

Universe



A Pinku and Dadaji
Series

Planets do not Twinkle

Dadaji: Hi Pinku

Pinku: Hello Dadaji

Dadaji: So what's up Pinku?

Pinku: Nothing Dadaji. I was observing stars and wondering how beautiful the sky is. If I had a space machine, I would travel through the space and would enjoy. I wonder Dadaji among other stars I see this star which is not twinkling. Can you tell me Dadaji why is this star not twinkling?

Dadaji: Oh! That's a planet. As planets derive light from the stars they do not twinkle.

Pinku: Then what planet is that Dadaji?

Dadaji: I am not sure my son but may be Venus.

Pinku: Dadaji... Venus circles around Sun. So you mean to say Sun is also a star Dadaji?

Dadaji: Yes Pinku sun is also a star.

Pinku: What is Planet Dadaji?

Dadaji: Pinku a planet is a celestial body moving in an elliptical orbit round a star.

Pinku: What do you mean by celestial body

Nicolaus Copernicus placed the Sun rather than Earth at center of the Solar system

Dadaji?

Dadaji: Celestial body is any natural body outside of the Earth's atmosphere. Easy examples are the moon, sun, and the other planets of our solar system.

Pinku: What is Solar System Dadaji?

Dadaji: The Solar System is made up of all the planets, moons, comets, asteroids, and dust & gas that orbit a star. In our Solar System the star is the sun and those objects revolving around sun in total become part our solar system. Nicolaus Copernicus made a very important discovery that the earth and all of the planets revolve around the sun. Copernicus proposed that the Sun, not the Earth, was the centre of the Solar System. Such a model is called a heliocentric system.



Moon is a natural satellite

Before Copernicus discovery astronomers believed that the Earth was the centre of the universe and the sun and planets revolved around it called the Ptolemaic system/ Geocentric model. The solar system is around 4.6 billion years old. Scientists estimate that it will probably last another 5000 million years.

Pinku: Can there be planets outside the solar system?

Dadaji: Yes ... they are called exo-planet or extra-solar planet; a planet which orbits a star outside the solar system. Some of the exo-planets are rocky, some are gaseous

Pinku: Than what do you mean by Elliptical orbit Dadaji?

Dadaji: Elliptical orbits are the paths taken by objects as they fly around a massive object, such as the sun or Earth. Such orbits are not “round” as is commonly supposed; instead, they orbit the massive body in the shape of an ellipse. Ellipses are like circles that have been elongated slightly, and they are also referred to as ovals.

Pinku: What might happen Dadaji if an orbit

Moon is called a natural Satellite because it orbits Earth

fails?

Dadaji: Pinku...An orbit is the perfect balance between a satellite's forward momentum and the pull of gravity on it. If either of these is changed, the orbit will fail, and the object will either crash down onto the object it is orbiting or spin off into space.

Pinku: Then what is moon called Dadaji?

Dadaji: Moon is our... I mean earth's natural satellite.

Pinku: Satellite hmm... what is a satellite Dadaji?

Dadaji: A natural satellite is any celestial body in space that orbits around a larger body. Moons are called natural satellites because they orbit planets. Satellites that are made by people and launched into orbit using rockets are called artificial satellites. There are thousands of artificial satellites orbiting the Earth.



Europa is an icy moon of Jupiter

Pinku: Yes I know Dadaji. Aryabhata was India's first Satellite.

Dadaji: Correct Pinku... the satellite was named so in remembrance of India's one of the greatest Astronomer Aryabhata.

Pinku: What were the other Satellites launched by India Dadaji?

Dadaji: Oh! There are so many. Bhaskara I, Insat series such as 1a, 1b, 1c so on.

Do you know pinku any large object that orbits around a planet is called a moon (small 'm'). The Earth has one moon called the Moon (capital 'M'). The Moon takes 27.3 days to orbit the Earth once, moving at an orbital speed of 1 km/s.

Pinku: Are there moons around other planets as well Dadaji?

Dadaji: Yes Pinku...Galileo was the first person to discover that other planets can have moons. He saw that Jupiter had four moons with his newly invented telescope in 1610 AD. At first, he thought they were stars, but he noticed that, each night, the four points of light appeared to change positions slightly. He realised they

Aryabhata was the first of the major mathematician-astronomers in India

were actually moons orbiting around Jupiter. We now know that Jupiter has at least 64 moons. All except two of the planets (Venus and Mercury) in our Solar System have natural satellites called moons. Europa is an icy moon of Jupiter which is slightly smaller than Earth's moon. It is unique in the solar system, being thought to have a global ocean of water. If the ocean is proven to exist, Europa could be a promising place to look for life beyond Earth.

Pinku: Oh! But there are other objects which also orbits around sun and planets... correct Dadaji?

Dadaji: Absolutely...They are other natural satellites such as Asteroids and comets. Our Solar System has eight official planets as well as millions of minor asteroids, comets and other objects orbiting around the Sun and planets. All of these can be thought of as natural satellites.



Asteroids are made up of rocks

All of these natural satellites are held in orbit by the attraction of gravity between the satellite and the object it is orbiting.

Pinku: I heard of asteroids Dadaji but not sure what exactly is an asteroid... Can you tell me what an asteroid is Dadaji?

Dadaji: Pinku...An asteroid is a large, irregularly shaped object in space that orbits our Sun. You can imagine giant rocks orbiting around sun. If one of these giant rocks ends up on a collision course with Earth, we are in for big trouble. Asteroids are made up of rock or even metal. This makes them dangerous because they can cause a lot of damage if they collide with a planet.

Pinku: Oh my God.

Dadaji: Do you see those big holes in moon?

Pinku: Yes Dadaji

Dadaji: They are called Craters. The craters on the Moon were formed by collision of asteroids in the moon. Do you know...? Some even think it was an asteroid that wiped out the dinosaurs.

Pinku: What?

A crater is a bowl-shaped depression produced by the impact of a meteorite

Dadaji: Yes Pinku. You heard what I said... We even have geological evidence that an asteroid may have hit Earth about 65 million years ago. This impact made a huge explosion and a crater. Debris from the explosion was thrown into the atmosphere, severely altering the climate, and leading to the extinction of roughly 3/4 of species that existed at that time, including the dinosaurs.

Pinku: Oh pity...

Dadaji: Do you know Pinku there are around a million asteroids located between Mars and Jupiter in an area called the “asteroid belt.”

Pinku: Do you know Dadaji how they must have formed?

Dadaji: I can barely remember one theory that astronomers have. Some billion years ago, when our solar system was being formed, a planet tried to form between Mars and Jupiter.



Life on earth are due to Comets collision

However, Jupiter's gravitational forces were too strong, so these objects could not form a planet hence they remained as asteroid belt.

Pinku: While we were talking about satellites, you said something called Comet. What is a comet Dadaji?

Dadaji: Pinku, a comet is an icy body that releases gas or dust. They are often compared to dirty snowballs. Comets contain dust, ice, carbon dioxide, ammonia, methane and more. Astronomers think comets are leftovers from the gas, dust, ice and rocks that initially formed the solar system about some billion years ago. Some researchers think comets might have originally brought some of the water and organic molecules to Earth that now make up life here.

Pinku: Ah is it?

Dadaji: Yes Pinku... Several scientists world over believe that life on earth originated from comets shelling our planet. Scientist's experiments show that early comet impacts could have caused amino acids to change into peptides, becoming the first building blocks of life. Not only would this help explain the

Oort Cloud is a thick bubble of icy debris that surrounds our solar system

genesis of life on Earth, but it could also have implications for life on other worlds too.

Pinku: Life on Other planets? Wow! Dadaji so do you mean to say there might be other worlds where they may be life.

Dadaji: Could be... however, we do not have any evidence as on date. We only have imagined existence of aliens in the movies.

Pinku: Hmm... somewhere someone in some other part of world is trying to contact us.

Dadaji: Do not float now into dreams Pinku. May be what you said is correct but nobody knows what the truth is... so do not think too much on these things.

Do you know Pinku... Comets orbit the sun, but most are believed to inhabit in an area known as the "Oort Cloud", far beyond the orbit of Pluto.



Debris is the remains of anything broken

Occasionally a comet streaks through the inner solar system; some do so regularly, some only once every few centuries. Many people have never seen a comet, but those who have won't easily forget the celestial show.

Pinku: Ah! That reminds me of Halley's Comet. I have read about it in my textbook.

Dadaji: Halley's Comet or Comet Halley named after astronomer Edmond Halley, is a short-period comet visible from Earth every 75 to 76 years. Halley is the only known short-period comet that is regularly visible to the naked eye from Earth, and the only naked-eye comet that might appear twice in a human lifetime. Halley last appeared in the inner parts of the Solar System in 1986 and next appearance is expected in mid-2061.

Pinku: Dadaji I wonder what you than call the star which falls on earth is that a comet?

Dadaji: No no Pinku... A falling star or better known as shooting star has nothing to do with a star. The amazing streaks of light that you can see sometimes in the night sky are caused by tiny bits of dust and rock called meteoroids falling into the Earth's atmosphere and

Halley, is a short-period comet visible from Earth every 75–76 years

burning up.

Pinku: Ah! A new word meteoroid... what are they Dadaji?

Dadaji: A meteoroid is also a celestial body that revolves around sun or planets. It is called so as it is too small to be called an asteroid or a comet. Most meteoroids are about the size of a pebble. Actually Pinku, many meteoroids are formed by comets that have decayed. They are the debris that might have formed several billions of years ago.

Pinku: Debris... what is Debris Dadaji?

Dadaji: Debris is the remains of anything broken down or destroyed you also call it as ruins or remains or rubble as you may understand it.

Pinku: Oh...! Than what a meteor is Dadaji?

Dadaji: We call it a meteor when meteoroid or a space rock that hits the atmosphere of the Earth. It's also called a shooting star/falling star.



Big Bang Theory is the foundation of Universe

When one of these pieces or debris of meteoroid enters the Earth's atmosphere, friction between the debris and atmospheric gases heats it to the point that it glows and becomes visible to our eyes appearing as a streak of light.

Pinku: Oh...! Got it Dadaji

Then what is meteorite Dadaji... It's so confusing...

Dadaji: My Son that's simple...If any part of a meteoroid survives the fall through the atmosphere and lands on Earth, it is called a meteorite. Although the vast majority of meteorites are very small, their size can range from about a fraction of a gram (the size of a pebble) to 100 kilograms or more.

Pinku: Really appreciate Dadaji you made the terminologies so easy to understand.

Dadaji: Thank you Pinku. Now I will tell you what Universe is. The universe is endless space which contains all of the matter (which we can touch, feel or sense) and energy in existence. The Universe contains billions of galaxies; each containing billions of stars; each contain-

A meteorite is debris from a comet, asteroid, or meteoroid

ing billions of planets so on and so forth.

Pinku: How was the Universe formed?

Dadaji: There are several theories associated to formation of Universe. The famous among them is Big Bang Theory. As per big bang theory, the Universe was a single particle which due to internal forces such as gravitational force blown up like a balloon and the pieces scattered all across forming Universe. Some scientists believe that the universe is ever expanding and each of the galaxies and planets are moving away from each other.

Pinku: Hmm...Like in Diwali atom bomb explodes similarly the universe was also formed with a big explosion. Dadaji but for a bomb to explode we fire the bomb what must have happened in the story of formation of Universe?

Dadaji: The density and intense heat might have been reasons for the big bang or explosion to happen.



Black hole can be a source of life

The reason why the big bang theory is so popular and so widely accepted is because Edwin Hubble discovered that everything in the universe is moving away from everything else in 1929. Hubble explained that the universe was expanding in every direction. If this observation was reversed, then this would indicate that the universe was smaller in the past than it is now.

Pinku: Were there any other theories associated to the formation of Universe Dadaji?

Dadaji: Yes Pinku... One of the theories called "Pulsating theory" states that the expansion in the universe will stop at a stage where it has reached its maximum and there may be the possibility of contraction again. When this contraction will approach to a particular size, the explosion will retake resulting expansion of universe again. Hence it results in a pulsating universe in which there is alternate expansion and contraction of universe.

Pinku: Hmm... interesting...expansion, contraction, explosion, expansion...hmm...

Dadaji: The second theory which is famous regarding the formation of universe is Study State Theory.

No particles or electromagnetic radiation such as light can escape from a black hole

The term 'steady state' means a stable condition that does not change over time or in which change in one direction is continually balanced by change in another. The Steady State Theory of the origin of the universe is also referred to as the infinite universe theory or continuous creation. There is another interesting theory of formation of Universe Pinku which is Universe originating from a black hole.

Pinku: Black Hole...What is a black hole Dadaji?

Dadaji: Pinku as the name suggests black hole is a region where strong gravitational effects exist so that nothing not even particles and electromagnetic radiation such as light can escape from inside it. Continuing the theory, this is a very interesting theory which believes that black holes which emit matter to an unknown location, in fact, create new universes. Every particle absorbed by a black hole may become a source of origin for a new universe, after the particle charged with enormous energy explodes.



A Galaxy is made up of millions of stars

It may be similar to the Big Bang only with a lot of explosions. Each newly-created universe in turn creates new black holes, and those give life to new universes. A recent study shows that our entire universe may have been born out of a black hole from another universe. In other words, the Big Bang was really just an extension of a black hole in a different universe. Also, if a star passes too close to a black hole, it can be torn apart.

Pinku: I heard of Quasars are they the same as blackhole?

Dadaji: Quasars are the brightest and most distant objects in the known universe. In the early 1960's, quasars were referred to as radio stars because they were discovered to be a strong source of radio waves. In fact, the term quasar comes from the words, "quasi-stellar radio source". Today most scientists believe that super massive black holes at the galactic centres are the "engines" that power the quasars.

Pinku: Now what is this super massive black hole Dadaji?

Dadaji: As the name suggests, supermassive black holes contain between a million and a

Quasars are the brightest and most distant objects in the known universe

billion times more mass than a typical stellar black hole. Although there are only a handful of confirmed supermassive black holes (most are too far away to be observed), they are thought to exist at the centre of most large galaxies, including the centre of our own galaxy, the Milky Way.

Pinku: Now what is this galactic centre Dadaji?

Dadaji: Galactic Centre is the innermost region of our Galaxy, or its exact centre of a Galaxy.

Pinku: While explaining Universe, you have spoken something about Galaxies... what are these any idea Dadaji?

Dadaji: A Galaxy can be considered as a separate system consisting millions of stars, together with gas and dust, held together by gravitational attraction. Most of the observed galaxies are elliptical. However, the Whirlpool Galaxy (M51) was the very first celestial object to be identified as being spiral.

Pinku: Oh...! What is the name of our Galaxy Dadaji?



Andromeda is our neighbor Galaxy

Dadaji: The name of our Galaxy is Milky-way.

Pinku: Why is it named so?

Dadaji: The Milky-way is made up of a very large number of small, tightly clustered stars, which, on account of their concentration and smallness, seem to be cloudy patches. Our galaxy was named because of the way the haze/fog/mist it casts in the night sky resembling spilled milk.

Do you know Pinku; Our Sun takes about 240 million years to orbit the Milky-way once, in what is known as a galactic year (or cosmic year). Do you know Pinku, there are about 50 small galaxies confirmed to be within 420 kiloparsecs (1.4 million light-years) of the Milky Way, these galaxies are called satellite galaxies of our Milky Way.

Pinku: Dadaji you have used several words such as Cosmos, Cosmic what is the exact meaning of this words?

Dadaji: Pinku the meaning of Cosmos is orderly. Even though the Universe is complex however, it is an orderly system. The study of the origin, evolution, and eventual fate of the universe is called Cosmology. Cosmic is similarly used for any region of the universe

The study of Universe is called Cosmology

distinct from Earth.

Pinku: What are the other galaxies that we are aware of Dadaji?

Dadaji: Pinku the other Galaxy that we know is “The Andromeda Galaxy” few million light-years away from Earth. It is the nearest major galaxy to the Milky Way and was often referred to as the Great Andromeda Nebula in older texts. The Other galaxy we know is the galaxy LEDA which is shaped more or less like a rectangle. While most galaxies are shaped like discs, three dimensional ellipses or irregular blobs, this one seems to have a regular rectangle or diamond-shaped appearance. Some have speculated that the shape results from the collision of two spiral-shaped galaxies, but no one knows for now.

Pinku: What is Light Year Dadaji?



Group of galaxies is called cluster

Dadaji: I am not sure of the definition in terms of value Pinku however; I can tell you that Light Year is a unit of astronomical distance equivalent to the distance that light travels in one year. A light-year is how astronomers measure distance in space.

Pinku: What would be the composition of Universe Dadaji?

Dadaji: I had read somewhere Pinku not sure but approximately 70% of Universe is just vacuum, 26% dark matter, 4% Ordinary matter (such as planets, stars...) and remaining % in light.

Pinku: Oh my goodness Dadaji... 4% of ordinary matter...hmm...

Dadaji: Do you know pinku there are several Clusters /Groups of the galaxies.

Pinku: Tell me more Dadaji.

Dadaji: Galaxies love to Group together. Their mutual gravity draws them together into a cluster. Some clusters have only a handful of galaxies and are called poor clusters. Other clusters with hundreds to thousands of galaxies are called rich clusters. The low mass of a poor cluster prevents the cluster from holding onto its members tightly. The poor cluster

Light years is the measure
of distance in space

tends to be a bit more irregular in shape than a rich cluster.

Pinku: Oh... Tell me more Dadaji

Dadaji: Certainly there is more Pinku... We also have Super Cluster which is a large groups of smaller galaxy clusters or galaxy groups, which is among the largest-known structures of the cosmos. The Milky Way is part of the Local Group galaxy cluster which in turn is part of the Laniakea Supercluster whose meaning is 'immeasurable heaven' in Hawaiian. Did you hear about Globular Clusters Pinku?

Pinku: Globular Clusters what are they Dadaji?

Dadaji: Globular clusters are densely packed collections of ancient stars. Roughly spherical in shape, they contain hundreds of thousands, and sometimes millions, of stars. Studying them helps astronomers estimate the age of the universe or figure out where the center of a galaxy lies.



Zodiac signs are based on Constellations

Pinku: While explaining Andromeda Galaxy you have used a word called Nebula. What is a Nebula Dadaji?

Dadaji: Ah! Pinku a nebula is named after the Latin word for “cloud”, nebulae are massive clouds of dust, hydrogen and helium gases. They are also often called the “stellar nurseries” i.e. the place where stars are born. And for centuries, distant galaxies were often mistaken for these massive clouds. On some moonless night, look for the Orion Nebula below Orion’s Belt. Your eye sees it as a tiny, hazy spot. But it’s a vast region of star formation.

Pinku: Orion Belt hmm... and what is that?

Dadaji: Orion belt is formed by three massive, bright stars located in our galaxy, in the direction of the constellation Orion, the Hunter.

Pinku: You are confusing me Dadaji and now what is this constellation?

Dadaji: Pinku a simple definition of a constellation is a group of stars which form a pattern in the night sky. The constellations are totally imaginary things that poets, farmers and astronomers have made up. The International Astronomical Union recognizes 88 constella-

Nebulae are massive clouds
of dust, hydrogen and
helium gases

tions covering the entire northern and southern sky. Most constellation names are Greek or Latin in origin.

Pinku: The constellations you are talking about how is it related to Zodiac signs Dadaji?

Dadaji: Pinku there are 13 constellations that pass through during earth’s rotation known as the stars of the Zodiac. The Zodiac constellations’ names are: Capricorn, Aquarius, Pisces, Aries, Taurus, Gemini, Cancer, Leo, Virgo, Libra, Scorpio, Ophiuchus and Sagittarius.

Astrologers use 12 of these constellations as signs of the Zodiac, omitting Ophiuchus, to make predictions.

Pinku: Why is then Ophiuchus not used for predictions?

Dadaji: Not very sure Pinku however, they must have picked 12 signs, one for each month of their lunar calendar.

Pinku: Does stars also die Dadaji?



Red giants can swallow Planets

Dadaji: Good question Pinku... Stars does die... however, it takes millions of years for a star to die.

Pinku: How does a star die Dadaji?

Dadaji: When a star like the Sun has burned all of its fuel, it starts to die.

Pinku: Sun also use fuel interesting... can you tell me more Dadaji:

Dadaji: Sure Pinku... The sun is made out of hydrogen. Nuclear fusion is what happens in the Sun. It's the combining of light elements into heavier elements to produce energy. The Sun produces a large amount of energy by combining very light elements such as hydrogen to heavier elements such as helium and then lithium, oxygen, carbon, right up to iron. If the same nuclear fusion that occurs in the sun can be replicated on earth, it will be possible to turn the heavy hydrogen that is available in abundance in seawater into a powerful, permanent, permanent source of energy.

Pinku: Oh! So the sun is a hydrogen bomb.

Dadaji: Not exactly Pinku. Talking facts; the sun has used up about half of its hydrogen fuel in the last few billion years, since its birth. It

Atomic nuclei combine with each other to form a new nuclei is called fusion

still has enough hydrogen to last about another few billion years.

Pinku: Tell me more Dadaji what happens when all the fuel is burnt up?

Dadaji: When the fuel is running out, the dying star starts expanding to become a red giant. This may be millions of kilometres across big enough to swallow the nearest planets. For e.g. if the sun reaches the stage of a red giant, it can swallow planets up to earth and may be beyond.

Pinku: Why it is called as red giant star Dadaji?

Dadaji: As you are aware Pinku that Red giants are stars that have exhausted the supply of fuel/hydrogen in their cores. Hence, their outer envelope is lower in temperature, giving them a red-dish-orange colour.

Pinku: What happens after the red giant phase Dadaji?

Dadaji: Well Pinku, after it has lost energy, the star collapses to form a very dense white dwarf.

Pinku: White Dwarf and what's that Dadaji?



1.44 is Chandrasekhar limit

Dadaji: A white dwarf is the final stage of the evolution of a star. When the stars stop burning, their mass shrink in size and as they shrink they start to grow very faint. White dwarf stars got their name because of the white colour of the first few that were discovered. Also, as this is the star of relatively small size and low luminosity it is called Dwarf star.

Pinku: What happens to star after white dwarf stage Dadaji?

Dadaji: Since we are talking about white dwarf, let me also talk about our own great scientist Chandrasekhar ji. It was Chandrasekharji who said that a white dwarf will stay a white dwarf if its mass is less than 1.44 times the mass of Sun. Hence, 1.44 is also called as Chandrasekhar limit. While a star that exceeds this mass is destined to end its life in its most violent of explosions called a supernova. Over billions of years, the white dwarf cools and becomes invisible.

Pinku: A supernova wow! Can you tell more Dadaji...

Dadaji: Sure, Pinku... Stars heavier than the Chandrasekhar limit might end their lives very suddenly. When they run out of fuel, they swell

Chandrasekhar limit is the maximum mass of a stable white dwarf star

into red super-giants. They try to keep alive by burning different fuels, but this only works for a few million years. Then they blow themselves apart in a huge supernova explosion. For a week or so, the supernova outshines all of the other stars in its galaxy. Then it quickly fades. All that is left is a tiny, dense object a neutron star or a black hole surrounded by an expanding cloud of very hot gas. The elements made inside the supergiant (such as oxygen, carbon and iron) are scattered through space. This stardust eventually makes other stars and planets.

Pinku: A neutron star...hmm... and what's that Dadaji?

Dadaji: Pinku... Neutron stars are the smallest and densest stars known to exist with a teaspoon weighing as much as a mountain. They are two to three times the mass of the sun and because of this density, the gravity is incredibly high around these stars.



Pulsars are light houses of Universe

Neutron stars are called so as they are composed predominantly of closely packed neutrons.

Pinku: Oh Dadaji I will land on one of these stars if I become an astronaut.

Dadaji: Landing is going to be incredibly tough here Pinku. Neutron stars can spin at thousands of times per second and many of them have magnetic fields over ten million times stronger than the Earth's. This is going to adversely affect you in a few ways. First, magnetic fields at those levels are almost certainly going to destroy anything with ferromagnetic materials including your computer systems. Also, the combination of spinning and strong magnetic fields means that neutron stars essentially have their own defence system. You may know them as "pulsars" and they basically consist of a high-energy radiation beam sweeping through the sky every fraction of a second. Finally, imagine if you have to land on a planet where the surface is rotating at thousands of kilometres a second? It isn't easy.

Pinku: Can a Neutron Star burst?

Dadaji: Usually not... as neutron star is the dense, core remains of an exploded star.

A neutron star is the collapsed core of a giant star

However, the same is possible. The neutron star contains about a sun's worth of mass packed in a sphere. Gas from the companion stars can funnel towards the neutron star, attracted by the neutron star's strong gravity. As matter crashes down on the neutron star it builds up layer of material comprised mostly of helium. The fusion of the helium into carbon and other heavier elements releases enormous energy and powers a strong burst of X-ray light, far more energetic than visible light. Such bursts can occur on a neutron star and last for about 10 seconds.

Pinku: You were talking about Pulsars Dadaji; are they the same as neutron stars?

Dadaji: Pulsars/Magnetars are known as the "lighthouses" of the universe. They are rotating neutron stars that emit a focused beam of electromagnetic radiation that is only visible if you're standing in its path known as pulsars, these stellar relics get their name because of the way their emissions appear to be "pulsating" out into space.



Pulsars are light houses of Universe

Although the first one was discovered in 60's, scientists have for decades struggled to understand what causes these stars to pulse and what causes pulsars to occasionally stop pulsing. In 2008, though, when one pulsar suddenly shut off for 580 days, scientists' observations allowed them to determine that the "on" and "off" periods are somehow related to magnetic currents slowing down the stars' spin. Astronomers are still at work trying to understand why these magnetic currents fluctuate in the first place.

Pinku: Oh! That was exciting. What about a black hole what is that Dadaji?

Dadaji: When the matter in a neutron star has been squeezed into a very tiny space, black hole is formed. It is a place in space where gravity pulls so much that even light cannot get out. As no light can get out, we cannot see black holes Pinku. They are invisible.

Pinku: Dadaji I have now started worrying and it is scary to imagine if there is a black hole in our galaxy. What if the black hole swallows us (/earth)?

Dadaji: Pinku the answer is no. Although there is probably a huge supermassive black hole

Pulsar is short for
Pulsating star

loitering in the middle of our galaxy, luckily, we are nowhere near this monster. So you can relax Pinku.

Pinku: Thank god...

Dadaji: Now let me tell you about the spaces which are lying between stars and Galaxies.

Pinku: Spaces... Do you mean no object area between stars or galaxies?

Dadaji: Yes Pinku. The space between stars is known as interstellar space, and so the space between galaxies is called intergalactic space. These are the vast empty spaces that sit between galaxies. For example, if you wanted to travel from the Milky Way to the Andromeda galaxy, you would need to cross some million light-years of intergalactic space.

Pinku: Are different galaxies travelling apart from each other?

Dadaji: I exactly do not know but theories suggest that the galaxies are not really moving through space away from each other.



Galaxies are moving away from each other

Instead, what is happening is the space between them is expanding. As the universe expands, the galaxies get farther from each other, and the apparent velocity will appear to be larger for the more distant galaxies.

Pinku: Then, is there a chance that two galaxies may collide.

Dadaji: I don't want to scare you Pinku, but at some point during the next few billion years, our galaxy and Andromeda which also happen to be the two largest galaxies in the Local Group are going to come together, and with catastrophic consequences. Stars will be thrown out of the galaxy; others will be destroyed as they crash into the merging super-massive black holes. And the delicate spiral structure of both galaxies will be destroyed and they become a single, giant, elliptical galaxy. Interactions between galaxies are quite common.

Pinku: Dadaji, how can you confirm that Andromeda is drifting towards our galaxy Dadaji.

Dadaji: To understand your question you should know concept of Blue Shift and Red shift. When an object in space moves towards us its light waves are compressed into higher

Galaxies at some point in time can interact with each other

frequencies or shorter wavelengths, and we say that the light is shifted towards blue. When an object moves away from us, its light waves are stretched into lower frequencies or longer wavelengths, and we say that the light is shifted towards red. Astronomers have proved that galaxies are moving away from us as the light has shifted to the red end of the spectrum. However, Andromeda when observed from Earth, its light is undergoing a blue shift meaning it is drifting towards our galaxy. This effect is called in physics as Doppler Effect.

Pinku: Doppler Effect and what is that Dadaji?

Dadaji: We are most familiar with the Doppler Effect because of our experiences with sound waves. Perhaps you recall an instance in which an ambulance was traveling towards you on the highway. As the ambulance approached with its siren blasting, the pitch of the siren sound was high; and then suddenly after the ambulance passed by, the pitch of the siren sound was low.



Mercury is the name of a Roman God

That was the Doppler Effect - an apparent shift in frequency for a sound wave produced by a moving source. The same is the effect of light which I explained you earlier. Electromagnetic radiation emitted by stars in a distant galaxy would appear to be shifted downward in frequency (a red shift) if the star is rotating in its cluster in a direction that is away from the Earth. On the other hand, there is an upward shift in frequency (a blue shift) of such observed radiation if the star is rotating in a direction that is towards the Earth.

Pinku: Yes Dadaji I Understood that. But basic question still hounds me Dadaji... What is the universe made up of?

Dadaji: A Difficult question. However, most of the astronomers think the Universe is made up of mostly the “Dark Matter” and “Dark Energy” and a small per-cent of “Matter” such as protons, neutrons and electrons. Protons and neutrons are bound together into nuclei and atoms are nuclei surrounded by a full complement of electrons. For e.g. Hydrogen is composed of one proton and one electron, Helium is composed of two protons, two neutrons and two electrons and Carbon is composed of six

Material made up of protons, neutrons, electrons are called baryonic matter

protons, six neutrons and six electrons. Heavier elements, such as iron, lead and uranium, contain even larger numbers of protons, neutrons and electrons. Astronomers like to call all material made up of protons, neutrons and electrons as "baryonic matter".

Pinku: Hmm... great knowledge. Any ways, Dadaji let us now talk about our own planets. Dadaji please start with Mercury.

Dadaji: Oh sure Pinku... as you are aware, Mercury is the first of the planets in our solar system and closest planet among eight planets to the sun. As such, it circles the sun faster than all the other planets, which is why Romans named it after their swift-footed messenger god. It is the smallest of the eight planets. It is also the closest to the sun. Mercury goes around the sun the fastest of all the planets. Mercury has no moons. It completes one revolution around the sun in just 88 Earth days. Dow you know what that means Pinku?



Mariner was the first to reach Mercury

Pinku: No Dadaji...

Dadaji: That means if you lived on Mercury, you'd have a birthday every three months.

Pinku: Hmm... that was very good information Dadaji. Let us go to Mercury and stay there. Please please please Dadaji. I can cut cake thrice in a year.

Dadaji: Pinku... my dear, no human has ever visited to Mercury but, spacecraft without people have been there. Mariner 10 was the first to visit Mercury however, not even half of Mercury was seen then. Messenger spacecraft then flew to Mercury around 2008 or 2009 which I exactly do now know Pinku which will let scientists learn many new things about the planet. Moreover, at nights Mercury becomes so cold that humans cannot survive in this atmosphere. Further, it has so many craters formed by falling rocks on it.

Pinku: Ah! The big holes in Mercury like the big holes in Moon correct Dadaji...

Dadaji: Yes Pinku Bingo you got it correct craters are big holes formed due to collision of space rocks or asteroids.

Pinku: But why do you say eight planets Dadaji? What about Pluto?

1 Astronomical Unit is
149 597 871 kilometers

Dadaji: My son...! Pluto, once considered the ninth and most distant planet from the sun, is now the largest known dwarf planet in the solar system.

Pinku: You told me about Dwarf Star. Now what is Dwarf planet Dadaji?

Dadaji: A dwarf planet is a planetary-mass object that is neither a planet nor a natural satellite. To explain you further, the definition of planet was set in Prague, Czech Republic in August 2006 by the International Astronomical Union (IAU). A planet is a celestial body which:
"Is in orbit around the Sun"

"Has sufficient mass to assume hydrostatic equilibrium (a nearly round shape)", and
"Has cleared the neighbourhood around its orbit."

Uh... Oh! Here's the rule breaker. According to rule number three, Pluto is not a planet...



Mars and Earth are called Twin Sisters

What does “cleared its neighbourhood” mean? As planets form, they become the dominant gravitational body in their orbit in the Solar System. As they interact with other, smaller objects, they either consume them, or sling them away with their gravity. Pluto is only a few times the mass of the other objects in its orbit. Hence, any object that doesn't meet these 3rd criteria is considered a dwarf planet. And so, Pluto is a dwarf planet and not a Planet.

Pinku: Ah...ha...! Now I understand the logic Dadaji.

Dadaji: Let us now talk about Venus.

Pinku: Oh sure Dadaji.

Dadaji: Venus is the Roman goddess of love and beauty. This second planet in our solar system has been named after the name of Roman Goddess as probably because it is the brightest of the planets known to the ancients. Venus rotates in the opposite direction to most other planets. As Mercury, Venus also has no natural satellite. Venus is sometimes called Earth's twin or "Sister Planet" because Venus and Earth are almost the same size, have about the same mass, and are made of the same/

Mars has earth like qualities
hence, life may exist here

similar material. Moreover, they are also neighbouring planets. The surface temperature in Venus is so high that even lead will melt. Mercury and Venus are the only two planets in our solar system that do not have any moons. Lastly, the hottest planet in our solar system is Venus. Most people often think that it would be Mercury, as it's the closest planet to the sun. This is because Venus has a lot of gasses in its atmosphere, which causes the “Greenhouse Effect”.

Pinku: Why the surface of venus is so hot Dadaji?

Dadaji: Pinku, Venus is so hot because it is surrounded by a very thick atmosphere which is about 100 times more massive than our atmosphere here on Earth. As sunlight passes through the atmosphere, it heats up the surface of Venus.

Pinku: Oh! Dadaji so we cannot imagine life at Venus. Can we at least imagine life at Mars?

Dadaji: Mars has Earth like qualities make it the number one planet for exploration.



Things weigh less on Mars

However, there are several atmospheric constraints which humans need to overcome.

Pinku: What are other traits of Planet Mars Dadaji?

Dadaji: As you are aware Pinku it is the fourth planet from the sun. Mars is known as the Red Planet as it gets its red colour from the iron in its soil. Mars has two small moons whose names are Phobos and Deimos. Mars is too cold. The average temperature on Mars is minus (-) 26 Degree Celsius way below freezing. Mars is rocky with canyons, volcanoes and craters all over it. Red dust covers almost all of Mars. It has clouds and wind, just as Earth does. Sometimes the wind blows the red dust into a dust storm. Tiny dust storms can look like tornados, and large ones can cover the whole planet. Mars has about one-third the gravity of Earth meaning, a rock dropped on Mars would fall slower than a rock dropped on Earth. Things weigh less on Mars than they weigh on Earth meaning a person who weighs 45 Kilos on Earth would only weigh about 16 Kilo's on Mars because of less gravity. Lastly, the highest mountain known to man is the Olympus Mons (it is nearly 3 times higher than

Things weigh less on Mars than they weigh on Earth

Mt Everest) which is located on Mars.

Pinku: Hmm... I don't know what would happen if earth is no more an option for us to survive.

Dadaji: True Pinku hence, I always suggest to save planet earth by planting more trees.

Pinku: How Plants will help our Planet Dadaji?

Dadaji: Plants reduce pollution by reducing the amount of carbon dioxide in the air and giving off oxygen (Plants during day inhale carbon dioxide and exhale Oxygen while preparing their food called process of photosynthesis), Plants help remove chemicals and bacteria from water in the ground. Trees and plants absorb sound and help with noise pollutions.

Pinku: Anyways Dadaji, let us move forward and understand Jupiter.

Dadaji: Sure Pinku... As you are aware the planet Jupiter is the fifth planet out from the Sun, and is two and a half times more massive than all the other planets in the solar system combined.



Jupiter's atmosphere is called gas giants

Jupiter's atmosphere is made up of mostly hydrogen gas and helium gas and is therefore known as a "gas giant". The planet is covered in thick red, brown, yellow and white clouds. The clouds make the planet look like it has stripes. Jupiter has an extremely powerful magnetic field, like a giant magnet. Deep under Jupiter's clouds is a huge ocean of liquid metallic hydrogen. Scientists now think Jupiter has a total of 67 moons. The most recent moons were discovered in 2011. The planet's four largest moons are Ganymede (GAN-i-meed), Callisto (kuh-LIS-toe), Io (eye-OH), and Europa (yur-O-puh). The Great Red Spot is a giant, spinning storm in Jupiter's atmosphere. It is like a hurricane on Earth, but it is much larger.

Pinku: Dadaji even in Jupiter we cannot find any alternative to our planet correct Dadaji?

Dadaji: Yes Pinku. Now let us learn about Saturn. As you are aware Pinku, Saturn is the sixth planet from the Sun and the second-largest in the Solar System, after Jupiter. Adorned with thousands of beautiful ringlets, Saturn is unique among the planets and is

Cassini–Huygens is an unmanned spacecraft sent to the planet Saturn.

frequently referred to as "The Jewel of the Solar System". The rings of Saturn are the most extensive planetary ring system of any planet in the Solar System. They consist of countless small particles, ranging in size from micrometres to metres that orbit about Saturn. The ring particles are made almost entirely of water ice, with a trace component of rocky material. Saturn has at least 150 moons and moonlets in total. Most of these moons are small, icy bodies that are little more than parts of its impressive ring system. Enceladus, one of Saturn's smaller moons, reflects some 90% of the sunlight, making it more reflective than snow. Cassini–Huygens is an unmanned spacecraft sent to the planet Saturn. Cassini is one of the most ambitious efforts in planetary space exploration ever mounted which is a joint endeavour of NASA, ESA and the Italian space agency. Its design includes a Saturn orbiter (Cassini) and a lander (Huygens) for the moon Titan.



Uranus is first visited by Voyager 2

Pinku: Titan whys is this so special Dadaji.

Dadaji: Good question Pinku... Saturn's largest moon Titan is the second largest moon in our solar system, second only to Jupiter's Gany-mede, which is only 2 percent larger. Cassini's observations of Saturn's largest moon, Titan, have given scientists a glimpse of what Earth might have been like before life evolved. They now believe Titan possesses many parallels to Earth, including lakes, rivers, rain, clouds, mountains and possibly volcanoes.

Pinku: Oh! Our exploration to find an alternate to earth is still on... hmm...

Dadaji: Yes Pinku... The seventh planet from the sun with the third largest diameter in our solar system is Uranus which is very cold and windy. The ice giant is surrounded by 13 faint rings and 27 small moons as it rotates at a nearly 90-degree angle from the plane of its orbit. This unique tilt makes Uranus appear to spin on its side, orbiting the sun like a rolling ball. The planet was named after the Greek god of the sky. Uranus has been visited by only one spacecraft; Voyager 2 on Jan 24 1986. Uranus is composed primarily of rock and various ices. Uranus' atmosphere is about 83% hydrogen,

Titan, the moon of Jupiter is similar to what early stage of Earth could have been

15% helium and 2% Methane. Uranus' blue colour is the result of absorption of red light by methane in the upper atmosphere. There may be coloured bands like Jupiter's but they are hidden from view by the overlaying methane layer. Further, it takes Uranus 84 years, more or less to orbit around sun. So, each season on Uranus lasts 21 years.

Pinku: Uranus hmm... good information Dadaji. Now can you speak about Neptune Dadaji.

Dadaji: Oh sure Pinku... Neptune is dark, cold, and very windy. As you are aware Pinku it's the last of the planets in our solar system. Its atmosphere similar to Uranus is also made of hydrogen, helium, and methane. The methane gives Neptune the same blue colour as Uranus. Neptune has six rings, but they're very thin hence, hard to see. Large storms whirl through its upper atmosphere. One of the largest storms ever seen was recorded in 1989. It was called the Great Dark Spot. It lasted about five years.



Vibrations in the air is called sound

The most interesting moon of Neptune is Triton, a frozen world that is spewing nitrogen ice and dust particles out from below its surface. It is probably the coldest world in the solar system. Also, the only large moon in our solar system to orbit in the opposite direction of its planet is Triton. Scientists say eventually Triton will get so close to Neptune, it will be torn apart by gravity, and Neptune could end up with more rings than Saturn currently has. Only one spacecraft has flown by Neptune which is the Voyager 2 spacecraft. The four planets in our solar system that are known as gas giants are Jupiter, Saturn, Uranus, and Neptune.

Pinku: Great Dadaji... you have said so many things about our solar system. Dadaji I wonder is the space silent?

Dadaji: Pinku there is no sound in space and that it is because there is no air in space and what we call "sound" is actually vibrations in the air. Now, there are indeed light waves and radio waves in space, but these waves are not sound, but light. When a big boat moves through water, the water has to get out of the way to make space for the boat. The water has

There is no sound in the space as there is no medium of transmission such as air

to curve around the boat! When the water moves out of the way, it makes ripples or waves on the surface. Like a boat moving through water, massive objects moving through space make ripples or waves in space. A massive star or black hole moving through space causes waves in space. We call these waves gravitational waves. We do not hear even a whisper of the massive black holes that may be orbiting closer and closer to each other in a violent death spiral. We do not hear a massive star exploding in a supernova at the end of its life. But these violent events create intense gravitational waves. No one has yet detected a gravitational wave. Gravitational waves are very, very weak by the time they reach us from some far distant event. But scientists are very close to having instruments precise enough to sense these faint ripples in space.

Pinku: Then how Astronauts in space do talk to each other?



Light do not require a medium to travel

Dadaji: Simple! In the spacecraft, there is plenty of air, so they just talk normally.

Pinku: Oh Dadaji! If that is the logic than you only said that there are gases in space, then why can't sounds move through them?

Dadaji: Aha! Excellent question Pinku... you are right that there are gases in space, and it's true that these gasses can propagate sound waves just like Earth's air allows sound to travel. The difference is that the gas clouds are much less dense than the Earth's atmosphere i.e. they have fewer atoms per cubic foot. So if a sound wave was traveling through a big gas cloud in space and we were out there listening; only a few atoms per second would impact our eardrum, and we wouldn't be able to hear the sound because our ears aren't sensitive enough. Maybe if we had an amazingly large and sensitive microphone we could detect these sounds, but to our human ear it would be silent.

Pinku: So you are trying to tell me Dadaji that sound requires a medium which is air. Then, how come we are able to see light. If my guess is correct it also requires a medium correct Dadaji?

Light waves can travel through a vacuum, and do not require a medium.

Dadaji: Oh my god... Bingo question Pinku. Only Sound requires a medium, in contrast, light waves can travel through a vacuum, and do not require a medium. In empty space, the wave does not dissipate (/grow smaller) no matter how far it travels, because the wave is not interacting with anything else. This is why light from distant stars can travel through space for billions of light-years and still reach us on earth.

Pinku: Hmm... logical... thank you Dadaji, this enlightens.

Dadaji: But, there is more for you to learn Pinku... Light just keeps going and going until it bumps into something. Then it can either be reflected or absorbed but not all.

Pinku: But for your but is that Dadaji how is it possible that when both sound and light are waves still one is able to traverse or move along in vaccum however, the other does not?



Laika was the first to reach space

Dadaji: What happened to you Pinku suddenly you are asking questions which really really make sense. I am proud of you Pinku. The answer is simple and I have already answered that infact. Vacuum does not contain matter that the sound can interact with, in order to move along however, as I told you earlier, light does not need a medium.

Pinku: Thanks Dadaji. Dadaji, who was the first person to reach space?

Dadaji: Pinku there was always a race between United States and the Soviet Union to reach space first. The Soviet's scored a victory when they launched a small craft carrying cosmonaut Yuri Gagarin to new heights which marked him in the history books as the first man in space. But before Yuri would hit the space, there was a dog which reached the space and its name was Laika. Soviet sent this dog to space as a test launcher for the humans to follow.

Pinku: That was interesting Dadaji. For sure I know that Neil Armstrong was the first person to land on moon.

Dadaji: Absolutely Pinku. In the year 1961 when John F. Kennedy was the president of

**Apollo 11 was the first
spaceflight that landed
humans on the Moon**

the United States, he wanted to land humans on the moon. Apollo 11 was the first spaceflight that landed humans on the Moon. Neil Armstrong, Edwin "Buzz" Aldrin and Michael Collins were the astronauts on Apollo 11.

Four days later, Armstrong was the first to land on the moon Aldrin followed about 20 minutes later. They landed on the moon in the Lunar Module. It was called the Eagle. Collins stayed in orbit around the moon. He did experiments and took pictures. Armstrong and Aldrin walked around for three hours, they did experiments, picked up bits of moon dirt and rocks. Also, Pinku they put a U.S. flag on the moon. On July 24, 1969, all three astronauts came back to Earth safely.

Pinku: Why Aldrin is called Buzz?

Dadaji: Oh! I forgot to tell you that. Pinku the astronaut received his nickname "Buzz" when his little sister pronounced the word brother as "buzzer."



ROSCOSMAS is the space agency of Russia

The family shortened it to Buzz, which Aldrin took as his legal name.

Pinku: Who arranges for space research and space travels Dadaji?

Dadaji. Sensible question Pinku. The space agencies of respective countries are responsible for space research and travel activities.

Pinku: Which countries have these capabilities of sending humans in space?

Dadaji: It's US, Russia and China Pinku. These three currently operating government space agencies in the world (NASA, RFSA and the CNSA) are capable of human spaceflight as of 2016.

Pinku: We had launched Mangalyan. What was that Dadaji?

Dadaji: Mangalyan, "The 4.5bn rupee (\$74m) mission is the cheapest inter-planetary mission ever to be undertaken by the world. Moreover, the project makes India and ISRO (Indian Space Research Organisation) distinct from the other superpowers of the world and Space Agencies like NASA, European Space Agency, Russian Federal Space Agency (ROSCOSMOS/RFSA), making it the only country to reach the orbit of Mars in its first

Mars Orbiter Mission (MOM) has entered Mars' on 24-September-2014

attempt. India's maiden spacecraft the Mars Orbiter Mission (MOM) has entered Mars' on this day 24-September-2014. The first attempt to study the red planet's atmosphere and search for life sustaining elements can be explored as scientists look to proceed to the next level.

Pinku: Fantastic achievement Dadaji. Who started ISRO or who was the pioneer of the ISRO Dadaji?

Dadaji: Indian Space Research Organisation, formed in 1969. Vikram Sarabhai, having identified the role and importance of space technology in a Nation's development, provided ISRO the necessary direction to function as an agent of development. ISRO then embarked on its mission to provide the Nation space based services and to develop the technologies to achieve the same independently.

Pinku: Who was Vikram Sarabhai Dadaji?

Dadaji: Vikram Sarabhai was one of the greatest scientists of India.



SN Bose Specialize in Quantum Mechanics

He is considered as the Father of the Indian space program. Apart from being a scientist, he was a rare combination of an innovator, industrialist and visionary.

Pinku: Who are the other famous Indians who are known for space research?

Dadaji: Oh there are several. Some of the well-known are as given below:

Venkatraman Radhakrishnan: Venkataraman was a globally renowned space scientist. He was an internationally acclaimed Astrophysicist and also known for his design and fabrication of ultralight aircraft and sailboats.

S. Chandrashekar: He was awarded the 1983 Nobel Prize for Physics for his mathematical theory of black holes. The Chandrasekhar limit is named after him.

Satyendra Nath Bose: SN Bose was an Indian physicist specialising in quantum mechanics. He is of course most remembered for his role played in the class of particles 'bosons', which were named after him by Paul Dirac to commemorate his work in the field.

Avul Pakir Jainulabdeen Abdul Kalam: Our own Shri APJ Abdul Kalam who worked as an Aerospace engineer with Defence Research

ISRO is the space exploration agency of the Government of India.

and Development Organisation (DRDO) and Indian Space Research Organisation (ISRO).

Pinku: Dadaji I also heard there are several Indians working with NASA also.

Dadaji: Yes Pinku... you will be surprised to note that around 36% or almost 4 out of 10 scientists are Indians/Indian Origins working for NASA... Do you know Pinku; she was selected as an Astronaut candidate in 1994 and went for her first mission in 1997 on Colombia STS-87, becoming the first Indian woman to go to space.

Pinku: Ah! Dadaji I know she is Kalpana Chawla. But I remember to read that she was killed in a space mission.

Dadaji: Unfortunate... Yes Pinku sadly, her second mission on-board Columbia STS 107 ended up being her last, when the space shuttle depressurised and broke while returning into the atmosphere and ended up killing everyone on board.



Sunita Williams took Samosa's to space

Pinku: I also heard of Sunita Williams who is she Dadaji?

Dadaji: Sunita Williams became a household name in India, being only the second Indian-American Female Astronaut at NASA. But what helped her gain international recognition was when she set the record of the longest cumulative spacewalk time by a female astronaut with 50 hours and 40 minutes on seven Extra-Vehicular activities as well as the longest spaceflight by a woman. Although she was born and brought up in the United States, India and her influences have always been close to her heart as she revealed on her visit to India in 2013. She took a copy of the Upanishads and a copy of the Bhagvad Gita to space to reflect and read, and even took samosas to space!

Pinku: Ha Ha Ha... Samosa Dadaji.

Dadaji: Yes dear Samosa... what is there to laugh don't you love them.

Pinku: Sorry Dadaji... I was laughing as I imagined Samosa floating in the spacecraft.

Pinku: The other day in my school, they placed a Telescope and all our students have seen celestial body so close.

Sunita Williams was the first to pick up Samosas in space

Dadaji: Do you know Pinku that there is a history associated with Telescopes? The history of the telescope dates back to the early 1600s. Galileo Galilei is commonly credited for inventing the telescope, but this is not accurate. It was Hans Lippershey, a Dutch spectacle maker, is generally credited as the inventor of the telescope, as his patent application is dated the earliest. Galileo Galilei in Italy heard of the telescope, and not only adapted the new technology to astronomy, but also pushed it to its limits. With his telescope he discovered the crescent shape of Venus and the satellites of Jupiter, saw the craters of the Moon, and noted that the fuzzy Milky Way stretching around the sky was in fact composed of huge numbers of faint stars.

Pinku: Are there any types of Telescopes Dadaji?

Dadaji: Oh! There are so many Pinku...Optical Telescopes, X-ray telescopes, Radio Telescopes, Gamma-ray Telescopes, High-energy particle Telescopes are some well-known ones.



Cosmic Ray's are created in Supernova's

One of the famous telescopes is the NuSTAR (Nuclear Spectroscopic Telescope Array) which is a space-based X-ray telescope. Its primary scientific goals are to conduct a deep survey for black holes a billion times more massive than the Sun, to investigate how particles are accelerated to very high energy in active galaxies, and to understand how the elements are created in the explosions of massive stars by imaging the remains, which are called supernova remnants.

Pinku: What else do the scientists study through these telescopes?

Dadaji: Telescopes are even helpful in study of Cosmic rays.

Pinku: Now what are these cosmic rays Dadaji?

Dadaji: Cosmic rays are atom fragments that rain down on the Earth from outside of the solar system. They blaze at the speed of light and have been blamed for electronics problems in satellites and other machinery. We know today that cosmic rays are atom fragments such as protons (positively charged particles), electrons (negatively charged particles) and atomic nuclei. We also know that they are most likely

Telescopes are helpful in study of Cosmic rays

created in Supernovas; however, there may be other sources available for cosmic ray creation. The high-energy "primary" rays collide with atoms in the Earth's upper atmosphere and rarely make it through to the ground, "secondary" particles are ejected from this collision and do reach us on the ground. But by the time these cosmic rays get to Earth, it's impossible to trace where they came from. That's because their path has been changed as they travelled through multiple magnetic fields (the galaxy's, the solar systems and Earth's itself). Cosmic rays therefore come equally from all directions of the sky. So scientists are trying to trace back cosmic ray origins by looking at what the cosmic rays are made of.

Pinku: Are these radiations harmful to us?

Dadaji: Yes they are. However, Earth's magnetic field and atmosphere shields our planet from 99.9 percent of the radiation from space.



Two Exploding hypernova's create Gamma-rays

However, for people outside the protection of Earth's magnetic field, space radiation becomes a serious hazard. A radiation dose received by astronauts on even the shortest Earth-Mars round trip would be like receiving a whole-body CT scan done every five or six days.

Pinku: Are you aware of any other such radiations/rays Dadaji.

Dadaji: Yes Pinku I know of Gamma-ray bursts which are brief, intense explosions of high-frequency electromagnetic radiation. These outbursts give off as much energy as the sun during its entire 10-billion-year lifetime in anywhere from milliseconds to minutes. Scientists think gamma-ray bursts may be caused by giant exploding stars known as hypernovas, or by collisions between pairs of dead stars known as neutron stars.

Pinku: Is there a chance of Gamma rays hitting Earth?

Dadaji: Yes Pinku...If a gamma-ray burst exploded within the Milky Way, it could wreak extraordinary havoc if it were pointed directly at Earth, even from thousands of light-years away. Although gamma rays would not

The most sever explosion of a star is called Hyper nova

penetrate Earth's atmosphere well enough to burn the ground, they would chemically damage the atmosphere, depleting the ozone layer that protects the planet from damaging ultraviolet rays that could trigger mass extinctions. It's also possible that gamma-ray bursts may spew out cosmic rays, which are high-energy particles that may create an experience similar to a nuclear explosion for those on the side of the Earth facing the explosion, causing radiation sickness.

Pinku: Now what are these hyper nova's Dadaji?

Dadaji: A hyper nova is the most destructive force in this universe. It is a type of star explosion with energy substantially higher than that of standard supernova. The power is almost incomprehensible and they seem to produce so much energy they defy the laws of physics. When one sets off it is the brighter than everything else you can see in the sky. Hence, it is also called as super-luminous supernova.



Astronomy is study of Universe

Pinku: I guessed so... Tell me one thing Dada-ji... we have been speaking about astronomy since long. What is Astronomy Dadaji?

Dadaji: Pinku Astronomy is the study of the universe and its contents outside of Earth's atmosphere. Astronomers examine the positions, motions, and properties of celestial objects.

Pinku: Hmm... than what is astrology Dadaji?

Dadaji: Astrology is the study as to how those positions, motions, and properties affect people and events on Earth.

Pinku: Does Astrology work? Are astrologers correct in making future predictions?

Dadaji: Some believe astrology is science, some believe it's just methodical formulae of probability of something happening relative to motion of something else. I exactly do not know how predictions work. But one thing I strongly believe that nature forces can be altered by human's will. We have many examples in Purana's as well for e.g., Sati Savitri could bring back her husband from death through her will.

Pinku: Hmm... makes sense... Dadaji we have been talking about Gravity what is gravity Da-

Gravity pulls in all the matter towards itself

daji?

Dadaji: Aha! I was just thinking why you did not ask this question earlier. Pinku Gravity is a force pulling together all matter. The more matter, the more gravity, so things that have a lot of matter such as planets and moons and stars pull more strongly.

Pinku: Why don't we float on earth as we do in space Dadaji?

Dadaji: I already told you Pinku that the more massive something is, the more of a gravitational pull it exerts. As we walk on the surface of the Earth, it pulls on us, and we pull back. But since the Earth is so much more massive than we are, the pull from us is not strong enough to move the Earth. In addition to that Pinku depending on the amount of mass, gravity also depends on how far you are from something. This is why we are stuck to the surface of the Earth instead of being pulled off into the Sun, which has many more times the gravity of the Earth.



Merger of Neutron Stars create short bursts

Pinku: You grabbed away my second question Dadaji. Any way thanks for answering that too.

Dadaji: Do you know Pinku around 60s, satellites designed to detect nuclear bomb explosions on Earth accidentally picked up short bursts of gamma rays coming from random points in the Universe. Since this discovery, the cause of gamma ray bursts (sometimes called GRBs) has been explored by Astronomers and Scientists.

Pinku: Gamma ray bursts... hmmm... how are they caused Dadaji?

Dadaji: GRBs are extremely energetic explosions and are the brightest electromagnetic events known to occur in the universe. Bursts can last from ten milliseconds to several hours. The intense radiation of most observed GRBs is believed to be released during a supernova or hyper-nova explosion as a rapidly rotating, high-mass star collapses to form a neutron star, quark star, or black hole. A subclass of GRBs (the “short” bursts) appears to originate from a different process such as the merger of neutron stars.

Pinku: Now what is this quark star Dadaji?

Dadaji: quark star is an intermediate stage in

No two gamma ray bursts (GRBs) are the same

between neutron stars and black holes. It has too much mass at its core for the neutrons to hold their atomness, but not enough to fully collapse into a black hole.

Pinku: How many such structures are there in Universe Dadaji?

Dadaji: Ah! That question of yours reminds me of recently found Green Blob. A strange green glow was spotted in the sky by a Dutch school teacher as he was hunting for galaxies in 2007. The ‘Green Blob’, lies near a gas bubble in a distant galaxy. Together (the Blob and the bubble) the pair is providing new evidence for how giant black holes affect their host galaxies. Blasts of ultraviolet and X-ray radiation from a galaxy are responsible for giving it its emerald glow. The radiation comes from the supermassive black hole, or quasar, at the centre of the galaxy.

Pinku: Dadaji is there a super earth in the Universe?



Universe has so many secrets within it

Dadaji: A humungous Earth-like planet was found by US astronomers. It has changed the perception of planet formation. A rocky world found by Kepler space observatory should have become a giant ball of gas, but has remained a planet for billions of years. The newly discovered Kepler-10c planet has been dubbed 'Mega-Earth' due to its diameter. Its estimated weight is 17 times greater than Earth. This makes Kepler-10c the biggest rocky planet ever discovered. Dimitar Sasselov, professor of astronomy at Harvard University and director of the Harvard Origins of Life Initiative, described the newly-found planet as "the Godzilla of Earths."

Pinku: Oh My god Dadaji I never knew that Universe has so many secrets.

Dadaji: Yes Pinku... It's very little I told you there is lot more known and lot more unknown.

Pinku: Thank you Dadaji. I appreciate your patience to teach me so many good things and vast knowledge that you have shared with me on Universe.

Kepler was a German astronomer, mathematician, and astrologer

Universe is not only vast but continuously expanding, how far will it expand no body knows but it will contract some day back to a single mass .

Thank You

