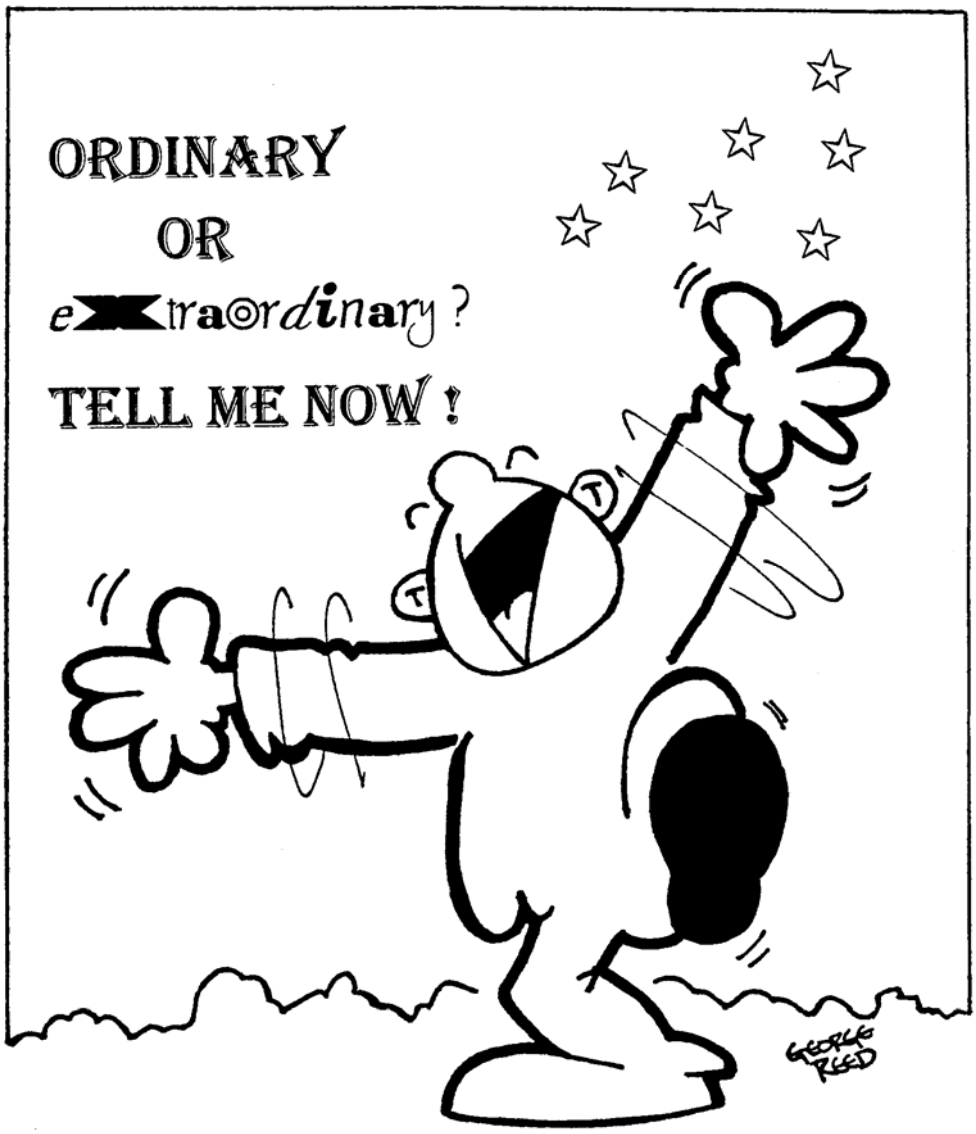
Life in the Universe



Thinking about Mars, Martians, aliens in films, contacting other civilisations and the distance to the stars……

Why Has Mars Attracted So Much Attention?

It all started in 1877 with the Italian astronomer **Giovanni Schiaparelli**. He reported seeing a series of straight lines or "canali" on the surface of Mars. He meant channels, but did not say what the channels were.

An American businessman, **Percival Lowell**, decided the canali were canals, waterways built by intelligent creatures. That's what we were doing on Earth at the time. Lowell thereafter devoted his time and wealth to the pursuit of astronomy. He believed the red planet was populated by a race of intelligent beings that were building canals to irrigate their dry and dying planet.

In 1894, Lowell selected Flagstaff, Arizona, as the site for his personally financed observatory. The site of the **Lowell Observatory**, now called Mars Hill, was carefully chosen because of its number of clear nights and quiet atmosphere. A great controversy raged about the existence of canals on Mars. Some astronomers saw them, some didn't.

Lowell's books in the early twentieth century about intelligent life on Mars excited people's imaginations. But more lastingly, they created a whole new science fiction industry. **Edgar Rice Burroughs**, who was the creator of Tarzan of the Apes, also created another successful fictional hero, Captain John Carter. John Carter was an American who was mysteriously transported to Mars. His popular adventures on Mars brought Lowell's ideas about Mars to life.

The Martians came to Earth in 1938 with the radio broadcast of **H.G. Wells** *War of the Worlds.* The play was broadcast as a live news report. It was so convincing that people fled their homes and crowded the highways in panic to avoid the invaders.

Hollywood recognized a good thing and in the 1950s started producing science fiction films that featured Martians.

As it turned out, Lowell, Burroughs and the rest of the science fiction writers, as well as Hollywood, were wrong about Mars. There are no intelligent beings and no canals on Mars. The myth was laid to rest in 1965 when the **Mariner 4** spacecraft sent back photographs of the Martian surface. Mars is a desert.

Exciting ideas are difficult to abandon. This is true of the red planet. If there are no signs of intelligent life living on Mars now, maybe there is evidence of intelligent life on Mars in the past. There is a rock on Mars that resembles a human face when viewed with the Sun at a particular angle. Is it a monument from some past civilization? Is it a message? People desperate to keep the mystery of Mars alive try to read more into the face than coincidence.

This doesn't mean there is no life or sign of past life on Mars. Evidence of water has been found on Mars. A meteorite from Mars has produced controversial evidence of a simple fossil organism. The search will go on.

In 2003 the European Space Agency (ESA) is sending the Mars Express with the British Beagle 2 Lander to further search for signs of life on Mars. If there is, or ever was, life on Mars the chances are very good that we will eventually find evidence for it.

Mars: In Literature and Films

The Next Best Thing to Going There!

Books

Mars, Percival Lowell (1896). A description and interpretation of Mars based upon Lowell's telescopic observations. A convincing book that fired a lot of imaginations at the time of its publication, but its conclusions are now known to be false

War of the Worlds, H.G. Wells (1898). This is the novel that created the idea that Martians were alien monsters. Martians invade a defenceless Earth and are only stopped by Earth's lowest form of life.

A Princess of Mars, Edgar Rice Burroughs (1911). The first book in a series describing the saga of Captain John Carter's adventures on the planet Barzoom, as Mars is known to its natives. The lesser gravity of Mars gives him superhuman strength. Burroughs was also the creator of Tarzan the Ape Man.

The Martian Chronicles, Ray Bradbury (1970). Earth colonizes the red planet.
Humans become the invaders. This collection of short stories questions human behaviour and raises questions about how we should react when we meet alien races.

Stranger in a Strange Land, Robert Heinlein (1971). The sole survivor of the first manned mission to Mars is raised and educated by Martians. He returns to Earth with human instincts, but with superhuman psychic powers and an alien perspective.

Red Mars, Green Mars, Blue Mars, Kim Stanley Robinson. This is a modern day trilogy about the colonisation and terraforming (changing to Earth environment) of Mars. It follows the story of the "first hundred" inhabitants based on our current understanding of the planet.

Films

War of the Worlds, (1953). This is a film version of H.G. Wells's classic novel about an invasion of Earth by Mars. This black and white film won an Academy Award for its special effects.

Duck Dodgers in the 24th and ½ Century, (1953). Warner Bros. Marvin the Martian is intent on destroying the Earth because it blocks the Martian view of Venus. Duck Dodgers (Daffy Duck) continues to thwart his efforts. Cartoon was ranked fourth in a recent survey of Greatest Cartoons.

Mars Attacks ,(1996) Warner Bros. Little green men from Mars terrify the Earth. This is a spoof on earlier films about Martians

The Red Planet, (2000), Warner Bros. Mars is being turned into an earth-like planet. Something goes wrong and a crew is dispatched to solve the problem.

Mission to Mars, (2000), Disney. There is something on Mars that relates to the origin of life on Earth. In 2020 a rescue mission goes to Mars and discovers the remains of an alien society.

Aliens-Why We Love Them. Why We Hate Them.

It's all Hollywood's fault.

You are in a situation where you must destroy each item on the survey list one after another. Rank the items with "6" being the first to be destroyed and "1" being the last to be destroyed. There are no other instructions. You can have no more information. Whether you want to or not, you must rank each item in the survey.

Survey 1

a. human adults _____
b. large insects _____
c. artificial intelligence computers _____
d. young human children _____
e. seed bearing plants _____
f. human-like beings _____

Now you must rank the following film aliens in terms of how much you like them or dislike them. Rank the aliens with "6" being the one you find most frightening and "1" the alien you find least frightening, or most likeable.

Survey 2

a. The Terminator from *Terminator I, II or III* ____
b. Darth Vader from *Star Wars* _____
c. the alien from the *Alien* films _____
d. E.T. from *E.T.-The Extraterrestrial* _____
e. the Gremlins from the Gremlins films_____
f. the aliens from Independence Day _____

Science fiction films about extraterrestrial life or aliens tell a story. To do this successfully, they create emotions as we watch the film. They want us to like the alien, or they want us to be frightened by the alien. How do they do this? Look at how you ranked the choices in Survey 1 and Survey 2 and see if you can figure out how science fiction films create love and hate emotions when we encounter aliens.

It's really simple once we are aware of what is happening. Science fiction filmmakers know how to take advantage of our fears, phobias, and psychological bonding experiences. The tendencies to fear and love are within us. They just need to be released. This is what Hollywood filmmakers know how to do best.

Psychological bonding results from our forming close specialized relationships with other living beings. The most obvious and strongest are those between parent and child. Some psychological bonding is innate. Children awaken our desire to protect and nurture. We fear strangers. Our sympathies lie with those aliens that are most similar to us.

We are attracted to creatures with large heads, large eyes, medium-sized bodies, and short thick legs and feet that produce a clumsy movement. They remind us of babies and young children that need to be protected. This is why you most likely ranked "young human children" as "1" in Survey 1 and E.T. as "1" in Survey 2.

The results of Survey 1 will show that our sympathies are with those creatures most like humans. We are least sympathetic to artificial intelligence computers and insects. This is not surprising since entomophobia (the fear of insects) is one of our most common phobias.

The results of Survey 2 will show that those aliens least frightening to us are most like humans. It will show that we are most frightened by an alien resembling a common phobia. An insect life form, such as the alien from the *Alien* films, overwhelmingly will prove to be the most frightening film alien.

Science fiction films provide a service. They offer outlets for the expression of our fears of the future. We need to imagine our fears of the future and our fears of contact with alien civilizations to deal with those fears. But what will happen when the fear becomes a reality? What will happen the first time we are confronted with the ultimate stranger, the extraterrestrial intelligence? How will we cope with our xenophobia, our fear of strangers? Will science fiction and science fiction films be a major influence in our reaction to this ultimate stranger?

Teacher's Notes:
Please note that due to copyright issues we cannot include the images of the aliens mentioned in survey 2 with the worksheet however it is possible to use the internet to locate these images.
The following sites may prove useful:
www.fast-rewind.com for 80's and 70's films including Gremlins, Empire Strikes Back (The), Aliens and E.T.
www.Terminator3.com

Aliens – Love them or Hate them?

STUDENT WORKSHEET

Survey 1

You must destroy each item in the list one at a time.
Rank them with "6" being the first to be destroyed to "1" being the last.

A	human adults	_____
B	large insects	_____
C	artificial intelligence computers	_____
D	young human children	_____
E	seed bearing plants	_____
F	human-like beings	_____

Survey 2

Now rank these in the order you like or dislike them.
"6" will be the one you find most frightening and "1" being the alien you find least frightening.

A	HAL 9000, artificial intelligence Computer from 2001-A Space Odyssey	_____
B	Darth Vader from Star Wars	_____
C	The alien from the Alien films	_____
D	E.T.	_____
E	The Gremlins	_____
F	Independence Day Aliens	_____

Does Intelligent Life Exist In The Universe?

No. And that includes us on Earth if we try to meet them.

There is no evidence that life exists anywhere else in the Universe. But there are a lot of statistical arguments that "prove" the Universe is populated with intelligent life forms of one kind or another.

But there is still the possibility that life on Earth is unique. We may have inherited the best part of the galaxy, the best Sun, the best planet, and the best early planetary history. We may be fortunate in having the gravity of our Moon and Jupiter provide us with the safe and stable environment for life to evolve to the point of intelligence. We may have won the Universe lottery. We may be number 1!

The easiest way to discover another intelligent civilization is to listen for it. The laws of physics are the same throughout the Universe. It seems logical that another intelligent civilization will have also developed the technology for a system to transmit and receive communication signals.

We began to announce that the Earth supported an intelligent civilization just over a century ago when we began to broadcast radio signals. That message is spreading out now at the speed of light. To find "the others" we need to eavesdrop on them with the use of radio telescopes. Many projects are being carried out today to look for intelligent signals from space. These projects are called SETI (Search for Extraterrestrial Intelligences) projects and include radio telescopes and scientists from all over the world, including the UK. All programs have produced negative results so far, but space is a big place, so the searching continues.

The least efficient way to announce our existence is by sending an Earth postcard. We sent a postcard picture attached to the Pioneer 1 and 2 spacecraft in 1972. Travelling at 60 000 kilometres per hour it will take 80 000 years to be delivered to the nearest star system, Alpha Centauri. If anyone there wanted to respond, it would take another 80 000 years to do so.

The consequences of the discovery of an extraterrestrial intelligent civilization, in the short term, will tell us that we are not alone in the Universe. It will tell us that intelligent life is a natural phenomenon. This wouldn't disturb us dramatically. It will be in the news for a while, but then nothing will be new. This is because new information will come too slowly. Any communication, even at the speed of light, will take years for a round trip. We would probably absorb this new discovery into our traditional ways of thinking about ourselves. The same would probably not be true if an alien life came to Earth.

"Be careful what you dream because your dreams may come true." If visiting extraterrestrials could come to Earth they would be technologically more advanced than us, and more intellectually advanced. Because they would have done something we can't, they would have travelled between the stars. We would have a lot to learn from them. But would the potential benefits gained outweigh the potential dangers? We could become the target for colonization and the taking of mineral resources by a "foreign power" with little regard for Earth life! The tremendous distances between all the stars will probably save us from ever having a direct contact.

Talking to the Aliens

How can two civilizations that evolved in completely different ways on separate planets communicate with each other in an intelligent manner?

Communication by language can certainly be ruled out. We will probably have to rely on the universal language of mathematics for our communication. Much of the information exchanged will be in the form of pictures created by mathematics.

A series of short and long pulses can be transmitted to represent filled and unfilled spaces on a grid. When these grid blocks are put together they can produce a picture. The concept of prime numbers would help the receiving civilization put the signal together in the proper way.

A prime number is a number divisible only by itself and the number 1. For example, the numbers 1, 3, 5, 7, 11, 13, 17, and 19 are all prime numbers. If the total number of pulses in the message is equal to the product of two prime numbers, the receiving civilization could put the signals together into two different grid patterns. Hopefully one of the patterns would be recognized as a message.

Here is a sample message. **111010010010010** The zeros can represent long pulses and the ones can represent short pulses. The total number of pulses is 15, which is the product of the prime numbers 3 and 5. The signal can be arranged in a 3 by 5 grid or a 5 by 3 grid. The 5 by 3 grid produces a pictogram of the letter "T", the 3 by 5 grid produces an unintelligible message.

5 × 3 Grid

1	1	1
0	1	0
0	1	0
0	1	0
0	1	0

3 × 5 Grid

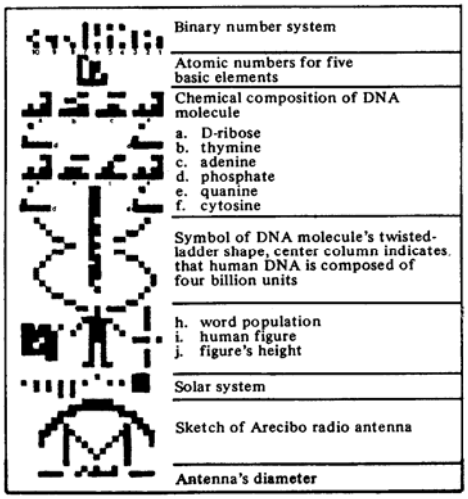
1	1	1	0	1
0	0	1	0	0
1	0	0	1	0

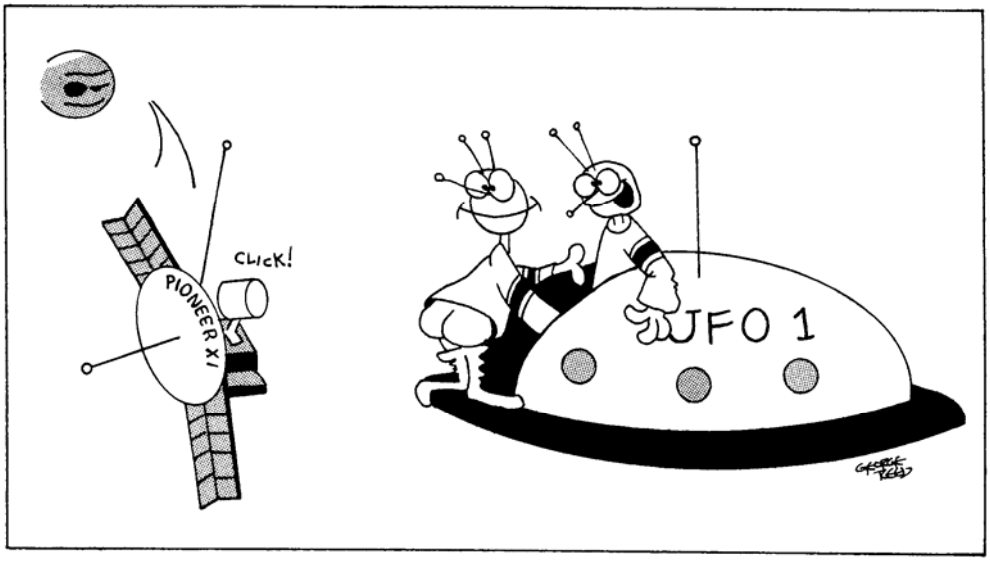
Suppose the following message consisting of a series of pulses was received on Earth. Decode the message using filled and unfilled blocks on a piece of graph paper. What can you determine about the civilization that sent the message?

Interstellar Message: **01010001010110001010**
10001100000000000000
00010100000000000100
00000001111111000000
10111010000000011100
00000000101000000000
11011000000000000000
000

On November 16, 1974, a very complex message was sent in long and short pulses to the globular cluster of stars known as M13. It took three minutes for the 305-metre diameter radio telescope in Arecibo, Puerto Rico to transmit 1679 pulses. The number was chosen because it is the product of the two prime numbers 23 and 73.

A 23 row by 73 columns arrangement leads to nothing, but a 73 row by 23 columns leads to a very complex message about our Solar System and intelligent life on Earth. The message will arrive in 25 000 years.





Well, that's one moon of Jupiter they won't soon forget!

ANSWER TO INTERSTELLAR MESSAGE:

The message has come from an American Mouse (closely resembles Mickey Mouse). The pulses across the top of the square represent our planets and Sun in the Solar System. The third planet is drawn out to show that is where the message has come from.

<u>Talking to Aliens</u>

STUDENT WORKSHEET

Interstellar message:

01010001010110001010
10001100000000000000
00010100000000000100
00000001111111000000
10111010000000011100
00000000101000000000
11011000000000000000
000

1. How many pulses are there?____________________
2. Which 2 prime numbers can be multiplied together to get the number of pulses? ____________________________
3. Decode the message on the squared paper. (you may need to try it twice)

What do you think the message is trying to say?

____

____

____

____

____

____

Contact: In Literature and Film

The Next Best Thing to Actually Having Them Here!

Books

Contact, Carl Sagan (1985) Simon and Schuster. Written by the very popular and late astronomer who played a lead role in the Mariner, Viking and Voyager Missions. Sagan was also the author of the book and TV series *Cosmos*. His look at the astronomy and politics involved in the search for extraterrestrial life was made into a very successful film.

The UFO Experience: A Scientific Inquiry, (1974) Allen Hynek. This is an intelligent overview of the history and characteristics of UFO phenomena by a very respected astronomer. The book provided the title for the film *Close Encounters of the Third Kind.*

The Black Cloud, Fred Hoyle with John Elliot (1957) and *A for Andromeda*, Fred Hoyle with John Elliot (1962). These two science fiction novels imaginatively explore the potential effects of future contacts with extraterrestrial intelligences. Sir Fred Hoyle is a distinguished astronomer whose science fiction emphasises the science part of science fiction. These books may be difficult to find.

Films

Contact, (1997) Warner Bros. A young radio astronomer makes a career choice to search for extraterrestrial life among the stars. A message is received with a blueprint for a machine to allow intergalactic travel. She makes the first journey.

ET: The Extraterrestrial, (1982) Universal. This is the story of an alien who is accidentally abandoned on Earth. A young brother and sister try to keep him a secret from their mother, but the government finds him.

Close Encounters of the Third Kind (1977). An electrical line worker has a close encounter with a UFO and feels drawn to an isolated area where he feels something spectacular is about to happen. It does. An alien spacecraft arrives on Earth. The group of gatherers at the site are willingly picked up and taken away.

What Is The Distance To The Nearest Star?

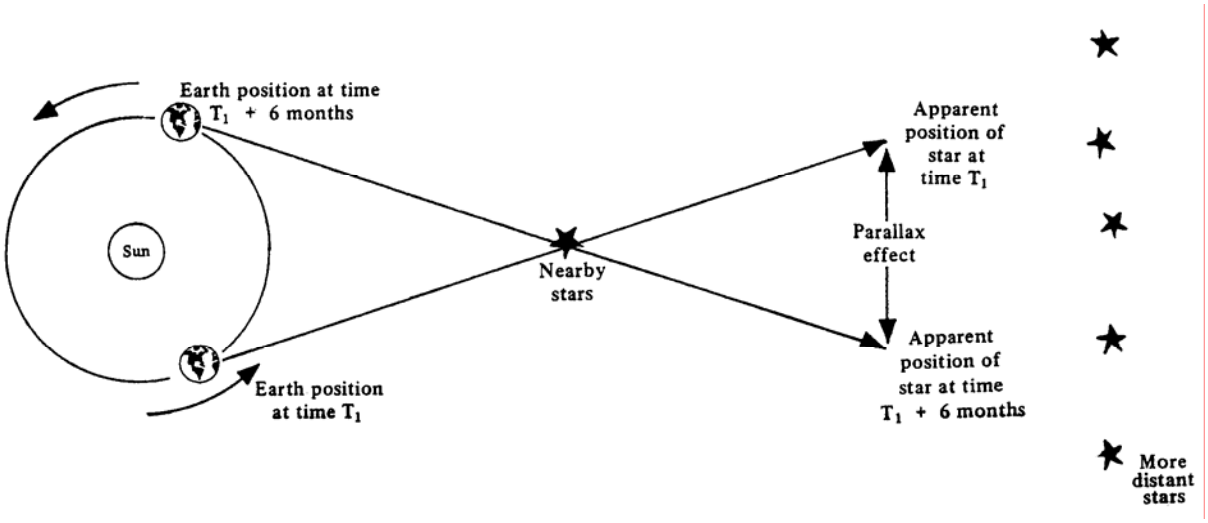
The Sun is 150 million kilometres or 8 light-minutes away.
It was a trick question.

The distance to stars farther than the Sun was a concern to astronomers since the beginning of astronomy. It was the piece of information needed to set the scale of the Universe. Many methods are used today, but they all depend on the method used to find the first star distance. This method is called **parallax**.

Parallax is easy to understand. Shut one eye; hold your thumb a few centimetres from your open eye and put your thumb in front of a distant object. Hold your thumb still and wink your eyes back and forth. The jumping back and forth of your thumb is a parallax shift.

Now repeat what you just did, but this time with your thumb held out at arm's length. The farther your thumb, the smaller the parallax you will see. In this activity your two eyes represent the Earth on opposite sides of the Sun. Your nose is the Sun, and your thumb and the distant object are stars.

The nearby stars should do this as the Earth revolves around the Sun. If the angle of the shift is known, the distance to the star can be calculated. The problem was measuring what turned out to be an extremely small angle.

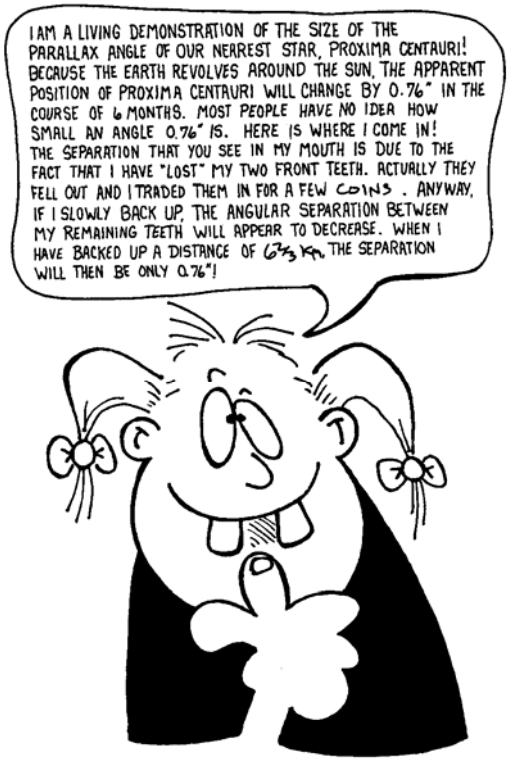


The first star beyond the Sun to have its distance measured is called **61 Cygni**. It's a very faint star in the constellation **Cygnus the Swan**. In 1838 its parallax angle was measured to be as small as the apparent size of a football from a seat 1000 kilometres away from the game. This is a very small angle. What would you expect from a star 110 trillion kilometres away?

The closest star to Earth is the fourth brightest star in the sky, **Alpha Centauri.** It's only 43 trillion kilometres away in the constellation **Centaurus the Centaur**. Well, actually this isn't true because, while Alpha Centauri looks like a single star, it is a three star system when seen through a telescope. The red dwarf star of the system is called **Proxima Centauri** because it is 1.6 trillion kilometres closer to Earth than the other two stars. Its name means "closest of Centauri."

The numbers to even the nearest stars are too large for convenience. The numbers are simply too big. The distances to the stars therefore required the invention of a new unit of measure. It's called the **light-year**. It gives distances in terms of time and the speed of light. The light-year is the distance light travels in one year, at the rate of 300 000 kilometres per second, which is about 10 trillion kilometres.

Using parallax angles measured from Earth observatories, astronomers have calculated the distances to some 2 000 of the nearest stars. **Hipparcos (HI**gh **P**recision **PAR**allax **CO**llecting **S**atellite**)** launched by the **European Space Agency (ESA)** in 1989 has measured 118 000 parallax angles. It could measure much smaller angles because the images of stars aren't blurred above the Earth's atmosphere. What a difference the Space Age has made.



Parallax Activity

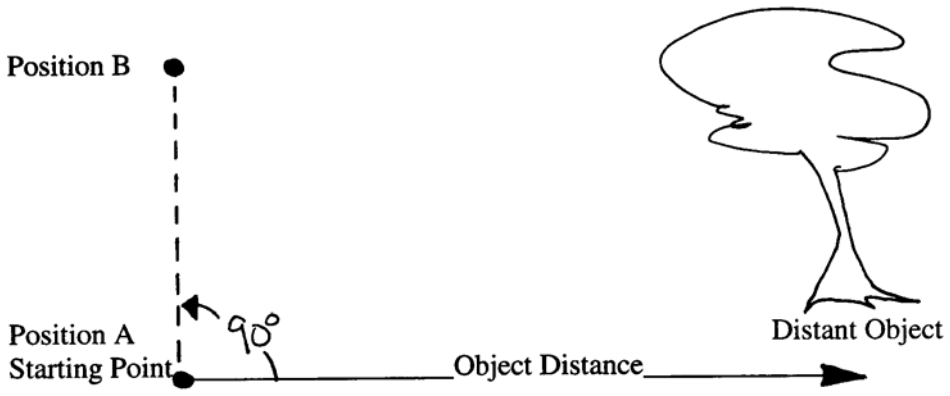
The parallax method can also be used to determine the distance of objects on the surface of the Earth. The same principles and the same problems are involved. However the time needed to make the two necessary observations is much shorter.

Parallax Method
STUDENT WORKSHEET

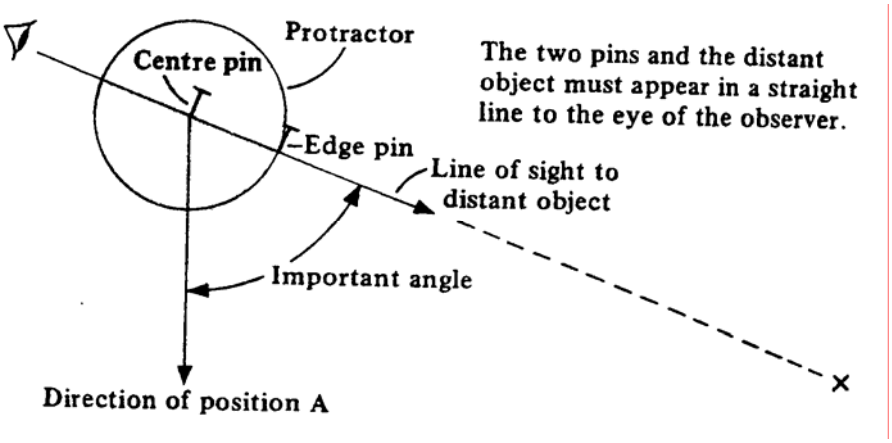
Find an open area with an unobstructed view of a stationary distant object such as a thin tree, flagpole or signpost. A sports ground is an excellent area to perform this activity. You will need:

a. a good protractor
b. some straight pins
c. a board of soft wood or a piece of thick cardboard
d. a metre stick
e. a long length of string.

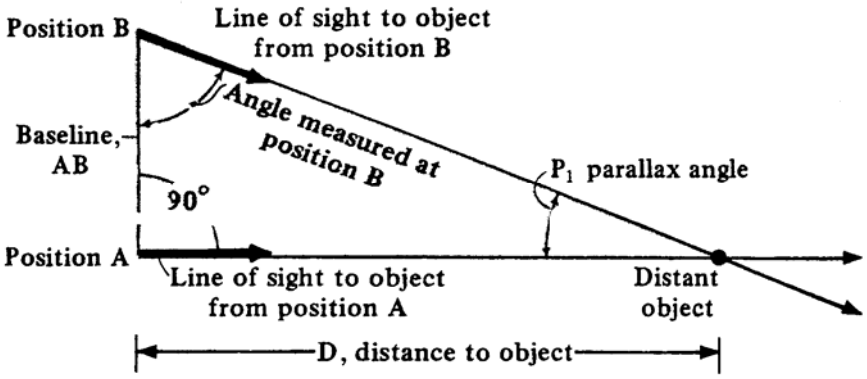
1. Mark a position on the ground as the starting point (A) of your baseline. The base line is the straight-line distance between your two points of observation (A, B). Place a stick in the ground or visibly identify the position of A in some other way.
2. From position A, establish a baseline at a right angle to the direction of the distant object and mark position B in some way. It is important that this 90º angle be as exact as possible. The larger the baseline established, the larger the parallax angle that will be measured. The baseline however should never become a significant portion of the distance to the object. You should be constructing a long thin triangle.



3. Line up your protractor at position B so that the 0º mark is in the direction of position A. The protractor should be attached to the thick cardboard or wooden board and placed on a horizontal surface. Place one straight pin in the exact centre of the protractor and another straight pin at the edge of the protractor between the first pin and the distant object.



4. Very carefully measure the angle between the direction of position A and the direction of the distant object *as accurately as possible*. The angle will be less than 90º. This angular measurement is most important.
5. A triangle has three angles that add up to 180º. At position A the angle is 90º. This means that the angle measured at position B and the parallax angle must add up to 90º.



6. Draw a scaled version of your big triangle using the same angles that were measured in the activity. Measure the baseline on the similar triangle and the distance to the object on the similar triangle. The following ratio applies.

$$\frac{\textit{Object Distance}}{\text{Measured Baseline}} = \frac{\textit{Similar Triangle Distance to Object}}{\text{Similar Triangle Baseline}}$$

7. The distance to the object can now be calculated.

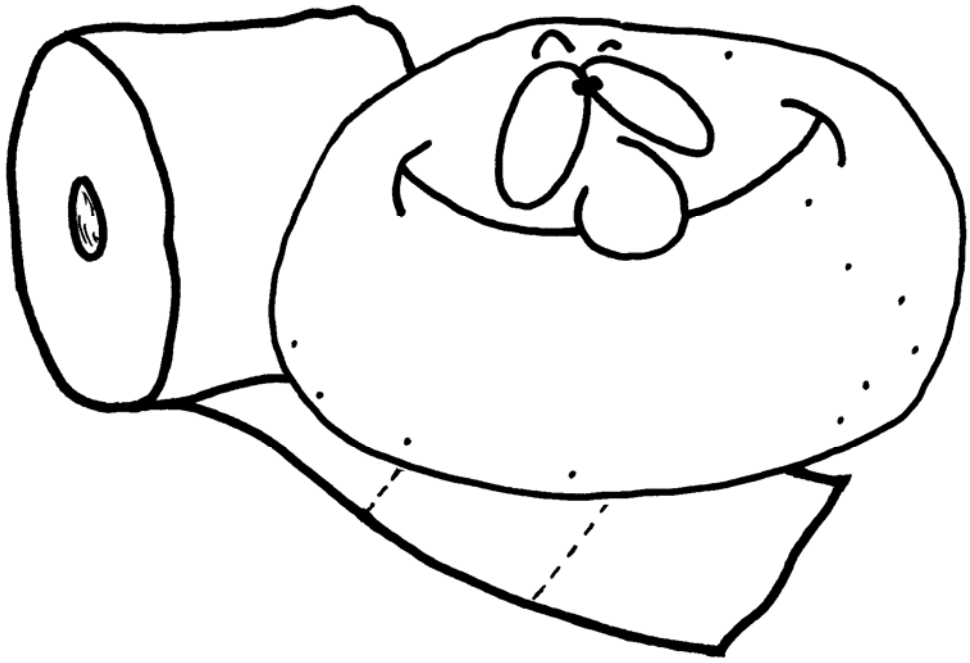
$$\text{True Distance} = \frac{\text{Measured Baseline} \times \text{Similar Triangle Distance}}{\text{Similar Triangle Baseline}}$$

8. How close was your calculation to the actual distance measured? Calculate the percentage of error between the calculated and measured distances. What could have caused the error?

$$\text{Percentage of Error} = \frac{\text{Measured Distance} - \text{Calculated Distance}}{\text{Measured Distance}} \times 100$$

Data Table:

Measured angle at position B (less than 90^o)	
Parallax angle, P_1, (90^o - angle at position B)	
Length of baseline	
Calculated distance of object	
Measured distance to object:	
Percentage of Error	



How many pieces of toilet paper do you need to get from the Sun to the nearest star?

You didn't even try to guess! If our Sun were reduced to the size of a decent grapefruit, then one sheet of toilet paper would represent a distance of one million kilometres. The nearest star is Proxima Centauri, 38 000 million billion kilometres distant from our Sun. To visualize this distance, you would need 122 185 rolls of toilet paper. Stacked one upon the other, the rolls would reach a height of 2.7 kilometres. Rolled out end to end, the sheets would span a distance of 2776 kilometres, the distance from the Space Centre to Moscow. And at the end of the sheets would be a small grapefruit, the star Proxima Centauri. The Sun would only be 150 sheets away from Earth.

Is Time Travel Through Space Possible?

Yes, but only at the speed of light.

H.G. Wells promoted the possibilities of time travel in his 1895 science fiction classic, *The Time Machine*. Since that time, millions of readers and cinema fans have sat in imaginary time machines of one kind or another, and moved *Back to the Future*, or "to boldly go where no one has gone before."

At the end of the novel, at the end of the film, science fantasy returns to reality. Imaginations are placed in storage until the next time. But they need not be, for the night sky is a true time machine. Without the expenditure of rocket fuel, you can travel back in time.

To use this time machine you only need to know that light takes time to move information from one place to another. Light travels at a speed of 300 000 kilometres per second. The distance it travels in one year, 10 trillion kilometres, is called a **light-year.**

If the Sun exploded right now we wouldn't know about it for 8 minutes.
The Sun is 150 million kilometres away and it takes light 8 minutes to make the journey. We always see the Sun as it was and where it was 8 minutes ago.

The farthest object we can see in our night sky with just our eyes is the Andromeda galaxy. It lies over 2 million light-years beyond our Milky Way galaxy. We don't see the **Andromeda galaxy** now; we see it as it appeared over 2 million years ago.

The **Hubble Space Telescope** has allowed us to see the farthest back in time. In 1995 the Hubble Space Telescope allowed us to see galaxies 11 billion years back in time. Light left these galaxies long before most of the stars we see in our night sky existed and certainly before the formation of the Earth, the Sun and the rest of the Solar System.

One of the goals of space exploration is to see the creation of the Universe out of the **Big Bang** some 12 to 15 billion years ago.

Some astronomers have proposed that space-time tunnels called **wormholes** may be at the bottom of a **black hole**. Suppose we survive the fall into a black hole. Then maybe we could use these black holes and space-time tunnels as time machines to journey forward or backward in time. We could journey to other parts of our Universe, and maybe to other unknown universes. What would it be like to suddenly appear sometime in the future or sometime in the past? How exciting! But is it possible?

Professor Stephen Hawking of Cambridge University, and an authority on black holes, says, "*I am sorry to disappoint prospective galactic tourists, but this scenario doesn't work. If you jump into a black hole, you will get torn apart and crushed out of existence."* Well, you still have the night sky.

Teacher Information

National Space Centre Exhibition Links

Exhibition Trail – "Can you be an Alien?"
The Planets – Earth, Mars and Voyager areas
Exploring the Universe – Rules and scales, Talking to Aliens, Black holes
Into Space – Space Travel / Worm holes
Space Theatre Show – BIG!

National Curriculum Links

Key Stage 3

En2 1,5,8,9
PSHE 3a,b
Ma2 1; 2a,b; 5d,e,f
Ma3 1; 2a-d; 4a-e
Sc1 1; Sc4 3a; 4e

Key Stage 4

En2 1,5,8,9
Foundation Ma2 1; 2a,b;4;5ef ; Ma3 1;2a-d;4a-e
Higher Ma2 1;2a,b;4;5e,f; Ma3 1;2a,b;4a-c
(single)Sc1 1; Sc4 2e; 3a,e
(double)Sc1 1; Sc4 3c,e,f; 4a,e