Trape : Stars
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TABLE OF CONTENTS

INTRODUCTION 4

Definition of a star 5

What is a star? 5

How does a star form/ Birth of star 5

Stellar evolution 6

Nothing lasts forever 6

Main sequence star 6

Red giant 7

Red supergiant 7

Planetary nebula 7

White dwarf 8

Black dwarf 8

Supernova 8

Type 1a supernova 8

Type 2 supernova 9

Black hole 9

Neutron star 9

Types of stars 10

Stars close to earth 10

How do astronomers observe stars? 11

Light years 11

Brown dwarf stars 11

Yellow dwarf stars 12

Red dwarf stars 12

Orange dwarf stars 12

Supergiant stars 12

Constellations 13

What are constellations? 13
Short history.. 13
Tabel of constellations……………………………………………………………………………………………14-15
Zodiac signs 16
How to spot them……………………………………………………………………………………………………16-17
Equipment 18
Which equipment do astronomers use?. 18
Development of the telescope through time…………………………………………………………………..18-20
How do telescopes work? 21
Result 21
Sources ………. 22-23

Introduction :

I chose this subject because I have always been fascinated in astronomy and every night the stars were out I really wanted to know about the science. So I started to watch documentaries and read articles on the web or books. However, this has nothing to do with my « Project personnel ». I want to become a peadriatician when I'm older but science interests me altogether.

Astronomy is a natural, science; you mostly study celestial objects outside of the Earth's atmosphere. But there is also astrology and cosmology and many more branches that is paired to it. Now don't confuse astronomy with astrology, because it's not the same. Astrology is a type of belief that tells information about yourself by looking at your star sign. (Zodiac sign) You study the movements and positions of the sun, moon. Some people believe in their horoscopes that means they think their star sign has something to do with their character and their daily lives.. Cosmology is one of the branches of astronomy that informs us about the universes evolution and future. It is a study about the origin, evolution and eventual fate of the universe.
However, astronomy is a study that helps us to comprehend space and celestial objects (stars, plantes, black holes…..).
It's one of the oldest natural sciences in history, today we also call it astrophysics. We need astronomy to help us understand the universe and our own solar system. Astronomers spend their life searching and searching for answers to fill that hole of curiosity.

(Fig.3 The Medusa nebula)

Definition of a star

What is a star ?

A star is a giant ball of gas, it's mostly made of helium and hydrogen. (He,H) It's held together by its own gravity. How? In a star's core there are nuclear reactions which support it against the gravitational pull, it stays their mostly for the stars entire life. A gravitational pull is a force that pulls two objects together. However, when a star dies depending on its size, it explodes, so all of its matter drifts into space. This is called a supernova. From that matter new stars and planets can form. Only massive stars from about 1.4 solar mass experience a supernova explosion. Stars can produce photons and heat and other types of heavy elements. Astronomers estimate that in our Milky Way galaxy alone, there are around 30 billion stars. Nevertheless, stars are really important to us human beings, because without them we wouldn't be here. The Sun is also a star, from the gas and dust it formed earth and all the other planets in our solar system, it is holding our orbit together. When it's night time and you look up and see stars shining, there light was always their but it took million years to reach earth depending on how many light years away they are.

How does a star form ?/ Birth of a star

The way the star is formed, is that intestellar gas and dust between other stars combine together and create a molecular cloud. CO and H^2 (Carbon monoxide and hydrogen) are the most general molecules in interstellar molecular clouds. As we all know that it's very cold in space, it's around -270 Celsius. Because of the cold, gases tend to clump to high densities. From the density of the gas it collapses under its own gravity. This is now a protostar. As soon as the pressure and temperature gets high enough for a nuclear fusion to ignite, it creates a star. What is the nuclear fusion? While the contraction of the gas and dust proceeds and the temperature hits about 15 million degrees the pressure becomes humongous. The electrons are removed from the atoms, therefore creating plasma. The contraction processes and the nuclei in the plasma start moving faster. Later on, they come on in each other so fast that they overcome the electrical repulsion that exists in their protons. (electrical attraction/ repulsion : if the two elements have the same charge, they repel, when they are not the same they attract together) The nuclei collapse into each other so hard that they stick together, in this process they release a big amount of energy. This energy from fusion pours out, setting up an outward pressure in the gas around it that balances the inward pull of gravity. However, when the released energy reaches the outer layers of the ball of gas and dust it shifts into space in a form of electromagnetic radiation. That's how the ball begins to glow and when we call it's officially called a star. This phase takes about 20 million years altogether.

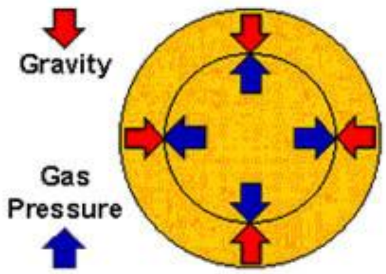
Stellar evolution

Nothing lasts forever

The stellar evolution are the different stages of a stars life. So from the amazing birth to the horrifying, catasrophic death. The presice lifetime of a star depends on the size of the star. Very massive stars burn their fuel more faster than smaller stars and maybe last only a few hundred thousand years and will have a different fate. Smaller stars will last for billions and billions of years and will also have a different fate, because they burn their fuel more slow. However, both ways, they die.

Main sequence star

I explained how a star is formed on page 4, that is also part of the stellar evolution.
When the hydrogen fusion process of a star begins, that's when we know it has reached its main sequence phase. This is the longest stage of the whole stars life. About 90% of the stars in our universe are main sequence stars. They can reach from approximatley a tenth of the mass if the sun is up to 200 times as huge. During this phase stars convert hydrogen into helium in its core, this process is called the nuclear fusion. What happens in the core that it starts to convert hydrogen into helium ? This process is really simple, four protons (hydrogen nucleus) are combined to form one helium nucleus, some of the mass of the hydrogen is converted into energy. This energy is released by the fusion of hydrogen, it pulls the star outward, preventing it from collapsing under its own gravity. This is the hydrostatic equilibrium balance, as long as the star is in this balance, the luminosity, size and temperature remains the same.



(Fig.4 The equilbrium balance)

However, there are much more particles involved in this process, for example : photons, electrons… How long a main sequence star lives depends on how massive it is. The Sun will spend 10 billion years on the main sequence, a star 10 times bigger than it will only be around for 20 million years. Smaller bodies with less than 0.08 the Sun's mass cannot reach the stage of nuclear fusion, therefore they become brown dwarfs. Why? For normal main sequence stars, the gravity pushes inward until hydrogen fusion is started in their core. Before the brown dwarfs temperatures gets hot enough for hydrogen fusion to start, the close-packed material reaches a stable state. A red dwarf, which is half the size of the sun, can last 80 to 100 billion years.

Red Giant

After the main sequence phase the low- and medium star mass reaches its red giant phase, as we all know stars do not have an internal life. So that means it is in the phase when the star is nearly close to its death. The star stops to produce hydrogen in its core. That means the hydrostatic equilibrium balance is broken. The star's core gets smaller and hotter, the outer layer of it expands. However, the surface is a bit cooler. The size can reach from 100 million to 1 billion km in diameter, it gets cooler and keeps on expanding its size. This lasts for approximately a billion years.

Red Supergiant

Stars that have a massive mass will not become a red giant but a supergiant. When the helium is getting weaker, the balance of pressure and radiation overturn. So gravity takes over pushing the star tighter than ever. The core burns hotter and faster, making the outer layer expand to an extreme big size, burning out heavier elements. Carbon burns into neon in centuries, neon to oxygen in a year, oxygen to silicon in months and silicon to iron in a day.

Planetary nebula

The planetary phase happens to only low mass stars such as the Sun from billions years from now, it will also soon be in this condition. After the star loses hydrogen from its core, all of the outer layer is shifted away, they expand into space, forming a nebula. (A ring shape)

(Fig.5 The planetary nebula ESO 577-24. ESO)

You can normally see the leftovers of the star, more precisely the star's core, but it's not always in sight. Astronomers have detected 3.000 planetary nebulas so far.

White dwarfs

The former core of the planetary nebula is now a white dwarf, it is the last stage before death. 95% of our stars will end their existence as white dwarfs. The core is as big as Earth, imagine the Sun being a white dwarf it would have half of its former mass then. It is extremely dense and its surface gravity is 100000 times higher than Earth's. These stars shine longer than other stars because of their heat, they are 40 times hotter than our Sun. Howbeit, they aren't really active. Their heat is trapped inside, therefore having nowhere to go, except for the outer layer, but space is mostly empty. The only way energy can escape is by radiation. The star is so hot that it takes a lot of trillion years to cool down. Scientists estimate that they could last 100 billion times longer than our whole universe has existed.

Black dwarfs

The white dwarf can last long enough, that galaxies would have been evaporated. Only then will the first white dwarf convert into the first black dwarf, so that means it's been cooled down. It will not be an active sphere and will not provide energy anymore. It's still big enough to kill you because of the deadly cold temperatures, the coldest possible temperature in the universe.
They are so dark that they would be invisible. Scientists are not sure what the destiny of the black dwarf is. They estimate that if the protons have a limited life, the star will slowly evaporate over trillions of years. If the protons do not decay, it will turn into a sphere of iron and travel though a dark and cold universe, nothing extra will happen. And it will stay like this forever.

Supernova

A supernova represents everything that a star is made of comes crashing into the core, all of its matter is packed into a tiny place becomes a nuclear ticking bomb.
All of the matter and radiation blasts into space into a catastrophic explosion. This is the largest explosion that takes place in space. There are two types a star can go supernova :

- Type 1 : supernova : the star gathers matter from a close neighbour until a nuclear reaction ignites.
- Type 2 :supernova : star runs out of nuclear fusion and collapses under its own gravity.

Type 1a

This type of a supernova happens in binary systems, that means two stars orbiting each other, one of the stars has to be a white dwarf. The other star can be any other star, even a white dwarf. As the gas of the other star gathers onto the white dwarf, it becomes more and more compressed and eventually it explodes.

Type 2a

For the star to explode it has to be extremely massive, so that means around serval times bigger than our sun. The star will eventually run out of hydrogen and then later on helium fills in its core. Heavier elements build up in the centre, becoming layered, with more elements becoming more weak. Later on as the star's core starts to excel a certain mass it begins to collapse. The core heats up and becomes denser. The collision bounces off the core and pushes outward, pushing off the stellar material into space.

Black holes

This is another way an extremely massive star can die depending on its size, leaving leftovers of the core behind, if it's approximately 3 times bigger than our sun. Gravity overwhelms all other forces and turns the core into a black hole, it is the strongest, most powerful thing in the universe. A black hole appears when an extremely massive amount of matter is tightened in a small space. The gravity that it contains is extremely powerful and whatever gets too close gets torn apart into its primary particles. Not even light can escape black holes. We identify them as spheres of darkness. You can't be sure what's really happening in there because once something gets in it, will never get out. It is like rowing a boat on a river, you cannot row back because the water is pulling you, it is the same scenario in a black hole. However, it is called an event horizon when we are speaking about black holes. They radiate their mass incredibly slowly, which means that it takes them 10 times 10 billions of years to lose 0,0000001% of its mass, this is called Hawking radiation. They will also be around when all of the stars have evaporated, the black hole will get smaller and eventually evaporate too, leaving a tiny bit of radiation behind.

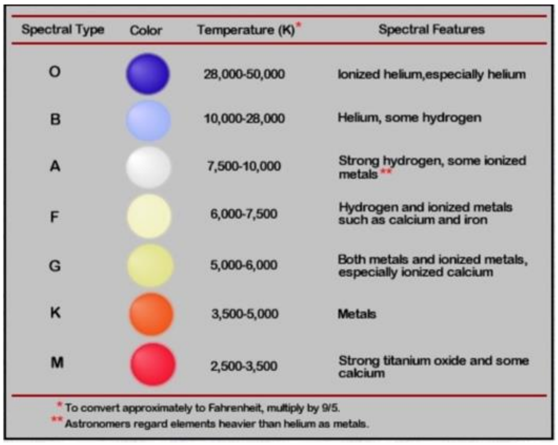
Neutron star

Scientists estimate that neutron stars are the most violent stars in the universe. Their mass is about a million times bigger than Earth, but compressed to an object about 25km wide. After a supernova explosion the neutron star is born, more precisely, that is the former core of the collapsed star. Furthermore, it could also turn into a black hole depending on the former star's mass. Neutrons stars are really dense. Their surfaces reach 1,000,000 degrees Celsius. They are filled with atomic nuclei. The electrons are transferred to the positively charged atomic nuclei, there is no space between the atomic nucleus and the electrons. Its gravity is the, strongest outside black holes, if it were any more dense it would become one. Light is bend around it. It is somehow also like a planet it has an atmosphere, a crust and a core. The crust is really hard. The outermost layers are made of iron from the supernova. As you get deeper into the core, gravity squeezes the nuclei together more and more. It becomes so dense that it may be the strongest material in the universe. Eventually we reach the core, but scientists aren't sure what the proprieties of matter are when they are squeezed this tight. It could be some sort of quark plasma. When neutron stars are about to collapse they begin to spin very fast, they spin multiple times per second. This creates pulses because of their magnetic field, they create a beam of radio waves, which passes every time they spin. These magnetic fields are the strongest in the universe. They are called magnetars until they calm down a little.

Types of stars

Nearest stars to earth

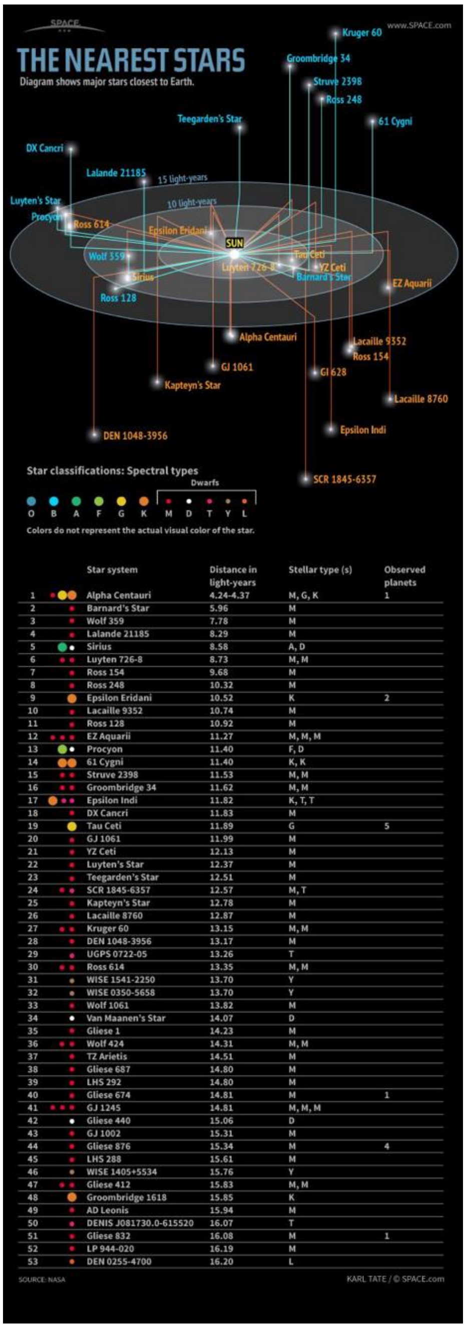
There are billions of stars in our solar system ; however, I'm particularly, interested in, which ones the closest are and what astronomers have discovered so far. As you can see on the diagram, Alpha Centuri is the closest star. The star classification is pretty complex. Each type of stars has a different colour, size, mass and temperature. Our sun's classification is a G2V main sequence star yellow dwarf. The picture below represents the classification of stars. Astronomers use a mnemonic phrase to keep the classification in :mind: Oh be a fine girl, kiss me. It's quite weird, but true. The O-type stars, have a spectral type of the colour blue, a temperature of 28.000-50.000 Kelvin and the features are that they mostly covert helium. B-type stars have a spectral type of a light blue color with a temperature of 10.000-28.000 K, it contains helium and some hydrogen. A-type stars have a spectral type of a white colour with a temperature of 7,500-10,000 K and contains strong hydrogen and some ionized metals. F-type stars have a spectral type of a light beige colour with a temperature of 6.000-7.500 K, they show a lot of spectral lines caused by metals such as calcium and iron. Like the Sun, G-type stars are yellow with a temperature of 5.000-6.000K. The K-type stars are orange at the temperature of 3.000-5.000. The M-type stars are red, they have a temperature of 2,500-3.500K, in their spectra there is strong titanium and ionized calcium.



Spectral Type	Color	Temperature (K)*	Spectral Features
O		28,000-50,000	Ionized helium,especially helium
B		10,000-28,000	Helium, some hydrogen
A		7,500-10,000	Strong hydrogen, some ionized metals**
F		6,000-7,500	Hydrogen and ionized metals such as calcium and iron
G		5,000-6,000	Both metals and ionized metals, especially ionized calcium
K		3,500-5,000	Metals
M		2,500-3,500	Strong titanium oxide and some calcium

* To convert approximately to Fahrenheit, multiply by 9/5.
** Astronomers regard elements heavier than helium as metals.

(Fig.7 The stellar classification chart)



	Star system	Distance in light-years	Stellar type (s)	Observed planets
1	Alpha Centauri	4.24-4.37	M, G, K	1
2	Barnard's Star	5.96	M	
3	Wolf 359	7.78	M	
4	Lalande 21185	8.29	M	
5	Sirius	8.58	A, D	
6	Luyten 726-8	8.73	M, M	
7	Ross 154	9.68	M	
8	Ross 248	10.32	M	
9	Epsilon Eridani	10.52	K	2
10	Lacaille 9352	10.74	M	
11	Ross 128	10.92	M	
12	EZ Aquarii	11.27	M, M, M	
13	Procyon	11.40	F, D	
14	61 Cygni	11.40	K, K	
15	Struve 2398	11.53	M, M	
16	Groombridge 34	11.62	M, M	
17	Epsilon Indi	11.82	K, T, T	
18	DX Cancri	11.83	M	
19	Tau Ceti	11.89	G	5
20	GJ 1061	11.99	M	
21	YZ Ceti	12.13	M	
22	Luyten's Star	12.37	M	
23	Teegarden's Star	12.51	M	
24	SCR 1845-6357	12.57	M, T	
25	Kapteyn's Star	12.78	M	
26	Lacaille 8760	12.87	M	
27	Kruger 60	13.15	M, M	
28	DEN 1048-3956	13.17	M	
29	UGPS 0722-05	13.26	T	
30	Ross 614	13.35	M, M	
31	WISE 1541-2250	13.70	Y	
32	WISE 0350-5658	13.70	Y	
33	Wolf 1061	13.82	M	
34	Van Maanen's Star	14.07	D	
35	Gliese 1	14.23	M	
36	Wolf 424	14.31	M, M	
37	TZ Arietis	14.51	M	
38	Gliese 687	14.80	M	
39	LHS 292	14.80	M	
40	Gliese 674	14.81	M	1
41	GJ 1245	14.81	M, M, M	
42	Gliese 440	15.06	D	
43	GJ 1002	15.31	M	
44	Gliese 876	15.34	M	4
45	LHS 288	15.61	M	
46	WISE 1405+5534	15.76	Y	
47	Gliese 412	15.83	M, M	
48	Groombridge 1618	15.85	K	
49	AD Leonis	15.94	M	
50	DENIS J081730.0-615520	16.07	T	
51	Gliese 832	16.08	M	1
52	LP 944-020	16.19	M	
53	DEN 0255-4700	16.20	L	

(Fig.6 The nearest stars to earth)

How do astronomers observe stars?

It takes years to fully understand astronomy and you need to understand much more than just physics. But how do astronomers observe stars? Astronomers usually observe stars in an obsevatory. A very long time ago, they did not have the equiment we have today, so you can imagine how different it was like to observe celestial objects back then. They spent the entire night just pointing the telescope at distant objects like stars, nebulas or galaxies. They collected the trickle of the light from each object. Astronomers never actually look through the telescope. Instead, they remain in the control room and montior the telescope and instruments as they record the data. Let me make something clear though. How can you tell the difference between a star and a planet , it´s really easy. You see a planet does not produce light but it is reflected by light. A star does produce its own light. Or say for example you are observing a solar system. What do you first notice? Well, at the center you will see a star, you know it's a star because it shines by itself and planets are orbiting it.

Lightyears

We mesure the distance between a star and the Earth by lightyears by using the speed of light. A light year is a mesurment of distance. The amount of distance light travels in one year is one light year. Light travels 299.792 kilometers per second, which is 1 096 000 000 per hour. Therefore, a light year is a distance of around 9.6 trillion kilometers. So say for example you have a star that is 2 light years away, it means that it will take you 2 years to get there in a rocket. Or how about a star that exploded 20 years ago. How long would it take for us to see the supernova? The answer is 20 years.

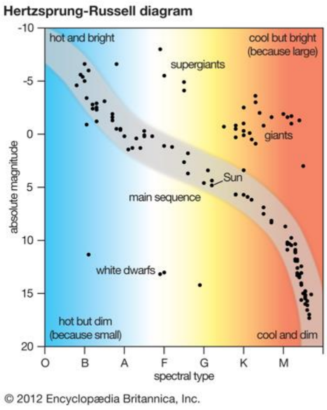
Brown dwarf stars

A brown dwarf is sort of like a failed star. Why? Because like every star, it forms from a could of gas, the temperature in its core is hot than it begins to fuse hydrogen into helium. Therefore, the star releases a lot of energy, by that it produces light. Nevertheless, smaller bodies with less than 0.08 the Sun’s mass cannot reach the stage of nuclear fusion, therefore they become what we call brown dwarfs. They aren't brown but they appear from deep red to magenta (type of red to pinkish), but it all depends on its temperature. The youngest brown dwarf has temperatures as high as 2.800 K. Every brown star cools down in time to, the minimum main-sequence stellar temperature is about 1.800 K. The oldest and smallest can be around 300 K.

Yellow dwarf stars

A yellow dwarf star is basically a medium size star, also referred to a G-type main-sequence star. It has a mass of about 0.84 to 1.15 solar masses. ((M ⊙) 1 solar mass= 2×10^{30}kg). 10% of the stars in the Milky Way are yellow dwarfs. They have a surface temperature of about 5.300-6.000 K. Some examples of G-type main-sequence stars are : Tau Ceti and Alpha Centauri.

Red dwarf stars



(Fig.8 The Hertzsprung-Russell diagram)

Red dwarfs are the most small stars in the universe, with about 7 to 50% of the mass of our sun. 70% of the universe is filled with red dwarfs. They are really dim, you can't see them with a naked eye. Red dwarfs stay convective, that means helium and hydrogen constantly mix. They use there fuel extremely slow before they are extinguished. Their average lifespan is between 1 and 10 trillion years.

Orange dwarf stars

An orange dwarf is a K-type main-sequence star, also called a K dwarf. It's s luminosity class is V. Its size is between red M-type main-sequence stars and yellow G-type main-sequence stars. It has a temperature of between 3.900 and 5.900 K, it is much cooler than yellow dwarfs. It is smaller than our sun and has a lifetime of 70 billion years. What scientists are mostly interested in that there might be extraterrestrial life inhabited there.

Subgiant stars

Subgiant stars are larger and redder than normal main-sequence stars. They fall in the region from F to K type stars. Their temperatures are ranging from 7.000 to 4.000 K. They have masses similar to or a bit massive than than of the Sun.

> Just to make sure.
> Kelvin is a unit we use to mesure extremely hot and cold temperatures like celestial objects in space.
> If you want to convert Kelvin into Celsius, all you have to do is subtract -273.15 °C
> 0 K = -273.15 °C

Constellations

What are constellations ?

Constellations are a group of stars that make a fictional shape in the night. They are named after mythological characters, people, animals and objects. In the past they used those constellations in the night sky to navigate and to keep track of the seasons. There are around 88 constellations. In other cultures there are other types of constellations. The ones you can see throughout the year are : Capricornus, Aquarius, Pisces, Aries, Taurus, Gemini, Cancer, Leo, Virgo, Libra, Scorpius and Sagittarius. A constellation can be a group of 5 to 20 stars. However, the exact location of the constellations changes throughout the year, this is how people could tell that the seasons were changing. We have an instrument that can be used to recognize stars and constellations. It has moveable wheels around the edge, you can adjust the wheels to the time of year you are in and your location on earth and it will show a complete accurate map of the sky and the constellations that you can see in the area you are in.

Short history

Most of the constellations were first known by the Greeks and maybe the Babylonians. The 48 constellations listed in Ptolemy's Almagest are highlighted in blue in the table down below. John Bayer (15th century), Johannes Hevelius (16th century) and Nicolas de Lacaille (17th century) added more constellations to the list
They were recorded over 5000 years ago. 2400 years ago a Greek astronomer Eudoxus wrote a list of such patterns. As you can see the names of a few constellations are somewhat unusual. They all have a meaning behind their name, most of them come from Greek mythology. For example stories or legends like Hercules, the son of Zeus. (Lightning God) The more recent ones were named after instruments or animals. The Zodiac constellations are the best known. The exotic animals were mostly introduced by the Dutch navigators Peirre Dirkszoon Keyser and Frederick de Houtman in the 16th century. Nicolas de Lacaille named the scientific instruments in the 18th century. Every constellation has a bright star, you can see them as well in the table below.

Constellation name in latin	Constellation name in English	Brightest star
Andromeda	Princess of Ethiopia	Alpheratz
Antlia	Air pump	Alpha Antliae
Apus	Bird of Paradise	Alpha Apodis
Aquarius	Water bearer	Sadalmelik
Aquila	Eagle	Altair
Ara Altar	Altar	Beta Arae
Aries	Ram	Hamal
Auriga	Charioteer	Capella
Boötes	Herdsman	Arcturus
Caelum	Graving tool	Alpha Caeli
Camelopardus	Giraff	Beta Camelopardalis
Cancer	Crab	Al Tarf
Canes Venatici	Hunting dogs	Cor Caroli
Canis Major	Big dog	Sirius
Canis Minor	Little dog	Procyon
Capricornus	Sea goat	Deneb Algedi
Carina	Keel of Argonauts ship	Canopus
Cassiopeia	Queen of Ethiopia	Schedar
Centaurus	Centaur	Rigil Kent
Cephus	King of Ethiopia	Alderamin
Cetus	Sea monster	Deneb Kaitos
Chamaeleon	Chameleon	Alpha Chamaeleontis
Circinus	Compasses	Alpha Circini
Columba		Phakt
Coma Berenices	Berenice's hair	Beta Comae Berenices
Corona Australis	Southern crown	Alpha Coronae Australis
Corona Borealis	Northern crown	Alphekka
Corvus	Crow	Gienah
Crater	Cup	Delta Crateris
Crux	Cross	Acrux
Cygnus	Swan	Deneb
Delphinus	Porpoise	Rotanev
Dorado	Swordfish	Alpha Doradus
Draco	Dragon	Thuban
Equuleus	Little horse	Kitalpha
Eridanus	River	Achernar
Fornax	Furnace	Alpha Fornacis
Gemini	Twins	Pollux
Grus	Crane	Alnair
Hercules	Hercules, son of Zeus	Ras Algethi
Horologium	Clock	Alpha Horologii
Hydra	Sea serpent	Alphard
Hydrus	Water snake	Beta Hydri
Indus	Indian	Alpha Indi

Lacerta	Lizard	Alpha Lacartae
Leo	Lion	Regulus
Leo Minor	Little lion	Praecipua
Lepus	Hare	Arneb
Libra	Balance	Zubeneschemali
Lupus	Wolf	Alpha Lupus
Lynx	Lynx	Alpha Lyncis
Lyra	Harp	Vega
Mensa	Table	Alpha Mensae
Microscopium	Microscope	Gamma Microscopii
Monoceros	Unicorn	Beta Monocerotis
Musca	Fly	Alpha Muscae
Norma	Rule	Gamma Normae
Octans	Octant	Nu Octanis
Ophiuchus	Serpent bearer	Rasalhague
Orion	The hunter	Rigel
Pavo	Peacock	Alpha Pavonis
Pegasus	The winged horse	Enif
Perseus	Hero who saved Andromeda	Mirphak
Phoenix	Phoenix	Ankaa
Pictor	Easel	Alpha Pictoris
Pisces	Fishes	Eta Piscium
Piscis Austrinis	Southern fish	Fomalhaut
Puppis	Poop deck	Naos
Pyxis (=Malus)	Compass box	Alpha Pyxidis
Reticulum	Net	Alpha Reticuli
Sagitta	Arrow	Gamma Sagittae
Sagittarius	Archer	Kaus Australis
Scorpius	Scorpio	Antares
Sculptor	Sculptor	Alpha Sculptoris
Scutum	Shield	Ionnina
Serpens	Serpent	Unukalhai
Sextans	Sextant	Alpha Sextantis
Taurus	Bull	Aldebaran
Telescopium	Telescope	Alpha Telescopii
Triangulum	Triangle	Beta Trianguli
Triangulum Australe	Southern triangle	Atria
Tucana	Toucan	Alpha Tucanae
Ursa Major	Big bear	Alioth
Ursa Minor	Little bear	Polaris
Vela	Sail of the Argonauts ship	Suhail
Virgo	Virgin	Spica
Volans	Flying fish	Beta Volantis
Vulpecula	Fox	Anser

Zodiac signs

Zodiac signs are actually a theory based on your sun sign, so that means the position of the Sun on the day and month you were born on. The constellations follow a certain circular path around the Earth. The Sun appears to pass in different constellations. The Zodiac constellations make it easier to track other constellations throughout the year. There are two solstices, the summer- and the winter solstice. At the beginning of the year in January, Sagittarius and Capricorn are highly visible in the night sky, then comes Aquarius in February, Pisces in march, Aries in April, Taurus in March, Gemini in June , Cancer in July, Leo in August, Virgo in in September, Libra in October and Scorpio in November. In Ancient Greek the word Zodiac means circle of life. Maybe you’ve heard about horoscopes, it is a forecast of a person’s future and short recitals about their character and fears. Not everyone believes in them, like I said it, is a choice to believe it or not.

ASTROLOGY DATES

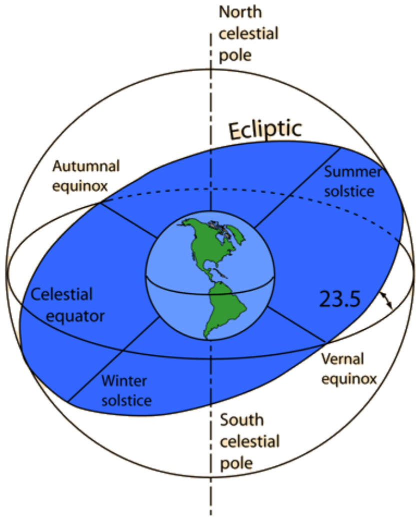
ARIES	MAR 21 - APR 19	♈
TAURUS	APR 20 - MAY 20	♉
GEMINI	MAY 21 - JUN 20	♊
CANCER	JUN 21 - JUL 22	♋
LEO	JUL 23 - AUG 22	♌
VIRGO	AUG 23 - SEP 22	♍
LIBRA	SEP 23 - OCT 22	♎
SCORPIO	OCT 23 - NOV 21	♏
SAGITTARIUS	NOV 22 - DEC 21	♐
CAPRICORN	DEC 22 - JAN 19	♑
AQUARIUS	JAN 20 - FEB 18	♒
PISCES	FEB 19 - MAR 20	♓

(Fig.9 The Zodiac/ Astrology dates)

How to spot them

How to observe constellations depends mostly on where you are and what time of year it is. As the earth spins, the place of the constellations changes. The best way to locate a constellation is with a star chart. It is basically a map of the night sky, where you can navigate different constellations. The way you’re supposed to orient the chart is simple. For example, if you are looking south, you have to rotate the chart south as well. So be sure you choose the bright stars first, because it's easier to identify them and later on you will find it much easier to find the rest. If you are in a place with a lot of streetlights it would be more difficult to observe them due to the light pollution, sometimes the Moon shines the brightest, that is why you should be in a dark space. It is also important that you look at the time. In just 2 and a half hours to 3 hours, stars move from about 1/8 further along the ecliptic. What is the ecliptic? The ecliptic is a line made up from astronomers to track the annual path of the Sun. Zodiac constellations follow a circular path around earth. The equinox is also important. What is the equinox? It is when the day and night are nearly equal, because the equator passes through the Sun. It happens in March and September. However, you know there are 4 seasons; winter, spring, summer and autumn. There are two solstices and two equinoxes. The solstices are, summer solstice and winter solstice. The equinoxes are the vernal (spring) equinox and autumnal equinox. What is the solstice? It happens twice a year once in June the 20st or 21nd and once in December the 21st or 22nd. It is basically when the days are shorter and longer. So in summer the days are shorter, because the Earth's equator is at its furthest from the Sun south or north. When it is winter in the in the northern hemisphere, it will be winter in the southern. Over the course of one of the Sun’s orbit, the axis slightly changes. Furthermore, the Earth moves and the Sun seems to pass through the constellations, so that depends where the Earth's orbit is pointing at. You see the constellations at a different time throughout the year. The Earth

wobbles, due to some tidal forces from the Sun and that allows the solstices to change a little amount. That also means when the Sun is facing to the stars, they drift a slight amount. In a few thousand years, the Sun will be sitting in a completely different constellation.



(Fig. 10 Scheme of the Earth's orbits)

Equipment

Which equipment do astronomers use?

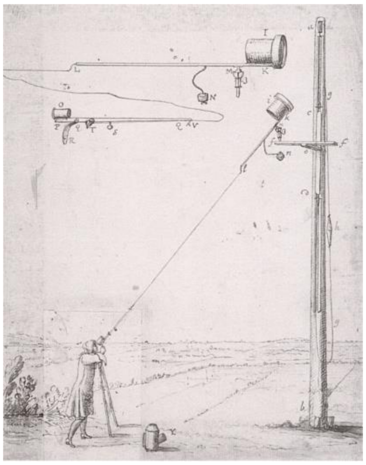
The most used and common parts of equipment astronomers use are-; telescopes, computers and, cameras. They use different types of telescopes.

Development of the telescope through time

The first ever spectacle to observe the wonders in the night sky was made in 1608 by Hans Lippershey. The Dutch scientist invented the eyeglass, it was called the Kijker. It magnified an image up to three times. He was the first man to apply for a patent for the telescope. Others also claimed to be the inventor, but the Dutch government accepted his patent as the rightful one. While the Kijker magnified things only a few times, Galileo Galilei later made a telescope that could magnify objects up to 10 times. At around the 16 century he worked even harder until he got the telescope to magnify things up to 30 times.

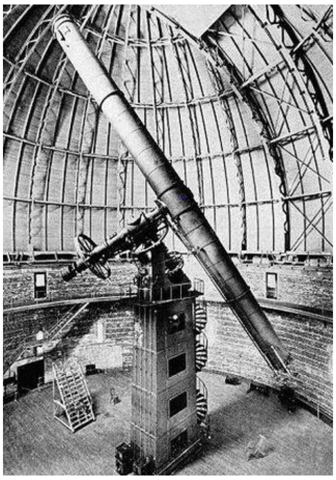
(Fig.11 A painting from 1754 where Galileo Galilei is displaying his telescope)

In the year 1655 a Dutch astronomer Christian Huygens, was inspired to build the most powerful telescope at the time. His goal was to build a telescope that would allow for detailed studies of the solar system. His great device was called the Huygens ocular telescope and the aerial. It is a tubeless telescope, and at that time it was a major development of telescopes. However, in the year 1654 he also made great upgrades to the grinding of lenses. He and his brother later on built a 3.7- meter long telescope. He made it detailed enough to make observations of Saturn, while observing Saturn with his telescope he discovered a moon orbiting it. He named it 'Saturni Luna', until John Herschel renamed it 'Titanin' 1847. Huygens was also the first to document the true shape of the planet´s rings in 1659.



(Fig.12 Aerial Telescope)

Johannes Kepler made the refractor telescope in 1611. It was shown in 1897 at Yerkes Observatory in Williams Bay, Wisconsin. It showed Kepler's large refracting telescope that had a 40-inch-wide lens. He used two convex lenses instead of a concave and a convex lens. The difference between concave and convex is the shape of the lenses. The convex has a shape that curves outwards and a concave is a shape that curves inwards.



(Fig.13 Refractor telescope at Yerks Obsevatory)

Sir Isaac Newton was interested in Kepler's work and decided it could be a better idea to build a telescope using mirrors instead of lenses. He stated that mirrors reflect light, while lenses allow light to pass through them and refract the light. In 1668 he built the first practical reflecting telescope. Today, scientists used both refracting and reflecting telescopes ; however, the reflector/ the Newtonian telescope has become the most useful one for astronomers.

(Fig.14 Newton's reflector)

For the next 60 years, there were some developments made to the technology by Laurent Cassegrain who introduced hyperbolic and parabolic mirrors and John Hadley who improved Newton's model.

Then Chester Moore Hall came and greatly reduced the chromatic issue of refracting telescopes when he introduced a new form of a lens in the 1700's. This lens consisted of two types of glass, the crown, and flint, that were stuck together. Hall proved that Newton was mistaken with his hypothesis that colour distortion could not be solved using refracting rather than reflecting telescopes. His study of the human eye helped him to find his way. This path led him to believe that achromatic lenses must be possible make. He did a lot of experiments with many types of glass until he found the perfect combination of crown and flint glass that met his absolute expectations. In 1733, he built several telescopes with openings of 6.5 cm and focal lengths of 50 cm.

William Herschel built a huge telescope based on the Newtonian telescope. The telescope was 12 meters long. He upgraded it by excluding the diagonal mirror completely and tilting the primary mirror to allow the user to directly view it. Due to some issues he stuck with a 6-

meters-long telescope. Also using his Herschelain telescope he made some discoveries about different moons.

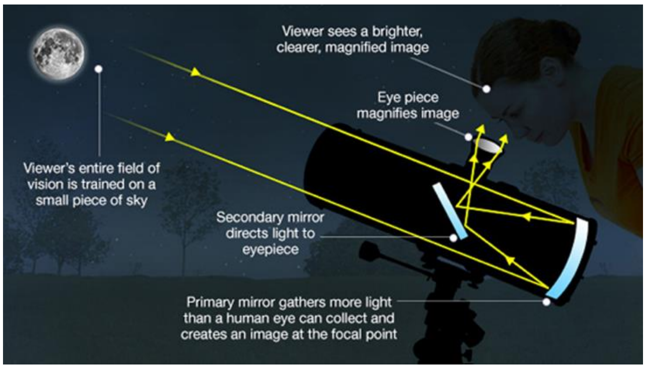
Then after one century of upgrades, in 1930 Karl Guthe Jansky built an array of dipoles and reflectors hat were designed to pick up a short wave radio signal at around 20.5 MHz. It could turn 360 degrees and had a diameter of 30 meters and stood 6 meters tall. It was designed to determine three types of ;interference; nearby thunderstorms static, distant thunderstorm static and constant background faint hisses that repeated in the cycle. Because of his work there are a lot of engineers today that are developing other types of telescopes for measuring, gamma rays, and other electromagnetic radiation.

Grote Reber an amateur radio enthusiast was inspired by Janskey´s work and would invent the first device to ‚see‘ the radio waves. He built this in the back of his garden in 1937. The parabolic telescope had a diameter of 9 meters. He identified the Milky Way as the first off-world radio source, he conducted the first sky survey and discovered other radio sources.

In 1990 NASA and ESA co-operated to build and deploy the Hubble Space Telescope making it one of the first telescope to be launched into space. Although not the first space telescope, Hubble is one of the largest an most flexible. Hubble can provide clear quality images of stars and planets. It contains a 2.4-meter mirror and a suite of other instruments to observe close UV, visible light and near IR spectra. Hubble should still continue functioning until the 2030’s.

How do telescopes work?

Telescopes are used to observe celestial objects that are far away in space. There are many different types of telescopes with different lenses, for example like Superachromat Telescopes that are made with achromat lenses or X-ray telescopes to observe the effects of huge explosions of hot objects in space that radiate X-rays. As I mentioned before Lippershey actually used glass lenses. We use mirrors today, because they are lighter, and they are easier than lenses to make perfectly smooth. These mirrors or lenses are called optics. To see things far away the optics have to be really big, the bigger the optics, the further you can see into space. A telescope made with lenses is called a refracting telescope. A telescope that uses mirrors is called a reflecting telescope. It is the lenses that help us see because, it concentrates light and the body around it makes it stable for us to observe. Like I said before it is always good to be in a space with less light, as it makes it much easier to see with a telescope.



(Fig.15 Scheme of how the telescope fuctions)

Result

This research has been interesting and overwhelming. Overwhelming, because there is so much involved in astronomy, you have to know a ton of physics and much more. Somehow, I lost my focus for a while because I was slightly confused about the facts. When it comes to space it is quite hard to actually know to the truth about such celestial objects, because we cannot go there, we can only observe from the ground and research with the help off our equipment. However, it was a lot of fun learning new things, I am really greateful for all the help I got. If I had not received any help, I do not know how I could have finished this project. In the end I am happy that this was my TRAPE.

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