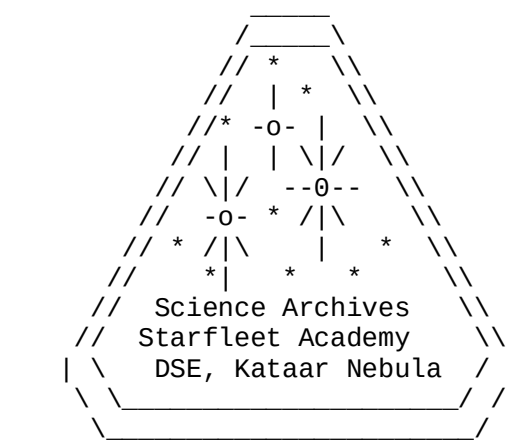

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"The great tragedy of science - the slaying of a beautiful hypothesis by an ugly fact"
- Thomas Henry Huxley

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:::Introduction:::
This course is designed to show you, as a person with obvious scientific interest (otherwise you wouldn't be reading this), about how the universe was created, evolved and its death in the future. The document contains most areas of astrophysics, areas containing more detail than others, but is based on the facts as we know them today, and how I can understand and communicate them to you. As new facts are revealed on the nature of the universe this document will be updated, but for now this is condensed information on the nature of the universe.

This *is* an advanced course and as such will *not* be easy to pass. Only the best will pass.

NOTE: This is the course; there is no guide at the academy. You will be able to discuss the topics below for any queries, problems or ideas that have been raised by it. You can either email me or talk to me in the academy at the weekend, during appropriate sessions.

:::The Universe:::
>>>Big Bang<<<
This theory states that the universes began as a single point with infinite mass and therefore zero volume, a singularity. We don't know how this formed or what came before it, but it is useless to try and think about this because time (and any other dimensions beyond this) was created at this point, being a dimension itself. Just as the single 'point' has no length, height, or depth nor does it have time.

At the beginning of the universe it expanded instantly and exponentially for just 10^-34 seconds (faster than the speed of light, otherwise it wouldn't be the size it is today), like a balloon (that's 1 with 34 0's before it with a decimal point before that). This ballooning effect was caused by a false vacuum, created by quantum fields that didn't balance and therefore it expanded, in the same way that matter would expand into a 'vacuum' on earth (except exponentially).

At the beginning of the universe, after 1/1000000 of second all the forces of the universe were unified (i.e. Gravitational, Strong, Weak and Electromagnetic). Then, after 1/10000s the temperature would have been around 10^12 degrees Kelvin (K = -273.16 C). At this temperature electron, muons (206.77 x mass of an electron) and a plasma of quarks and gluons would have existed. As the temperature dropped to around 4x10^9 K, protons and neutrons would have formed. After 15 minutes the universe would still be hot, at 5x10^8 K and therefore radiating strong amounts of energy. It would have been during this period and temperature drop to around 1 million K that the unattached electrons would have been scattering the radiation that we can detect today as background microwaves at 3 K. Up until this stage the universe would have been opaque, but when the temperature reached 3000 K,

after around 300,000 years the electrons would have joined with the nuclei that existed and the universe would have become transparent.
Then proto-galaxies would have formed from the gathering of matter and as the first stars were born, the galaxies that we see today would have grown and matured.

--Space-Time Continuum--
General Relativity causes the effect of space-time. It is the concept that the universe is not just 3-Dimensional but actually 4 (or more...see later). The fourth dimension is time. Time is not a single direction. Because we are 3D and live 'in' 4D we move through time in what we perceive to be one direction (also due to the quantum configuration of our quarks we are made of). There is no way you can imagine this reality but it can be drawn in 2D if you combine the 3 dimensions into 'space' on one axes (of a graph) and time on another. Particles do in fact move in both directions and strange things occur at the speed of Light.

In fact the universe probably started out being incredibly warped. The universe was a sphere of space-time which was warped into that shape due to the mass in the universe being so densely compact and creating the effect. Warped space itself is actually the effect we perceive and feel to be gravity. Although there are the predicted mass-less particles called gravitons (like photons of light and are what would exist as gravity waves/gravitation force), the gravitational force created by, for example, the sun, which keeps the planets in orbit due to the exchange of gravitons, is actually warping space-time around it. The Earth (and other planets) would then follow what it would perceive to be a straight line along this gravitational curvature-like path. To image this you could look at yourself walking around Earth. If you didn't know Earth was a sphere, like people did hundreds of years ago, you would assume it was flat. It's also comparable to an airplane flying through the air, following a straight path while its shadow wraps around the landscape's hills and valleys.

You cannot draw space-time; take this example which proves why not, in 2 and 3D. If you draw a triangle on a piece of paper the internal angles add up to 180 degrees. However, draw a triangle on a sphere and removing the triangle produces internal angles above 180 degrees. This is because of the curvature of the sphere of a 2D object in a 3D reality (like cartographers of Earth have the problem of drawing the Earth on paper, they have to stretch and squeeze parts of the Earth creating a distorted image). Therefore from 3D to 4D, space-time cannot be visualized (or perceived) in our frame of reference. Therefore we can't perceive the universe to be curved, as it was at the beginning of the universe because we are so tiny, infinitesimal in comparison, and therefore perceive (remember everything we know and discover is based on how we perceive it) it to flat. It is so big in fact, that it is thought to be 10^10^12 in size. If we were large enough then we could actually detect the curvature of the universe. But one curiosity produced by space-time states that if we were to travel in one direction (like if we were trying to find the edge of the universe) it would take an infinite amount of time to reach it. In fact, when you reached infinity you would be back where you started (a walk around the globe).

>>>The Fate of the Universe<<<
There are three theories on the fate of the universe. It is based on the properties of matter within it. The universe expanded at its creation but no-one is quite sure what will happen to it at its end. However, new

evidence destroys one of the theories as you will see later. There are two theories which describe an open universe and one which is closed.

--Closed Universe--
When the universe was created, if the mass within it was greater than a critical point, Omega > 1, then the gravitational pull created by the mass in the universe will cause the matter to slow its expansion and eventually contract back to its single point, to something called the 'big crunch'. At this point space and time would disappear and that could be the end.
However, it is also possible, and probable that the universe would be reborn, creating a continuously oscillating universe.

--Open Universe--
If the mass of the universe was equal to or below the critical mass required to make it contract under gravity, Omega = 1; Omega < 1, then its expansion could not be halted and the universe would continue to grow forever.

If Omega = 1 then the universe's expansion would be such that it slowed its expansion at the exact rate required to prevent gravitational contraction into a closed universe. At infinity the universe would stop expanding.

If Omega was < 1 then the universe's expansion would be a constant expansion. This would mean a dark future for the universe. As citizens of one galaxy, in billions of year’s time our galaxy would be so far away from others (except for our 'local group') that we would be alone.

However, it is in light of new evidence that the universe has an Omega rating of less than 1. But, the expansion is not constant; in fact it is increasing its rate of expansion in an exponential curve. This would mean a dark future if it wasn't for the reason of this exponential expansion. The theory is of the Lambda Force (or the Cosmological Constant). Basically it is a resultant negative pressure, or negative gravity. This effect has been found in laboratories. It is produced by the Casimir Effect (more later) and goes hand in hand with springy space, which might mean a bright future for our galaxy.

>>>Multiverse<<<
The theory behind this works on Quantum mechanics, and therefore probability. If we are in a sea of infinite nothingness then there is a possibility of an infinite number of big bangs. Therefore if there are an infinite number of universes there are an infinite number of different possibilities from universe to universe, in which only a few we can exist in, although we could exist in an infinite number of universes (it would be an infinitesimal amount), but the properties between universes far away from ours in reality would be too wild for us to exist in. This would be because with an infinite number of universes, that would contain an infinite number of shapes, sizes and arrangements. We exist in this one because of what's known as the Anthropic Theory which simply is 'because'.

These universes would also have begun at the same time because at a 'point' where time does not exist the universes would have begun at the same 'time' or 'whatever'.

However, the reason we can't detect these universes is because on the large scale, the 'classical scale' (Newtonian Physics), the universes become independent. It's only when Quantum mechanics become the dominate force, on the microscopic scale (10^-35 m), that the universes can effect each other,

subtly. The single particle, quark etc, that we can detect is actually an object (if it's even that) which sprawls through a trans-universe structure of the multiverse. This theory has been proved by the use of Quantum computers which could only work if this theory worked.

:::Galaxies:::
Galaxies are big clusters of stars and gas in a sea of space, like islands in the ocean. Some contain billions of stars, our own Milky Way containing roughly 200 billion stars. However, looking into deep space we see billions upon billions of galaxies themselves. These galaxies are not the same either, each having distinct characteristics. The closest galaxy to our own is 2 million light years away (the Andromeda Galaxy), but there are two minor galaxies orbiting the Milky Way, the Large and Small Magellanic Clouds at roughly 150,000 light years away, just outside the halo of our galaxy.

>>>Galactic formation<<<
After the Big Bang and the matter condensed, it is thought that this matter contract under gravity into pockets of high density matter (much in the same way a star forms). This would have formed dwarf galaxies. This is thought to have occurred about 5 million years after the Big Bang. Small proto-galaxies formed and many joined to create large ones, but as the mass increased in a galaxy the density decreased because the merge resulted in a lot of orbital energy being gained. The galaxies themselves would have had a central point of great mass to make the gas orbit the center. This is probably where the first stars formed, and merged later to form a black hole which scientist believe are found at the center of all galaxies. Within the dust clouds more pockets of density would have been found which would have contracted to form stars (once the density was high enough, because gravity is a very weak force and practically non-existent on the atomic scale), this would have in turn caused a catalyst for millions and eventually billions of stars to be formed. At the beginning it would have been pockets of these early stars that probably resulted in the globular clusters we see today, which date back to the beginning of the galaxy.

Looking at our galaxy, it is class SB, it contains spiral arms and between them vast amounts of gas. The center of the galaxy is populated with mainly old, red stars of the Population II variety, but the further out, and especially in the spiral arms are Population I stars which are new and bright stars. Looking out into the spirals you can see large amounts of plasma, hundreds of light years across, created by supernovae. The shock waves of these dying stars would produce new stars in a wave of new births. New supernovae are created and the circle continues.

However, this can't continue forever. It is a regulating system that will continue for billions of years to come. However, as more and more black holes form and white dwarfs of condensed matter increase the activity will decrease. Eventually the process will stop and you will have a vast dark 'galaxy' with a massive black hole, with billions of solar masses which will swallow it up and itself disappear eventually.

It is thought that the galactic make-up of elliptical galaxies was created by a massive nuclear explosion, enough to force all the dust and gas out of it (which probably could have only been created by an exploding/dying massive black hole or a massive hyper nova) explosion in the center of the

galaxy, which drove off most or all of the gas, this might also be a future for our galaxy, but scientists don't believe that galaxies 'evolve'.

>>>Classes of Galaxy<<<
Galaxies, being so various in designs, also fall into several different categories, which most galaxies conform to.

--Elliptical Galaxies--
Range from E1 to E7
Range is from spherical in shape (E1) to a flattened galaxy (E7) Elliptical galaxies are galaxies containing Population II stars, and therefore have little gas.

--Lenticular Galaxies--
Only one class - SO
These galaxies resemble flattened elliptical galaxies containing a disk without spiral arms.

--Spiral Galaxies--
Range from SA to SD
Range is from bright centers with tightly wound, thin arms (SA) to lightly glowing centers with loosely wrapped arms (SD). These galaxies contain vast amounts of gas as well as stars

--Barred Spiral Galaxies--
Range from SBA to SBD
Range is the same as spiral galaxies and similarly contains the same number of stars and gas on average. Barred Galaxies have a bright bar going across the central bulge with arms protruding from the bar (either end) and wrapping around the galaxy.

--Irregular Galaxies--
Only one class - IR
They are galaxies that can't be defined because they lack structure or organization. They contain areas with and without stars.

>>>Quasars and Galactic Centers<<<
At the center of the galaxies there are huge concentrations of mass which produces the vast amounts of gravity that maintains the galaxy's shape and rotation. But what is at the center of these galaxies?

--Galactic Centers--
Like the galaxies themselves, the galactic center varies as well. In all galaxies the concentration of stars gets higher the closer you get to the galaxy's center. The center of a spiral galaxy itself is thought to be constructed in the same manner of an elliptical galaxy, especially since it contains mainly Population II stars (old, red stars) like an elliptical which is made of old stars due to the tiny amounts of gas found within it which could cause star formation. Therefore, in a spiral galaxy you have the arms which stretch out around the galactic bulge often being a 10th of the diameter of the bulge itself. In the Milky Way the galaxy is 100,000 light years across (we are situated about 33,000 Lyres from the center) with a bulge of 1000 Lyres in height (although globular clusters orbit it within the halo - which surrounds galaxies like a sphere).

It is widely thought that at the center of a galaxy is a massive black hole created at a very young age of the galaxy's life. In fact, a measurement of the Milky Way’s (MW) center reveals an invisible mass of which stars are orbiting. It has been measured to be around 2-3 million solar masses. The black holes at the center of galaxies is proportional to the mass of the stars (mainly Population II) located in the galactic bulge (or elliptical galaxies with the whole galaxy being measured) with a black hole weighing around 1/200th of the galaxy itself.

Galaxies that have been observed have different results due to observational positions. Some are radio-galaxies, some blazars and some quasars. But why are these huge amounts of energy emitted and what are they caused by?

--Quasi-Stellar Radio Sources--
Quasar is short for Quasi-Stellar Radio Source. Quasars are thought to have been extremely common around 2-4 billion years ago as galaxies were maturing and galaxies were 3-4 times more densely packed than today (you could have looked into the night sky and seen galaxies as bright as stars). Therefore galaxies would have been merging more commonly too and it is these merges that are thought to produce quasars.

When galaxies merge the dust and gas from these galaxies are densely concentrated at the merging point. This would produce an explosion of stars births and would have produced vast amounts of energy equivalent to a mediocre quasar. However, this is not a quasar, since a quasar appears to be single point of emitted energy. Black holes would have formed from the star births and would quickly have formed into a larger and large one eventually forming a super massive black hole. The gas produced at the center of the merger and the gas left from supernovae would have been pulled into the black hole under the huge gravitational pull. As it got closer the gases would have become denser and denser and heated up as they reached large fractions of the speed of light. This matter and gas would have swirled around the black hole continuing to heat up to millions of degrees as it was dragged closer to the event horizon. The matter would then have climbed, more concentrated, around up to the poles of the rotating black hole and the now ionized matter would have had nowhere to go but away from the black hole, now having enough energy to do so. This matter would flow away at near light speed along with the energy it produced, creating long columns of energy, hundreds of thousands of light years high. When we view a galaxy like this we can see these galactic jets being ejected. A quasar is a view of such a galaxy from a slight angle of a polar galactic view. The power produced is measured in trillions of suns, but when viewed directly on, know as a 'blazar' (or 'BL Lacertae- objects') we can measure it being 10 to 100 times more energetic than quasars. On the other hand, some radio galaxies are thought to be side-on views of quasar galaxies which emit vastly reduced, but still more than normal, amounts of radio waves.

A lack of gas and matter would produce a 'dormant' black hole which is thought to be like ours. However, the mass of the black hole required to produce a quasar is around 100 million solar masses, about 50 times the mass of our galactic black hole. If there was some great change in a galaxy or a merger did occur then the dormant black hole would probably flare up again.

:::Stars:::
>>>Nebulae<<<
--Formation--

Nebulae were probably the result of, initially, the formation of the galaxy when the universe cooled down into galaxies. The nebulae we see today are the results of dead or dying stars. Supernovae produce nebulae consisting of heavy metals and 'planetary nebulae' (so called because they looked like planets when first observed) are caused by the death of small stars. The force of gas caused by a supernova's explosion causes interstellar gases (and those found between the arms) to be compressed with the gas of the dying star and this makes the gas dense enough to produce heat and then stars, which how we see nebulae (because of the heat they produce). In fact, the nebulae tend to produce more than one star at the same ratio to single star systems. But it's not just binary systems, there are the tertiary and quaternary at roughly 57:35:6:1 respectively (although it varies from star to star, i.e. Class G is 57:38:4:1 and M is 58:33:7:1). The reason we can't see the whole of the central bulge in our galaxy is because there are vast gas clouds in the way, but they do not light up because they are not producing heat, or given heat from another source.

>>>Life of a Star<<<
Most stars live in two different ways, although the length of a star's life depends on the mass of that star. However, all stars form from interstellar gas contracting, after being compressed enough for gravity to take a hold on the gas particles. After that, as the nebula heats up under gravity causing the particles to collide and produce heat, the contraction slows. Eventually, at a central point the gas has become so dense and so hot under gravity that nuclear fusion begins and the contraction stops producing a new star instantly. The energy from the fusion pushes most of the gas (which hasn't formed into planetary bodies) away from the star (it probably ends up orbiting the star billions of kilometers away, producing what we have in our system know as the Oort Cloud - loosely held rocks and asteroids). For the beginning of the life of the star the size does not change much, but eventually changes force it to.

--(Dwarf) Stars < 1.4 Solar Masses--
In these stars (like ours - the sun = 1 solar mass), hydrogen is fused in helium in the initial stage (:4 hydrogen atoms are forced together under pressure, they lose their electrons and as they are forced together two of the protons release anti-electrons, or positrons, and anti-neutrinos. With this positive charge release the two protons for neutrons and helium nucleus are produced which quickly rejoins four of the many billions of free electrons from other reactions in the core.). This will occur for billions of years, with a core temperature of around 20 million K but as the helium core becomes larger and larger the temperature of the star becomes 10% hotter every billion years. When the core reaches a critical size it quickly contracts (more about this in stars > 1.4 solar masses and produces vast amounts of energy causing the other layer of hydrogen to expand drastically. Since the star is now much bigger the surface is area is much larger too and therefore more heat is lost quicker, as well as more heat being produced at the core, the net energy release is higher. Because the surface is cooler the star becomes red in color, producing a red-giant. The core has contracted further, pressure and heat rises and carbon is produced and again with further contraction an oxygen-neon core is formed. This produces a star with several shells with fusion taking place in. But the star's days are numbered. With the fusion of helium producing 1/20th the heat of the hydrogen fusion, the star finds it difficult to maintain the equilibrium between heat and gravitational contraction that kept the nebula/star from contracting at its birth. The star will reach a point when it can no longer fuse matter in its core and the fusion slowly stops. Gravity then takes a

hold and the star contracts. The heat produced with matter becoming denser causes vast amounts of energy to be released which the outer layer absorbs and is blown off instead of contracting with the core. This gas will expand, into a 'planetary nebula', eventually in to space or may cool and return to the dying star under gravity. The contraction of matter will go beyond that of the original star's size because there is no heat to prevent it from doing so. This produces a 'white dwarf' with matter so dense that one grain of sand worth would be as massive as a mountain.

--Novae--
These tend to occur in binary systems (or tertiary or quaternary) when one of the stars has formed into a white dwarf. Matter released from the 'living' star would be caught by the white dwarf. This hydrogen would be compressed onto the surface and when enough accumulated over a short enough time the gravitational compression would cause fusion on the surface of the star and it would flare up again very brightly, these stars are called 'recurrent novae'.

--(Giant) Stars > 1.4 Solar Masses/Supernovae--
Stars with more mass than 1.4 solar masses have different lives which are quicker and more active. Only 1/30th of the 200 billion stars in our galaxy are this massive yet they are the main reason for the continued matter recycling of stars. The life of this type of star begins in the same way a dwarf star starts out. However, because it is more massive, the star's core is hotter and therefore fuses the matter quicker. In the biggest of stars, all the hydrogen is used up (except for on the surface) in less than a few hundred thousand years. But fusion in the core does not stop at oxygen and neon. Being more compressed and hotter the core continues to fuse Neon into Magnesium, Magnesium is fused into Silicon. This forms concentric shells around the star's core, with different fuels being used in each shell. With many different shells in the later life of a star, the star will oscillate in contraction and expansion as the different layers stop and start fusing under different pressures. By the time the core starts fusing Silicon into Iron the temperature would have reached around 3-4 billion degrees K. It is at this point that the star will start to die. Iron represents a maximum stability, minimum energy content atomic structure which results in a dead end for fusion. The core will stop fusing and it will cool. In order to survive the star must produce heat quickly, since the core is beginning to shrink. In order to do so Iron must be ripped apart to form Helium; however, to do this the core must contract quickly, in fact so quickly it must contract in about 1 second. Without the energy to keep equilibrium the core shrinks in an instant and the gravitational energy converted into heat is enormous. Radiation produced from a heat source increases by a ^4 for every double in temperature (i.e. Temp x2 = Radiation x 16). When Helium is produced from the Iron, as already said, vast amounts of energy are produced. The atoms surrounding the core absorb this and rush to expand squashing all the shells above it. At this point all the other atoms up to Iron maybe produced as the heat and pressure of all the shells being compressed increases. The shells then explode off the core in a spectacular sight known as a 'Supernova'.

The matter blown off by the supernovae will expand into interstellar space and may compress other gas clouds out there. This will produce second generation stars. The matter produced by a supernova will also include many heavy elements which may produce planets in the vicinity of the new star, planets like Earth, which has a mainly iron core. We, in actual fact, are made of the matter produced in stars too.

The core of the star will have three possible outcomes. It may form into a Lazarus star, which is a star which survives the explosion and has enough of the 'right' materials to continue its life, it will, however, again explode in a supernova explosion. Another possibility is the creation of a 'Neutron Star' or 'Pulsar'. This type of star is named so because the star is made mainly of the sub-atomic particles, neutrons. This is formed because the electrons in the atomic structure fuse with protons under the immense pressure to form neutrons and this is thought to be how it forms. The contraction of the star will result in an object just 10km in diameter. The neutron star will also have immense magnetic fields surrounding it and later in its life will rotate up to 30 times a second emitting gamma-ray bursts at its poles, this is known as a 'millisecond pulsar'. The other result is a black hole, discussed below.

:::Observations:::

>>>Doppler/Redshift effect<<<

The Doppler Effect is produced when sound waves, for example, produced by an ambulance siren coming towards you, are compressed, but as they move away from you they become further apart because the object creating them is further away each time a crest on the wave is produced. Therefore the pitch is high when the object approaches you and gets lower as it moves away. The same can be said of light, which itself is a wave. This Doppler Effect, for light or electromagnetic waves, is known as the Redshift (or Blueshift) because of the spectrum of light. At the Violet end of visible light, waves are shorter (remember UV radiation is small still), and at the Red end waves are longer (IR waves even longer). If an object is moving towards you at very high speeds, significant fractions of light speed (which is actually 299,792,458 miles per second), then the wave crests will bunch up like sound waves coming from the moving ambulance. The result will be that the object appears bluer. Now in our universe, other galaxies are not blue-shifting because everything is moving away from everything, like dots on an expanding balloon (we can observe blue shifts of stars and matter in orbit within galaxies relative to that galaxy's redshift), but we need to know of red-shifts because it is used in the calculations of speeds of and of the Big Bang, which helps collaborate our theories. It also helps when charting movements of objects within galaxies, even our own.

These calculations stated that the universe should be at a certain point in its expansion rates and therefore galaxies should be at a certain distance from each other. However, when this was checked after studying supernovae explosions in other galaxies (supernovae have the same light output due to exploding at a critical point in their lives, only distance reduces their brightness), the galaxies seemed to be further away than they should be. Why should that be?

>>>Lambda Force/Exotic Matter<<<

The Lambda force is a negative energy, opposite to that of gravity. It was originally created by Einstein and named the 'Cosmological Constant'. It can be proven using the Casimir Effect. Two metal plates are placed nanometers apart. A vacuum is created within the area that the two plates are held. The result is that the plates move together. The answer is a negative pressure acting on the plates, because if the pressure in the vacuum=0 then the pressure must be less than 0. The reason this occurs is because of Quantum mechanics. This states that particles are jumping in and out of existence (actually due to particles appearing from places in the multiverse. These

particles would be more numerous on the outside of the plates than between them, which is why they are so close, close enough to prevent the wave-particles from having an effect within them. This negative pressure is known as the Lambda force. It is thought that this force could be produced in the same way that gravity is produced; from particles know as 'Exotic Matter'. However it would be extremely difficult to find any of this matter because it would be located in the depths of inter-galactic space away from all the matter of which it repels from.

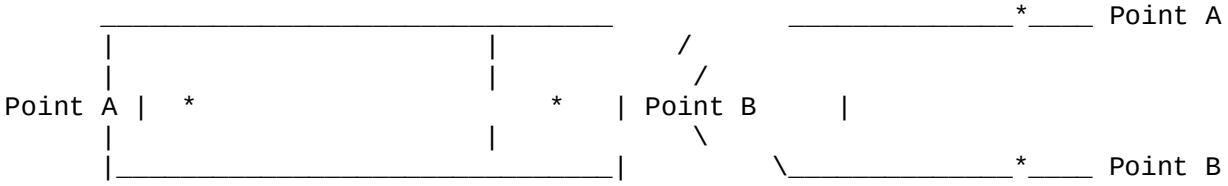
The two different particles, matter and exotic, would not cancel each other out like anti-matter, but would simply force each other apart (you could create a ship engine using this principle).

>>>Dark Matter<<<
Dark Matter is basically all the matter in the universe that can't be seen. It was thought to be just matter you can't see, like planetary bodies or vast amounts of gas or even black holes. However, new studies have made the probable result of dark matter stranger. The detection of this invisible matter was caused by the indirect observations of the galaxies.

Motion and gravity are what keep the stars in position when orbiting the galaxy (in the Milky Way it takes the Sun takes 225 million years to orbit the galaxy). This equilibrium is maintained by a perfect velocity to gravity ratio which keeps the star at roughly the same distances from its central gravitational point of which it orbits. If the velocity was too small then stars would fall in to the center. However, when viewing the visible mass in the Milky Way it is too little, to account for the momentum of stars. As stars become further from the center of the galaxy they should be moving slower, but in actual fact their velocities are the same for these outer stars as inner stars. The reason for this is thought to be because there is a large amount of dark matter located in the galactic halo (a sphere 150,000 light years across, surrounding the galactic disc). In fact, the luminous mass only accounts for 50% of matter in the MW. But strange observations have been found in smaller galaxies - 'dwarf galaxies'. It appears, due to observations of star momentum, which as the galactic size reduces the percentage of dark matter increases in density and proportion. In fact, in galaxies with 1/100th luminosity of the MW, the dark matter accounts for 90% with dwarf galaxies with faint stars visible have 99% dark matter, with 1 solar mass of dark matter per 30 cubic light years - denser than the stars and gas in our galaxy disc. In galactic companions (i.e. the Local Group, about 30 galaxies with M31 - Andromeda and the Milky Way being dominate forced off) of the Milky Way, with luminosity of 1/100000, dwarf galaxies have been found to have massive dark halos. This dark matter is the result of the Big Bang itself. When you look at a dwarf galaxy you are looking at matter as it was at its pristine beginning, because these galaxies managed to miss 'their' merger. In fact dwarf galaxies outnumber all the other galaxies, but because of the lack of gravity at dwarf-galactic centers the gas thrown off by supernovas may have escaped away into inter-galactic space, but the dark matter would be unaffected, which is thought to be why dwarf galaxies contain such a high percentage of dark matter. However, it still remains to be seen (or not) what the matter that makes up most of the universe is made of.

:::Theoretical Studies:::
>>>Wormholes<<<

The effect of a wormhole is the result of 4D space. It is thought that since space-time is itself like an 'object' it can be shaped in many ways. Imagine this: Take a piece of paper, imagine it to be flat space time, now if you fold it over on itself (don't crease the paper), so that the two ends are parallel to each other, you have a warped bit of space, but any matter within it would not feel any effects. Any matter at point A on the sheet would view point B to be at a distance that is across the whole flat sheet. However, if you move the two ends closer and stick a hole in both parts you would be able to move the large distance in a tiny amount of time.



A wormhole based on the Schwarzschild model: The wormhole would already exist (if you want my theory on it, just ask), but it would be very unstable. In fact to keep a wormhole open you would require exotic matter to stabilize it. The exotic matter would spread out around the central hole of the wormhole creating a ring-like shape (but as space time is involved, it would probably not appear like a ring). The exotic matter would maintain the shape for an object to pass through. However, if an object containing more mass than the exotic matter contained in the wormhole was to pass through then the wormhole would collapse, creating two ends with a singularity at each. In order to recreate/maintain that worm hole, you would need to pump exotic matter in to a point where there is more than the ship is made of. Looking through a wormhole would not be exciting, unlike the wormhole is in DS9. In fact, you probably wouldn't even notice it because it would just look like space. The light going in would spread out on the way out and it would look normal, like a symmetrical lens effect does. You might even be looking into space and be seeing something from the other side of the universe.

>>>Black holes/White holes<<<
--Black holes--
Created after a supernova and is even denser than a neutron star. Because of the immense amount of matter in one point (the massive star has shrunk into something only 10km across) it is able to have an escape velocity greater than the speed of light. In fact, because of this reason it is thought to have a singularity at the core of the object. However, the star could, and probably did collapse completely into the singularity and the actual reason that light can't escape is because it pulled space-time back on itself, effectively creating a pocket within the universe.

The point at which light and matter has no return is when it passes the 'event horizon'. This is the point at which the escape velocity reaches 300,000 km/s and is probably where space becomes too warped. The 'Event Horizon' is a mathematical point/location at which these events occur and not a tangible object. If light was trying to escape at the time the star collapsed to this point (and the black hole didn't change in shape or size) then the photon would live forever on the event horizon. Beyond this point and you will see at first a reddish mass, because of the gravitational redshift, but then it would be over, because your legs (if they were closer to the singularity) would have been stretched and then ripped off your body.

This because even a fraction of your body in diameter is closer to the singularity and the gravitational pull is much stronger at that point than the point a bit further away (you are existing within the event horizon, just not for long).

There is a way to detect black holes, however. Not only the indirect observations of matter around it but due to 'Hawking Radiation'. This is the result of quantum fluctuations at the point of the event horizon. Quantum mechanics states that a vacuum is not a vacuum but with the continually incoming and outgoing particles which appear and then annihilate each other. At the event horizon, when this happens, the particles appear and one gets trapped on the 'wrong' side of the event horizon while the other which didn't get caught flies off into space. This also produces energy losses from the black hole itself.

--White holes--
Also using Schwarzschild's principle White holes are created by wormholes leading a black hole through to a White hole. White holes cannot, however, exist in our universe. The directions of Thermodynamics prohibits this (Thermodynamics is the movement from order to disorder in a universe (i.e. When you turn the pages of a book you use energy, but reading the book still requires energy too which is created from the energy in your body and converted into heat which is radiated out into the universe creating disorder). In a black hole thermodynamics is maintained because in falling matter increases the event horizon which will create more disorder in the universe as a whole. The white hole does the opposite. It is a black hole in reverse. Instead of absorbing 'everything' it spews it all out into space. However, it is only white from our point of view, because if we existed in the White hole's universe we would be going backwards too! One could never go into the White hole's universe either. This is because after falling into the black hole (you wouldn't see the other universe through the wormhole before being crushed at the singularity) you would die at the singularity.

:::Epilogue:::
The information in this text is more in depth than the Basic Science Course, but it tries to maintain a distance from the confusing stuff. I hope this has given you an insight into many astrological phenomena and that you enjoyed reading about it. Don't stop here though, there are many other places that you can find information on these and many other topics listed above.

You must remember that as time goes on there will be changes in scientific views due to new discoveries and time will reflect on this document. However, I cannot keep up all the time, so in order to maintain accuracy, I will update as necessary and whenever I can, but you could help as well by telling me about new advances. This document also reflects on my memory so if there are any problems within this document that you want straightened out, send me an email and I will review your comments and update this document if necessary. Thanks.

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