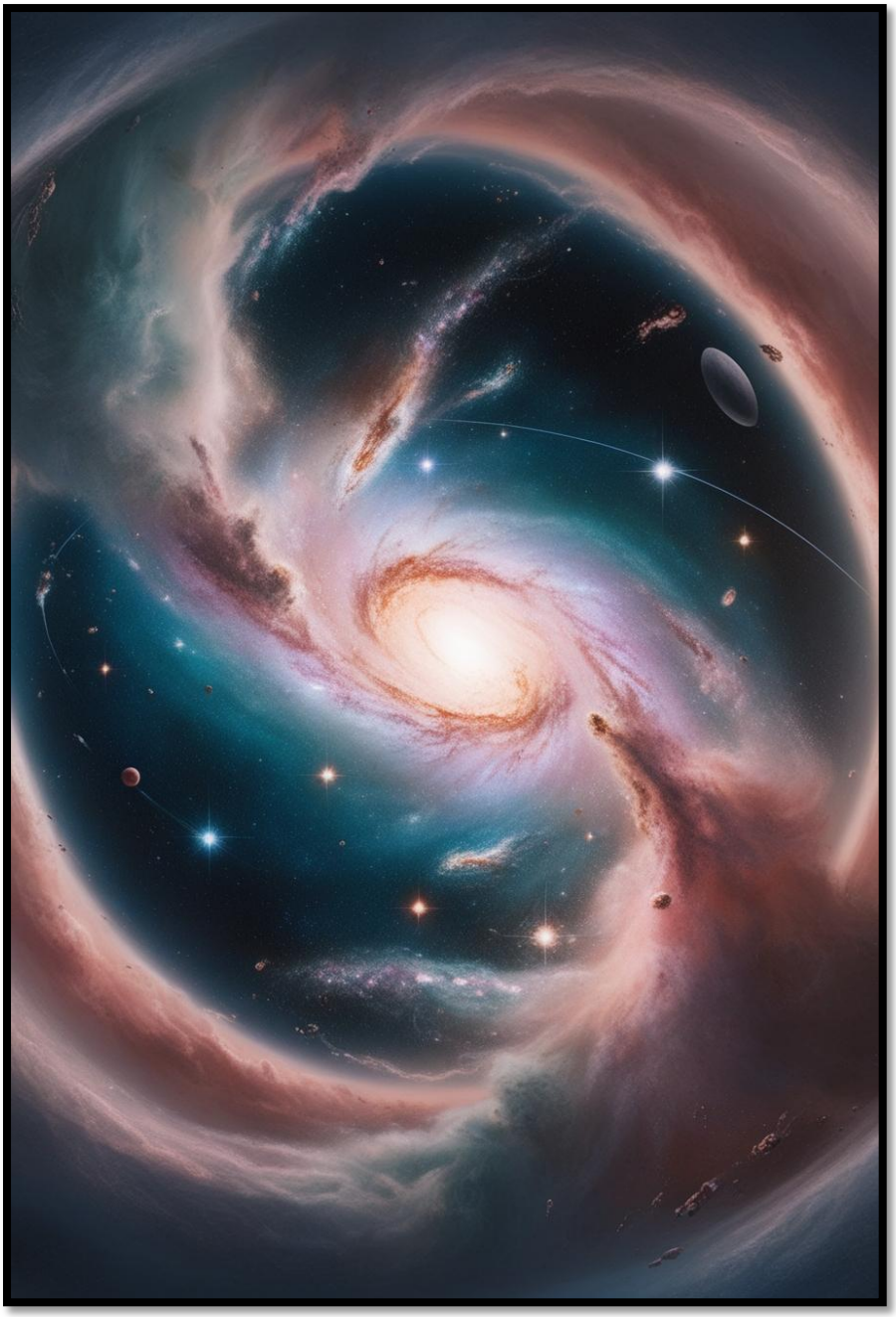
THE BEGINNING

The land of suns is a wonder land, it sparkles by the light of billions of tiny lamps that we call stars. These amazing lamps are the windows to our vast universe. The stars, the sun, the earth, the moon and all object in the sky, whether we can see them or not, make the universe. In fact, everything around us or everything that exists is called the universe. It is immense. It is difficult to measure it or even imagine its vastness.

And, it is all made of matter. In simple terms, matter is what a thing is made of. Anything that takes up space and has weight is called matter. Our ideas, feelings, memories, thoughts shadow etc. have no weight and are not matter. Matter can be gas (like air), liquid (like water) or solid (like rocks, stones and metals). But strange as it may seem most of our universe is made of gas, hydrogen gas. Stars, as I told you, are all gas. Gas is also their food. They shine only by eating this simple diet. A very small part of the universe exists in the form of liquid or solid as our earth.

The story of stars (the land of suns) is endlessly strange and mysterious. Let me tell you how the stars were formed. This great event took place when the universe came into existence. But I must add that the beginning of the universe is a great mystery. No one knows for sure.

The scientists have put forward many ideas called theories about the beginning of the universe. Our knowledge of the universe comes from these theories. But they are not the final word. They are constantly being tested by further observations and evidence. The present theories which we think are correct may change.



One of the theories about the origin of the universe is particularly popular. According to it, before the universe came into existence, all matter was heaped up in one place as a huge single ball. So big it was that it is difficult to imagine anything of its size. Since everything was packed in a ball, there were no separate bodies like stars, the sun or the earth. Then something unusual happened. The intense heat of this tightly packed material caused the ball to explode with a most powerful blast. The entire matter in it shot out in all directions and began spreading in space trillions and trillions of miles/kilometers as a shapeless cloud of hot gas. The universe was born. The great explosion is known as the Big Bang and the theory is called the Big Bang Theory. It is believed that this explosion took place about 15-20 billion years ago.

THREE

STARS LIGHT UP THE UNIVERSE

Millions of years after the explosion, the shapeless cloud of hot gas that had been spreading and spreading, cooled. Then it began to shrink and spin. Eventually it broke into separate cloud masses called galaxies. Each galaxy was colossal, trillions of miles/kilometers across, and consisted mainly of hydrogen gas, the stuff of which our universes, including our stars, are made.

The swirling galaxy cloud further broke into smaller clouds (star clouds). They were dark without any light. Though smaller than the galaxy cloud, they were still very huge, billions of miles/kilometers wide. These were the ones that finally became the stars that we see. But don't be mistaken that this happened overnight. It took several million years before the star clouds lighted up and the first stars were born. Many stars were formed several million years after the big bang. Many (like our sun) were formed several billion years later.

Stars are being formed in the galaxies even today. Let me now tell you about the magical moments in star formation, the dark star clouds in the galaxies were not evenly thick and had denser (thicker) layers at some places. These denser regions pulled more and more surrounding clouds by gravity! When they became too big, they started to contract by the pull of their own inward gravity. The crushing pressure and friction at the center (core) of these massive bodies produced enormous heat in the same way heat is produced when we squeeze or rub our hands together. The center of the star became so hot that it began to glow. The magic moment arrived when the core temperature rose to some 10-15 million degrees Centigrade or more. The hydrogen gas burst into flames.

The star was born.

In this way millions of stars began to shine. The sky glowed with the light from a myriad stars. The dark universe was turned into a land of brilliant suns. Gravity is a force by which objects (large or small) pull each other. Objects which are heavy with more mass (quantity of matter in them) have greater pull than objects with lesser mass. Therefore, the denser region of a star cloud has far greater pull than that which is less dense. There is gravitational pull between stars, sun, earth, moon and all other heavenly bodies which keep them from flying apart. The distance between the two objects affects gravity. The gravitational pull decreases when an object is distant but increases when it is close.

But what will happen if the hydrogen gas is finished?

Eventually, of course, the hydrogen will burn out, but it will take a very long time before it is exhausted. Hydrogen burning is not like the burning of coal, wood or oil which does not last long and cannot produce much heat. What takes place inside the stars is a complicated nuclear reaction. It keeps the star shining for millions and billions of years. A very little hydrogen is used in this process.

In this nuclear reaction which is similar to the one that occurs in a hydrogen bomb, hydrogen begins to fuse (change) into another gas called helium. Tremendous amount of energy is released in this process, which flows from the center of the star to its surface and makes it shine.

An Illustration of the Birth of a Star

FOUR

STARS LIVE IN CASTLES

Stars are the kings of the skies; they live in grand castles in royal splendor. The castles are the galaxies in which they are born and live all their lives. Like stars, the galaxies are also countless. It has not been possible to count their number even with the most modern telescopes or methods. But they are estimated to be in the billions, probably 100 billion, with about the same number of stars in each. The gigantic bodies are scattered in space in all directions to an unending limit, one beyond the other.

The stars and galaxies are not fixed at one point as they appear. They are spinning around themselves. They are also rushing through space like speeding cars. Scientists say that the universe is still expanding as a consequence of the big bang explosion and galaxies are moving away from one another at great speed.

The galaxies contain not only stars but also vast quantities of gas (mostly hydrogen with some helium) and dust containing extremely thin particles of matter such as iron, silicon, nickel etc. out of which new stars are formed. These clouds of gas and dust are called nebulae (singular: nebula means cloud in Latin). Generations of stars have been formed from this material. Some stars are old but some are still toddlers or teenagers; some have died and some are being born. This star building factory is the nuclear furnace at the center of the stars which changes the gaseous raw material into shining stars.

The star castles or galaxies are of different shapes and sizes. Many of them are spirals in which the stars are arranged in the shape of a wheel or a clock spring. They have two or three spiral arms. Some galaxies are elliptical. They are flat and have no arms. Then there are irregular galaxies. They do not have any shape.

Our sun belongs to a spiral galaxy. It is called the Milky Way. I will tell you more about it later; our sun is surrounded by nine objects that are called planets. Earth is one of them. They are not suns as they do not shine by their own light. They get their light from our sun and stay around it. But mistakenly we call them stars, as they look like them. What happens is that sunlight falling on their surface is reflected as in a mirror and they appear to a shine. These nine planets, in order of distance from the Sun are Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune and Pluto*. Our Sun and its planets make a small family. Therefore, we call it a solar family or the solar system. They are all part of the Milky Way galaxy. Thus, Milky Way is our galaxy.

You might ask if the other suns in the Milky Way or in other galaxies have planets like our earth with people living on them. Nobody has seen any planets in the land of suns. But it may be fairly reasonable to presume that out of trillions of suns, many have planets with civilization like ours. We hope somebody would find a planet with people like us. So we could talk to them and find out what kind of schools they have, what games they play and what T.V. shows they watch! Maybe one day this dream will come true.

An Illustration of Humans contacting Alien Civilizations

FIVE

MILKY WAY AND NEIGHBORING GALAXIES

Before I go on further, let me tell you about distances between stars. The stars appear to be too close and crowded. Actually it is not so. They are far apart from one another, trillions of miles/kilometers apart. The star next to our sun is Proxima Centauri which is 25 trillion (25,000,000,000,000) miles/40 trillion (40,000,000,000,000) kilometers away. There are many stars which are many times farther. It is difficult to describe these distances in miles or kilometers.

Actually all of us would get confused by such long figures. Scientists have found another unit called a Light Year to measure these distances. A light year is the distance over which light travels in one year. Light travels faster than anything else - 186,000 miles (300,000 km) per second. At this speed it covers about 6 trillion miles (9 trillion km) in one year. Therefore, we can more simply say that Proxima Centauri is four light years away instead of expressing long figures in miles or kilometers. Go outside; look up there at the sky, above your shoulder. You can see the white hazy band across the sky. That is the Milky Way. The white color is the combined light of billions of stars which cannot be seen separately. It is estimated that there are more than a 100 billion stars (suns) in it.

Since we are inside the galaxy, we cannot see all of it. It is like being inside a castle; you cannot see how huge the structure looks from the outside. If we could somehow come out of the Milky Way and view it from above, it would look like a spiral disk full of stars. From the side, it would appear like a long row of gleaming stars bulging in the middle due to the concentration of a great many stars in this region. But when we look at it from our earth, which is within the galaxy, the view is different. The area crowded with stars towards the center looks like a stream of milk.

Our sun is one of the billions of stars in the Milky Way galaxy. It occupies a spot along with the earth and other planets in one of the galaxy's spiral arms, far away from the center, 2/3rd way down, about 28,000 light years away. The Milky Way galaxy is huge, about 100,000 light years wide from one end to the other. On an average, the stars in the galaxy are 4-5 light years apart. But around the center, they are closer, about a light year apart.

Furthermore, many stars in our galaxy make clusters - open clusters or globular clusters. Stars in open clusters are not too close and contain a few hundred comparatively younger stars. These clusters do not have any special shape. The globular clusters, on the other hand, are compact and have a rounded appearance. They generally contain older stars, the senior citizens of the land, perhaps billions of years old. There may be several thousand to a million stars in these clusters.

The galaxy also has innumerable nebulae (patches of gas and dust) in its spiral arms. These are massive clouds, hundreds of light years wide. As I told you, new stars are formed from this material.

Like all galaxies, our galaxy too is drifting in space. It is also rotating (spinning) around its center. Our sun, planets and we (as passengers on board the earth) are also moving around the center of the galaxy. The galaxy being so big, it takes about 200 million years for the sun and its family to make one round. Beyond our galaxy, there is an endless realm of other galaxies. Even though they are separated by several thousand light years, they make their own groups - some small (10-20 galaxies) and some very large (hundreds or thousands of galaxies). Our own galaxy, the Milky Way and nearby galaxies within a range of about 3 million light years make their own group, called the 'Local Group" which consists of about 30 galaxies.

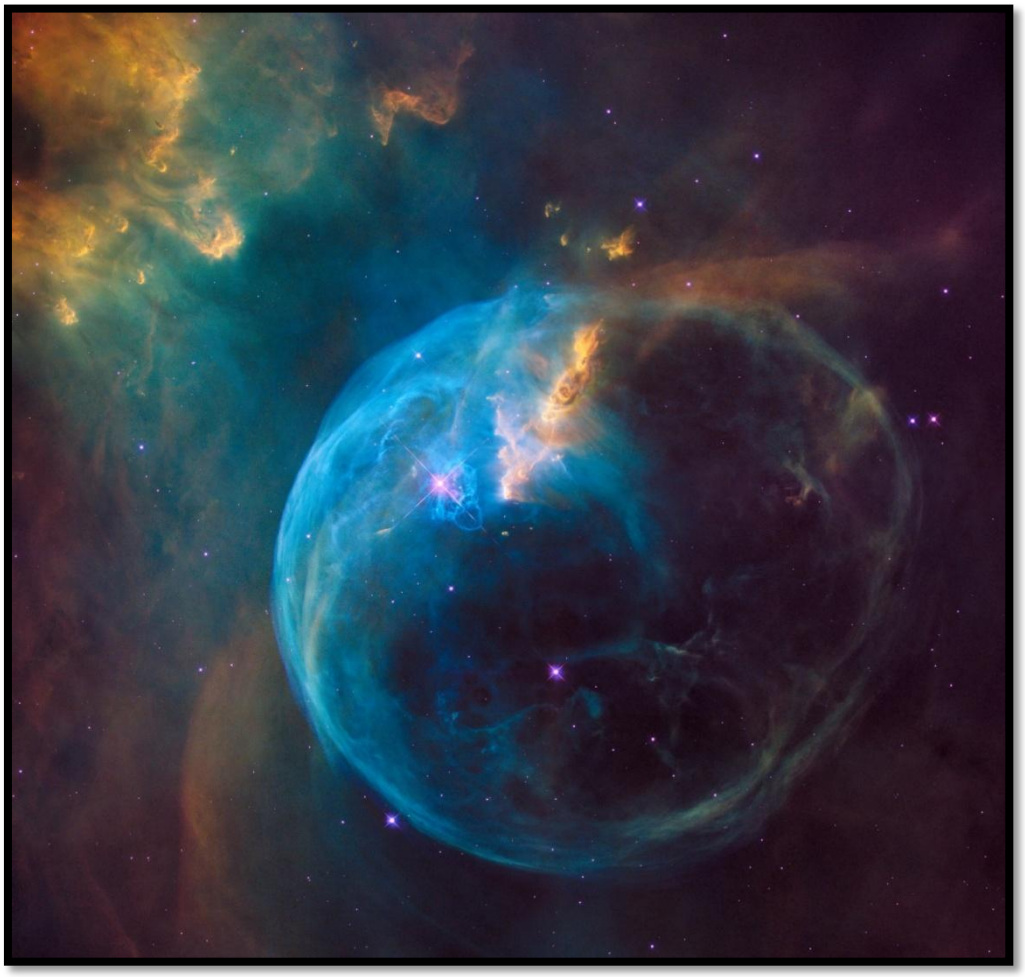
In this group, our galaxy is the second largest. The largest is the Andromeda Galaxy which is also a spiral galaxy. It has almost twice the number of stars as in our galaxy. It can be seen without any optical aid as a distant spot of mist. It is about 2 million light years away. That means its light reaches the earth after 2 million years and we see it today, as it looked when it left.

So long ago, it must have left when human beings first appeared on earth. Beyond the Local Group of galaxies, some 60 million light years from the earth, is the Virgo Cluster. It looks like a tiny cloud and has as many as 3000 big and small galaxies. Further than this there are other galaxies, millions of light years from us.

3 Galaxies of this local group are listed in Appendix A

An Image of the Bubble Nebula

Image Courtesy: NASA



SIX

STARS ALSO DIE

It is the destiny of everything to die. Stars die too. The road leading to their end is perplexing because stars are mysterious in many ways. But in a general way it can be said that medium stars like our sun die quietly without a noise and the more massive ones meet their end in an explosive manner.

Hydrogen, as you know, is the fuel by which a star shines. In the case of a star of medium mass like our sun, it lasts for billions of years. A time comes when very little hydrogen is left since it has been steadily converting into helium. The nuclear reaction slows down. With the reduced outward pressure of the gas, the gravity pulls the overlying matter. The star collapses raising the core temperature to more than a hundred million degrees. At this extremely high temperature, helium begins to burn and convert into carbon to produce energy (heat and light). The high temperature also increases the outer layers of the star to almost 100 times its size. The expanded area makes it appear 1,000 times brighter. Since heat is distributed over a much larger surface, it becomes cooler. The lower surface temperature makes the star appear red. Because of its giant size and red color, the star is called a red giant.

The bloated surface of the red giant expands and contracts like huge lungs. In the course of time, the outer layers of the star are thrown off leaving behind its small, dense inner core, about the size of the earth (8,000 miles/13,000 km) wide. The surface temperature of the star again rises making it shine with a white light. Because of this white color and small size the star is called a white dwarf. It is the final stage before journey's end. Ultimately the lights go out and the star shines no more. The star becomes a cold dark ball and is called a black dwarf.

Is this going to happen to our sun? Yes, that is what is predicted. Our sun has already lived half of its life, about 5 billion years. It has 5 billion years more to go. What will happen to us, and the Earth? The doomsday for our planet Earth will come when the Sun starts swelling and becomes a red giant. It may expand 100 million miles (160 million kilometers) and become 1000 times brighter. The change to a giant form may take millions of years. Like a giant, the Sun will first swallow up Mercury and Venus, the two planets closest to it. As it expands and approaches us, the Earth will heat up further, oceans will begin to boil, rocks will melt, and forests will be aflame.

All remaining life on earth will come to an end. Probably there will be nobody by then to see these dreadful events. The Sun itself will end up as a black dwarf (without light) moving around unseen. All the planets will be dark, including our Earth which may follow the Sun around. There are stars 10-50 times more massive than our sun. They shine with an exceedingly hot blue light and exhaust their hydrogen in a short time, about 100 million years or so. When this happens, they also swell to brighter, cooler and enormously large size and are called red _ super Giants. Such stars follow a different road to their end. Instead of becoming a white dwarf or a black dwarf, the nuclear forces within the star cause it to explode violently. The exploding star is called a supernova. Titanic energy is released in this explosion. The brightness of the supernova blast surpasses the light of billions of stars in the galaxy.

After the supernova explosion, the dead corpse of the star is left behind known as a neutron star. It is only 10-20 miles (16-32 km) wide. A neutron star may further collapse and form a monstrous black hole, the density and gravity of which is so immense that even a ray of light cannot escape it. Even though the stars die, they help in the creation of new stars. The blast waves of the exploding star may cause nearby clouds of gas and dust in the galaxy to contract and form into new stars and planets.

Our solar system perhaps owes its birth to a supernova explosion in the distant past. The supernovas also manufacture certain useful substances called elements which come down to us.

An Illustration of a Dying Sun

SEVEN

WE ARE STAR DUST

The land of suns has its tragedies and comedies. The good news is that stars give us the most valuable gift that no one else does.

Every generation bequeaths something to the next. Stars have been doing the same. Generations of stars lived and died in our galaxy. They left a wealth of materials from which the life on earth began and is continuing to this day. There are 92 basic substances in nature called elements from which everything else is made. All these are on our earth. Seventy of them have also been found in the sun. You may recognize the names of some of the elements such as hydrogen, helium, carbon, oxygen, nitrogen, phosphorus, calcium, sodium, iron, nickel, copper, zinc, gold, silver, lead, uranium etc. Of these, hydrogen (the stuff from which the stars, galaxies and everything in the universe is made) is the simplest and lightest of all. Helium comes next. All the rest are heavier and more complex, uranium being the heaviest.

The furnace of ordinary stars can 'cook up' only one or two heavy elements such as carbon and oxygen. But all other heavier elements are manufactured in the furnace of super-massive stars which burn and explode (as supernovas) with an unbelievably high temperature of some billion degrees before their death. In this way, when the old stars died and blew up (as supernovas), they showered the galaxy with the dust of newly made elements which enriched the gas clouds from which the next generation of stars like our sun (which is a second generation star) were formed. This was a parting gift of the stars. Since our earth was formed from the same cloud as our sun, we inherited these elements too.

Imagine for a moment, life on earth started with the basic ingredients - carbon, oxygen and nitrogen which were formed in the stars. We cannot live without breathing oxygen or drinking water which is hydrogen and oxygen. We have calcium in our bones and iron in our blood.

Our skin is made of carbon, phosphorous, hydrogen and oxygen. We need all the elements in one form or another.

An Illustration of a Supernova

EIGHT

MEET THE SUPERSTARS

The story of the land of suns would be incomplete without mention of the superstars. There are a number of them. In fact, most stars we see at night with the naked eye are bigger than our sun. But that does not mean there are no smaller stars. In the galaxy as a whole, many stars are smaller than our sun or are of the same size.

I will introduce you to some of the superstars, far bigger than the sun. But before I do so, I might add a word about star brightness. If you look at the stars, you will find they are not of equal brightness. Some are very bright, some are moderately bright and some are dim Scientists describe the brightness of a star in 'magnitude'. According to this scale, the brightest stars are of magnitude 0 (zero) or below zero.

Then come the 1st magnitude stars which are also extremely bright. The next brighter stars are of magnitude 2,3,4,5 and so on. Magnitude 2 stars are moderately bright. Magnitude 3, 4, 5 stars decrease in brightness and are fainter. Stars below magnitude 6 are difficult to observe without the help of a binocular or a telescope.

You must remember that magnitude only tells us how bright a star looks to the eye (i.e., apparently bright). It does not tell its luminosity (actual brightness, power or energy output). Stars with greater luminosity may appear less bright (in terms of magnitude) if they are too distant. A 100 watt street lamp next to your house looks brighter than a 1000 watt lamp a mile or a kilometer away. The distance reduces brightness. The superstars I want to tell you about are just a few of the many colossal suns in our galaxy. Try and remember their names and the constellations in which they are located*.

*

Twenty one of the brightest stars are listed in Appendix 'B¢

The sky has been divided into a number of star groups called constellations. I will tell you about them later. Every star belongs to one or the other constellation (star group). The name of the constellation is invariably mentioned with the star name. It is like giving its street address.

An Illustration of the early stages of Star's birth cycle

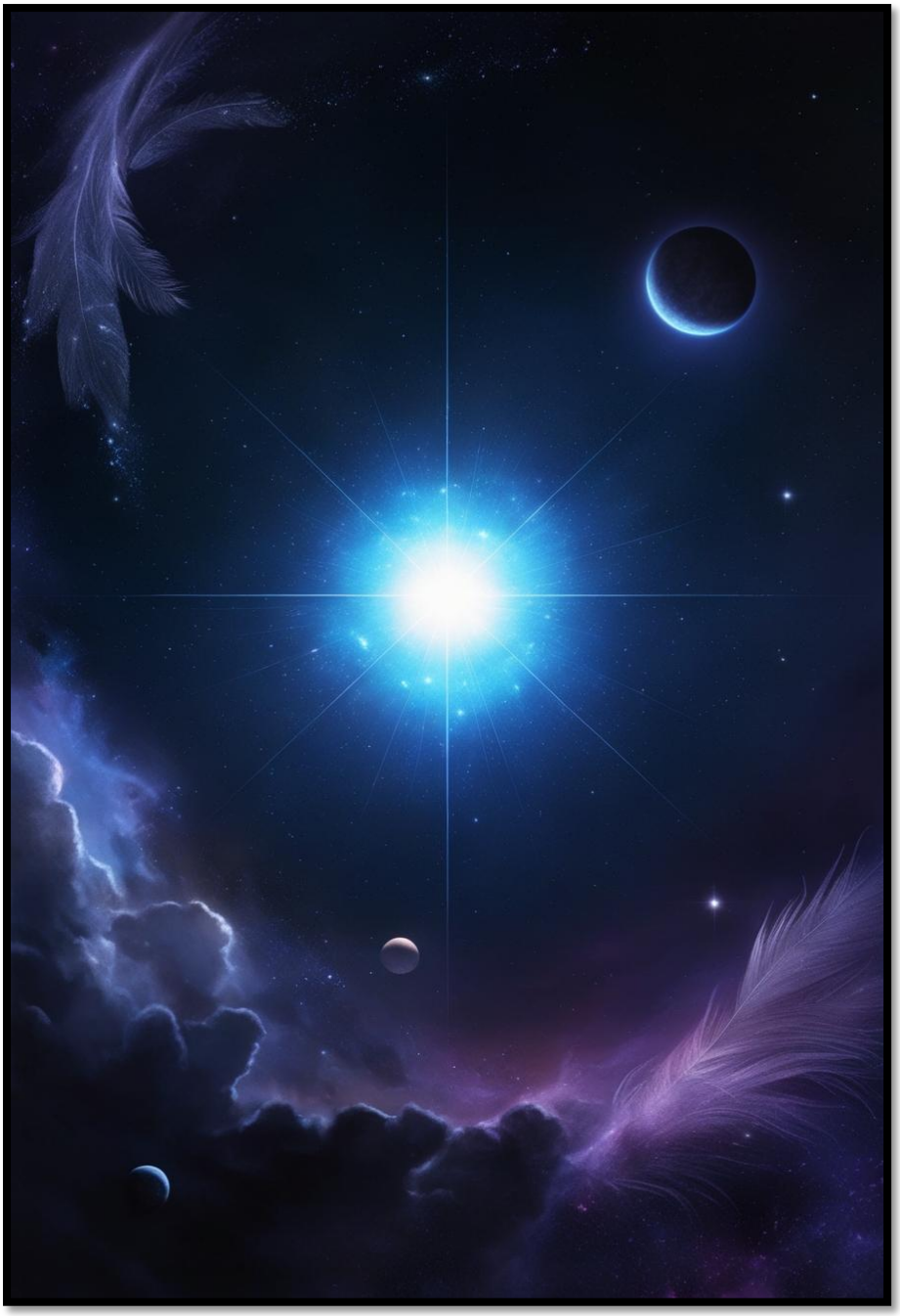
North Star

Let me first introduce you to the North Star which is located in the constellation Ursa Minor (The Little Bear). It is also called the Pole Star or Polaris. It is called North Star because it is seen over the North Pole where it remains nearly unmoved. In olden days when people did not have any means to find directions, they travelled and sailed on the high seas with the help of this star. It guided the navigators.

Because of the immense distance of the North Star from us (680 light years), it does not appear very bright. It is a 2nd magnitude star, but it is very powerful (luminous) and equals almost 5000 suns.

Sirus

Next to our sun, Sirus is the brightest of all stars in the sky. It is in the constellation Canis Major (The Big Dog). With its sparkling white color and brilliance, it looks like a piece of diamond hanging in the heavens, Compared to other stars it is quite near us, about 9 light years away. It is twice the size of our sun and is 26 times more luminous.

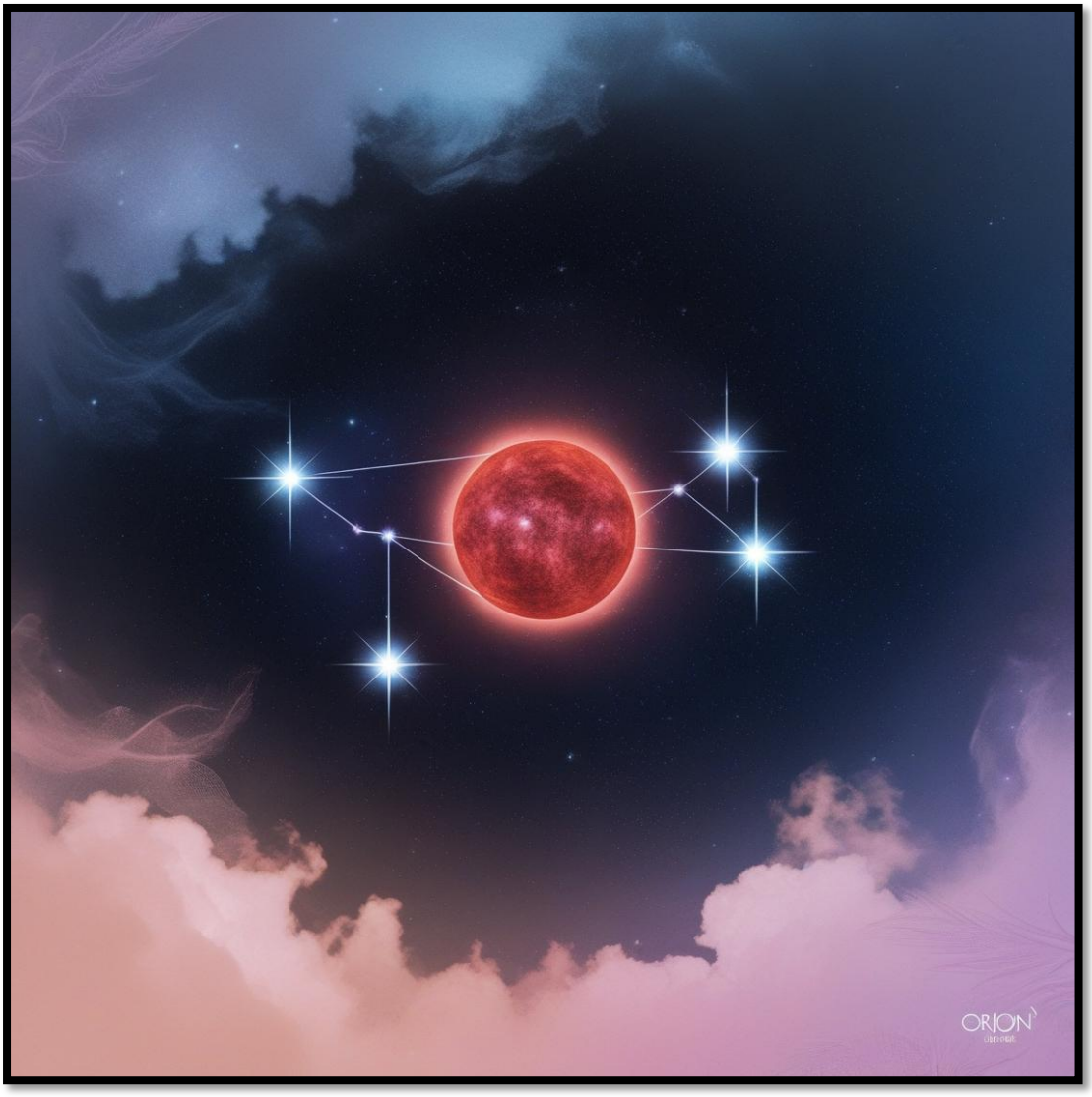


Rigel (Ry-jel)

Rigel, in the constellation Orion, is a very distant star, 900 light years away. It takes 900 years for its light to reach the earth. It is about 30 times bigger than our sun. Despite such enormous distance, it is one of the brightest stars. It appears bluish white which means it has the hottest temperature. It is 60,000 times more powerful (luminous) than the sun. It is a blue super giant. If Rigel were nearer, it would look like another sun and cast shadows. But since it burns its hydrogen much faster, it may have a much shorter life than our sun.

Betelgeuse (Beet-'l]-juhz)

Betelgeuse is also in the constellation Orion. You may call it 'Beetle Juice' for fun. It is a red supergiant. You will recall that such stars are very huge because of their bloated surface. However, they are cooler and thus appear red. That is what happens to stars when they become old and approach the end of their lives. In its younger days, Betelgeuse was probably an immensely hot blue giant like Rigel. It is now a swollen star, about 800 times the diameter of our sun and is one of the largest stars. It is 500 light years from earth and is 15,000 times more luminous than the sun. Because its surface swells and shrinks, its brightness varies – brighter when it swells and a little less so when it shrinks.

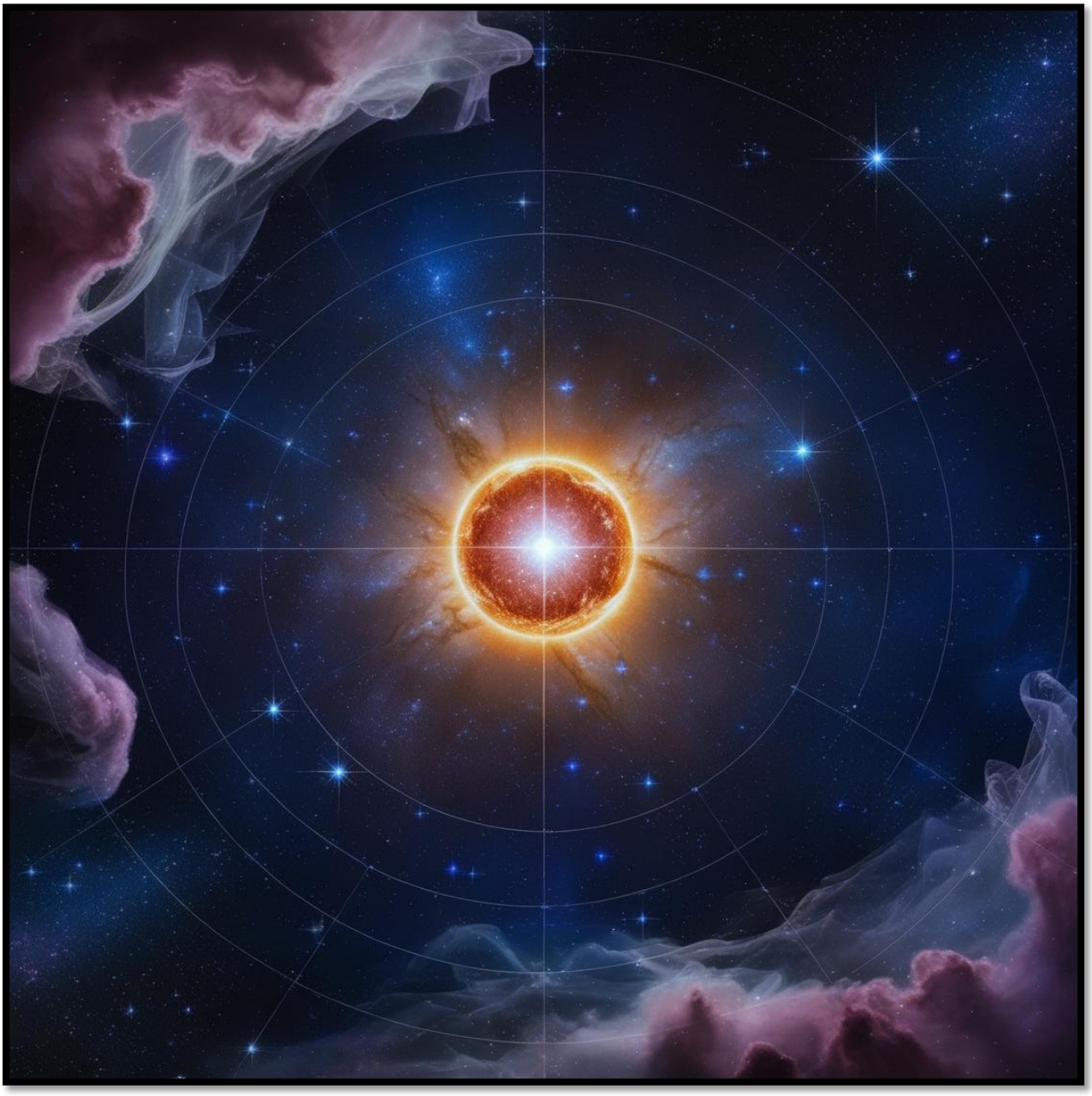


Aldebaran (Al-deb-ran)

Aldebaran is also a red star but is not as big as Betelgeuse. It is a red giant. It is 45 times wider than the sun and is 360 times more luminous. Its distance from the earth is about 70 light years. It is in the constellation Taurus (The Bull). It also appears to be one of the stars on its last legs! Even so, it takes thousands of years after red giant or supergiant stage before stars end their lives.

Arcturus (Ark-too-rus)

Arcturus, in the constellation Bootes (The Herdsman), is the 4th brightest star in the sky. At 36 light years from the earth, it is 23 times bigger than the sun and 130 times more luminous. Its orange color suggests that it may be getting old and cooler.

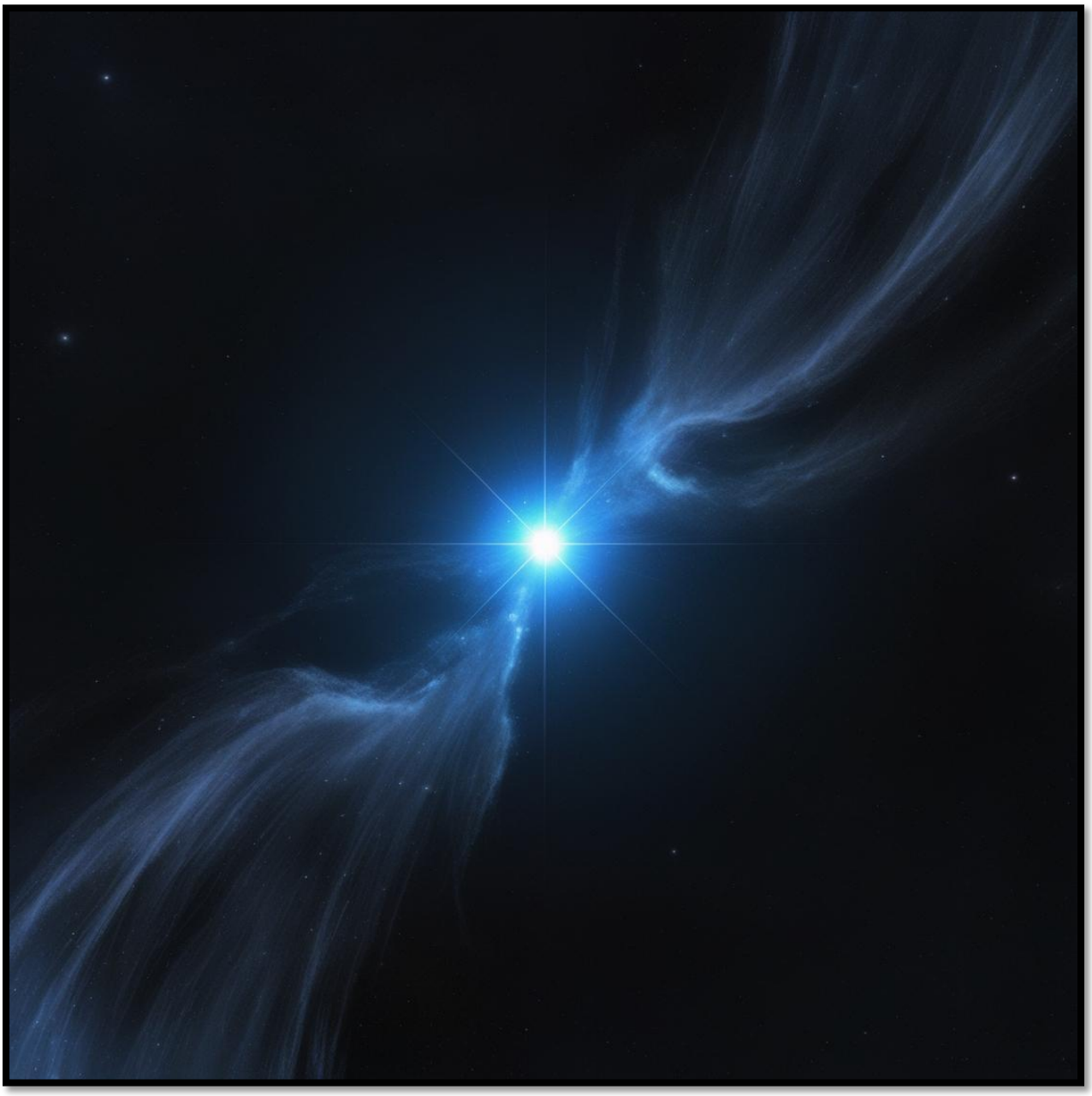


Vega

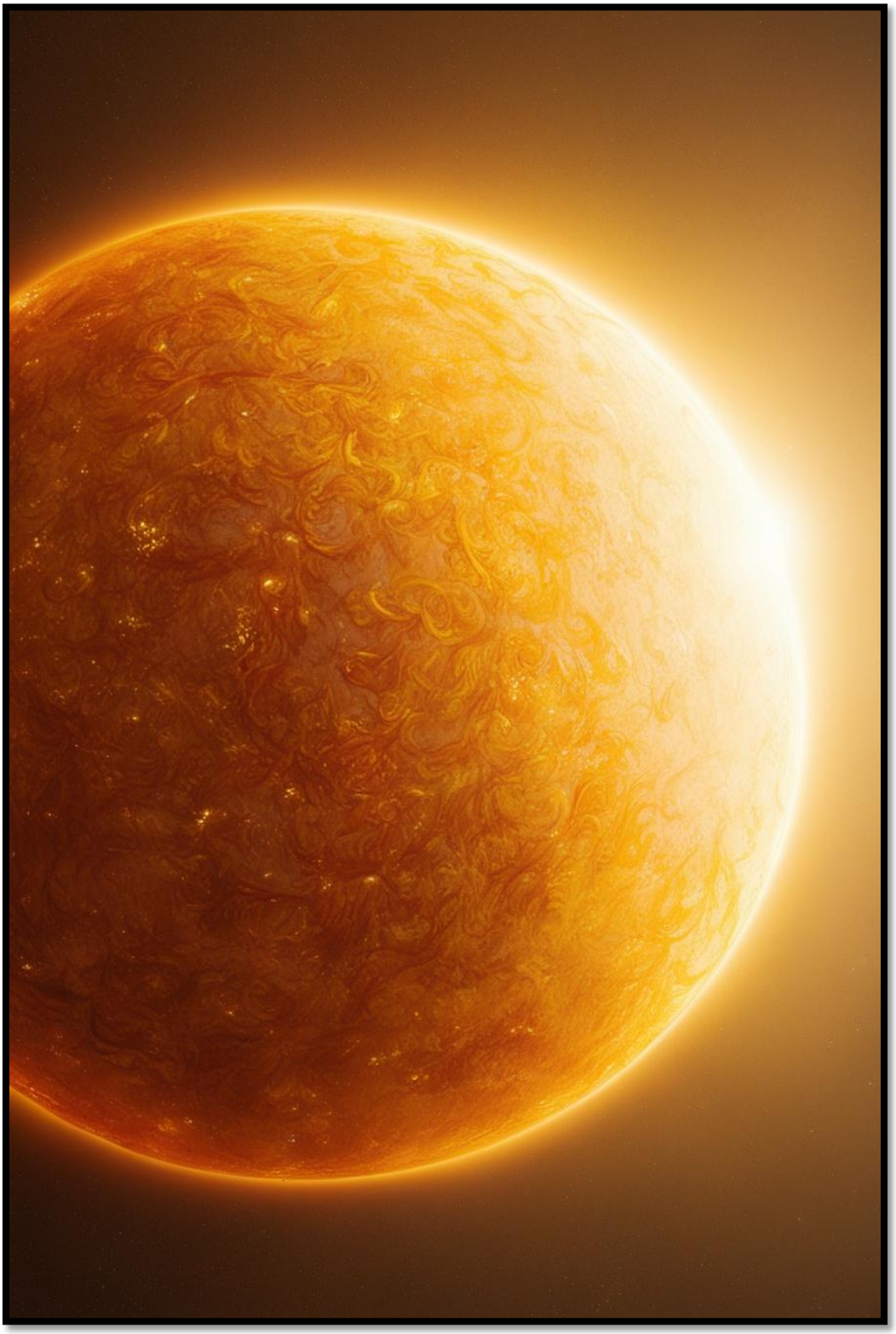
Vega is 26 light years from us and shines with a white light. It is the 5th brightest star in the night sky and equals 58 suns. It is, therefore, much hotter and luminous. It is in the constellation Lyra (The Lyre). Thousands of years ago, Vega was the North Star and was important to people. Assyrians called it the 'Judge of Heaven' as having the highest seat. Scientists say that due to a 'wobble' in earth's motion like a spinning top, it will again be a Pole Star several thousand years from now.

Deneb

Deneb is a little fainter star because of its immense distance from us, 1,800 light years, but is an amazingly powerful sun in our galaxy. It is a blue supergiant of the same class as Rigel. It is 60 times bigger than the sun and is about 70,000 times more luminous. It can be seen in the constellation Cygnus (The Swan).



There are many more such stars. For the present, let me end here and introduce you to one of the most wonderful stars, our sun.



NINE

THE SUN IS OUR STAR

You have seen there are billions and billions of suns above us and our sun is just one of them. By comparison, it is also quite ordinary. But to us, it is the most important of all. It is our star. Without it, we could not exist. The sun is also the nearest of the stars. Its light reaches us in about 8 minutes compared to the next nearest star (Proxima Centauri) whose light reaches us in 4 years.

About 5 billion years ago, the sun was born from a vast cloud of gas and dust in our galaxy, the way all stars are born. Tremendous forces caused this cloud to contract and light up as a star. Without the sun, our earth would have been dark and lifeless. Practically everything on earth comes directly or indirectly from the sun. Since ancient times, the sun has been an object of great curiosity. People in different ages have worshipped it out of respect or sheer fear. Many do it even today. Even though the sun is an average star, it is very huge. And it must be remembered that it is all made of gas, mainly hydrogen. It has no solid surface. Like all stars, the sun is also mysterious and keeps many secrets to itself. But the scientists have been spying on it and collecting lots of information.

The scientists have pieced together a lot of facts about the sun. But its mysteries are not fully solved. As with all stars, the sun's hot interior (about 15 million degrees C) is the source of its energy. From the core, the solar energy travels to its surface, some 400,000 miles (600,000 Km) above it and comes to us in the form of sunshine. But that does not mean that all the sun's energy comes to the earth alone. It would be catastrophic if that were to happen. The sun radiates its energy in all directions. Only a tiny fraction, about half of a thousand millionth of it, comes to us.

The round face of the sun that we see is its surface and is called the photosphere (light sphere). It is not calm and glassy as it appears. It is terribly rough and is a turbulent ocean of

hot gases rising and falling all the time. This gives the sun's surface a granular (grainy) appearance. The temperature of the sun at the surface is about 6,000 degrees c. above the photosphere, is the sun's atmosphere. Its lower layer is called the chromospheres (sphere of color) which are about 6,000 miles (10,000 Km) thick. The upper layer known as corona (crown) extends millions of miles/kilometers into space. Since the various layers of the sun are nothing but gas, they merge into one another without definite boundaries.

The chromospheres and corona are not easily visible. They consist of almost transparent gases. There is also an intense solar glare which interferes with the visibility. They can be seen only when the strong light of the sun's surface is covered during a solar eclipse. At that time the chromospheres appears as a pink colored ring of fire around the eclipsed disk (surface). The corona appears as a pearly white halo. With special equipment, they can also be observed anytime without waiting for an eclipse. The chromospheres and the corona are important areas for scientists to observe the sun's activities. Actually the study of the sun provides clues to what may be happening in other stars, which are too far away.

But I should warn you that scientists take great precautions before looking up at the sun. Looking directly into the sun can be very dangerous, even during a solar eclipse. It can cause blindness. The use of binoculars or a telescope without a reliable sun ray filter is also equally risky. The safest way is to project the sun's image with a telescope on a piece of paper or see it on a T.V. screen.

The sun is a blazing inferno. Its flaming gases jump and leap in a wild dance. The sun's Magnetic forces cause peculiar happenings which affect our earth in one way or another. The happenings on the sun may seem like a strange ghost story. For instance, there are sun spots, solar flares, prominences and other activities which have not been fully understood. The sun spots are dark irregular smudges on sun's face. They shift and change position unpredictably. Even the small spots may be of the size of earth. A number of earths could disappear in large ones. They stay for a few hours or weeks or for several months. They come and go in a cycle ie., increase every 11 years when hundreds of them appear in hordes. They become less in between. But, this regularity is not fixed.

The sun spots are giant whirlpools of gases which rise from below. At the surface they expand and become cool. These cooler gases appear darker against the surrounding hotter surface of the sun. The sun spots may indicate the level of the sun's activity and influence on the earth. The spots make the sun more active and they are often accompanied by flares and prominences. Greater solar activity makes the earth somewhat warmer than when the sun is not active. Flares are explosive outbursts of light. In general, they are small and last for a few minutes. Sometimes they may be of giant size, as wide as ten earths and may last for an hour or so. The big ones give off tremendous energy equaling millions of hydrogen bombs. Some of these flares cause damaging effects on our normal life on earth.

The outflow of particles from the flares which reach the earth sometime disrupt our radio, telephone and telegraph communications. The scientists have not been able to predict flares. Furthermore, the most amazing feature of the sun is the prominences. Loop prominences are particularly spectacular. These are hot glowing gases that leap thousands of miles into the sun's atmosphere, at times more than the distance between our earth and the moon. We see them in different forms. Some hang in the sun's atmosphere for months. Some soar very high and burst, showering gases and particles into space. But more often they shower gases downward and return to the surface in the shape of symmetrical arches. There are other fiery activities on the sun's surface such as shooting flames of gases called spicules. These keep shooting up to 6000 miles (9650 Km) like countless fountains. They are active all the time and cover the solar surface.

This is what has been going on for billions of years. The scientists calculate that the sun will remain het and fiery for 5 billion years.

TEN

SUN'S FAMILY (PLANETS)

As I told you, the Sun's family is called the solar system. It consists of not only the nine planets? (Our Earth is one of them) but also many moons (satellites of planets), thousands of asteroids (minor planets) and innumerable comets. The Sun keeps them under control. But even though this is a family, its members live at great distance from one another and there is hardly any contact between them. We see them only by their photographs.

It is a family all the same. The scientists have sent the finest photographers of the world to take their pictures. These photographers are the modern spacecrafts, great scientific wonders, which travel millions and billions of miles/kilometers in space and send us news and portraits of our relatives. Imagine, one of the spacecrafts (Voyager 2) travelled 3 billion miles (4.5 billion km) for 12 years to send back information about Uranus and Neptune, the most distant planets. We know a lot more about our planets today than three or four decades ago.

5 A Comparative Data of Planets is in Appendix C

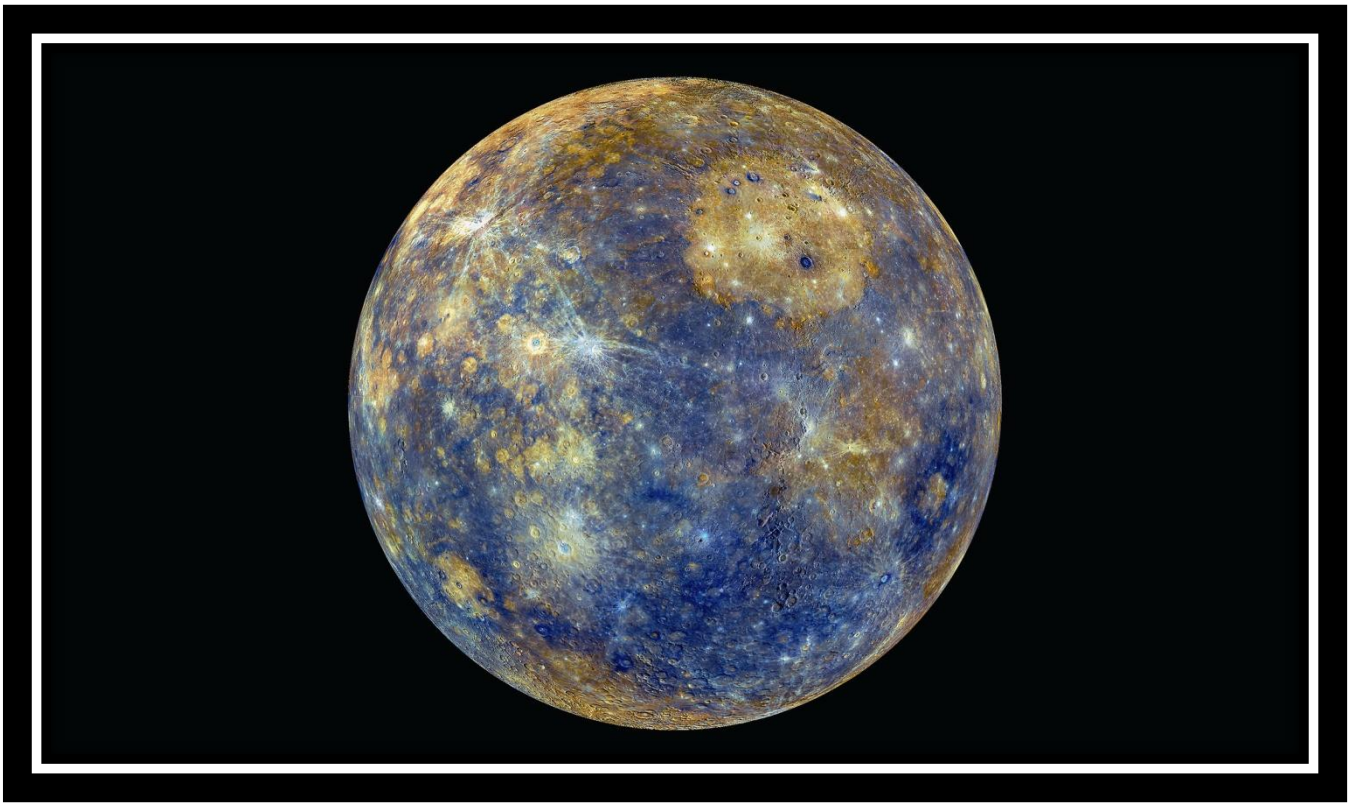
One of the reasons of exploring the other planets in our solar family is to understand their nature and composition. Many pages of our Earth's early history are missing. We do not know what happened in the beginning and how the solar system was formed. A study of the planets may hold these answers. Some of the planets are closer to the Sun and some are distant. I will begin with those nearest to the Sun and go outward to the farthest ones. Earth, the planet on which we live is the third planet from the Sun. The presence cf water on it makes it a unique world among the known planets. Life, as we know, began in simple forms in its ancient oceans. It is the only planet which presents conditions favorable to life and has human beings living on it. The Earth's present atmosphere which has oxygen is neither too thick nor too thin. It protects us from the harmful rays of the Sun and preserves life on this beautiful planet.

Mercury: A Tiny Planet

The planet closet to the Sun is Mercury. It is the baby of the family in the sense that it is very small. It is a little bigger than our Moon and less than half the size of the Earth. But it is a very fast runner. It moves (orbits) fastest of all other planets around the Sun. In ancient mythology, Mercury was called the messenger of the gods and was considered very clever in hiding its movements.

As it is too close to the bright Sun, it is a little difficult to see the planet. The sad part is that Mercury has no atmosphere as we have on Earth. The temperature on its surface varies from burning hot, about 800 degrees Fahrenheit(400 degrees C) during its long day to freezing cold, -300 degrees Fahrenheit (-180 degrees C) during its equally long night. Its surface is rugged and dusty, marked by craters, mountains, valleys and cliffs called scarps. It is a lifeless, airless and waterless planet.

An Image of Mercury Image Courtesy: NASA



Venus: Cloud-Covered Planet

Venus is Earth's sister planet and is almost its size, smaller only by 400 miles (600 Km). Mythologically, Venus is the Roman goddess of love and beauty. Next to the Moon, Venus is actually the brightest and most attractive planet in the sky. It is closer to the Sun than the Earth and can be seen before sunrise and after sunset. Thus, it is also called the Morning Star or Evening Star. But the outward beauty is deceptive. Venus has been a mystery planet. It is always surrounded by thick clouds which do not allow a look on its surface. For generations people pictured the planet in many different ways. Some even speculated about the possibility of life on it.

The picture of Venus which now comes to us is fearsome, No life could possibly exist there. The planet has a hellish atmosphere which is thick and choking. It mostly consists of carbon dioxide, a heavy gas (97 percent compared to a mere 0.03 percent in our Earth's atmosphere). The clouds of Venus, made of sulfuric acid drops (instead of water) add to the tragedy. While this dense atmosphere allows a little bit of sunlight to reach its surface, it traps the Sun's heat and does not let it escape. This raises the surface temperature as in a furnace, beyond 900 degrees Fahrenheit (500 degrees Cc). The surface almost glows with heat. Any liquid drops falling on it evaporate.

Scientists have recently received pictures of Venus giving signs of active volcanoes on its surface. It may appear the planet is not dead as presumed but is active.

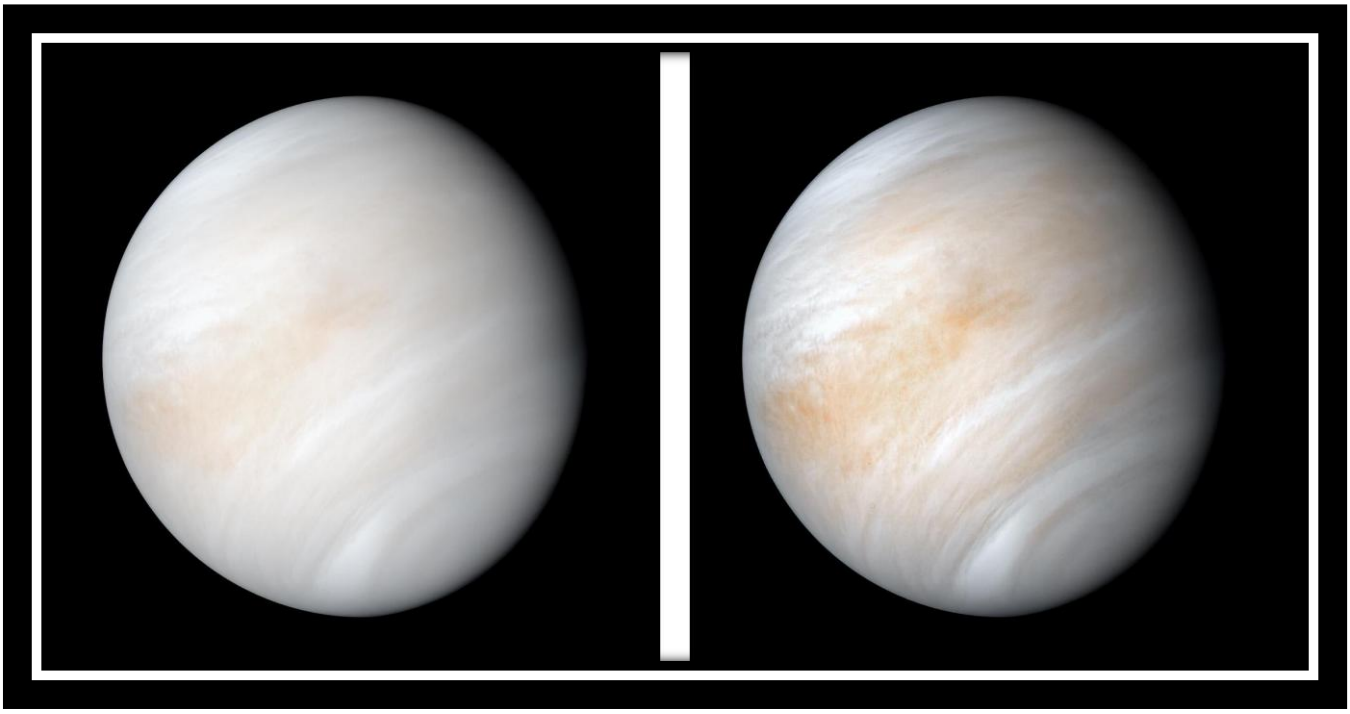
The pressure of Venus's thick atmosphere (90 times greater than earth's) is also crushing. The spacecrafts which ventured to land on Venus were destroyed by its pressure, heat and corrosive acid. Venus, as you can see, is practically without water.

Its sky is always grim and cloudy with frequent flashes of lightning and thunder. It has, of course, plains, valleys, volcanoes and mountains. One of the mountain chains has a peak higher than Mt. Everest, the highest mountain on Earth.

The light reflected by the massive clouds of Venus, apparently gives it a bright silvery appearance. That seems to be the only silver lining in the acid dripping clouds!

An Image of Venus

Image Courtesy: NASA



Mars: the Red Planet

An Image of Mars

Image Courtesy: NASA

Mars has always fascinated people on Earth. It is a small planet, about half as big as the Earth. The Greeks regarded it as the god of war. More than a century ago, some canal-like lines were observed on the surface of Mars. It gave rise to speculations that Martian people had made canals for irrigation; that the planet was populated by an advanced civilization. Mars became a topic of fairy tales, fiction and romantic stories. It was even imagined that the Martian people were of red color and were preparing to invade the Earth.

The recent observations reveal that Mars is not like our Earth. The climatic conditions are different. There is no evidence of life or Canals on it. Presently the planet is a vast rocky desert. It has some impressive features such as huge canyons (far bigger in size than any found on Earth), giant volcanoes, the tallest being three times higher than Mt. Everest. There are also dust storms on Mars which sometime envelop it entirely. The rusty (reddish) soil of the planet and the storms which raise it in the air may be giving it reddish look. So the good news is that the Martian people are not coming to invade us. And the bad news is that it is a dessert with no life on it!

Like Venus the atmosphere of Mars is also predominantly made of carbon dioxide (95 percent) but it is very thin and does not prevent the loss of heat from its surface. Being farther from the Sun (it is the fourth planet from the Sun after Mercury, Venus and Earth), it also gets much less heat than we do on Earth. Mars is thus a cold planet. The temperature drops to minus 150 degrees Fahrenheit (100 degrees C). Its surface is permanently frozen down to a depth of a mile (1 1/2 Km) or more. There can be no liquid water on the surface. It may be buried underneath, frozen. Traces of water vapor in the air show up as thin frost, fog, and mist or light clouds. The Polar Regions have some ice made of frozen water or frozen carbon dioxide (dry ice).

The Giants: Jupiter, Saturn, Uranus and Neptune are the giant planets of the solar system. They are also the coldest and the farthest from the Sun. Jupiter is the largest of all and is more massive than the combined mass of all other planets in the solar system. It can take 1,300 Earths within it.

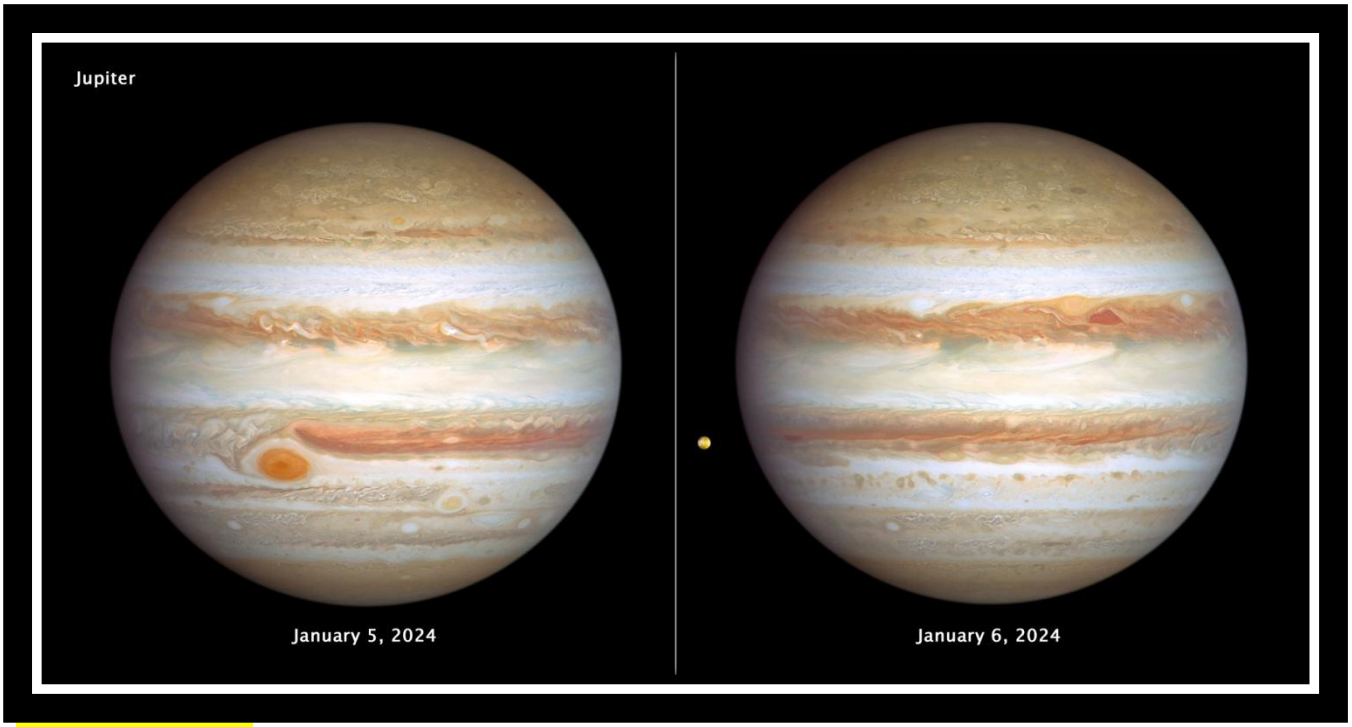
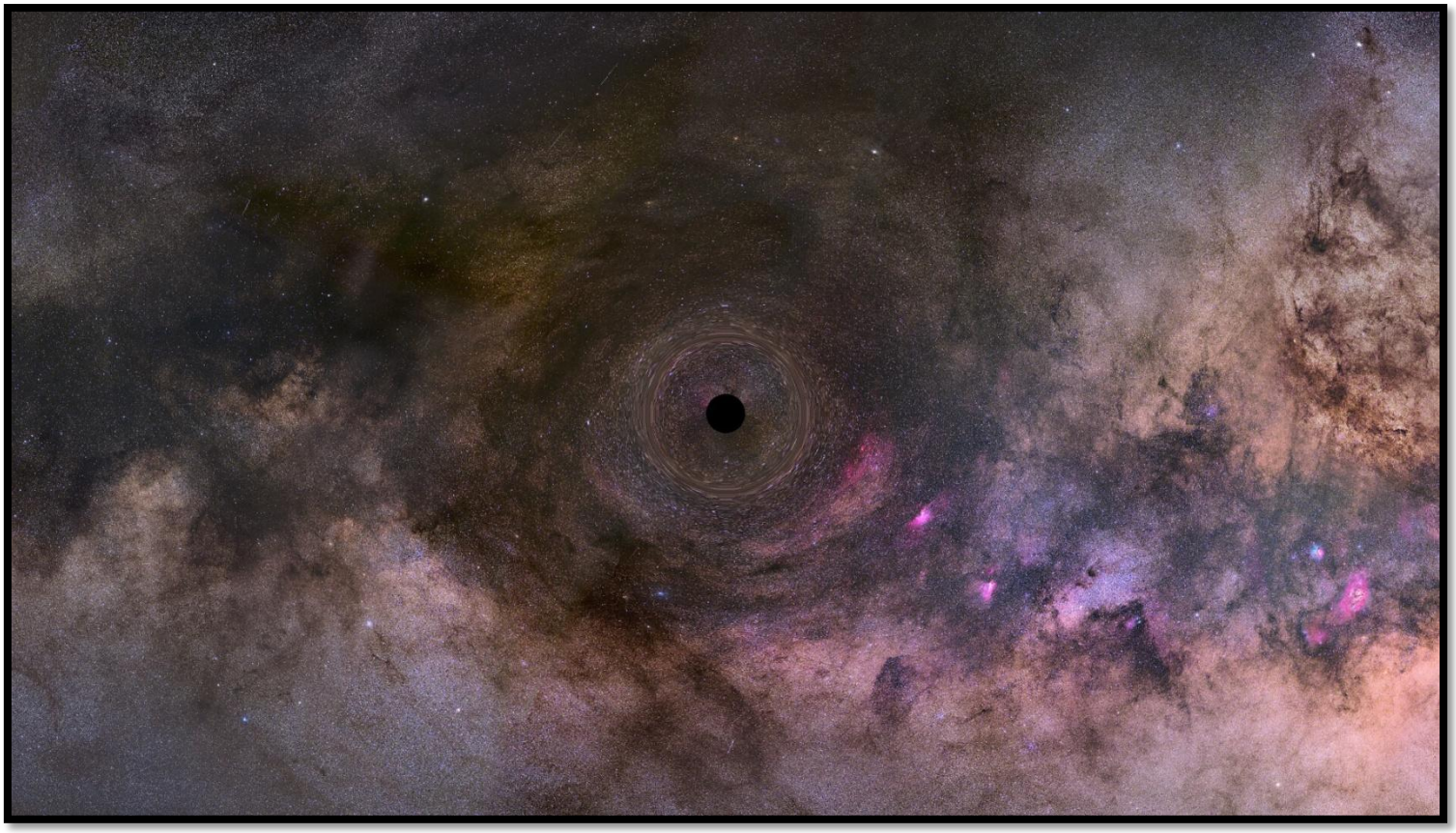


Image Courtesy: NASA



An Image of a Black Hole

Image Courtesy: NASA

Jupiter (Zeus to the Greeks) was the Roman supreme god. Scientists think if Jupiter were more massive, it might have lighted up as a star since it has an abundance of hydrogen.

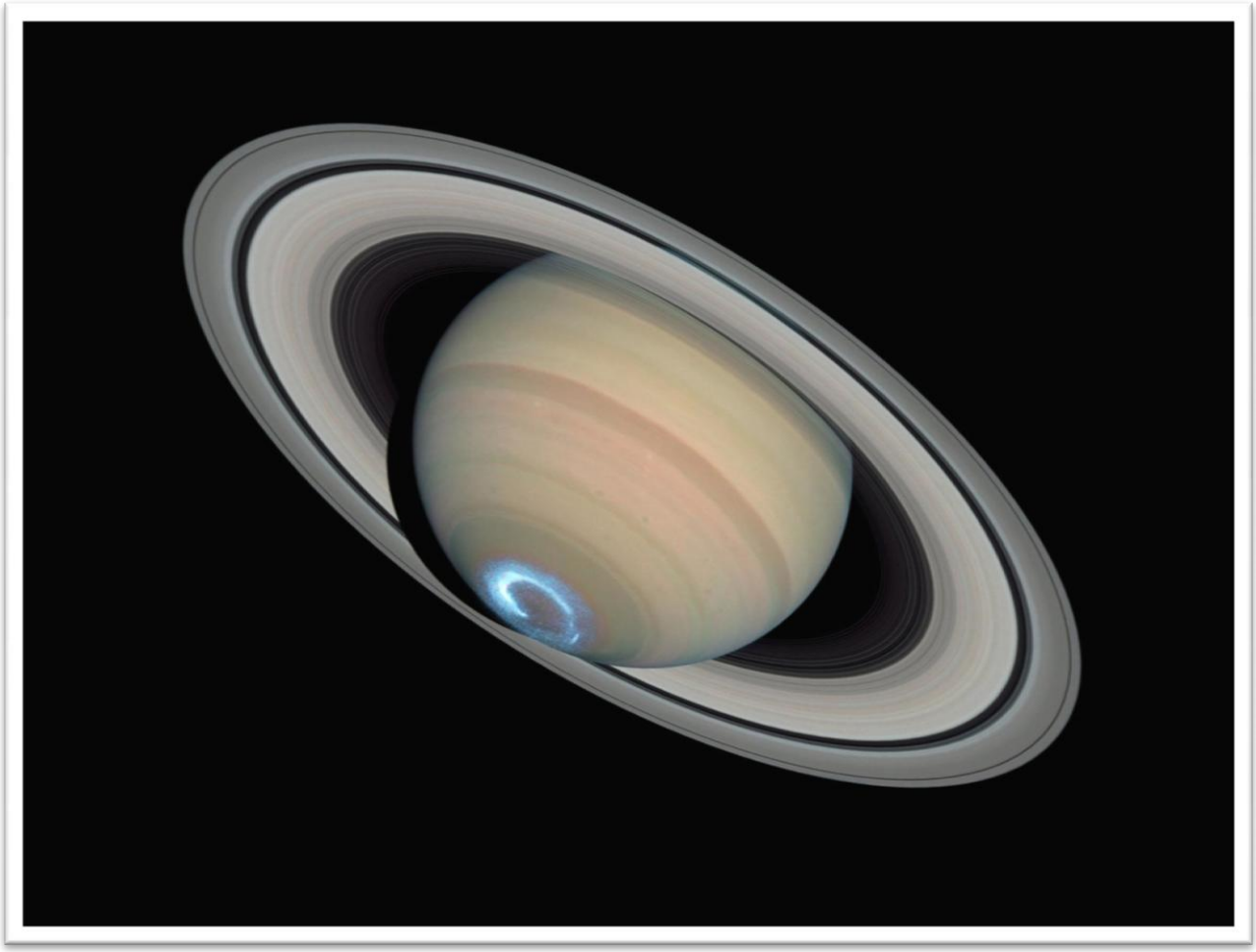
Imagine, instead of one, two suns would have been shining above us. But then, who knows, there may have been no life on Earth. The temperature and other conditions might have eliminated life altogether.

There are differences in the personalities of these four big giants but certain features are more or less common. For instance, (a) they are mostly gaseous /fluid and have no solid surface; the main gases are hydrogen, helium, methane and ammonia; (b) they are all bigger than our Earth; (c) there is no life on them; (d) they are icy cold; as we move from one planet to the other, it becomes increasingly cold because of the great distance from the Sun which is the source of heat; the Sun itself looks smaller and smaller as the distance increases; (e)

they are circled by rings though these are not equally prominent in all cases; (f) their clouds form stripes (bands or belts) around them parallel to the equator but they differ in contrast and clarity; (g) they are accompanied by many moons (satellites) .Jupiter and Saturn are similar in many ways. Their thick clouds, which constantly swirl about and are hundreds of miles/kilometers deep, cover these planets completely and do not reveal their surface. The clouds of Jupiter make colorful multiple bands with lighter zones across its disk. Saturn also shows the same banded pattern of clouds but they lack vivid color and contrast. Since both Jupiter and Saturn spin fast, their bellies bulge outs.

An Image of Saturn

Image Courtesy: NASA



A well-known feature of Jupiter is its Great Red Spot which is larger than the size of Earth. It is actually an enormous whirling storm which changes in size and travels around the

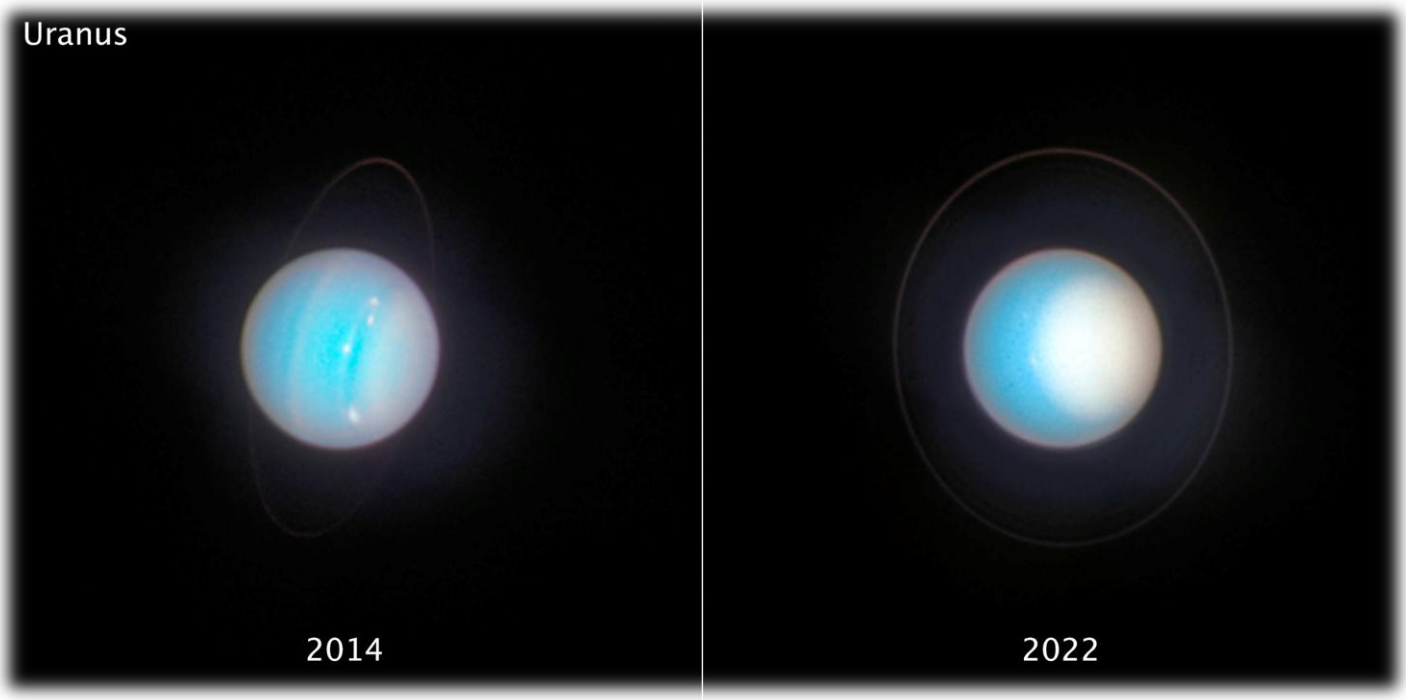
planet. Saturn is also swept by strong winds, particularly at the equator. The high speed of these winds (about 1000 miles/1800 Km per hour) are sometime four times stronger than Jupiter's. Jupiter is a bright planet to look at. This is apparently due to its big size and thick clouds which reflect more sunlight.

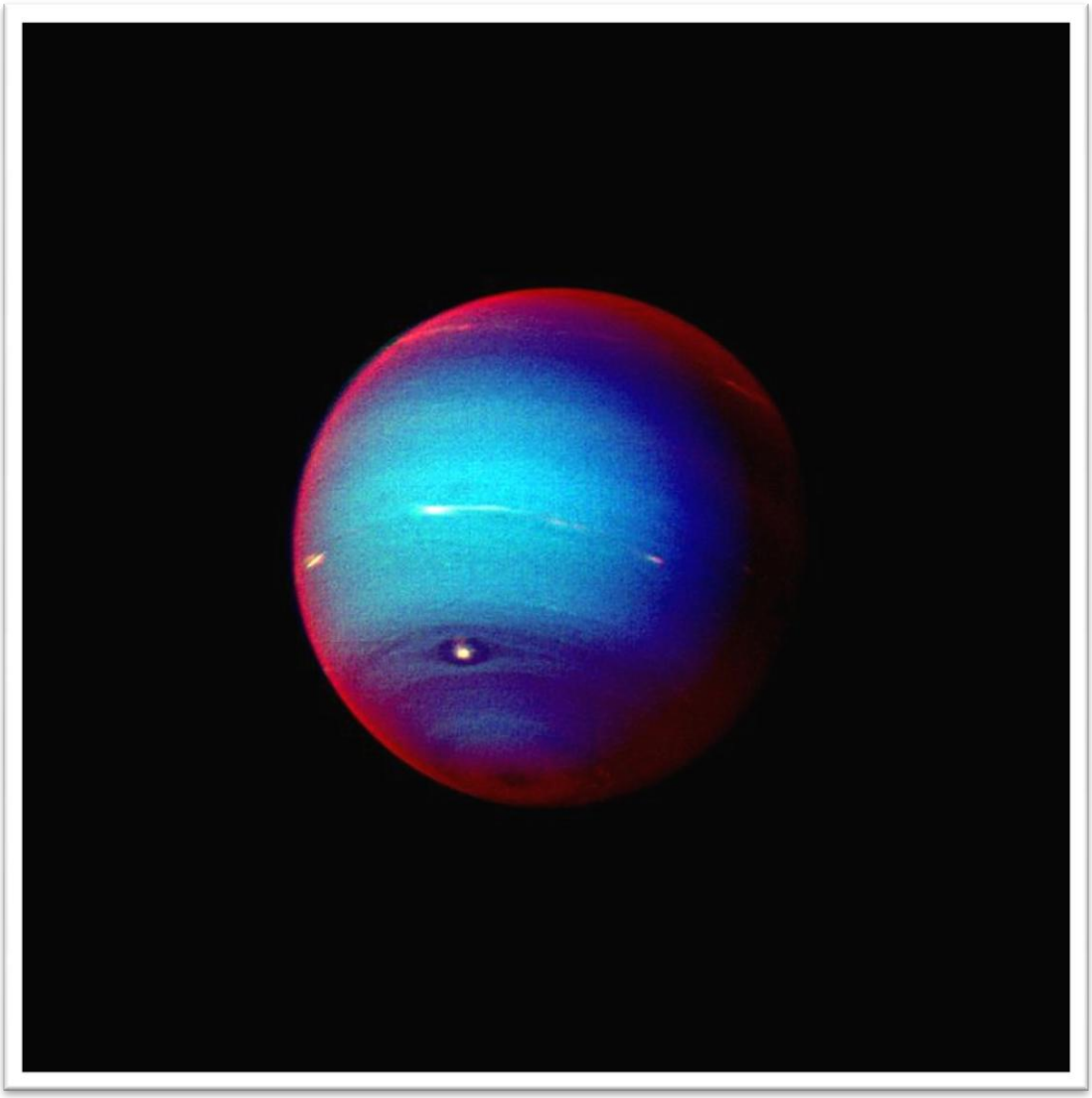
As for Saturn, it is the second largest planet in the solar family, big enough to hold 900 Earths inside it. But of all the planets, it has the lowest density so that it can float on water. A grand feature of Saturn is its rings which make it the well-dressed member of the solar family. It beats Jupiter and every other planet in this respect. Countless particles of ice and rock make up these rings. They shine by reflecting sunlight.

Uranus and Neptune, each four times bigger than the Earth, are very distant worlds. Uranus at about 2 billion miles (3 billion Km), receives less than 1 percent of sunlight than Earth. Neptune at 3 billion miles (4.5 billion Km) receives still less.

An Image of the Uranus

Image Courtesy: NASA





An Image of Neptune

Image Courtesy: NASA

They also have long orbits around the Sun which they complete in 84 and 164 years respectively. There is a peculiar thing about the motion of Uranus. While all other planets travel around the Sun in a more or less upright position, it moves almost lying on its side. This must be causing peculiar season. It was thought that Neptune would be a quiet planet. But it has turned out to be very active. There is evidence of violent storms on its surface. These have been given fancy names like Great Dark Spot, Scooter (as it moves fast like a scooter) and Eyeball (because of its appearance). Some winds are fastest in the solar system. Both Uranus and Neptune appear bluish green. Neptune, however, is more photogenic as it shows faint markings and spots.

Pluto: The Tiniest Icy Planet

Pluto is a tiny world of rock and ice, much smaller than even our Moon. It is regarded as a little snowball. It is also the farthest planet, about 3.7 billion miles (5.9 Km) from the Earth. However, Pluto sometime likes to snuggle closer to the sun than Neptune. From Pluto, the sun would look like a bright star with insignificant heat and light. While spacecrafts have gone and sent photographs of all the other planets, none has visited Pluto yet. Scientists haven't had a closer look at it.

An Image of Pluto

Image Courtesy: NASA

ELEVEN

SUNS'S FAMILY

(MCCNS, ASTEROIDS AND COMETS)

Now let me tell you about the moons (satellites) of different planets, asteroids (minor planets) and comets.

Moons (Satellites of the Planets)

All the planets except Mercury and Venus have their own moons (satellites) like ours. They go around the planets just as the planets go around the Sun. Some of these moons are very fascinating. Our Earth as you know has one moon. Mars has two moons - Phobos and Deimos which mean 'fear' and 'terror' in Greek. They attend on the war god (Mars) but they are quite small, mere 14 miles (22 Km) and 7 miles (12 Km) wide.

Jupiter and Saturn have a large family of moons. Jupiter has 95 moons and Saturn has 146. Of the 95 moons of Jupiter, 12 are too small, about 12 to 100 miles (19 to 160 Km) wide. Only four of its moons are large. They are Ganymede, Callisto, Io and Europa. Ganymede and Callisto are very big, bigger than our moon. In fact, Ganymede is the largest moon in the entire solar system and is even bigger than the planet Mercury. The other two moons, Io and Europa are about the size of our moon, Io is a little bigger and Europa slightly smaller. As for Saturn, its largest moon is Titan. It is the second largest moon in the solar system. Four of its moons (Rhea, Iapetus, Dione and Tethys) are of moderate size ranging from about 650-950 miles (1045-1545 Km) in diameter. The rest are small, around 15-300 miles (24-500 Km) across.

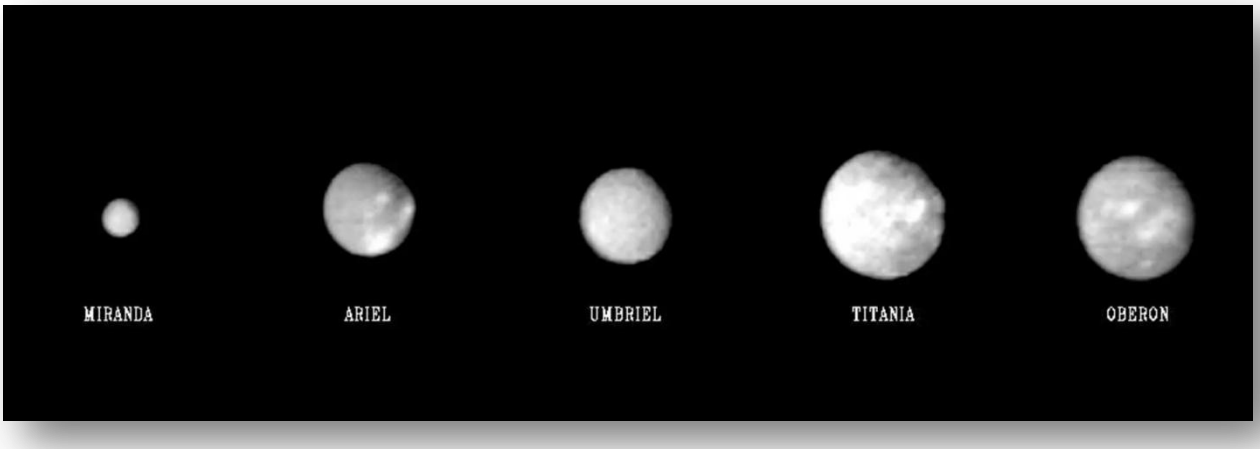
As we now know Uranus has 28 moons and Neptune has 16. The five moons of Uranus (Miranda, Ariel, Umbriel, Titania and Oberon) are well known. One of the moons of Neptune (Triton) is large. The rest are small. Pluto perched at the far end of the solar

system is the most distant planet. It has a small moon named Charon which is about 750 miles (1300 Km) wide.

What we have to be thankful for is that our Earth is ideally located in the solar system which led to the development of life on it. If we were a little closer or farther from the Sun, the conditions might have been different. The Earth could have been a planet like Venus or Mars. So, we have to preserve our planet Earth; keep it safe from pollution which destroys its air, water and vegetation on which our life depends.

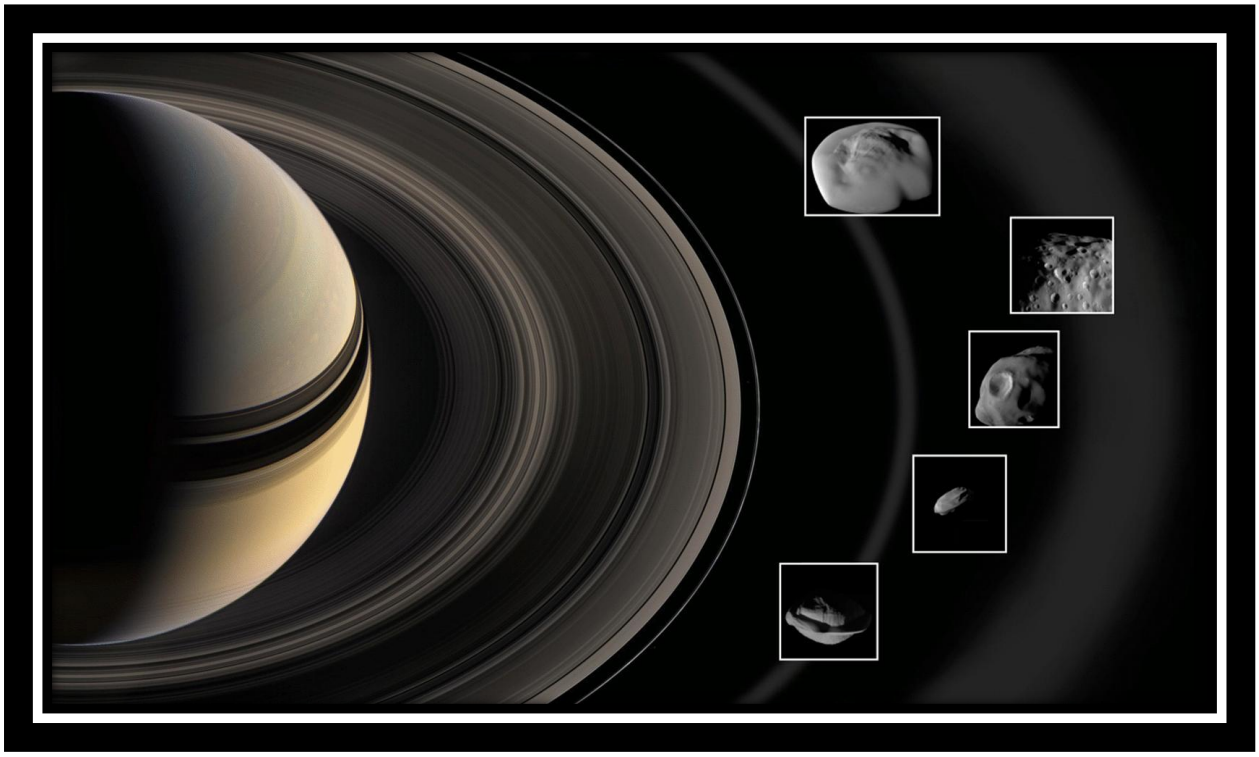
An Image of Jupiter's Moons

Image Courtesy: NASA



An Image of Uranus's Moons

Image Courtesy: NASA



An Image of the Asteroid Belt

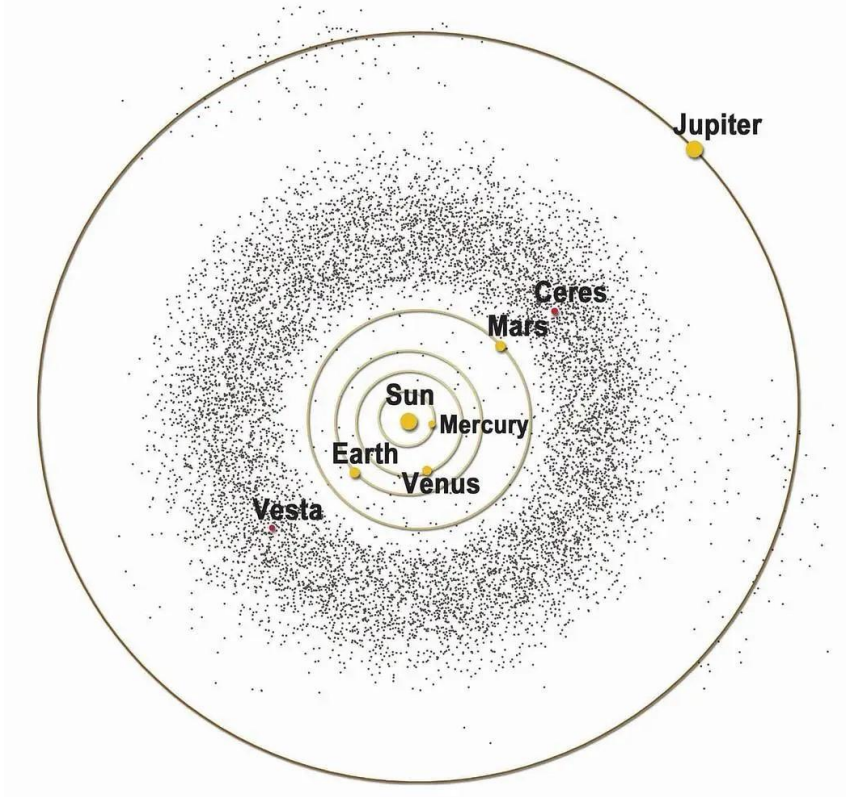
Image Courtesy: NASA

Asteroids (Minor Planets) - Rocks of the Solar System

In the space between Mars and Jupiter there is a broad belt known as the Asteroid Belt on which roll mountain size rocks and boulders with lumps of iron and other metals imbedded in them. They go around the Sun like other planets and are called minor planets or asteroids. There are thousands of asteroids of different shapes and sizes. Ceres is the largest, about 600 miles (1000 Km) wide.

Some asteroids may be 100 miles (160 Km) wide. But most of them are only a few miles across or even smaller. Occasionally, they develop unusual orbits and stray from their normal course. Sometimes they swing dangerously close to the Earth's path (orbit) causing concern of possible collision.

Such asteroids are called Earth-grazers. Asteroids are not the reliable members of the solar family and their neighborhood is not safe. Some scientists think that asteroids pose a great threat to our Earth as a large asteroid could wipe out the human race. But I should not unduly worry. Nothing catastrophic has happened for thousands of years.



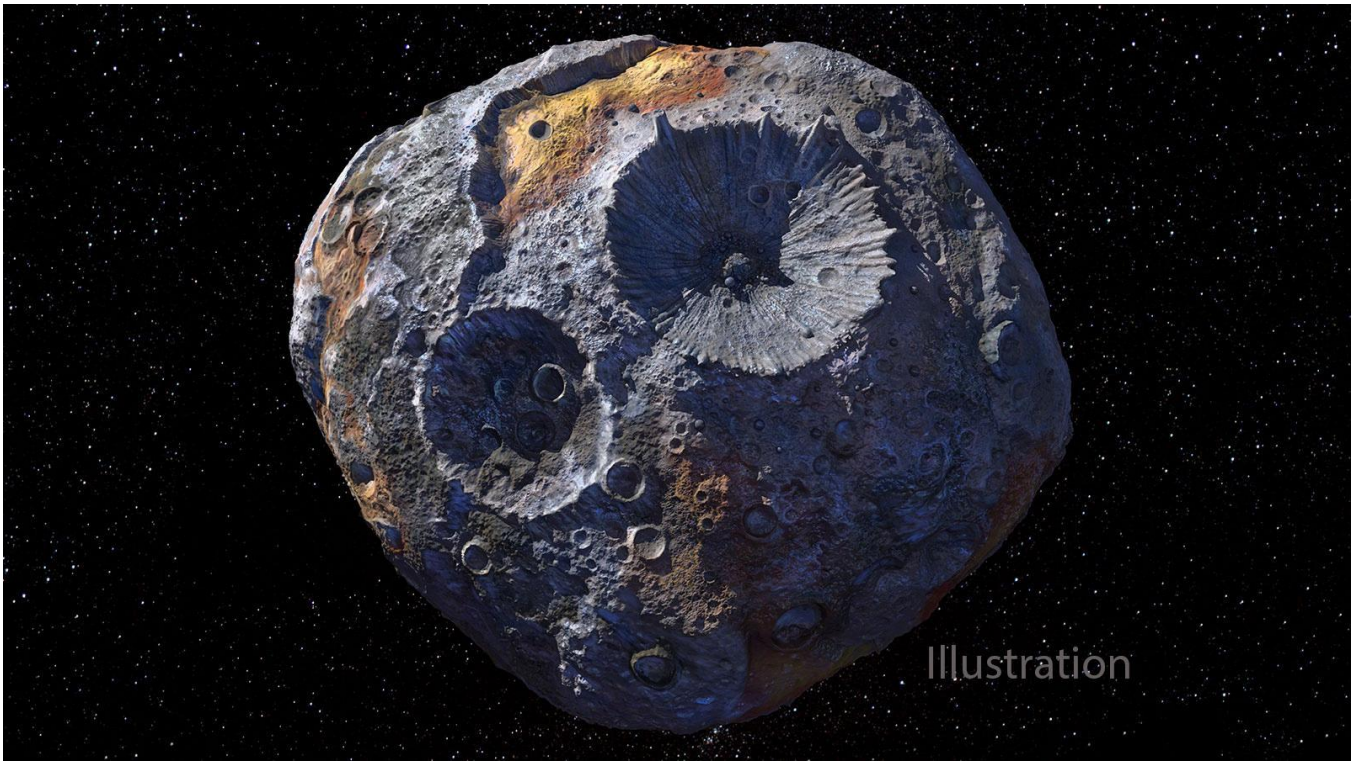
An Illustration of the Asteroid Belt

Meteoroids, Meteors and Meteorites

Smaller Asteroids (rocks of boulder size) are known as meteoroids. They are numerous, probably the result of repeated collision among bigger asteroids. Many meteoroids (small asteroids) fall on the Earth almost every day. Fortunately for us, before they reach the ground they burn out in the Earth's atmosphere due to heat caused by friction. A burning meteoroid which produces a streak of light for a few seconds is called meteor. It is also known as a shooting star or a falling star. Once in a while when a meteoroid does not burn up and hits the Earth it is called a meteorite. Meteorites have actually been seen and even hit houses.

Millions of years ago, big and small rocks (asteroids and meteoroids) regularly hit the moon and planets, even our Earth and left marks on their surfaces in the form of craters. As our moon has no wind or rain these pock marks have remained there for millions of years. The rain, wind and vegetation on Earth have wiped out most of them.

An Illustration of a Meteoroid



An Image of Haley's Comet

Image Courtesy: NASA

Comets

Comets are mysterious and may number in the billions. It is said there are more comets than there are fishes in the oceans. They are believed to revolve around the Sun in the coldest region, far beyond Pluto, our farthest Planet.

They are chunks of frozen gases and rock and are only a few miles wide, they have been called dirty snow balls. The appearance of a comet has always filled people with fear. These unexpected visitors from space are considered as heaven's warning of some kind of evil happening on Earth such as war, death, destruction or famine.

Sometime war, destruction and deaths have coincided with the appearance of comets. But such calamities have occurred even without them. Like asteroids comets are also disorderly members of the solar family and disregard normal rules of the road. Occasionally a comet leaves its normal orbit and makes a looping swing towards the Sun.

The outflow of solar energy evaporates and drives out its gases which sometime extend millions of miles as a comet's tail. The comet then shines brightly by Sun's light. Some comets go around the Sun once and return to their distant home, never to return again. Some disintegrate (break up) and vanish forever. A few others develop smaller orbits and visit at regular intervals varying from a couple of years to a hundred or hundreds of years. The well known Halley's Comet returns to earth after every 76 years.

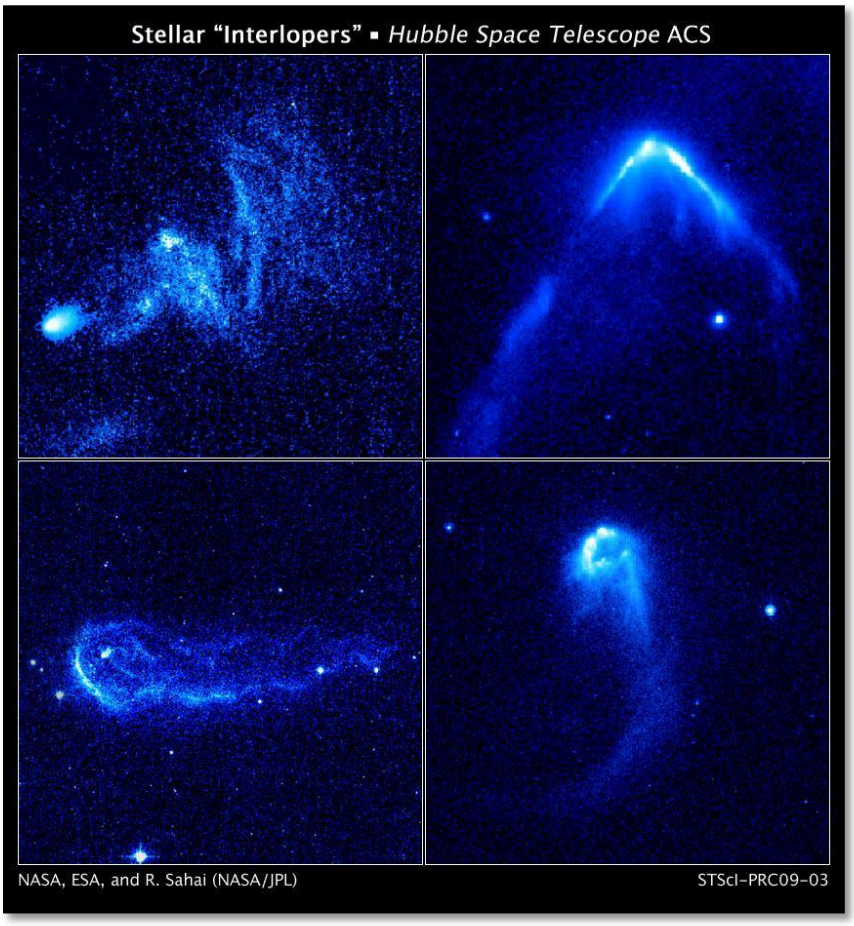


Image Courtesy: NASA

Every time a comet passes around the Sun, it loses some of its material which is left behind as dust particles. When the Earth, in its normal orbit, passes through this debris (remnants of a broken comet), these come in contact with its atmosphere and burn up as meteors. Sometime so many such meteors are seen falling from the sky that the event is called a Meteor Shower.

TWELVE

STORIES IN THE SRY

All the stars we see at night are a part of our galaxy. In ancient times people thought that they made some kind of shapes, patterns or pictures. Some appeared to them like human figures, some like animals and some as objects of everyday use. Depending on how they imagined, they named them after animals, birds, brave warriors or other figures. These imaginary star groups are called constellations. There are attractive stories associated with many of the constellations. Some have many stories. The charm of constellations is as much in the wonder of their stars as in the magic of their legends.

Constellations are generally known by their Latin names. Many do not look like the names given to them. About 2000 years ago, only 48 constellations were known. Since then new groups of stars have been named. Today we have 88 constellations®. Their position in the sky has been shown in the sky maps in the same way the land maps show the cities and states on earth.

Even though these star groups (constellations) are imaginary, they are useful; Constellations mark definite boundaries in the sky and thus help us in finding the position of different stars, even distant galaxies and objects. You have to understand that most constellations are visible either in the northern hemisphere (the part of the earth above the equator) or in the southern hemisphere (the part below the equator). This is because people in these different halves of the earth see different parts of the sky.

The stars are practically stationary. They are so distant that we cannot see them move for thousands of years. It is actually our earth, from where we look at them, which is moving. Like passengers on a moving bus who see the outside objects (trees and buildings) in motion, we see the stars move in the sky. It is the bus which moves not the trees; so also it is our earth which is in motion and not the stars.

5 Names of Well-known Constellations are in Appendix D.

You must have noticed that the sun and the stars rise in the east and slowly move to the west and disappear under the horizon. This appears because our earth is constantly turning round its axis (center) like a top in the opposite direction, from west to east. It completes one turn in 24 hours.

As you know, the earth also goes around the sun in a circular path (orbit) which it completes in one year. This is like going around a race track. The changing angles of the earth gives us different views of the stars and constellations at different times of the year - summer, autumn, winter and spring.

An Illustration of the Seasons on Earth

Ursa Major (The Big Bear)

Ursa Major in Latin means 'Big Bear'. It is commonly recognized by seven bright stars that catch everybody's attention. If you connect these stars by an imaginary line, they will make the shape of a dipper. Four of its stars make the bowl or a cup and the other three make the handle. This is called the Big Dipper. The Big Dipper is also called 'Plough' since it makes that shape also. Some people call it by other names such as Wagon, Chariot, and Seven Wise Men.

Although the constellation is known as the Big Bear, it does not look like it. It is difficult to see the whole constellation as many of its stars is too dim. The three stars of the handle of the dipper are thought to make the tail of the bear. It might interest you to know that all the seven suns of the Big Dipper are more powerful than our sun.

The middle star of the dipper's handle is called Mizar. It means horse in Arabic. Almost touching this star is a very dim star called Alkor which in Arabic means a horseman. Anyone who could see this star was considered to have good sight. The Arabs used it as a test for good eye-sight.

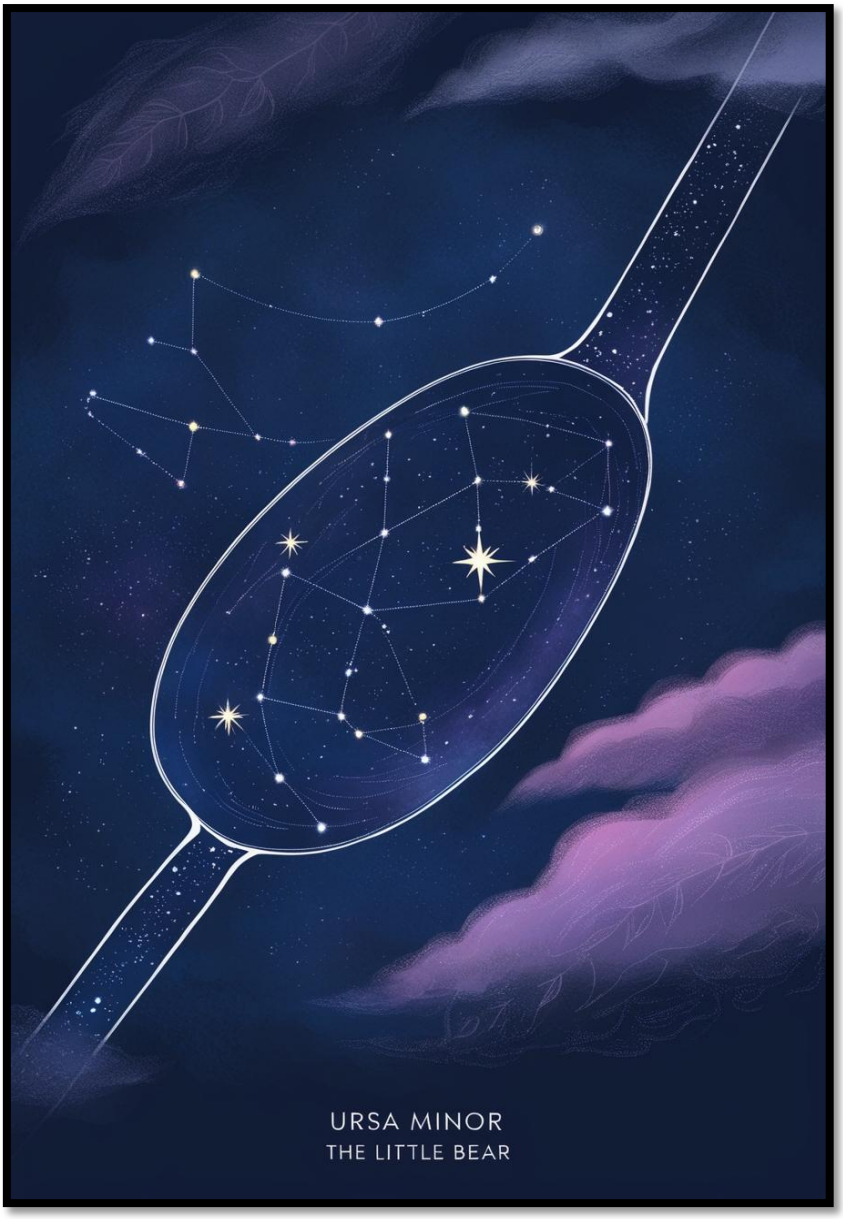
The two stars of the cup away from the handle (known as the pointer stars) help to find the direction of the North Star which is in another constellation called Ursa Minor (The Little Bear). If we draw an imaginary line from the inner pointer star to the outer pointer star and extend it all the way up, it will touch the North Star.

Ursa Minor (The Little Bear)

The constellation Ursa Minor does not have very bright stars. Therefore, it is not easy to see it. But its shape is similar to that of the Big Dipper. Being small in size, it is called Little Dipper. The star at the upper end of its handle is the North Star.

There are interesting stories about the Great Bear and the Little Bear. According to a legend, Zeus, the king of gods fell in love with Callisto, the beautiful daughter of a king. Together they had a son named Arcas. Goddess Hera (Juno), wife of Zeus became jealous of Callisto and changed her into a bear. When Callisto's son grew up, he saw a bear while hunting. Not knowing that it was his mother, he was about to kill her.

Zeus, his father was watching all this from heaven. He saved, Callisto by turning Arcas into another bear, just like his mother. Zeus then pulled both the bears by their tails and placed them in heaven as constellations. They are there now, near each other. Since they were pulled by the tail, it got stretched and became long.

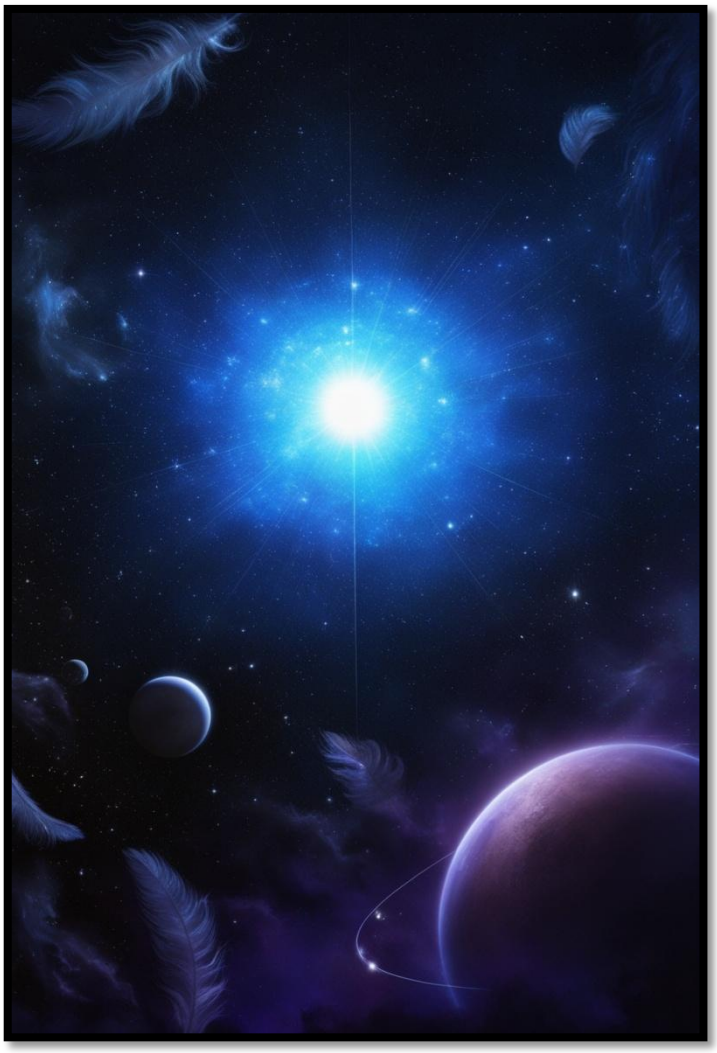


The Hindus of India have another legend. They believe that Dhruva was the son of a mighty king. Since he was the crown prince, his stepmother became jealous of him because she wanted her own son to be the crown prince. Dhruva left the palace and went into the forest where he met seven holy men (rishis). They taught him how to meditate to reach god. He meditated very hard. God was very pleased with him and gave him a place in heaven as the Dhruva Tara (Pole Star). The seven holy men who had taught the Prince were also sent to heaven. They are the seven stars of the Big Dipper, and are called the sapt rishis (seven sages).

Orion (The Hunter)

Orion makes a wonderful sight during the winter months that no one can miss. This constellation has also seven main stars which make the figure of a hunter named Orion, the tallest and most handsome of men in old legends. Its three glittering stars in the middle make the hunter's belt. It is thought that Orion is holding a club in his right hand which is raised and a shield in his left hand.

The two super giants, Rigel and Betelgeuse I told you about, belong to this constellation. Rigel is near the left knee of the hunter and Betelgeuse is at his right shoulder. The fuzzy middle star of the sword is not a star. It is the Great Orion Nebula, a vast cloud of gas and dust, about 1500 light years away. It is the birth place of stars, probably closest to us. There are many such places in our galaxy and others.



An Illustration of the Great Orion Nebula

I had told you about another star, Sirus which looks like a diamond in the sky. It is seen close to Orion's feet. Although it belongs to another constellation (Canis Major - The Big Dog), it has a close companionship with Orion. Sirus represents one of the hunting dogs of Orion. For this reason it is also called the Dog Star.

There are a number of stories about Orion. According to one story, Orion always boasted of his strength as a great hunter. Goddess Hera did not like it. She got a scorpion to kill him. Goddess Diana, protector of hunters, begged the chief god Zeus, to bring Orion back to life. Zeus agreed and sent Orion to heaven to live there forever. His two dogs (the big dog and the small dog) along with a hare were also placed nearby. All three are in different constellations.

To please goddess Hera, the scorpion was also sent to the sky but was placed at the opposite end, away from Orion. It makes another constellation named Scorpious. In another story the great hunter Orion was hunting in the forest with his faithful dog, Sirus. He saw seven beautiful girls (all sisters) and thought of marrying one of them. As he chased the girls, they got freighted and called the god Zeus for help. To help them escape, he changed the girls into doves. They all flew away and Orion was left alone with his dog.

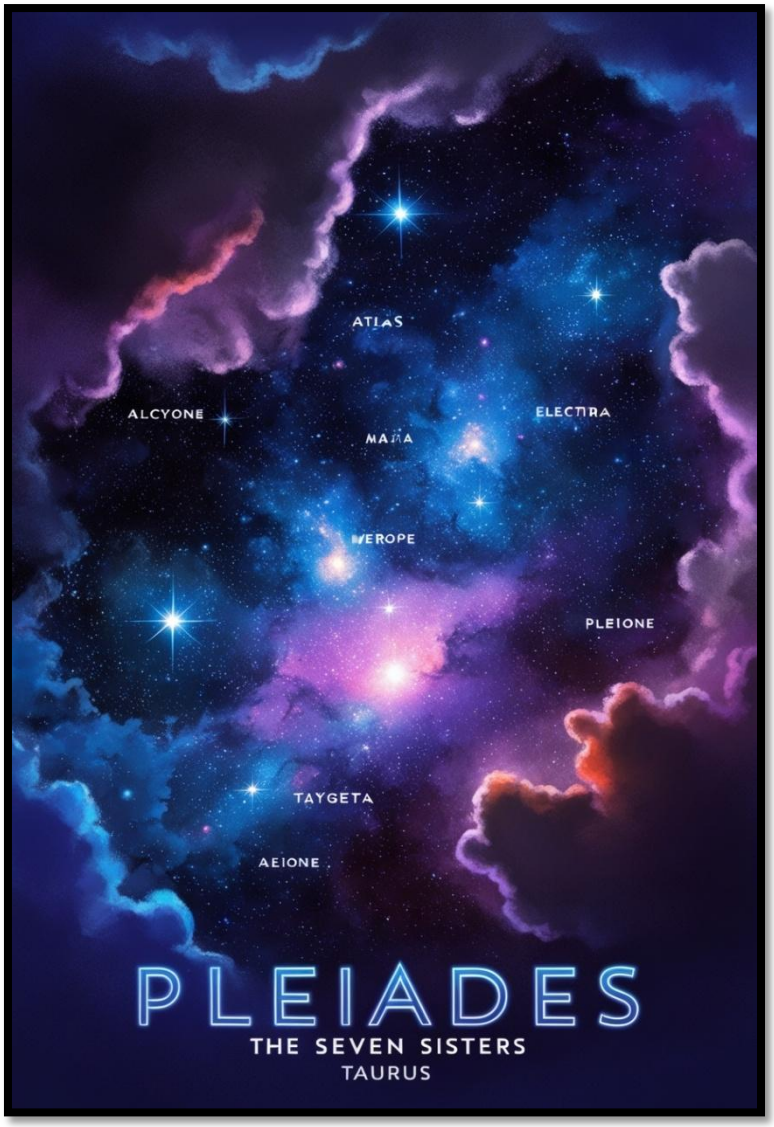
Taurus (The Bull)

Taurus can be located in the sky by its bright red star, Aldebaran, the red giant, I told you about before. It is easy to find this star. If you draw an imaginary line from Orion's belt all the way to the right, it will point in the direction of Aldebaran. It makes the red eye of the bull. To the left of Aldebaran are two stars which make the tip of the bull's horns and to the right the stars make its body.

A romantic story goes with this constellation, Zeus, the king of gods fell in love with Europa, the young princess of Phoenicia. To reach the princess, he changed himself into a white bull. Europa was delighted to see this beautiful and gentle animal. Playfully she sat on his back. The bull raced her to a distant land and changed back to Zeus before marrying her. It is

believed that the continent of Europe is named after Europa. The bull is seen in the sky as the constellation Taurus.

Pleiades (Plee-a-deez)



A description of Taurus may be incomplete without a mention of the Pleiades, called 'sisters of the skies' or 'seven sisters'. The Pleiades is a well known open cluster which appears as a tiny white mist towards the right of Aldebaran. There are several hundred stars in this cluster. These are mostly young stars, only a few million years old which makes them youngsters compared to our sun. They shine with white blue light.

With the naked eye it is normally possible to see the six stars of the Pleiades. It is an eye test if someone can see the seventh star. These seven stars are believed to be the seven sisters who were turned into doves and then stars by the god Zeus to save them from Orion. The bull is protecting them from the hunter. Some people thought, that one of the sisters was struck by lightning and is not visible. She recited the following lines of a poem:

The Sister Stars that once were seven, Mourn for their missing mate in Heaven.

THIRTEEN

FINDING YOUR WAY THROUGH THE STARS

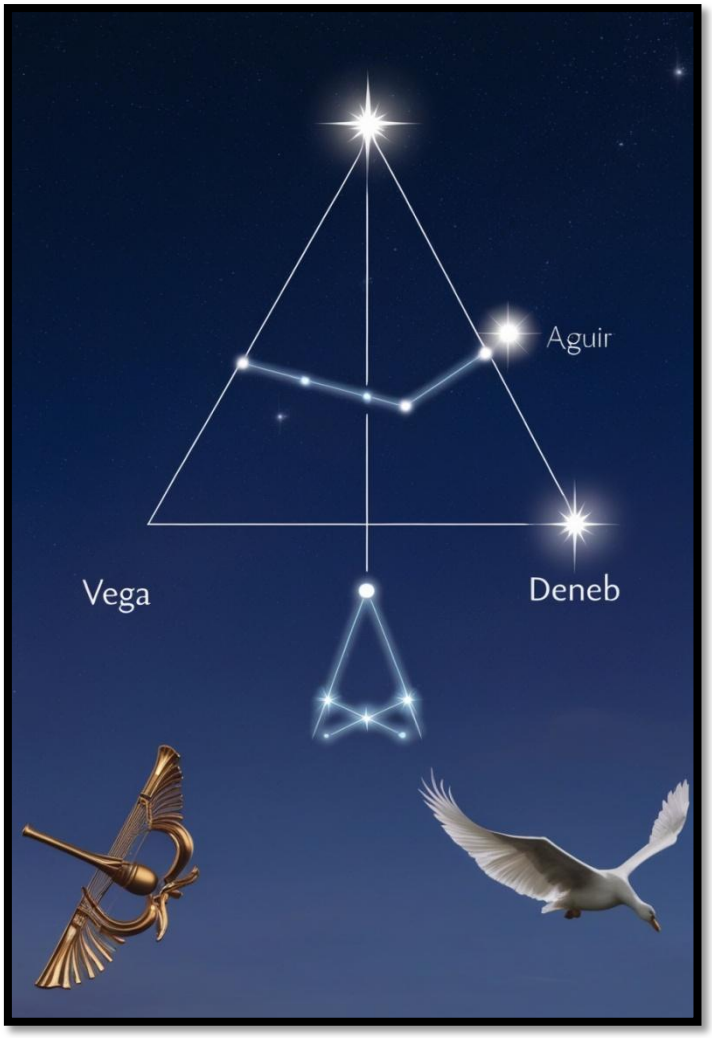
The sky is a maze of stars. It is confusing for anyone to find the shapes of constellations at first glance or even recognize prominent stars. There are no road signs up there to find your way. There are star maps which tell us where to look for particular constellations or stars at a given time.

We can also take the help of the Big Dipper or Orion (both easily visible) to locate some constellations. And from those points proceed further on. The bright stars often reveal the location of constellations to which they belong. Before you go out to look for the constellations, a mental picture of their shapes makes it easy to recognize them. It is like a treasure hunt. You must know where to dig.

Arcturus and Spica

Let's start with Arcturus, the bright star I told you about. It is in the constellation Bootes (the Herdsman). We can locate it by following the curve of the Big Dipper's handle. If we continue this curve beyond Arcturus, it will take us to Spica, a brilliant blue white star in the constellation Virgo (the Virgin). It is 260 light years from us and is 2100 times more powerful than the sun.

Summer Triangle



The Summer Triangle is not a constellation. It is a large Triangle formed by three bright stars of three different constellations viz., Vega in the constellation Lyra (the Lyre); Altair in the constellation Aguila (the Eagle); and Deneb in the constellation Cygnus (the Swan). They are all brighter than any other stars in the area. Therefore, it is not difficult to locate them.

I have already told you about Vega and Deneb. Altair is also a big star, eleven times more powerful than the sun. During the summer months if you look at the sky towards the North, Vega will be on your right. Its blue color is unmistakable. Close to Vega you will see a line of stars which is thought to make the head and neck of a swan. Follow this line down to a bright star at the tail end of the bird.

This will be Deneb. Another line of stars which intersects this makes the swan's wings. These two intersecting lines also make the shape of a cross called the Northern Cross. Altair can be seen to the South of Vega and Deneb. The Big Dipper can also be used to find Vega, Altair and Deneb. A line from the lower star of the cup towards the upper star joining the Dipper's handle and extended beyond will lead to Vega. Having come upon Vega, proceed further in the same direction to see Altair. Deneb which is slightly fainter than Vega and Altair can be seen to the East of Vega and cannot be missed.

Cygnus was a friend of Phaethon, son of the sun god Helios. He took his father's chariot to drive across the sky. He could not control the horses. He zig zagged in the sky, going up and down. When he went too high, the earth became cold and when he came too close to it, it made some places too hot like the Sahara. People living there became tanned. Finally, he spiraled down into a river to his death. Cygnus dived to save him but could not. He became very sad after Phaethon's death. Feeling sorry for him, the gods changed Cygnus into a swan and placed him in the heavens as a constellation.

As for Lyra the legend goes that this was designed with the shell of a tortoise. Its music attracted everyone who heard it. So it was given a place in heaven. There is also a story about Aquila (the Eagle). Prometheus, one of the gods, was a friend of mankind. People on earth liked him. In the beginning animals were better off than man since they had strength and speed which man did not have. Man suffered. Prometheus found a way to help them. He

brought fire from heaven and gave it to man so that he could make weapons to protect himself and make tools for ploughing the fields to grow food.

The gods became angry. Prometheus was arrested for stealing the fire and chained to a rock. An eagle was ordered to tear him apart. The wounds would heal at night only to be pecked the next day. After many days of torture, the mighty Greek hero, Hercules killed the eagle and freed Prometheus. The eagle was given a place in heaven.

According to another version of the story, the eagle was sent by Zeus (Jupiter) to earth to bring a cup- bearer for the gods. The eagle brought in his claws a handsome shepherd boy, Ganymede. As a reward the eagle was placed in heaven. It is also said that this eagle carried the thunderbolts of Zeus.

We can see some other constellations also with the help of the +Big Dipper, such a Leo (the Lion), Gemini (the Twins), Auriga (the Charioteer), Cassiopeia (the Queen) and Andromeda (the Princess). Gemini and Auriga can also be located with the help of Orion. Orion can also direct us to two brilliant stars, Sirus in the constellation Canis Major (the Big Dog) and Procyon in the constellation Canis Minor (the Little Dog)

Leo (The Lion)

If a line drawn from the Big Dipper towards Vega is extended in the opposite direction, it will connect with Regulus, the brightest star in the constellation Leo. It is 85 light years away from us. It is a blue white star, five times bigger than the sun and 160 times more luminous. The stars above Regulus make the shape of a sickle (or a backward question mark) which is easy to recognize. This is supposed to be the lion's head. The back of the lion is formed by a triangle. The second brightest star of the constellation, Denebola is at its tail.

Then there is a legend of a lion. Nemean was a ferocious lion whom nobody could kill. Its body was so tough that arrows and weapons could not pierce it. Hercules, the strongest Greek hero wrestled with the lion and strangled it to death. People narrated the stories of this lion and remembered it by looking at the constellation Leo.

Gemini (The Twins) and Auriga (The Charioteer)

It's easy to locate Gemini (the Twins) and Auriga (the Charicteer) with the help of the Big Dipper and Orion. Pollux and Castor are the leading stars of the constellation Gemini. According to a legend, they were twin brothers but had two fathers. Castor was the son of a mortal farther but Pollux was the son of god Zeus and was immortal. When Castor was killed in a battle, Pollux asked Zeus to let him share his immortality with his brother. The request was granted. The constellation Gemini represents them in heaven. [The Romans identified them with Romulus and Remus, the two brothers who founded Rome. Castor stands for "war' and Pollux for 'peace'. Pollux shines with an orange light. It is 35 light years from us and is 35 times more luminous than the sun.

Capella is the chief star of Auriga. It is the 6th brightest star in the sky and is 42 light years from us. It is an extremely powerful sun.

Cassiopeia, Andromeda, Cepheus, Perseus, Pegasus (the Winged Horse)

Before you see the constellations of Cassiopeia, Andromeda, Cepheus, Perseus and Pegasus (the Winged Horse). I will tell you a story. This is the story of a royal family which is cast in the sky.

Cassiopeia was the Queen of Ethiopia. Her husband, Cepheus, was the King. They had a daughter named Andromeda. The queen boasted that she and her daughter were more beautiful than the sea nymphs. This enraged the nymphs, the divine inhabitants of the seas. They asked Poseidon (Neptune), the god of the sea, to punish her by sending Cetus, a sea monster to destroy the kingdom. Cepheus sought an oracle's advice. He was told that the only way to calm the anger of the sea nymphs and save the kingdom was to sacrifice their daughter, Andromeda. The Princess was chained to a rock at the edge of the sea to the devoured by the sea monster. Perseus, the hero of those days while riding on his flying horse, Pegasus looked down at the sea coast, there he saw Princess Andromeda chained and in danger. He came to

her rescue and killed the monster. He then married Andromeda and they both lived happily ever After.

All the characters of this story can be seen in the sky as different constellations. Cassiopeia is very easy to see during autumn. It makes the shape of a 'W', and is supposed to be an ivory chair on which the queen is sitting. The constellation can also be seen with the help of the Big Dipper. A line from Mizar, (second star from the top of the Dipper's handle) to North Star and extended to about the same distance beyond will come upon the 'W' sign of the constellation. Below Cassiopeia is a line of stars which makes Andromeda's body. This is the Andromeda constellation. The other constellations of the royal family viz, Cepheus, Perseus and even Pegasus are close by. The stories often help in locating the constellations.

The distant galaxy of Andromeda can also be seen as a misty spot in the direction of the Andromeda constellation.

An Illustration of the Andromeda Galaxy

FOURTEEN

A LONG JOURNEY FROM THE PAST

We have come a long way in our search of the heavens. From the dawn of human intelligence, people have wondered looking at the sun, moon, and stars. They tried to explain these heavenly wonders in different ways. Astronomy (science of stars and other heavenly bodies) was thus the first science of ancient civilization.

An Illustration of Galileo Galilei with his Telescope

About 1800 years ago, a Greek astronomer, Ptolemy (Claudius Ptolemaeus) wrote a text in which he said that our earth was the center of the universe and that the sun, moon and the planets moved around it. For nearly 1,400 years this view prevailed. In 1543, a Polish scholar named Nicholas Copernicus challenged this belief. He suggested that it was the earth and the planets that revolved around the sun and not the other way round.

People finally accepted Copernicus's view. Man's pride of being at the center of everything burst like a bubble. In 1609 (about 400 years ago), another important thing happened. An Italian scientist, Galileo Galilei, made the first telescope which could see far beyond the human eye. This was an event which transformed the science of astronomy.

Many new discoveries were made. Since ancient times, there have been many great scientists who enriched the science of astronomy. Until the beginning of this century, the universe did not exist beyond our galaxy, the Milky Way. Today we know that there are billions of galaxies beyond our own. Even though there are mysteries at every step, the scientists know a great deal more than a few generations ago.

The progress during recent times has been phenomenal, particularly after the beginning of space age in 1957 when scientists began sending satellites into space. Since then men have landed on the moon and space satellites have sent us information from distant planets. The modern scientific instruments, space telescopes, improved photo techniques and amazing computers have changed the picture of our universe.

An Illustration of the First Moon Landing

We all are living in an exciting age. What I have told you is only an outline. I am sure you will see many more wonders in the land of the suns in your life. There are many things you can read about. Or maybe in the future a distant star may tell them to you.

THE END

SOME MEMBERS OF THE LOCAL GROUP OF GALAXIES

Appendix A

Name of Galaxy	Width in Light Years (Approx)	Type
Andromeda M 31(NGC 24)	130,000	Spiral
Milky Way	100,000	Spiral
M 33 (NGC 598)	60,000	Spiral
Large Magellanic Cloud (L.M.c.)	30,000	Irregular
Small Magellanic Cloud	25,000	Irregular
Fornax	22,000	Elliptical
NGC 205	16,000	Elliptical
C 1613	16,000	Irregular
NGC 147	10,000	Elliptical
NGC 6822	9,000	Irregular
M 32 (NGC 221)	8,000	Elliptical
NGC 185	8,000	Elliptical
Sculptor	7,000	Elliptical
Leo I	5,000	Elliptical
Leo II	5,000	Elliptical
Draco	4,500	Elliptical
Ursa Minor	3,000	Elliptical
Snickers		

SCIENTISTS HAVE LISTED GALAXIES, NEBULAE AND STAR CLUSTERS, ETC. TO DISTINGUISH ONE FROM THE CTHER. FRENCH ASTRONOMER C HARLES MESSIER PREPARED THE FIRST CATALOG IN 1771. SINCE ANDROMEDA GALAXY IS NUMBERED 31 IN MESSIER'S CATALOG, IT IS CALLED M 31. ANOTHER CATALOG IN USE IS NEW GENERAL CATALOG (NGC). SOME OBJECTS IN MESSIER'S CATALOG HAVE ALSO BEEN SIVEN NGC NUMBERS VIZ., ANDROMEDA GALAXY (M. 31) IS ALSO CALLED NOC 24.

APPENDIX B

TWENTY ONE BRIGHTEST STARS IN OUR SKY

Of the thousands of stars visible at night, some stars appear brighter than others. Twentyone brightest stars in our sky are given here in order of their apparent brightness (as it appears to the eye).

No	Star	Constellation	Apparent Magnitude	Distance from Earth (Light Years) Appr.	Luminosity (x) Sun's
1	SIRUS	Canis Major	-1.50	9	26
2	Canopus	Carina	-0.72	1,200	200,000
3	Alpha Centauri	Centaurus	-0.27	4.3	1.5
4	Arcturus	Bootes	-0.04	36	130
5	Vega	Lyra	+0.03	26	58
6	Capella	Auriga	+0.10	42	70
7	Rigel	Orion	+0.10	900	60,000
8	Procyon	Canis Minor	+0.40	11.4	11
9	Achernar	Eridanus	+0.50	85	780
10	Betelgeuse	Orion	+0.50	500	15,000
11	Agena	Centaurus	+0.61	460	10,500
12	Altair	Aquila	+0.80	16.6	11
13	Acrux	Crux	+0.83	360	4,000
14	Aldebaran	Taurus	+0.90	70	360
15	Antares	Scorpius	+1.00	520	9,000
16	Spica	Virgo	+1.00	260	2,100
17	Pollux	Gemini	+1.14	35	60
18	Fomalhaut	Pisces Australis	+1.16	22	13
19	Deneb	Cygnus	+1.25	1800	70,000
20	Beta Crucis	Crux	+1.28	425	8,200
21	Regulus	Leo	+1.35	85	160

APPENDIX C

COMPARATIVE DATA OF PLANETS

Name	Average Distance from Sun in million Miles	Km	Diameter Miles	Km	Time taken to orbit the Sun	Time taken to rotate on Axis
Mercury	36.0	57.9	3,030	4,880	88d	59d
Venus	67.0	108.2	7,520	12,100	225d	243d
Earth	93.0	149.6	7,927	12,756	365d	1d 23h 56m 4 s
Mars	142.0	228.0	4,217	6,786	687d	24h 37m 23s
Jupiter	484.0	778.4	88,733	142,796	11.9y	9h 50m 30s
Saturn	885.0	1,425.6	74,978	120,660	29.5y	10h 40m
Uranus	1,780.0	2,867.0	31,765	51,118	84y	17h 14m
Neptune	2,790.0	4,486.0	30,777	49,528	164y	17h 50m
Pluto	3,660.0	5,890.0	1,500	3,000	248y	6d 9h 17m

Name	Inclination of equator to axis (rounded in degrees)	Mass Earth=1	Density Water=1	Gravity Earth=1	Number of Moons
Mercury	2	0.055	5.4	0.39	-
Venus	177	0.814	5.3	0.91	-
Earth	23.45	1.00	5.5	1.00	1
Mars	25	0.107	3.9	0.38	2
Jupiter	3	317.93	1.3	2.60	16
Saturn	27	95.18	0.7	1.10	17
Uranus	98	14.53	1.2	0.88	15
Neptune	29	17.13	1.6	1.14	8
Pluto	122	0.0022	2.0?	0.05?	1

(i)

Appendix 'D'

NAMES OF WELL-KNOWN CONSTELLATIONS

There are 88 constellations but it is difficult to see all of them. Some constellations are too faint. The others are too far in the southern hemisphere and cannot be viewed from countries in the northern hemisphere excepting those close to the equator.

For an easy acquaintance, the constellations have been grouped according to the season in which they can be best seen. Depending upon the time and place, they may also be visible before or after a particular season.

Wherever the constellation has a 1st magnitude star, it has been mentioned against its name.

Summer Constellations

Aquila (The Eagle)	- ALTAIR
Capricornus (The Sea -Goat)	
Cygnus (The Swan)	- Deneb
Darco (The Dragon)	
Hercules	
Libra (The Scales)	
Lyra (The Lyre)	- VEGA
Ophiuchus (The Serpent Holder)	
Serpens (The Serpent)	
Sagitta (The Arrow)	
Sagittarius (The Archer)	
Scorpius (The Scorpion)	- ANTARES

AutumnConstellations

Andromeda
Aquarius(The Water Carrier)

Aries (TheRam)
Cassiopeia
Cepheus
Cetus (The Whale)
Pegasus (The Flying Horse)
Perseus
Pisces (The Fishes)
Taurus (The Bull) - can be seen until late winter - ALDEBARAN

Winter Constellations

Auriga (The Charioteer)	- CAPELLA
Canis Major (The Big Dog)	- SIRUS
Canis Minor (The Little Dog)	- PROCYON
Gemini (The Twins)	- POLLUX
Orion (The Hunter)	- RIGEL AND BETELGEUSE

Spring Constellations

Bootes (The Herdsman)	- ARCTURUS
Cancer (The Crab)	
Leo (The Lion)	- REGULUS
Virgo (The Virgin)	- SPICA

Circumpolar Constellations

Ursa Major (The Big Bear)	They are visible all year round from latitude 40° North (approxi-mately midway between the equator and the North Pole).
Ursa Minor (The Little Bear)	

Constellations of The Zodiac

The orbits of almost all planets, including our earth lie along a horizontal narrow belt (circular

highway or a beltway) called the Zodiac which goes around the sky. This is also the sun's apparent path. Twelve of the 88 constellations (names given below and included in the above list) form the background of this circular parth just as viewers around a boxing ring or a circular race course. They are called the Constellations of the Zodiac. ('Zodiac' means circle of animals; a majority of these constellations represent animals.)

Aries, Taurus, Gemini, Cancer, Leo, Virgo, Libra, Scorpius, Sagittarius, Capricornus, Aquarius, Pisces.

In ancient times these twelve constellations were considered special as they were thought to influence the destiny of nations and human beings. Even today the position of these constellations and the planets (erroneously called stars) is used to predict future events. This is astrology. Although astrology and astronomy had common beginnings, they are both totally different. Astronomy is a science but astrology is based on belief.

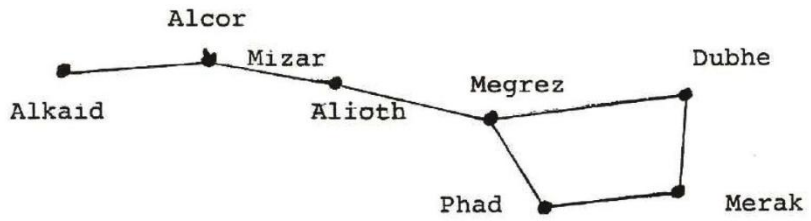
‘We are but a speck of dust, floating in desolate skies’ –
NARINDER KUMAR CHAUHAN

THE AUTHOR

Narinder Kumar Chauhan (1929-1996) was a distinguished former IAS officer whose career spanned numerous influential roles within the Government of India. Initially embarking on his professional journey as a university lecturer, he later rose to prominence as an Advisor for the First International Surveillance act (FISA) and served as the Director of Education. His diplomatic assignments included significant postings in Washington, San Francisco, and Moscow. He served as an Advisor to two Prime Ministers during his distinguished career, starting with the Late Indira Gandhi, and continuing with her successor, Rajiv Gandhi. His tenure spanned from the early 1960s through to the late 1980s, shaping key decisions across two significant political eras.

Mr. Chauhan played a pivotal role in facilitating cultural agreements, notably overseeing programs that promoted the exchange of scientific information and literature targeted at young people across Eastern Europe and Africa. His dedication to fostering international collaboration led him to visit Kenya and Algiers to finalize these important protocols. Additionally, he contributed to the editorial staff of national publications aimed at young audiences, enriching their educational landscape.

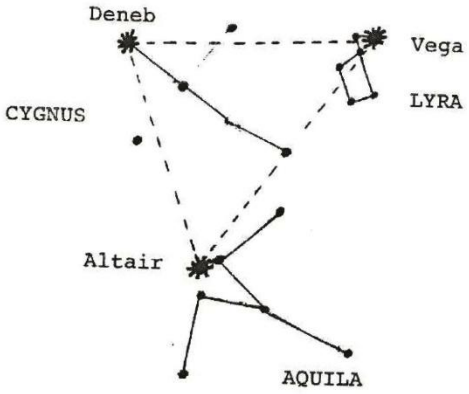
A recipient of the prestigious Rockefeller Foundation scholarship, he furthered his studies at Johns Hopkins University, enhancing his expertise in education and international relations. Upon retiring as Deputy Secretary/Deputy Educational Adviser with the Government of India, Mr. Chauhan split his time between Virginia, USA, and Chandigarh, India. His remarkable journey concluded in 1996 when he passed away due to leukemia, leaving behind a legacy of commitment to education and cultural diplomacy.



The Big Dipper with names of stars.

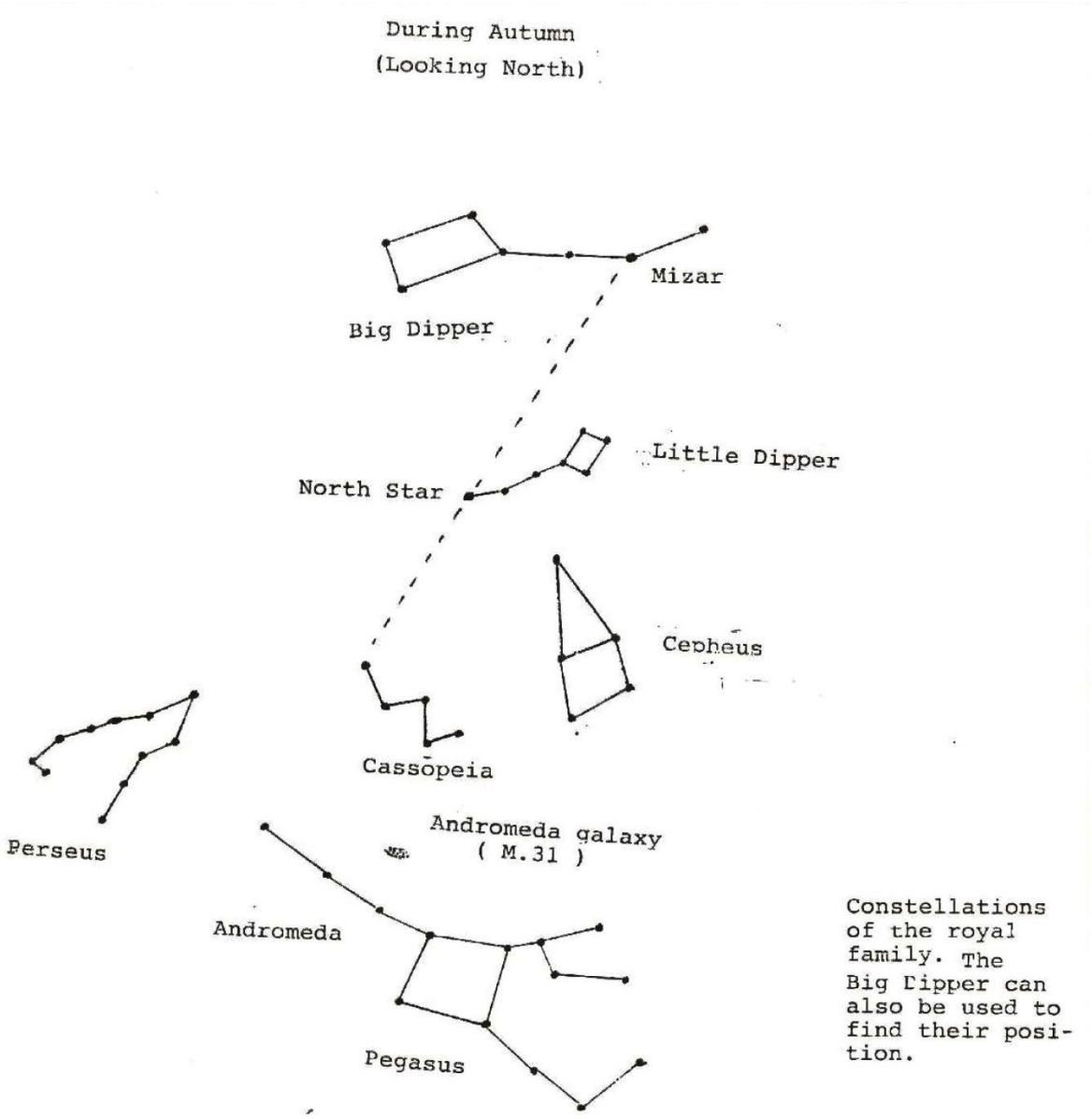
All stars of the Dipper are more powerful than the sun. Except Dubhe which is somewhat orange, all other stars are white. Orange color means lower surface temperature. The magnitude, luminosity and distance of these stars from us are given below.

	Mag.	Lum. (power times sun)	Distance
Alkaid	1.9	600	200 ly.
Mizar	2.0	70	90 ly.
Alioth	1.8	85	70 ly.
Magrez	3.3	20	65 ly.
Phad	2.4	75	90 ly.
Merk	2.4	65	80 ly.
Dubhe	1.8	140	100 ly.

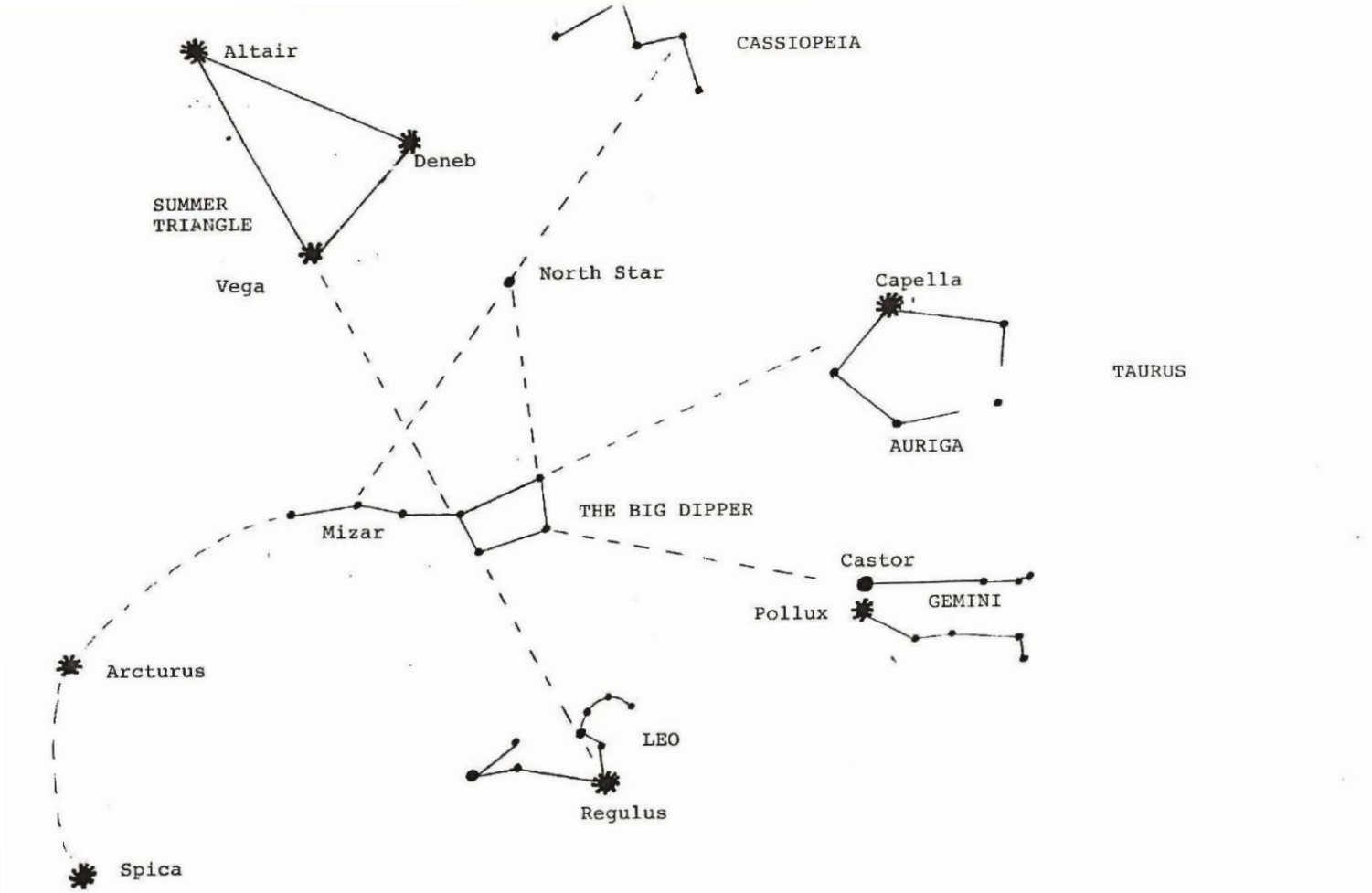


The Summer Triangle

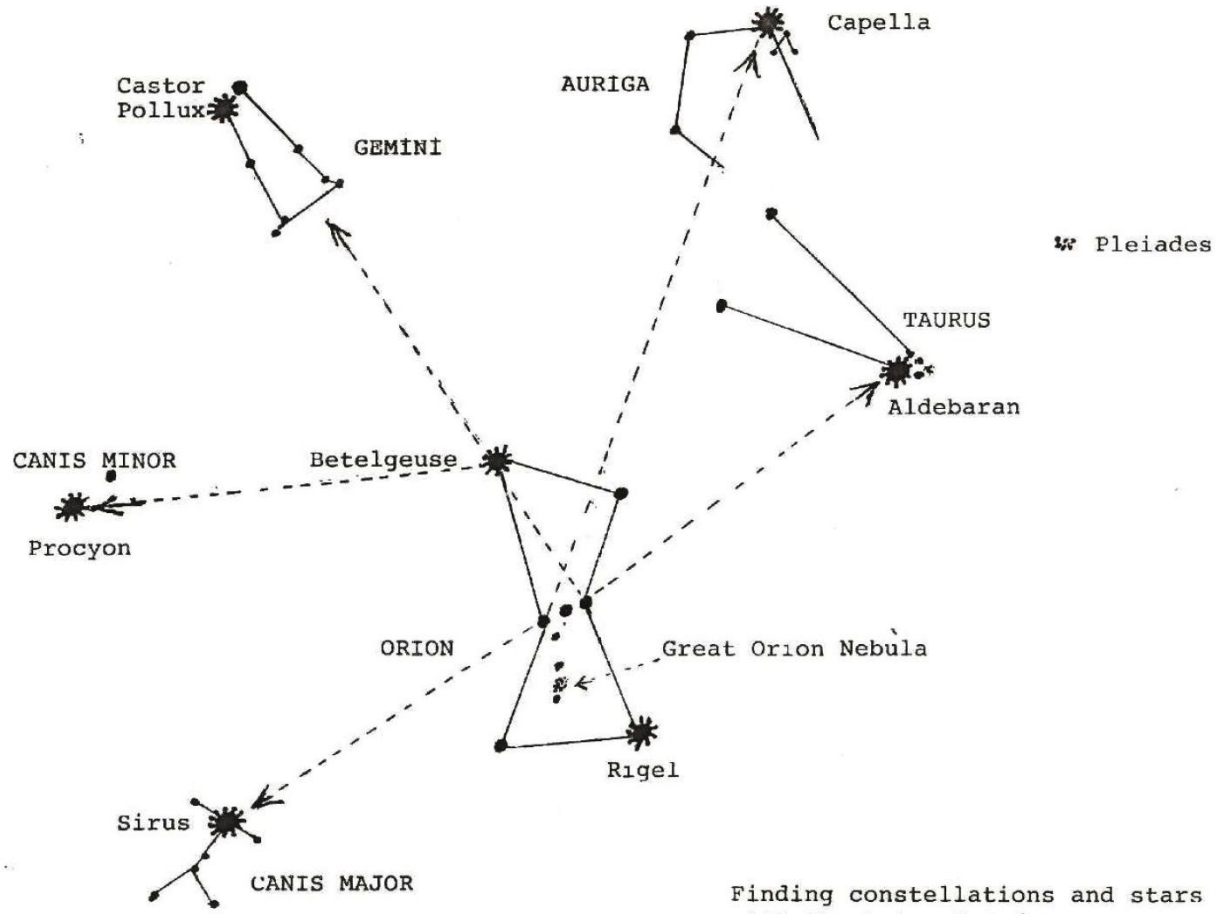
To find the North Star (Polaris), take the help of two pointer stars away from the Big Dipper handle. Draw an imaginary line from the inner star to the outer star and extend it all the way up. It will lead to the North Star.



Constellations of the royal family. The Big Dipper can also be used to find their position.



Finding constellations and stars
with the help of Big Dipper



Finding constellations and stars with the help of Orion.

THE LAND OF SUNS

BY

NARINDER KUMAR CHAUHAN

SUMMARY: THIRTY YEARS AGO, THE LATE MR. NARINDER KUMAR CHAUHAN PENNED THIS BOOK, BUT DUE TO HIS UNTIMELY PASSING, IT REMAINED UNPUBLISHED. NOW, AFTER THREE DECADES, HIS FAMILY HAS LOVINGLY BROUGHT IT TO LIFE, METICULOUSLY UPDATING AND REFINING THE ORIGINAL CONTENT, AND PRESENTING IT WITH ENTIRELY NEW ILLUSTRATIONS, DESIGN, AND ARTWORK. THIS LONG-AWAITED RELEASE PAYS TRIBUTE TO THE AUTHOR'S LEGACY AND BRINGSHIS VISION TO A NEW GENERATION OF READERS. IT IS A STORY OF THE UNIVERSE — HOW THE UNIVERSE BEGAN, STARS FORMED AND HOW THEY SHINE AND DIE. ALSO CONTAINS INFORMATION ABOUT SOME OF THE BIGGEST STARS, STAR GALAXIES, CONSTELLATIONS AND OUR OWN SOLAR SYSTEM.

PRODUCTION & DISTRIBUTION

AMIT CHAUHAN FILM CO

+91-6280214403, 7099862579
amit63chd@gmail.com
amitchauhanfilmco@gmail.com
https://linktr.ee/amitchauhanfilmco