The challenges of 2012

Why did not the end of the world come?

Beginning

Almost everyone has heard about the famous prediction about the end of the world in 2012. A lot of movies have been made and some even likely present the anticipated apocalypse and scare the people.

So, 2012 has already passed, but nothing special happened! Anyway we went to the 5 most popular end of the world hypothesis, connected with the astronomy:

- Geomagnetic Reversal
- Killer solar flares
- Cosmic impacts
- The mysterious Planet X
- Special galactic or planetary alignments

We also created a Solar System simulator.

Sleep peacefully, the end of the world was postponed at least for last year… but it still can be in 2014, 2015… Until 2020 at least 10 more ends of the world are planned.
You decide which one you are going to prepare yourself for! ☺)

More information about the Maya people

The Maya is a Mesoamerican civilization, that noted for its architecture, mathematical and astronomical systems. Their ancient Long Count Calendar starts at 3114 BC and measures the time in nearly 394-year periods, called baktuns. The most important number in the Maya mythology is 13 and exactly the 13-th baktun from its calendar ends at 21 Dec 2012.

The expectations about the end of the world intensified after the discovery of Monument six (a T-shaped stone carving) in 1960s in Mexico. It was marked that the end of the era would end up with a tremendous event. However, the end of the text could not be read because of erosion and cracks in the stone. According to a group of scientists there are writings, that include dates after 2012 (in one of them even 4772 is mentioned).

The Maya of today state that the interpretation of the writings is not according to the Maya mythology, but according to the Christian ideology. They explain that on 21 Dec 2012 ends only an important period for the Maya people. David Stewart also said that this date was only a special creation anniversary and Maya had never noted that 21.12.2012 was the end of the world. They had never mentioned that something terrifying was going to happen, they had just pointed out the future Monument Six's anniversary.

To sum up, nothing in the Maya's calendar, which started the whole story about 21 Dec 2012 from, forebodes apocalypse. Anyway we are going to the 5 most popular end of the world hypothesis, connected with the astronomy.

Geomagnetic Reversal

What is geomagnetic field and where it comes from?

Earth's magnetic field (also known as the *geomagnetic field*) is the magnetic field that extends from the Earth's inner core to where it meets the solar wind, a stream of energetic particles emanating from the Sun. Its magnitude at the Earth's surface ranges from 25 to 65 microteslas (0.25 to 0.65 gauss). It is approximately the field of a magnetic dipole tilted at an angle of 11 degrees with respect to the rotational axis—as if there were a bar magnet placed at that angle at the center of the Earth. However, unlike the field of a bar magnet, Earth's field changes over time because it is generated by the motion of molten iron alloys in the Earth's outer core (the geodynamo).

Elements

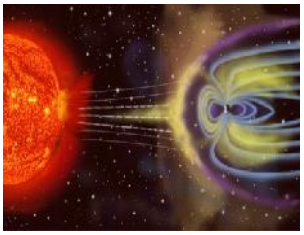
The values of the different elements of the geomagnetic field are constantly changing by place and time. Depending on the period, for which variations of a certain element are examined, there are three kinds of variations – for a day, a year or a century. Therefore when a geomagnetic map for one of the elements of the field is made, the values of all the map's points should be for a certain moment, called era.

Natural motion

The geomagnetic field measured at any point on the Earth's surface is a combination of several magnetic fields generated by various sources. These fields are superimposed on and interact with each other. More than 90% of the field measured is generated INTERNAL to the planet in the Earth's outer core. This portion of the geomagnetic field is often referred to as the Main Field. The Main Field varies slowly in time. The differential flow of ions and electrons inside the magnetosphere and in the ionosphere form current systems, which cause variations in the intensity of the Earth's magnetic field. These EXTERNAL currents in the ionized upper atmosphere and magnetosphere vary on a much shorter time scale than the INTERNAL Main Field and may create magnetic fields as large as 10% of the Main Field.

Magnetic anomalies are divided into continental, regional, and local, according to the size of the territory they cover. Continental anomalies spread over areas of 10,000-100,000 sq km. The normal field for them is the field of a uniformly magnetized sphere (a dipole field). According to current ideas, they are associated with characteristics of the movement of matter in the core of the earth (that is, they are part of the main geomagnetic field). The largest continental magnetic anomalies are in East Siberia and in the Sunda Islands.

Regional magnetic anomalies, which cover areas of 1,000-10,000 sq km, are caused by characteristics of the structure of the earth's crust (primarily the crystalline foundation) and stand out against the background of the main geomagnetic field (dipole field + continental magnetic anomaly). They are known on the Siberian and East European platforms.



Local magnetic anomalies cover areas from a few square meters to hundreds of square kilometers. They are caused by irregularities in the structure of the upper parts of the earth's crust or characteristics of magnetized rock (for example, as a result of a lightning strike). Local anomalies are often associated with mineral deposits; therefore, their study by means of magnetic prospecting is of great practical importance.

The geomagnetic field has a regular small variation with a fundamental period of 24 hours. This variation is easiest to observe during periods of low solar activity when large irregular disturbances are less frequent. As well as the regular daily variation the Earth's magnetic field also exhibits irregular disturbances, and when these are large they are called magnetic storms. These disturbances are caused by interaction of the solar wind, and disturbances therein, with the Earth's magnetic field.

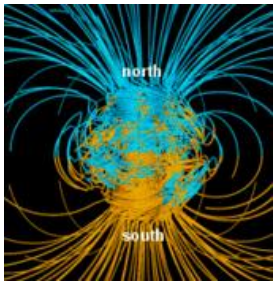
Geomagnetic reversal

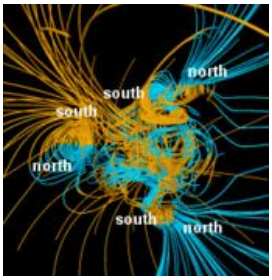
Reversals are the rule, not the exception. Earth has settled in the last 20 million years into a pattern of a pole reversal about every 200,000 to 300,000 years, although it has been more than twice that long since the last reversal. A reversal happens over hundreds or thousands of years, and it is not exactly a clean back flip. There is not any evidence for relation with the sun activity.

Sediment cores taken from deep ocean floors can tell scientists about magnetic polarity shifts, providing a direct link between magnetic field activity and the fossil record. The last time that Earth's poles flipped in a major reversal was about 780,000 years ago. The fossil record shows no drastic changes in plant or animal life. Deep ocean sediment cores from this period also indicate no changes in glacial activity, based on the amount of oxygen isotopes in the cores. This is also proof that a polarity reversal would not affect the rotation axis of Earth, as the planet's rotation axis tilt has a significant effect on climate and glaciation and any change would be evident in the glacial record.

Scientists have long known that the magnetic pole moves. James Ross located the pole for the first time in 1831 after an exhausting arctic journey during which his ship got stuck in the ice for four years. No one returned until the next century. In 1904 Roald Amundsen found the pole again and discovered that it had moved - at least 50 km since the days of Ross. The pole kept going during the 20th century, north at an average speed of 10 km per year, lately accelerating "to 40 km per year," says Newitt. Magnetic field has weakened with 10% for last two centuries, but scientists explain this fact with its constant changes.

Reversals take a few thousand years to complete, and during that time - contrary to popular belief - the magnetic field does not vanish. "It just gets more complicated," says Glatzmaier. Magnetic lines of force near Earth's surface become twisted and tangled, and magnetic poles pop up in unaccustomed places. Weird. But it's still a planetary magnetic field, and it still protects us from space radiation and solar storms.





Human beings have been on the Earth for a number of million years, during which there have been many reversals, and there is no obvious correlation between human development and reversals. Similarly, reversal patterns do not match patterns in species extinction during geological history.

Some animals, such as pigeons and whales, may use the Earth's magnetic field for direction finding. Assuming that a reversal takes a number of thousand years, that is, over many generations of each species, each animal may well adapt to the changing magnetic environment, or develop different methods of navigation. Therefore we can conclude that geomagnetic reversal does not have a negative effect on animate nature.

To sum up, there was not any scientific evidence that a geomagnetic reversal was going to occur on 21.12.2012. Simply because the magnetic field of the Earth was weakening did not mean it was near collapse. The magnetic poles are not set in geographical locations, they move (at varying speeds) and have done ever since measurements began. But even when it happens, this reversal is not likely to have a disastrous effect on life on Earth.

Killer solar flares

Solar activity

It was claimed that in 2012 there would be higher solar activity along with powerful coronal mass ejections, which would rise dramatically temperature on Earth and would be so harmful, that they would cause the end of the world.

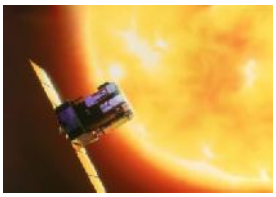
Solar activity is the aggregate of phenomena observed on the sun and associated, for example, with the formation of sun-spots, faculae, flocculi, filaments, and prominences, with the occurrence of solar flares and disturbances in the solar corona, and with an increase in ultraviolet, X- , and corpuscular radiation.

Earth's protection

Sunspots, temporary disturbances in the Sun's photosphere, are the most visible advertisement of the solar magnetic field. They appear dark because temperatures are considerably lower than in surrounding areas. Sunspots occur where the magnetic field lines emerge from the inside of the Sun to form expanding loops above its surface. Coronal mass ejections are the sudden release of large masses of plasma from the very hot corona, which is the atmosphere just above the surface of the sun. Most ejections originate from active regions on Sun's surface, such as groupings of sunspots associated with frequent flares.CMEs expand away from the Sun at speeds as high as 4 million miles per hours! Coronal mass ejections are more likely to have a significant effect on our activities than solar flares because they carry more material into a larger volume of interplanetary space, increasing the likelihood that they will interact with the Earth.

The results from the observation of the Sun, made by SOHO and TRACE (USA, Europe) and CORONAS-F satellite show that CME are the main carrier of the solar influence on the Earth, but our planet is protected due to its atmosphere, particularly its ionosphere.

Systems for observation

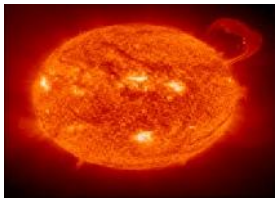


SOHO, the Solar & Heliospheric Observatory, is a project of international collaboration between ESA and NASA to study the Sun from its deep core to the outer corona and the solar wind - a stream of charged particles released from the upper atmosphere of the Sun. SOHO moves around the Sun on the sunward side of Earth. It observes the Sun on a permanent basis from a special orbit situated at 1.5 million km from the Earth.

It is currently the main source of near-real time solar data for space weather prediction. *SOHO's* data about solar activity are used to predict solar flares, so electrical gridsand satellites can be protected from their damaging effects.

Observing the ejection of CMEs from the Sun provides an early warning of geomagnetic storms. Only recently, with SOHO, has it been possible to continuously observe the emission of CMEs from the Sun and determine if they are aimed at the Earth.

Solar activity waxes and wanes according to approximately 11-year cycles. Big flares can indeed damage communications and other Earthly systems, but scientists have no indications the sun, at least in the short term, will unleash storms strong enough to fry the planet. Solar activity is not punctual, and the next solar maximum is predicted to occur in late 2013 or early 2014. It is possible to be even weaker than the previous cycles in the history.



"The slowdown we see now means that Solar Cycle 25, peaking around the year 2022, could be one of the weakest in centuries," says Hathaway. Solar Cycle 24 has been unusual thus far; the latest prediction that it will produce only about half of the sunspots as the previous cycle. If this forecast is realized, it would make Solar Cycle 24 the least active since Solar Cycle 6, which ended in 1823. Recently reported research indicates that several of the precursors of Solar Cycle 25 have not yet begun. This, combined with the diminished current cycle, is causing some solar physicists to speculate that the next cycle may be further reduced, or even stranger, to not occur at all.

<u>Cosmic impacts</u>

One of the hypotheses for the end of the world in 2012 was that a giant cosmic body would hit the Earth and bring about Apocalypse.

Asteroids

They are found at the beginning of the last century. Nowadays, approximately 300 000 asteroids have been found and the orbits of 100 000 are known. Asteroids are a class of small Solar System bodies with irregular shape in orbit around the Sun. Their orbits are elliptical. Asteroids' diameter varies from 1 to 80km, but there are bigger ones: Ceres – 770km; Vesta - 380km; Juno – 190km. A large majority of known asteroids orbit in the asteroid belt between the orbits of Mars and Jupiter or co-orbital with Jupiter (the Jupiter Trojans). It is supposed that they used to be part of a disintegrated planet.

Comets

Comets are also called "hairy stars" and orbit the Sun.

Comets have a wide range of orbital periods, ranging from a few years to hundreds of thousands of years. When they are near the Sun and active, comets have several distinct parts: nucleus, coma and tail. Short-period comets need roughly 200 years or less to complete one orbit, long-period comets take more than 200 years. Scientists think short-period comets, also known as periodic comets, originate from a disk-shaped band of icy objects known as the Kuiper belt beyond Neptune's orbit, with gravitational interactions with the outer planets dragging these bodies inward, where they become active comets. Long-period comets are thought to come from the nearly spherical Oort cloud even further out, which get slung inward by the gravitational pull of passing stars. Rare hyperbolic comets pass once through the inner Solar System before being thrown out into interstellar space along hyperbolic trajectories

It is a well-known fact that our planet has been stricken by large celestial bodies (some scientists even believe that such a collision caused the dinosaurs' extinction) and undoubtedly such impacts are liable to occur in the uncertain future, but there was not any scientifically proven information for such an event, had been expected on 21.12.2012.

Different systems for observation of asteroids and comets in our Solar System makes possible for us to observe objects, coming near to the Earth, many years before it reaches dangerously close to our planet. Many of the observed comets are familiar to the scientists, because they have been observed more than once in the mankind's history.

More attention has been paid to identification of asteroids, which orbit crosses the Earth' one and are probable to strike the Earth in the future.

All these considerations helped spur the launch of highly efficient automated systems that consist of Charge-Coupled Device (CCD) cameras and computers directly connected to telescopes. A large majority of the asteroids have been discovered by such automated systems. Now NASA explores objects, which size is over 700m, but in future it attends to card-index all bodies, which size is over 70m. A list of teams using such automated systems includes:

- The Lincoln Near-Earth Asteroid Research (LINEAR) team
- The Near-Earth Asteroid Tracking (NEAT) team
- Spacewatch
- The Lowell Observatory Near-Earth-Object Search (LONEOS) team
- The Catalina Sky Survey (CSS)
- The Campo Imperatore Near-Earth Objects Survey (CINEOS) team
- The Japanese Spaceguard Association
- The Asiago-DLR Asteroid Survey (ADAS)

One of the asteroids, that have passed closest to the Earth, is Hermes. It passed the Earth at 0.005 AU in 1937. The asteroid that is expected to pass close to the Earth in the nearest future is Apophis. When it was discovered in 2004, astronomers calculated that there was a very small probability (up to 2.7%) that it would strike the Earth in 2029. That was clearly unsettling, but the concern was short-lived. The 2029 impact possibility was quickly ruled out, but, almost as quickly, another possibility reared its head: a possible impact in 2036. For a time, astronomers thought there was a 1-in-45,000 chance that Apophis would strike Earth on April 13, 2036. Then, in October 2009, the numbers were updated again, and the impact possibility decreased again. Currently, the chance of an impact with Earth by asteroid Apophis in 2036 has dropped to about 1-in-233,000. If a struck really happens, the comparatively small size of Apophis (210-330 meter), it will cause not global, but local catastrophe.

Small pieces of older, disintegrated comets and asteroids enter Earth's atmosphere all the time, but they do not have a harmful effect on the life on the planet. Most burn up in the upper atmosphere, occasionally, larger ones make it through the atmosphere intact and strike the ground.

Meteors (falling stars) are small cosmic bodies, usually pieces of comets. They enter the Earth's atmosphere from space and burn, because of the friction and the heating. The bright meteors are called bolides or fireballs. It is found that for 24 hours the Earth meets over 10 millions meteors, which mass varies from 15 to 4600mg.

Meteorites are meteoroids, fallen to the Earth. A very large number of meteoroids enter the Earth's atmosphere each day amounting to five hundred tons of material. Meteorites fall often to the Earth's surface – over 10 000 per year, but most of them are vanishing without leaving a trace, because they fall in seas, oceans, deserts, mountains or in other difficult to access places. A meteorite's size can range from small to extremely large. (Hoba – the largest known meteorite is over 100tons.) The falling of the Bogusavka Meteorite in 1916 in Russia was seen by people. Large meteoroids may strike the ground, leaving behind an impact crater. The kind of crater will depend on the size, composition, degree of fragmentation, and incoming angle of the impactor. There are a lot of craters in the USA, Russia, Argentina and Australia. The biggest know n impact crater is the Barringer Crater (also known as the Canyon Diablo Crater) in Arizona, USA. It is about 1,200 m (4,000 ft) in diameter and some 170 m deep (570 ft).

In conclusion, our planet meets every day tens of thousands small bodies, that could not have a harmful effect on the life on the Earth. The bigger ones, such as comets and asteroids, are observed by special systems, which can predict potential treats and their passing close to our planets in the future.

The mysterious planet X

Planet X

"Planet X" is an oxymoron when applied to a real object. The term has been used by astronomers over the past century for a possible or suspected object. Once the object is found, it is given a real name, as was done with Pluto and Eris, both of which were at some time referred to as Planet X.

Pluto

In 1843, John Couch Adams (a British mathematician and astronomer) studied the orbital perturbations of Uranus and deduced that through gravitational interactions, there must be an eighth planet, tugging at the gas giant. This led to the discovery of Neptune, orbiting at a distance of 30AU from the Sun. There have been numerous occasions where this method has been used to deduce the existence of other bodies in the Solar System before they were directly observed.

Neptune was also experiencing orbital perturbations, and on the discovery of Pluto in 1930, it was thought that the aptly named "Planet X" had been discovered. Alas, Pluto's mass was tiny, and once the orbit of Charon (Pluto's moon) was analysed it was found that the mass of the Pluto-Charon system was far too small to affect the orbit of Neptune. The hunt for Planet X continued…

Eris

Eris is one of the dwarf planets, found beyond Pluto's orbit. Like Pluto it is smaller than our Moon. It is far away from us and never gets nearer than 4 million miles. Eris and its orbit are not mysterious at all and you can easily make sure of it in the Internet.

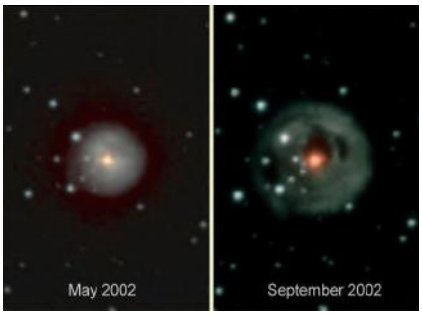
Nibiru

The story started with claims that Nibiru, a supposed planet discovered by the Sumerians, is headed toward Earth. Zecharia Sitchin, who wrote fiction about the ancient Mesopotamian civilization of Sumer, claimed in several books (e.g. "The Twelfth Planet", published in 1976) that he had found and translated Sumerian documents that identify the planet Nibiru, orbiting the Sun every 3600 years. These Sumerian fables include stories of "ancient astronauts" visiting Earth from a civilization of aliens called the Anunnaki. In Babylonian astrology Nibiru is often associated with Marduk. Sitchin's ideas were rejected by scientists and academics, who dismiss his work as pseudoscience and pseudohistory. Sitchin's work has been criticized for flawed methodology and mistranslations of ancient texts as well as for incorrect astronomical and scientific claims.[2]

* **Zecharia Sitchin** (July 11, 1920 – October 9, 2010) was an Azerbaijani-born American author of books proposing an explanation for human origins involving ancient astronauts. Sitchin attributes the creation of the ancient Sumerian culture to the *Anunnaki*, which he states was a race of extraterrestrials from a planet beyond Neptune called *Nibiru*. He believed this hypothetical planet of Nibiru to be in an elongated, elliptical orbit in the Earth's own Solar System, asserting thatSumerian mythology reflects this view.

There are a lot of websites, in which it is claimed that they show photos of the Planet X. Most of these pictures are obviously fake and can be made in Photoshop. The great majority of the photos and videos on the Internet are of some feature near the Sun (apparently supporting the claim that Nibiru has been hiding behind the Sun for the past several years.) These are actually false images of the Sun caused by internal reflections in the lens, often called lens flare. These photos showing something nearly as large and bright as the Sun (a "second sun") are accepted together with claims made on some of the same websites that Nibiru is too faint to be seen or photographed except with large telescopes.

One widely reported telescopic photo shows two views of an expanding gas cloud far beyond the solar system. A sharp-eyed reader of this website identified these photos as a gas shell around the star V838 Mon. NASA has a nice write-up and a beautiful photo of it from Hubble.



Another high school student was initially impressed by posted images of a red blob that were said to be of Nibiru. Then he worked out in his Photoshop class how to make just such pictures starting from scratch.

Observations

IRAS (the NASA Infrared Astronomy Satellite, which carried out a sky survey for 10 months in 1983) discovered many infrared sources, but none of them was Nibiru or Planet X. IRAS cataloged 350,000 infrared sources, and initially many of these sources were unidentified but these "mystery objects" were subsequently found to be distant galaxies

There will always be mysterious Planets X, which we have not got to know yet and play with our imagination, but they are far away from the Earth. We already know, that on 21.12.2012 Planet X did not threaten our planet, but its search will still be so exciting – when we have fond one, there will be another, and one more, and one more… because the Planets X in our Universe are numerous.

Special galactic or planetary alignments

Galactic Alignment

Just like the Earth orbits the Sun, the Sun itself is part of the Milky Way galaxy. It takes about 220 million years for the Sun to complete a single journey around the Milky Way. But the Sun also bobs up and down as it travels in orbit around the center of the galaxy. The oscillation takes a total of 64 million years to complete. And there's a moment when the Sun passes directly through the galactic disk and there's a perfect galactic alignment between the Sun and the center of the galaxy.

There has to be a moment when everything's in perfect alignment, but the timescales are so long that astronomers couldn't calculate it. Of course, this alignment with the center of the galaxy doesn't have an effect on the Earth or the Solar System, it's just like crossing an imaginary line in space,

There's another type of galactic alignment. This is where the Earth, Sun and the center of the galaxy are in perfect alignment from our perspective. This actually happens every year during the winter solstice, on December 21st. Because of a wobble in the Earth's orbit, the positions of the constellations slowly shift from year to year.

Planetary Alignment

First of all, the complete alignment of all the planets in the Solar System is impossible because the planetary orbits are tilted slightly in relation to the orbit of the Earth.

Our calculated probability for an exact planetary alignment to occur is once in 86 billion-trillion-trillion-trillion years! The odds strongly favor that an exact planetary alignment will NEVER occur throughout the entire history of the solar system.(As you can see, since the solar system is only 4.6 x 109 (4.6 billion) years old, and will only be in existence for a grand total of 1010 (10 billion) years).

According to a lot of scientists, since the other planets are far away from Earth, the intensity of the total force they exert on it is very small. Thus, the resultant gravity of other planets caused by planetary alignment (or something similar) does not have greater influence on Earth. While all the planets would exert gravitational force on the Earth, the total amount would be relatively small compared to the Sun. Dr. Phil Plait at Bad Astronomy calculates the force of all the planets' combined gravity on Earth at the moment of alignment as less than 2 percent of the gravitational force of the moon.

The Moon completes one revolution around the earth about once a month. At perigree, the closest the Moon is to the Earth is 363,000 kilometers away, and at apogee, the furthest, the Moon is 403,000 kilometers from Earth. This is a difference of 25 percent and has a more significant impact on gravity and tides than the outer planets. The perigree and apogee occur every two weeks. Therefore every month our planet goes through changes, which has 10 times bigger impact than the outer planets.

Planetary alignment is one of the most often exploited reasons for the end of the world. Periodically messages for special alignment are presented and people, who are not well grounded in the root of the matter, are easily scared, because these are the objects that are situated closest to the Earth. Now we know that even if such an event occurs, it will not have a disastrous effect on the Earth. Planetary alignments of two planets occur relatively often.

A conjunction occurs when two astronomical objects have either the same right ascension or the same ecliptical longitude, normally when observed from the Earth. In the case of two objects that always appear close to the ecliptic – such as two planets, or the Moon and a planet, or the Sun and a planet – this implies an apparent close approach between the objects as seen on the sky. A Great Conjunction is a conjunction of the planets Jupiter and Saturn. It takes place regularly, every 18–20 years. A conjunction of Mercury, Venus, Mars, Jupiter and Saturn occur on average every 57 years. Once every 200 years all planets are visible in the sky at the same time. It is a long period compared to the average human life expectancy, but it is not so long in the Solar System's history.

Our task

Celestial mechanics is the branch of astronomy that deals with the motions of celestial objects. It applies principles of physics, historically classical mechanics, to astronomical objects such as stars and planets to produce ephemeris data. Perturbation theory comprises mathematical methods that are used to find an approximate solution to a problem which cannot be solved exactly. (It is closely related to methods used in numerical analysis, which are ancient.) The earliest use of perturbation theory was to deal with the otherwise unsolveable mathematical problems of celestial mechanics:Newton's solution for the orbit of the Moon, which moves noticeably differently from a simple Keplerian ellipse because of the competing gravitation of the Earth and the Sun.

Perturbation methods start with a simplified form of the original problem, which is carefully chosen to be exactly solvable. In celestial mechanics, this is usually a Keplerian ellipse, which is correct when there are only two gravitating bodies (say, the Earth and the Moon), or a circular orbit, which is only correct in special cases of two-body motion, but is often close enough for practical use.

The solved, but simplified problem is then *"perturbed"* to make its starting conditions closer to the real problem, such as including the gravitational attraction of a third body (the Sun). The slight changes that result, which themselves may have been simplified yet again, are used as corrections. Because of simplifications introduced along every step of the way, the corrections are never perfect, but even one cycle of corrections often provides a remarkably better approximate solution to the real problem.

There is no requirement to stop at only one cycle of corrections. A partially corrected solution can be re-used as the new starting point for yet another cycle of perturbations and corrections. The common difficulty with the method is that usually the corrections progressively make the new solutions very much more complicated, so each cycle is much more difficult to manage than the previous cycle of corrections. Newton is reported to have said, regarding the problem of the Moon's orbit *"It causeth my head to ache."*[16]

This general procedure – starting with a simplified problem and gradually adding corrections that make the starting point of the corrected problem closer to the real situation – is a widely used mathematical tool in advanced sciences and engineering. It is the natural extension of the "guess, check, and fix" method used anciently with numbers.

A main characteristic of planets' motion is that it is close to an elliptic orbit motion without external impact. This is true because of the fact that the mass of the Sun is much bigger than the mass of all the other bodies considered together, so every planet is pulled up by the Sun much stronger than by any other celestial body. The main force, that rules the motion of the bodies in the Solar system, is the gravitation of the Sun. The impact of the interaction of the planets is much weaker compared to it, so the planets' orbits are almost elliptical with small diversion.

Defining a position of a planet along an elliptical orbit

There are three angular parameters ("anomalies") that define a position along an orbit – mean anomaly, eccentric anomaly and true anomaly

Mean anomaly is a parameter relating position and time for a body moving in a Kepler orbit. The mean anomaly increases uniformly from 0 to 2π radians during each orbit. However, it is not an angle.

Kepler used his two first laws to compute the position of a planet as a function of time. The procedure for calculating the heliocentric polar coordinates (*r*,*θ*) of a planet as a function of the time *t* since perihelion, and the mean motion $n = 2\pi/P$, is the following four steps:

1. Compute the **mean anomaly**

$$M = nt$$

Eccentric anomaly is an angular parameter that defines the position of a body that is moving along an elliptic Kepler orbit.

2. Compute the **eccentric anomaly** *E* by solving Kepler's equation:

$$M = E - \varepsilon \cdot \sin E$$

True anomaly is an angular parameter that defines the position of a body moving along a Keplerian orbit. It is the angle between the direction of periapsis and the current position of the body, as seen from the main focus of the ellipse (the point around which the object orbits).

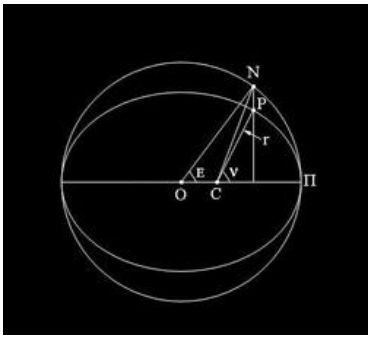
The true anomaly is usually denoted by the Greek letters ν or θ, or the Latin letter f.

3. Compute the **true anomaly** *θ* by the equation:

$$\tan\frac{\theta}{2} = \sqrt{\frac{1+\varepsilon}{1-\varepsilon}} \cdot \tan\frac{E}{2}$$

4. Graphic

This is only the case when the orbit is a circle, but we did our calculations without taking in consideration planets' interaction and orbits' elliptical form.



Our task

1. We situated our Solar system in a frame of reference. The center of the frame reference with co-ordinates (0; 0) is the Sun. In order to realize our simulator, we accepted that the Solar system planets move uniformly along circular orbits.

2. Using NASA's simulator we determined the dates, on which the positive x-axis crossed the orbits of Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus and Neptune. This date serves as a basic date for the corresponding planet (all the planets have different dates) and we calculate the moving of the planet in comparison with it.

3. Using the period of a complete rotation of a planet around the Sun, the program calculates how many degrees it moves away for a day.

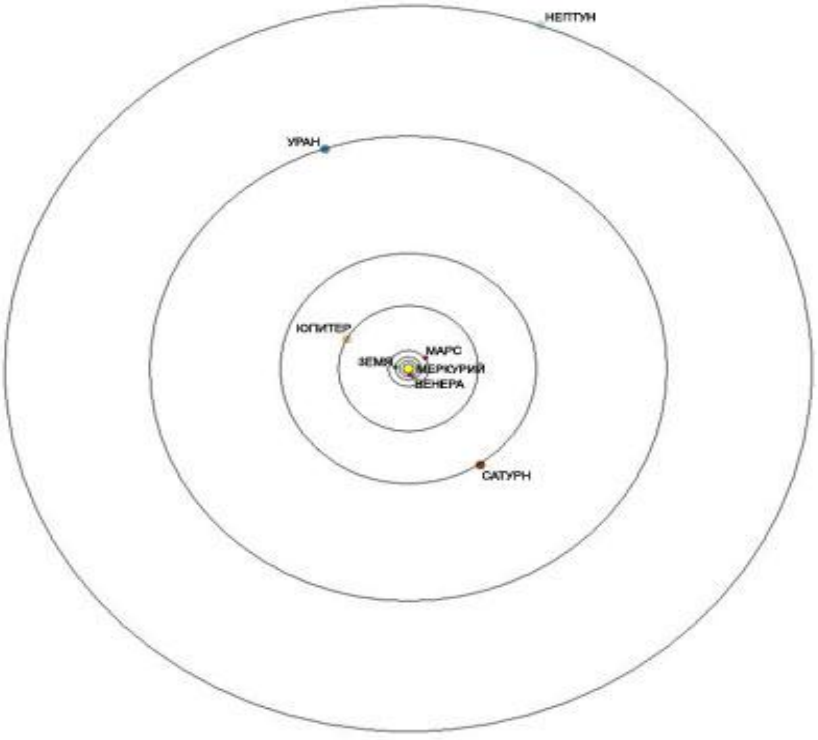
4. It calculates the period T (in days) between the basic date and 21.12.2012

5. It calculates the angle of the moving for the time T by subtracting the complete rotations.

6. The point, where the planet is on 21.12.2012, has co-ordinates (X1; Y1). The program calculates their values, using the functions cos and sin and the planet's mean distance from the Sun.

7. The program draws a graphic of the planets' location on 21.12.2012

This is the graphic and you can compare it with the graphic in NASA's website for the planets' location on 21.12.2012. (http://space.jpl.nasa.gov/) There are relatively small deviations, but the graphic serves as a sketchily representation of the 8 planets' location in comparison to the Sun. Obviously on 21.12.2012 there was not any special alignment of the Solar system planets.



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