

Grki

Geometrijska predstava o Zemlji, Luni in Soncu.

Heliocentrični (Aristarh) pogled.

**Geocentrični (Aristotel) pogled
utemeljen na „izkušnji“, da se Zemlja ne
vrti z veliko hitrostjo.**

Mikolaj Kopernik (1473-1543)

- Leta 1514: *Commentariolus*
- Leta 1543 izdan *De Revolutionibus Orbium Celestium Libri VI.*
- Heliocentrični pogled: vsa telesa razen Lune krožijo okrog Sonca.
- Krožni tiri.
- Logična razlaga notranjih/zunanjih planetov, ni pa izboljšave podrobnih napovedi gibanja.

Tycho Brahe

Iz Wikipedije, proste enciklopedije

Tycho de Brahe, rojen **Tyge Ottesen Brahe**, danski astronom in astrolog, * 14. december 1546, Knudstrup na Schonenu, Skanija, južna Švedska (tedaj del Danske), † 24. oktober 1601, Praga, Češka.

Življenje in delo

[uredi]

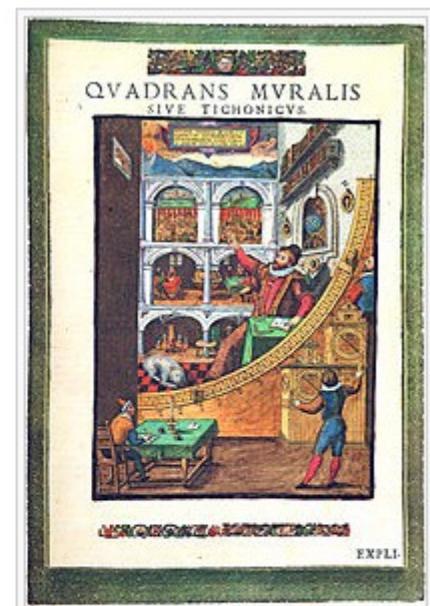
De Brahe je študiral pravo in filozofijo na univerzah v København in Leipzigu. Ponoči je opazoval zvezde. Samo z globusom brez dobrih inštrumentov in z nekaj kompasi je uspel najti precej napak v standardnih astronomskih tabelah. Odločil se je, da jih popravi.

Leta 1572 je odkril supernovo SN 1572 v ozvezdju Kasiopeje in zaslovel. Veliko je potoval in poučeval. Kralj Danske in Norveške Friderik II. je ponudil de Braheju sredstva za izgradnjo in opremo astronomskega observatorija na otoku Hueenu (Hveen) (sedaj Venu). De Brahe je sprejel predlog. Leta 1576 so začeli graditi grad Uranienborg »trdnjavo neba« (»nebesno vas«). Za observatorij je v lastni delavnici izdelal inštrumente. Njegovi pripomočki še niso imeli leč. Zato so morali zaradi točnih merjenj biti veliki. Izdelal je celo kvadrant s premerom 12 m. Na krogu s polmerom 6 m sta 1° ustrezala manj kot 2 mm. Njegov znameniti zidni kvadrant premera 3 m je imel ločljivost že 100" in je botroval Keplerjevim zakonom za gibanje Marsa in ostalih planetov, s tem, da eliptičnega gibanja planetov niti Ulug-beg niti de Brahe še nista zaznala. De Brahe je opravil mnoge meritve v Osončju in premeril je več kot 700 zvezd. Po smrti Friderika II. leta 1588 mu je Friderikov naslednik Kristian IV. odvzel vse prihodke.

Leta 1597 je de Brahe zapustil Dansko in se naselil v Pragi. Observatorij je uničilo vreme, otoški kmetje pa so raznesli ostanke tako, da je leta 1671 Picard na tem mestu našel samo še temelje. Brahe je postal astronom carja Rudolfa II., kateremu je kot astrolog delal horoskope. Rudolf II. mu je podaril pokojnino 3.000 dukatov in posestvo blizu Prage, kjer naj bi zgradil novi Uranienborg, vendar je prej umrl. De Brahe ni nikoli popolnoma sprejel Kopernikove teorije. Zavzemal se je za svojo teorijo. V njegovem sestavu naj bi 5 tedaj znanih planetov krožilo okoli Sonca, ki naj bi skupaj s planeti krožil okoli Zemlje. Krogle zvezd naj bi krožila okoli nepomične Zemlje enkrat na dan. Čeprav je bila njegova teorija napačna, so njegova točna astronomska merjenja po smrti koristila Keplerju za odkritje svojih 3. zakonov gibanja planetov. Kepler, ki je bil de Brahov pomočnik od leta 1600 do Brahove smrti, je izdal njegovo glavno delo *Astronomiae instauratae progymnasmata*. Bil je navdušen nad de Brahovim delom in je zanj dejal, da je mislil v kotnih sekundah.



Tycho de Brahe

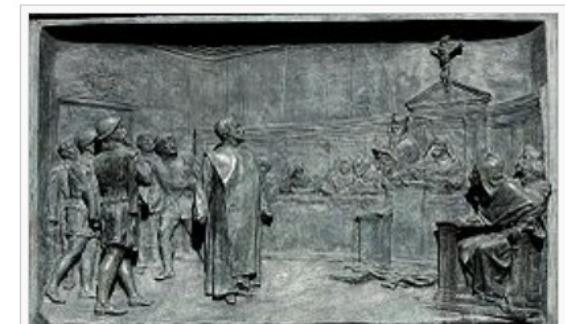


Zidni kvadrant s premerom 3 m (Tycho de Brahe 1598)



Giordano Bruno (1548 – February 17, 1600), (Latin: *Iordanus Brunus Nolanus*) born **Filippo Bruno**, was an Italian Dominican friar, philosopher, mathematician and astronomer. His cosmological theories went beyond the Copernican model in proposing that the Sun was essentially a star, and moreover, that the universe contained an infinite number of inhabited worlds populated by other intelligent beings.^[1] He was burned at the stake by civil authorities in 1600 after the Roman Inquisition found him guilty of heresy for his pantheism and turned him over to the state, which at that time considered heresy illegal. After his death he gained considerable fame, particularly among 19th- and early 20th-century commentators who, focusing on his astronomical beliefs, regarded him as a martyr for free thought and modern scientific ideas.

Some assessments suggest that Bruno's ideas about the universe played a smaller role in his trial than his pantheist beliefs, which differed from the interpretations and scope of God held by the Catholic Church.^{[2][3]} In addition to his cosmological writings, Bruno also wrote extensively on the art of memory, a loosely organized group of mnemonic techniques and principles. The pioneering work of Frances Yates, especially influential in anglophone scholarship, argues that Bruno was deeply influenced by the astronomical facts of the universe inherited from Arab astrology, Neoplatonism and Renaissance Hermeticism.^[4] Other recent studies of Bruno have focused on his qualitative approach to mathematics and his application of the spatial paradigms of geometry to language.^[5]



The trial of Giordano Bruno by the Roman Inquisition. Bronze relief by Ettore Ferrari, Campo de' Fiori, Rome.

In these grim circumstances Bruno continued his Venetian defensive strategy, which consisted in bowing to the Church's dogmatic teachings, while trying to preserve the basis of his philosophy. In particular Bruno held firm to his belief in the plurality of worlds, although he was admonished to abandon it. His trial was overseen by the Inquisitor Cardinal Bellarmine, who demanded a full recantation, which Bruno eventually refused. Instead he appealed in vain to Pope Clement VIII, hoping to save his life through a partial recantation. The Pope expressed himself in favor of a guilty verdict, recommending a sentence of death. Consequently, Bruno was declared a heretic, and told he would be handed over to secular authorities. According to the correspondence of one Gaspar Schopp of Breslau, he is said to have made a threatening gesture towards his judges and to have replied:

"Maiori forsan cum timore sententiam in me fertis quam ego accipiam (Perhaps you pronounce this sentence against me with greater fear than I receive it)."^[17] He was quickly turned over to the secular authorities and, on February 17, 1600 in the Campo de' Fiori, a central Roman market square, "his tongue imprisoned because of his wicked words" he was burned at the stake.^[18] His ashes were dumped into the Tiber river. All of Bruno's

works were placed on the *Index Librorum Prohibitorum* in 1603. Inquisition Cardinals who judged Giordano Bruno were: St. Roberto Francesco Romolo Cardinal Bellarmine (Bellarmine), Carlo Gaudenzio Cardinal Madruzzo (Madruzzi), Cardinal Camillo Borghese (later Pope Paul V), Domenico Cardinal Pinelli, Pompeo Cardinal Arrigoni, Paolo Emilio Cardinal Sfondrati, Pedro Cardinal De Deza Manuel, Giulio Antonio Cardinal Santorio (Archbishop of Santa Severina, Cardinal-Bishop of Palestrina).

Late Vatican position

[edit]

In the years since Bruno's execution, the Vatican has published few official statements about the matter. In 1942, Cardinal Mercati, who discovered the lost documents relating to Bruno's trial, stated that the Church was perfectly justified in condemning Bruno. Later, on the 400th anniversary of Bruno's death, Cardinal Angelo Sodano declared Bruno's death to be a "sad episode" but, despite his regret, he defended Bruno's prosecutors, maintaining that the Inquisitors were "motivated by the desire to serve the truth and promote the common good, also doing their utmost to save his life" by trying to convince him to recant and subsequently by appealing the capital punishment with the secular authorities of Rome.^[19]

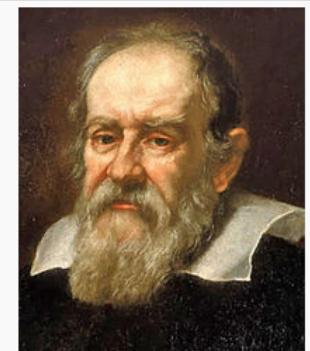
Galileo Galilei

Iz Wikipedije, proste enciklopedije

»Galileo« se preusmerja sem. Za sistem pozicioniranja glej [Galileo \(navigacijski sistem\)](#). Za druge pomene glej [Galileo \(razločitev\)](#).

Galileo Galilei [galileó galilé] (latinsko *Galileo Galilei*), italijanski fizik, matematik, astronom in filozof, * 15. februar 1564, Pisa, Italija, † 8. januar 1642, Arcetri pri Firencah, Italija.

Galileo Galilei



Galileo Galilei, kot ga je upodobil Giusto Sustermans

Vsebina	[skrij]
1 Življenje in delo	
2 Opombe in sklici	
3 Glej tudi	
4 Zunanje povezave	

Življenje in delo

[uredi]

Njegov oče je bil italijanski [skladatelj Vincenzo Galilei](#).

Po končanih medicinskih študijih se je Galileo posvetil raziskovanju [geometrije](#) in [Arhimedovih](#) del in postal eden od največjih fizikov in astronomov. Bil je prvi po Arhimedu, ki je proučeval [naravne pojave](#) s poskusi.

Znan je postal leta 1586, ko je objavil podrobnosti o svojem [izumu, hidrostatični tehnični](#). Podal je [zakone prostega pada, nihala in meta](#). Ovrgel je Aristotelovo prepričanje, ki je bilo še tedaj v veljavi, da različno težka [telesa](#) padajo z različnimi [hitrostmi](#). Proučeval je [gibanje teles](#) in ugotovil [Galilejev zakon](#) ali zakon o vztrajnosti, po katerem telo miruje ali se giblje enakovremeno po premici s stalno hitrostjo, če nanj ne deluje nobena zunanjia sila, kar pravi tudi [1. Newtonov zakon](#), ki ga je [Newton](#) povzel po [Descartesu](#). Descartes ga je postavil zelo splošno, češ da ima vsaka spremembu svoj vzrok. Galilei pri tem ni imel zaslug. Ugotovili so, da je Newton sicer prebral [angleški](#) prevod Galilejevega [Pogovora](#), nič pa ne kaže, da bi poznal Govore. Nekateri menijo, da je zakon nepotreben, ker sledi iz 2. Newtonovega zakona.

Leta 1592 je postal profesor matematike na [Univerzi v Padovi](#), kjer je tudi dosegel večino pomembnih odkritij. Leta 1604 je dokazal, da se hitrost prosto padajočih teles enakovremeno veča s časom ter pojasnil in matematično opisal gibanje izstrelkov po [parabol](#). Podal je [Galilejevo transformacijo](#), ki prevede opis kakega pojava v danem inercialnem ali nepospešenem opazovalnem sistemu v opis tega pojava v drugem nepospešenem opazovalnem sistemu, gibajočem se glede na prvega.

Leta 1609 je prikazal izum [daljnogleda](#) na vrhu zvonika sv. Marka v [Benetkah](#). Sestavil je svoj Galilejev ali nizozemski daljnogled in ga kot prvi uporabil za astronomska opazovanja. Daljnogled ima za [objektiv](#) zbiralno lečo in za [okular](#) razpršilno lečo s kratko goriščno razdaljo. Daje pokončno sliko. Daljnogled je razmeroma kratek in vidno polje je majhno. Uporabljal ga je še kot operno kukalo. Daljnogled je leta 1608 verjetno iznašel [Lippershey](#) na [Nizozemskem](#). Morda so v Španiji poznali daljnogled že nekaj deset let prej, a so ga zaradi izrednega pomena za plovbo ohranili v tajnosti. Z daljnogledom je Galilei odkril, da [Rimska cesta](#) razпадa v ogromno število [zvezd](#) slabega sijaja in tako ovrgel številne legende o njenem nastanku, saj o njeni naravi do njega niso vedeli ničesar. V [razsuti kopici Jasli](#) ([Prezepe \(Praesepe\)](#)), M44 je s svojim daljnogledom naštel 36 zvezd. [Lunino](#) površino je opazoval kot izbrzdano z dolinami in bregovi.

Leta 1610 je narisal še popolnejše karte Lunine površine od prvih, ki jih je leto poprej narisal [Harriot](#). Galilei je podrobno opisal številne Lunine [kraterje](#), planine in »morja«. Pozimi leta 1609 na 1610 je odkril 4 najsvetlejše [Jupiterove lune, Io, Evropo, Ganimed in Kalisto](#), po njem imenovane [Galilejeve satelite](#). Približno istočasno jih je opazil tudi [Marij](#). Gibanje Jupitrovih satelitov je prepričalo Galileja, da ne [krožijo](#) vsa nebesna telesa okrog [Zemlje](#), kot je bilo tedaj splošno veljavno mnenje. Odkril je [Venerine](#) mene in [Sončeve](#) pege. Napravil je znamenite prve skice [Saturna](#), vendar njegov daljnogled ni imel dovolj moči in povečave, da bi sistem kolobarjev videl v pravi podobi. Verjel je, da je Saturn trojni planet, po dveh letih opazovanja pa kolobarja ni več opazil, ker je k Zemlji obrnil svoj rob. Svoja prva astronomska odkritja je objavil v delu [Zvezdni glasnik \(sel\) \(Sidereus nuncius\)](#) (1610). Na osnovi svojih opazovanj je Galilei predvideval, da je v središču gibanja Sonce, Zemlja pa kroži okrog njega kot vsi drugi [planeti](#). Ker je podpiral [Kopernikov](#) sistem, ki je edini pravilen in resničen, je prišel v spor s cerkvenim naukom in mu je leta 1616 [inkvizicija](#) prepovedala učenje, da se Zemlja vrti okoli Sonca in, da je Sonce središče sveta. Leta 1632 (1638) je v svojem delu [Dvogovor o dveh glavnih svetovnih sestavah, Ptolemejevem in Kopernikovem \(Dialogo Sopra I Due Massimi Sistemi Del Mondo, Tolemaico E Copernicano...\)](#) izdal svoj heliocentrični sistem, ki je bilo obsojeno kot heretično. Leta 1633 je bil v Rimu proces proti Galileju, ki je bil takrat v 70.-letu življenja. Galilei se je moral javno odreči svojim nazorom in preživeti zadnja leta življenja hišnem zaporu. Od leta 1757 so njegova dela spet dovoljena.

Rojstvo:	15. februar 1564 ^[1] Pisa, Italija ^[1]
Smrt:	8. januar 1642 (77 let) ^[1] Arcetri, Italija ^[1]
Bivališče:	Velika vojvodina Toskana
Narodnost:	italijanska
Področje:	astronomija, fizika in matematika
Ustanove:	Univerza v Padovi
Alma mater:	Univerza v Pisi
Poznan po:	kinematiki daljnogledu Osončju Galilejeva transformacija
Verska opredelitev:	rimskokatoliška

Based only on uncertain descriptions of the first practical telescope, invented by [Hans Lippershey](#) in the Netherlands in 1608, Galileo, in the following year, made a telescope with about 3x magnification. He later made improved versions with up to about 30x magnification.^[78] With a [Galilean telescope](#) the observer could see magnified, upright images on the earth—it was what is commonly known as a terrestrial telescope or a spyglass. He could also use it to observe the sky; for a time he was one of those who could construct telescopes good enough for that purpose. On 25 August 1609, he demonstrated one of his early telescopes, with a magnification of about 8 or 9, to [Venetian](#) lawmakers. His telescopes were also a profitable sideline for Galileo selling them to merchants who found them useful both at sea and as items of trade. He published his initial telescopic astronomical observations in March 1610 in a brief treatise entitled *Sidereus Nuncius* (*Starry Messenger*).^[79]

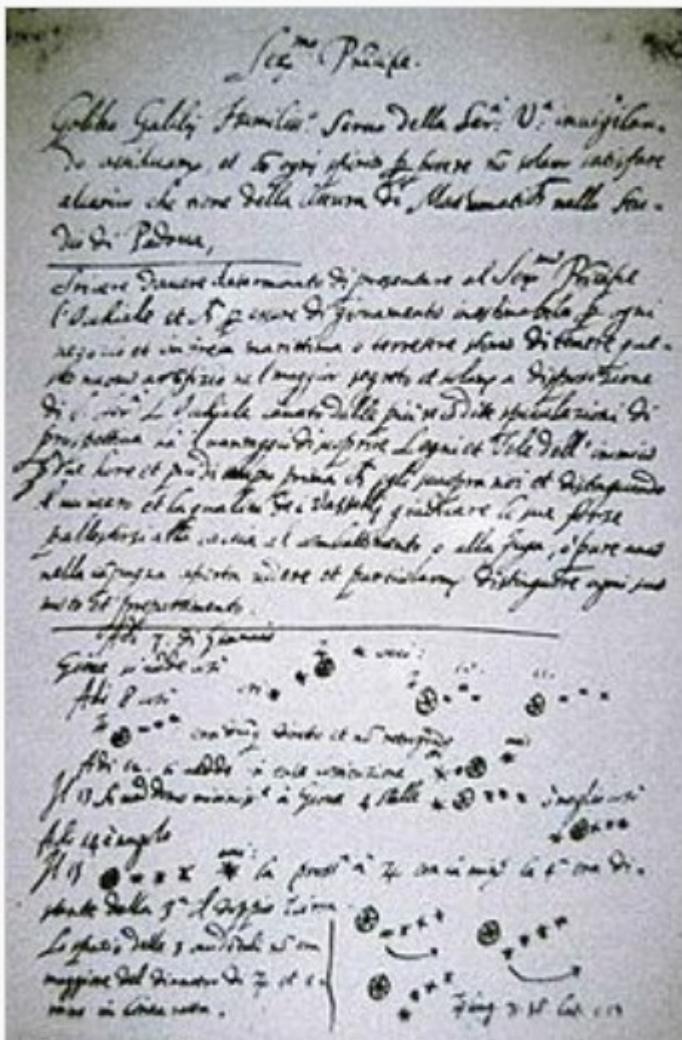


Fresco by [Giuseppe Bertini](#) depicting Galileo showing the [Doge of Venice](#) how to use the telescope

Jupiter

On 7 January 1610 Galileo observed with his telescope what he described at the time as "three fixed stars, totally invisible^[80] by their smallness", all close to Jupiter, and lying on a straight line through it.^[81] Observations on subsequent nights showed that the positions of these "stars" relative to Jupiter were changing in a way that would have been inexplicable if they had really been fixed stars. On 10 January Galileo noted that one of them had disappeared, an observation which he attributed to its being hidden behind Jupiter. Within a few days he concluded that they were orbiting Jupiter:^[82] He had discovered three of Jupiter's four largest [satellites](#) (moons). He discovered the fourth on 13 January. These satellites are now called [Io](#), [Europa](#), [Ganymede](#), and [Callisto](#). Galileo named the group of four the *Medicean stars*, in honour of his future patron, [Cosimo II de' Medici](#), [Grand Duke of Tuscany](#), and Cosimo's three brothers.^[83] Later astronomers, however, renamed them [Galilean satellites](#) in honour of their discoverer.

His observations of the satellites of Jupiter created a revolution in astronomy that reverberates to this day: a planet with smaller planets orbiting it did not conform to the principles of [Aristotelian Cosmology](#), which held that all heavenly bodies should circle the Earth,^[84] and many astronomers and philosophers initially refused to believe that Galileo could have discovered such a thing.^[85] His observations were confirmed by the observatory of [Christopher Clavius](#) and he received a hero's welcome when he visited Rome in 1611.^[86] Galileo continued to observe the satellites over the next eighteen months, and by mid 1611 he had obtained remarkably accurate estimates for their periods—a feat which [Kepler](#) had believed impossible.^[87]



It was on this page that Galileo first noted an observation of the **moons of Jupiter**. This observation upset the notion that all celestial bodies must revolve around the Earth. Galileo published a full description in *Sidereus Nuncius* in March 1610.

DISCOVERY OBSERVATIONS OF JUPITER'S FOUR LARGE MOONS

7 January 1610

East	*	*	○	*	West
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8 January 1610

East		○	*	*	*	West
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10 January 1610

East	*	*	○	West
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11 January 1610

East	*	*	○	West
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12 January 1610

East	*	*	○	*	West
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13 January 1610

East	*	○	*	*	West
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15 January 1610

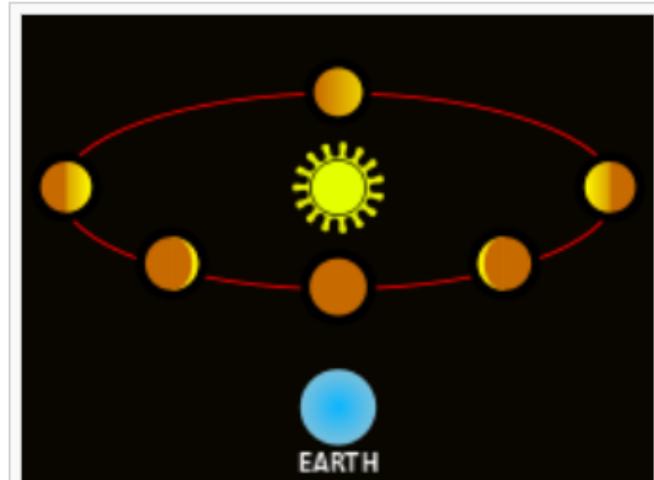
East	○	*	*	*	*	West
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Venus, Saturn, and Neptune

From September 1610, Galileo observed that [Venus](#) exhibited a full set of [phases](#) similar to that of the [Moon](#). The [heliocentric model](#) of the solar system developed by Nicolaus Copernicus predicted that all phases would be visible since the orbit of Venus around the [Sun](#) would cause its illuminated hemisphere to face the Earth when it was on the opposite side of the Sun and to face away from the Earth when it was on the Earth-side of the Sun. On the other hand, in [Ptolemy's geocentric model](#) it was impossible for any of the planets' orbits to intersect the spherical shell carrying the Sun. Traditionally the orbit of Venus was placed entirely on the near side of the Sun, where it could exhibit only crescent and new phases. It was, however, also possible to place it entirely on the far side of the Sun, where it could exhibit only gibbous and full phases. After Galileo's telescopic observations of the crescent, gibbous and full phases of Venus, therefore, this Ptolemaic model became untenable. Thus in the early 17th century as a result of his discovery the great majority of astronomers converted to one of the various geo-heliocentric planetary models,^[88] such as the Tychonic, Capellan and Extended Capellan models,^[89] each either with or without a daily rotating Earth. These all had the virtue of explaining the phases of Venus without the vice of the 'refutation' of full heliocentrism's prediction of stellar parallax. Galileo's discovery of the phases of Venus was thus arguably his most empirically practically influential contribution to the two-stage transition from full geocentrism to full heliocentrism via geo-heliocentrism.

Galileo observed the planet [Saturn](#), and at first mistook its rings for planets, thinking it was a three-bodied system. When he observed the planet later, Saturn's rings were directly oriented at Earth, causing him to think that two of the bodies had disappeared. The rings reappeared when he observed the planet in 1616, further confusing him.^[90]

Galileo also observed the planet [Neptune](#) in 1612. It appears in his notebooks as one of many unremarkable dim stars. He did not realize that it was a planet, but he did note its motion relative to the stars before losing track of it.^[91]



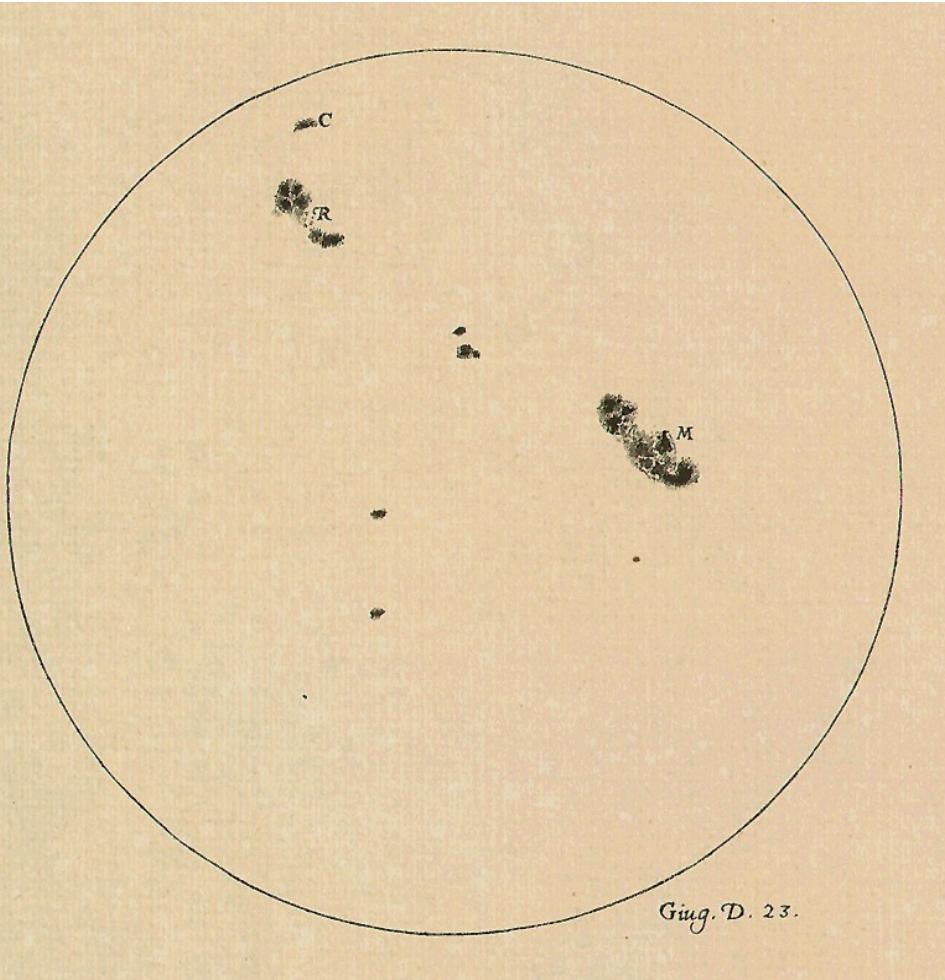
The [phases of Venus](#), observed by Galileo in 1610

Sunspots

Galileo was one of the first Europeans to observe sunspots, although Kepler had unwittingly observed one in 1607, but mistook it for a transit of Mercury. He also reinterpreted a sunspot observation from the time of Charlemagne, which formerly had been attributed (impossibly) to a transit of Mercury. The very existence of sunspots showed another difficulty with the unchanging perfection of the heavens posited by orthodox Aristotelian celestial physics, but their regular periodic transits also confirmed the dramatic novel prediction of Kepler's Aristotelian celestial dynamics in his 1609 *Astronomia Nova* that the sun rotates, which was the first successful novel prediction of post-spherist celestial physics.^[92] And the annual variations in sunspots' motions, discovered by Francesco Sizzi and others in 1612–1613,^[93] provided a powerful argument against both the Ptolemaic system and the geoheliocentric system of Tycho Brahe.^[94] A dispute over priority in the discovery of sunspots, and in their interpretation, led Galileo to a long and bitter feud with the Jesuit Christoph Scheiner; in fact, there is little doubt that both of them were beaten by David Fabricius and his son Johannes, looking for confirmation of Kepler's prediction of the sun's rotation. Scheiner quickly adopted Kepler's 1615 proposal of the modern telescope design, which gave larger magnification at the cost of inverted images; Galileo apparently never changed to Kepler's design.

Moon

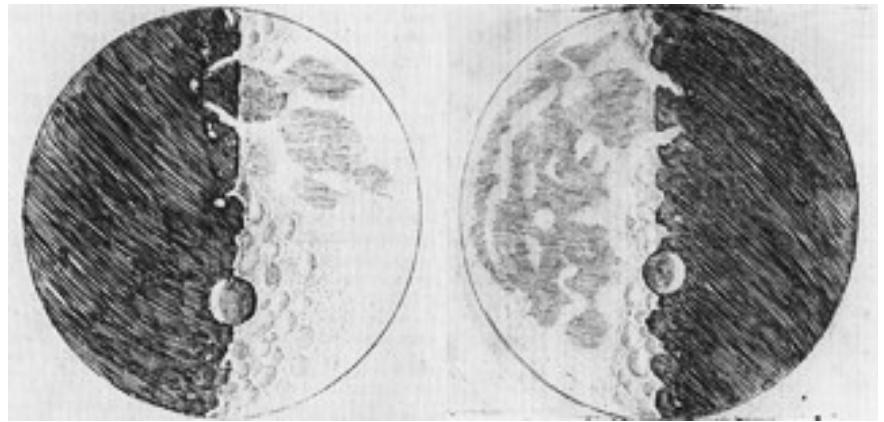
Prior to Galileo's construction of his version of a telescope, Thomas Harriot, an English mathematician and explorer, had already used what he dubbed a "perspective tube" to observe the moon. Reporting his observations, Harriot noted only "strange spottednesse" in the waning of the crescent, but was ignorant to the cause. Galileo, due in part to his artistic training^[23] and the knowledge of chiaroscuro,^[22] had understood the patterns of light and shadow were in fact topological markers. While not being the only one to observe the moon through a telescope, Galileo was the first to deduce the cause of the uneven waning as light occlusion from lunar mountains and craters. In his study he also made topological charts, estimating the heights of the mountains. The moon was not what was long thought to have been a translucent and perfect sphere, as Aristotle claimed, and hardly the first "planet", an "eternal pearl to magnificently ascend into the heavenly empyrian", as put forth by Dante.



Galileo's Sunspot Drawings

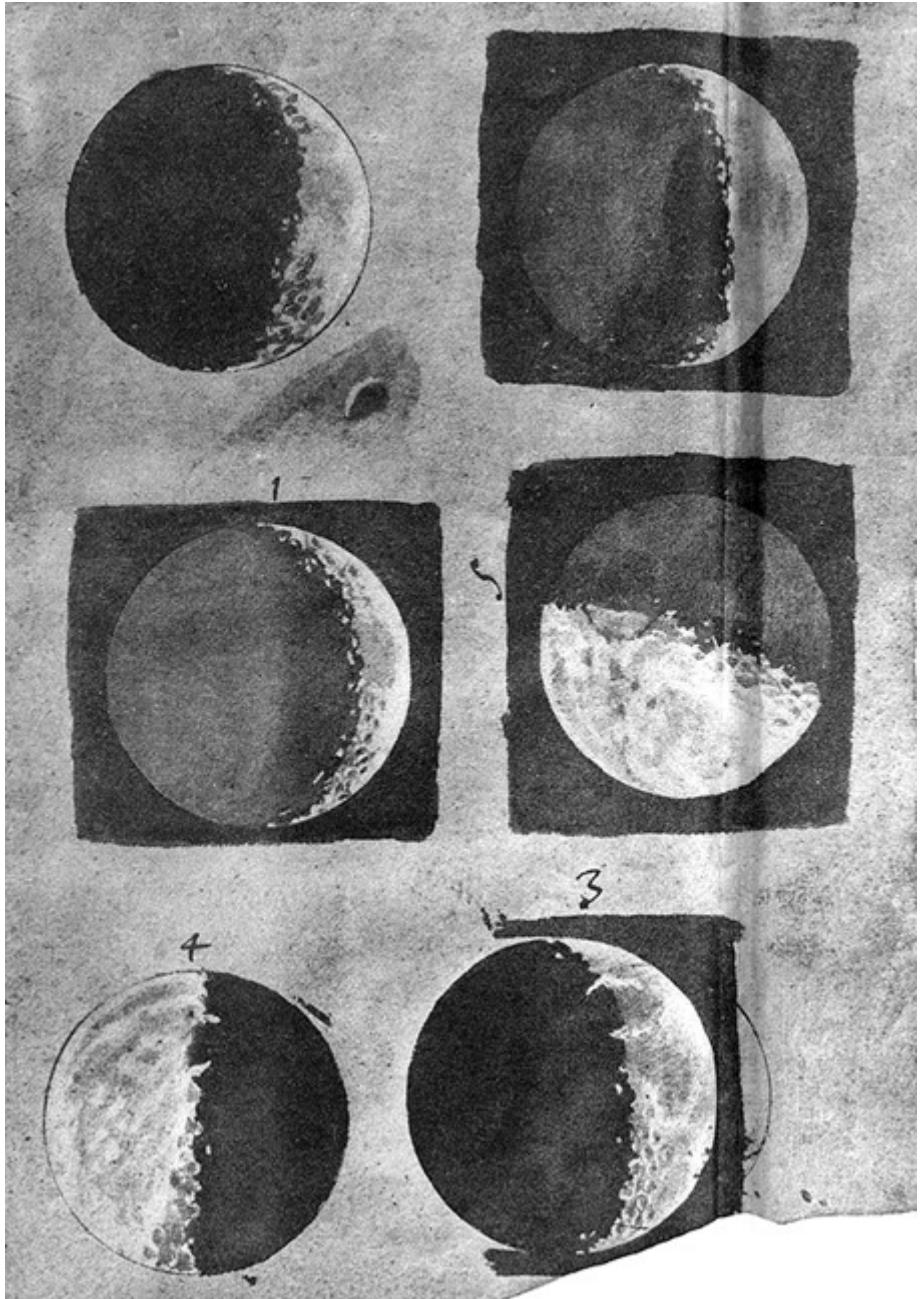
In 1612 during the summer months, Galileo made a series of sunspot observations which were published in *Istoria e Dimostrazioni Intorno Alle Macchie Solari e Loro Accidenti* Rome (History and Demonstrations Concerning Sunspots and their Properties, published 1613). Because these observations were made at approximately the same time of day, the motion of the spots across the Sun can easily be seen. To illustrate this, thirty-six of Galileo's sunspot drawings have been placed in sequence as "flip-book" type animation.

http://galileo.rice.edu/sci/observations/sunspot_drawings.html



Luna v Sidereus Nuncius.

Galilejevi akvareli Lune.



Earlier, Pope Urban VIII had personally asked Galileo to give arguments for and against heliocentrism in the book, and to be careful not to advocate heliocentrism. He made another request, that his own views on the matter be included in Galileo's book. Only the latter of those requests was fulfilled by Galileo. Whether unknowingly or deliberately, Simplicio, the defender of the Aristotelian Geocentric view in *Dialogue Concerning the Two Chief World Systems*, was often caught in his own errors and sometimes came across as a fool. Indeed, although Galileo states in the preface of his book that the character is named after a famous Aristotelian philosopher (*Simplicius* in Latin, Simplicio in Italian), the name "Simplicio" in Italian also has the connotation of "simpleton".^[55] This portrayal of Simplicio made *Dialogue Concerning the Two Chief World Systems* appear as an advocacy book: an attack on Aristotelian geocentrism and defence of the Copernican theory. Unfortunately for his relationship with the Pope, Galileo put the words of Urban VIII into the mouth of Simplicio. Most historians agree Galileo did not act out of malice and felt blindsided by the reaction to his book.^[56] However, the Pope did not take the suspected public ridicule lightly, nor the Copernican advocacy. Galileo had alienated one of his biggest and most powerful supporters, the Pope, and was called to Rome to defend his writings.

In September 1632, Galileo was ordered to come to Rome to stand trial, where he finally arrived in February 1633. Throughout his trial Galileo steadfastly maintained that since 1616 he had faithfully kept his promise not to hold any of the condemned opinions, and initially he denied even defending them. However, he was eventually persuaded to admit that, contrary to his true intention, a reader of his *Dialogue* could well have obtained the impression that it was intended to be a defence of Copernicanism. In view of Galileo's rather implausible denial that he had ever held Copernican ideas after 1616 or ever intended to defend them in the *Dialogue*, his final interrogation, in July 1633, concluded with his being threatened with torture if he did not tell the truth, but he maintained his denial despite the threat.^[57] The sentence of the Inquisition was delivered on June 22. It was in three essential parts:

- Galileo was found "vehemently suspect of heresy", namely of having held the opinions that the Sun lies motionless at the centre of the universe, that the Earth is not at its centre and moves, and that one may hold and defend an opinion as probable after it has been declared contrary to Holy Scripture. He was required to "abjure, curse and detest" those opinions.^[58]
- He was sentenced to formal imprisonment at the pleasure of the Inquisition.^[59] On the following day this was commuted to house arrest, which he remained under for the rest of his life.
- His offending *Dialogue* was banned; and in an action not announced at the trial, publication of any of his works was forbidden, including any he might write in the future.^[60]

On 15 February 1990, in a speech delivered at the [Sapienza University of Rome](#),^[140] Cardinal Ratzinger (later to become Pope Benedict XVI) cited some current views on the Galileo affair as forming what he called "a symptomatic case that permits us to see how deep the self-doubt of the modern age, of science and technology goes today".^[141] Some of the views he cited were those of the philosopher Paul Feyerabend, whom he quoted as saying "The Church at the time of Galileo kept much more closely to reason than did Galileo himself, and she took into consideration the ethical and social consequences of Galileo's teaching too. Her verdict against Galileo was rational and just and the revision of this verdict can be justified only on the grounds of what is politically opportune."^[141] The Cardinal did not clearly indicate whether he agreed or disagreed with Feyerabend's assertions. He did, however, say "It would be foolish to construct an impulsive apologetic on the basis of such views."^[141]

On 31 October 1992, Pope John Paul II expressed regret for how the Galileo affair was handled, and issued a declaration acknowledging the errors committed by the Catholic Church tribunal that judged the scientific positions of Galileo Galilei, as the result of a study conducted by the [Pontifical Council for Culture](#).^{[142][143]} In March 2008 the head of the Pontifical Academy of Sciences, Nicola Cabibbo, announced a plan to honour Galileo by erecting a statue of him inside the Vatican walls.^[144] In December of the same year, during events to mark the 400th anniversary of Galileo's earliest telescopic observations, Pope Benedict XVI praised his contributions to astronomy.^[145] A month later, however, the head of the Pontifical Council for Culture, Gianfranco Ravasi, revealed that the plan to erect a statue of Galileo in the grounds of the Vatican had been suspended.^[146]

Jan. 14, 2008

By John L Allen Jr Daily

Note: Recently a group of professors and students from Rome's La Sapienza University, including the entire physics faculty, wrote a letter protesting Pope Benedict XVI's scheduled Jan. 17 lecture to open the academic year. They cited comments from then-Cardinal Joseph Ratzinger in 1990 on the Galileo case. Those comments are presented here.

Cardinal Joseph Ratzinger

"The Crisis of Faith in Science"

March 15, 1990, Parma

Extracts taken from *A Turning Point for Europe? The Church and Modernity in the Europe of Upheavals*, Paoline Editions, 1992, pp. 76–79. English translation by NCR.

* * *

In the last decade, creation's resistance to allowing itself to be manipulated by humanity has emerged as a new element in the overall cultural situation. The question of the limits of science, and the criteria which it must observe, has become unavoidable.

Particularly emblematic of this change of intellectual climate, it seems to me, is the different way in which the Galileo case is seen.

This episode, which was little considered in the 18th century, was elevated to a myth of the Enlightenment in the century that followed. Galileo appeared as a victim of that medieval obscurantism that endures in the Church. Good and evil were sharply distinguished. On the one hand, we find the Inquisition: a power that incarnates superstition, the adversary of freedom and conscience. On the other, there's natural science represented by Galileo: the force of progress and liberation of humanity from the chains of ignorance that kept it impotent in the face of nature. The star of modernity shines in the dark night of medieval obscurity.

Today, things have changed.

According to [Ernst] Bloch, the heliocentric system – just like the geocentric – is based upon presuppositions that can't be empirically demonstrated. Among these, an important role is played by the affirmation of the existence of an absolute space; that's an opinion that, in any event, has been cancelled by the Theory of Relativity. Bloch writes, in his own words: 'From the moment that, with the abolition of the presupposition of an empty and immobile space, movement is no longer produced towards something, but there's only a relative movement of bodies among themselves, and therefore the measurement of that [movement] depends to a great extent on the choice of a body to serve as a point of reference, in this case is it not merely the complexity of calculations that renders the [geocentric] hypothesis impractical? Then as now, one can suppose the earth to be fixed and the sun as mobile.'

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Curiously, it was precisely Bloch, with his Romantic Marxism, who was among the first to openly oppose the [Galileo] myth, offering a new interpretation of what happened: The advantage of the heliocentric system over the geocentric, he suggested, does not consist in a greater correspondence to objective truth, but solely in the fact that it offers us greater ease of calculation. To this point, Bloch follows solely a modern conception of natural science. What is surprising, however, is the conclusion he draws: "Once the relativity of movement is taken for granted, an ancient human and Christian system of reference has no right to interfere in astronomic calculations and their heliocentric simplification; however, it has the right to remain faithful to its method of preserving the earth in relation to human dignity, and to order the world with regard to what will happen and what has happened in the world."



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Johannes Kepler

Iz Wikipedije, proste enciklopedije

Johannes Kepler [johánes képler], nemški astrolog, astronom in matematik, * 27. december 1571, Weil der Stadt, Würtenberg, Sveti rimski cesarstvo (zdaj Nemčija), † 15. november 1630, Regensburg, Bavarska (zdaj Nemčija).

Vsebina [skrij]

- 1 Življenje in delo
- 2 Priznanja
 - 2.1 Poimenovanja
- 3 Glej tudi
- 4 Viri

Življenje in delo

[uredi]

Kepler je študiral teologijo in klasiko na Univerzi v Tübingenu. Tam je nanj vplival profesor matematike Michael Maestlin in Kopernikova teorija. Kepler je takoj sprejel Kopernikovo teorijo, saj je verjel, da mora biti enostavnost Kopernikovih tircic božje delo.

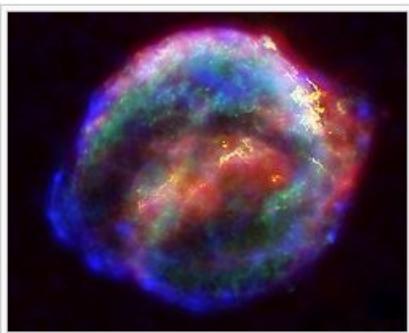
Leta 1594 je odšel iz Tübingena v Gradec. Tam je začel delati na obsežni geometrijski domnevi, ki se je nanašala na oddaljenosti planetov.

V letu 1596 je objavil svoje prvo astronomsko delo *Kozmografska nedoumljivost* (latinsko *Mysterium cosmographicum*). To delo je pomembno, ker je predstavljalo prvo razumljivo in neizpodbitno poročilo geometrijskih prednosti Kopernikove teorije.

Od leta 1594 do 1600 je bil v Gradcu profesor astronomije in matematike. Leta 1600 je postal pomočnik de Braheja blizu Prage, po njegovi smrti leta 1601 pa cesarski dvorni astronom in kraljevi matematik Rudolfa II., svetega rimskega kralja.

17. oktobra 1604 je v ozvezdju Kačenosca opazoval supernovo SN 1604, ki je dobila ime po njem Keplerjeva supernova, oziroma Keplerjeva zvezda. Prvič so jo zapazili že 9. oktobra.

V svoji knjigi *Nova astronomija* (*Astronomia nova*), ki je bila objavljena leta 1609, je pojasnil svoj zakon o ravninah, ki ga je odkril leta 1602, in zakon o eliptičnem gibanju, ki ga je odkril leta 1605.



Ostanek Keplerjeve supernove SN 1604.

Leta 1612 je bil matematik v Zgornji Avstriji (Oberösterreich). Leta 1614 je izvedel za Bürgljeve logaritme, leta 1617 pa je že poznal Napierjevo knjigo *Descriptio*. V tem času se ni uspel ukvarjati z logaritmi, ker je bil zaposlen z zakonom o gibanju planetov in je v Linzu leta 1619 izdal knjigo *Ubranost sveta* (*Harmonices mundi*), v kateri je pojasnil svoj 3. Keplerjev zakon o gibanju planetov. S pomočjo vrednosti Napierjevih logaritmov za funkcijo *sinus* je izračunal numerično-logaritemsko tabele. Nekako v tem času je začel z objavo knjige, ki je izšla 3 leta pozneje *Epitom Kopernikovi astronomiji* (*Epitome Astronomiae Copernicanae*), 1618 - 1621. V njej so bili zbrani vsi njegovi zakoni. Pomembna je tudi zato, ker je bila to prva astronomска knjiga na osnovi Kopernikovih načel.

Leta 1624 je izdal svoje tabele *Chillas Logarithmorum ad totidem Numerus Rotundus* (v prvi izdaji je tudi opis, kako so logaritmi izračunani) in nato še 1627 (1625) Rudolfove (Rudolfske) tabele (tablice) (*Tabulae Rudolphinae*), kjer je dodal posamezne tabele za logaritem kosinusa po koraku 10 sekund, vendar na zelo majhnem intervalu. Tabele so temeljile na de Braheovih podatkih in z njihovo pomočjo so se zmanjšale glavne napake resničnih položajev planetov od 5° na samo $10'$.

Newton se je pri oblikovanju svojega splošnega gravitacijskega zakona zelo zanašal na Keplerjevo teorijo in opazovanja. Kepler je veliko prispeval tudi v optiki in je razvil sistem infinitezimalov, s čimer je bil tudi predhodnik integralnega računa.

Johannes Kepler



Kopija izgubljenega portreta iz leta 1610

Rojstvo:	27. december 1571 Weil der Stadt blizu Stuttgart, Nemčija
Smrt:	15. november 1630 (58 let) Regensburg, Bavarska, Nemčija
Bivališče:	Baden-Württemberg; Štajerska; Češka; Zgornja Avstrija
Narodnost:	nemška
Področje:	astronomija, astrologija, matematika in naravoslovje
Ustanove:	Univerza v Linzu
Alma mater:	Univerza v Tübingenu
Poznan po:	Keplerjevi zakoni Keplerjeva domneva
Verska opredelitev:	Iuteranska



Newton se preusmerja sem. Za enoto sile glej [Njuton](#).

Sir **Isaac Newton** [àjzak njúton], PRS, angleški fizik, matematik, astronom, filozof, **ezoterik** in alkimist, * 4. januar 1643 (25. december 1642, stari angleški koledar), **hamlet Woolsthorpe-by-Colsterworth** pri **Grenthamu**, grofija **Lincolnshire**, Anglija, † 31. marec (20. marec) 1727, **Kensington**, London, Anglija.

Vsebina [skrij]

- 1 Življenje in delo
- 2 Dela
- 3 Priznanja
 - 3.1 Poimenovanja
- 4 Glej tudi
- 5 Opombe in sklici
- 6 Zunanje povezave

Življenje in delo

[uredi]

Delo, ki ga je v **fiziki** začel **Galilei**, je nadaljeval in do prvega viška pripeljal Newton. Večkrat naletimo na podatek, da se je Newton rodil v letu, v katerem je umrl Galilei, vendar so v Angliji tedaj upoštevali še stari koledar; po novem, ki je že veljal drugod, je bilo to leto po Galilejevi smrti. Rodil se je po očetovi smrti. Menda je bil ob rojstvu zelo šibek, a si je proti pričakovanju opomogel.

Newton je bil **čudežni otrok**. Za delo na **kmetiji** ni bil pripraven in po priporočilu strica, ki je učil v **Cambridgeu**, so ga poslali tja študirat. Brez težav, a tudi brez posebnih uspehov je leta **1665** študij končal. Menda je na nekem merjenju moči v znanju končal na 24. mestu. V tistem času so zaradi **kuge** cambriško **univerzo** za poldrugo leto zaprli. Preživel je prisilne počitnice v domači **vasi**. Imel je veliko časa za razmišljjanje in tedaj naj bi odkril **infinitesimalni račun** in **splošni gravitacijski zakon** ter razstavil belo **svetlobo** na **mavrico**. Nek njegov življenjepisec pravi, da »v zgodovini znanosti ni primerov, ki bi jih lahko primerjali z Newtonovimi dosežki« v tem poldrugem letu. Vendar vse kaže, da ni bilo čisto tako. Po vsej verjetnosti je Newton tedaj zares razmišljal o **gibanju Lune** in **planetov** in o svetlobi, ker sta ti vprašanja zaposlovali vse tedanje **fizike**. Morda se je tedaj odločil, kaj bo raziskoval, a čas vsaj za obe fizikalni odkritiji še ni dozorel. Živel je v zelo razgibanem času, v katerem je dozorevala angleška **država**. To je bilo obdobje, ko je **Oliver Cromwell** odstavil **kralja Karla I.** in postal **lord protektor**. Newton se je vrnil v Cambridge, ko so univerzo spet odprli, in postal mladi raziskovalec, kot bi rekli danes. Leta **1669** pa se je primerilo nekaj dokaj nenavadnega: njegov učitelj **Barrow** je šel predčasno v pokoj in svoje profesorsko mesto prepustil Newtonu, češ da ga ta prekaša. Profesor, ki zaseda to stolico, se imenuje **Lucasov profesor matematike**. Danes to mesto na **cambriški univerzi** (Cambridge University) zaseda **Stephen Hawking**. Newton se je lotil raziskovanja svetlobe in uspehi pri tem so mu leta **1672** odprli pot v **Kraljevo družbo**, angleško akademijo znanosti. Zaradi svojih poskusov s svetlobo je tu prišel v spor s **Hookom**. Ta je bil nemiren in zajedljiv. Hooke je kritiziral dve optični razpravi, ki ju je Newton predložil družbi. To je Newtona vznejevoljilo, tako da je zagrozil z izstopom iz Kraljeve družbe. Spor so komaj zgladili. Zaradi tega je Newton odložil pisanje knjige o **optiki**. Izšla je šele leta **1704**, leto dni po Hookovi smrti.

Znani pisec poljudnih knjig in znanstvene fantastike **Isaac Asimov** je o Newtonu napisal tole: »Čeprav je bil Newton največji um, je bil slab primerek moža. Nikoli se ni poročil in nikoli ni pokazal znakov, da se zaveda, da ženske sploh obstajajo. Bil je smešno raztresen in vedno se je zanimal le za stvari, ki niso bile v njegovi neposredni okolini. Bil je tudi izredno občutljiv na kritiko in otročji v svojih reakcijah nanjo. Večkrat se je trdno odločil, da raje ne bo objavil nobenega znanstvenega dela, kot da bi se ponovno izpostavil kritiki. [...] Sovraštvo do kritike pa mu ni branilo, da ne bi bil prepirljiv kot Hooke, čeprav ta lastnost pri njem ni bila tako izrazita. Sam se je izmikal sporom in prepustil svojim prijateljem, da so nosili njegov najtežji delež. Iz ozadja jih je spodbujal, pri tem pa ni naredil nobenega koraka, da bi jih branil ali kaj priznal.«

Vendar se je po Hookovi zaslugi proti koncu leta **1679** Newton začel podrobno zanimati za gibanje planetov. Leta **1687** je izšla njegova knjiga z naslovom (**Matematična**) **Načela naravoslovja** (**filozofije narave**) (**Philosophiae naturalis principia mathematica**). **Filozofijo narave** bi danes lahko nadomestili s **fiziko** ali še bolje z **mehaniko**.

Newton je prvi uporabil sodobne znake za višje korene.

Poleg raziskovanja na področju matematike in fizike je Newton veliko časa posvetil tudi **ezoteriki** in preučevanju **Biblike**. Proučeval jo je v upanju, da bo našel **biblijsko kodo**.

Po Newtonu se imenuje:

- **v fiziki**

- **Newtonovi zakoni gibanja** - temelj **Newtonove mehanike**
- **Newtonov splošni gravitacijski zakon**
- **newton** - enota za **merjenje sile**

Odkritje planeta Uran, ki je sicer ravno še viden s prostimi očmi

Discovery

Uranus had been observed on many occasions before its discovery as a planet, but it was generally mistaken for a star. The earliest recorded sighting was in 1690 when [John Flamsteed](#) observed the planet at least six times, cataloging it as [34 Tauri](#). The French astronomer [Pierre Lemonnier](#) observed Uranus at least twelve times between 1750 and 1769,^[19] including on four consecutive nights.

Sir [William Herschel](#) observed the planet on March 13, 1781 while in the garden of his house at 19 New King Street in the town of Bath, [Somerset, England](#) (now the [Herschel Museum of Astronomy](#)),^[20] but initially reported it (on April 26, 1781) as a "comet".^[21] Herschel "engaged in a series of observations on the parallax of the fixed stars",^[22] using a telescope of his own design.

He recorded in his journal "In the quartile near ζ Tauri ... either [a] Nebulous star or perhaps a comet".^[23] On March 17, he noted, "I looked for the Comet or Nebulous Star and found that it is a Comet, for it has changed its place".^[24] When he presented his discovery to the [Royal Society](#), he continued to assert that he had found a comet while also implicitly comparing it to a planet:^[25]

The power I had on when I first saw the comet was 227. From experience I know that the diameters of the fixed stars are not proportionally magnified with higher powers, as planets are; therefore I now put the powers at 460 and 932, and found that the diameter of the comet increased in proportion to the power, as it ought to be, on the supposition of its not being a fixed star, while the diameters of the stars to which I compared it were not increased in the same ratio. Moreover, the comet being magnified much beyond what its light would admit of, appeared hazy and ill-defined with these great powers, while the stars preserved that lustre and distinctness which from many thousand observations I knew they would retain. The sequel has shown that my surmises were well-founded, this proving to be the Comet we have lately observed.

Herschel notified the [Astronomer Royal, Nevil Maskelyne](#), of his discovery and received this flummoxed reply from him on April 23: "I don't know what to call it. It is as likely to be a regular planet moving in an orbit nearly circular to the sun as a Comet moving in a very eccentric ellipsis. I have not yet seen any coma or tail to it".^[26]

While Herschel continued to cautiously describe his new object as a comet, other astronomers had already begun to suspect otherwise. Russian astronomer [Anders Johan Lexell](#) was the first to compute the orbit of the new object^[27] and its nearly circular orbit led him to a conclusion that it was a planet rather than a comet. Berlin astronomer [Johann Elert Bode](#) described Herschel's discovery as "a moving star that can be deemed a hitherto unknown planet-like object circulating beyond the orbit of Saturn".^[28] Bode concluded that its near-circular orbit was more like a planet than a comet.^[29]

The object was soon universally accepted as a new planet. By 1783, Herschel himself acknowledged this fact to Royal Society president [Joseph Banks](#): "By the observation of the most eminent Astronomers in Europe it appears that the new star, which I had the honour of pointing out to them in March 1781, is a Primary Planet of our Solar System."^[30] In recognition of his achievement, [King George III](#) gave Herschel an annual stipend of £200 on the condition that he move to Windsor so that the Royal Family could have a chance to look through his telescopes.^[31]



Model of Telescope with which [William Herschel](#) discovered [Uranus](#). In the [William Herschel](#) museum in [Bath](#). The secret of Herschel's success as an observer was the power and magnification of his telescopes. This seven foot long, six inch diameter, f14 reflector was particularly favoured. Its main mirror at the bottom of the tube and the secondary mirror near the top in front of the ocular were made of [speculum](#) metal. It was with a seven foot telescope that Herschel made the discovery of the planet Uranus in 1781.

Discovery

[edit]

The first asteroid to be discovered, Ceres, was found in 1801 by Giuseppe Piazzi, and was originally considered to be a new planet.^[note 1] This was followed by the discovery of other similar bodies, which with the equipment of the time appeared to be points of light, like stars, showing little or no planetary disc, though readily distinguishable from stars due to their apparent motions. This prompted the astronomer Sir William Herschel to propose the term "asteroid", from Greek *ἀστεροειδής*, *asteroeidēs* 'star-like, star-shaped', from ancient Greek *ἀστήρ*, *astér* 'star, planet'. In the early second half of the nineteenth century, the terms "asteroid" and "planet" (not always qualified as "minor") were still used interchangeably; for example, the *Annual of Scientific Discovery for 1871* [↗](#), page 316, reads

"Professor J. Watson has been awarded by the Paris Academy of Sciences, the astronomical prize, Lalande foundation, for the discovery of eight new asteroids in one year. The planet Lydia (No. 110), discovered by M. Borelly at the Marseilles Observatory [...] M. Borelly had previously discovered two planets bearing the numbers 91 and 99 in the system of asteroids revolving between Mars and Jupiter".



243 Ida and its moon Dactyl. Dactyl [↗](#) is the first satellite of an asteroid to be discovered.

Titius – Bodejev „zakon“ zaporedja planetov, ki to ni

$$a_n = a = 0.4 + 0.3 \cdot 2^m, m = -\infty, 0, 1, 2, \dots$$

Planet	k	T-B rule distance (AU)	Real distance (AU)	% error (using real distance as the accepted value)
Mercury	0	0.4	0.39	2.56 %
Venus	1	0.7	0.72	2.78 %
Earth	2	1.0	1.00	0.00 %
Mars	4	1.6	1.52	5.26 %
Ceres ¹	8	2.8	2.77	1.08 %
Jupiter	16	5.2	5.20	0.00 %
Saturn	32	10.0	9.54	4.82 %
Uranus	64	19.6	19.2	2.08 %
Neptune	128	38.8	30.06	29.08 %
Pluto ¹	256	77.2 ²	39.44	95.75 %

¹ Ceres was considered a planet from 1801 until the 1860s. Pluto was considered a planet from 1930 to 2006. Both are now classified as [dwarf planets](#).

² While the difference between the T-B rule distance and real distance seems very large here, if Neptune is 'skipped,' the T-B rule's distance of 38.8 is quite close to Pluto's real distance with an error of only 1.62%.

~4 prosti parametri in 8 točk približnega ujemanja (če štejemo Ceres), torej eno od (slučajnih) ujemanj ob predpostavki vedno hitreje naraščajočih razdalj planetov.

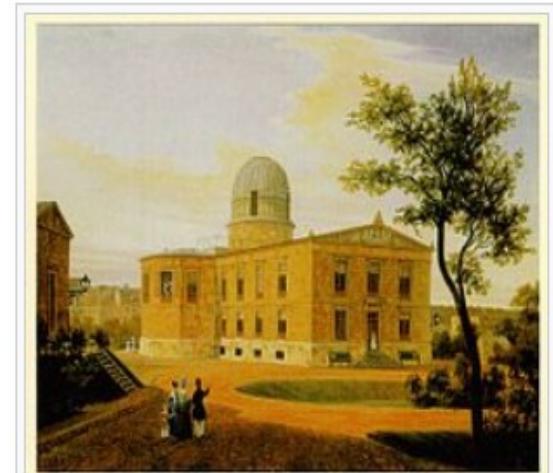
Discovery of Neptune

From Wikipedia, the free encyclopedia

Neptune was mathematically predicted before it was directly observed. With a prediction by Urbain Le Verrier, telescopic observations confirming the existence of a major planet were made on the night of September 23, 1846, and into the early morning of the 24th,^[1] at the Berlin Observatory, by astronomer Johann Gottfried Galle (assisted by Heinrich Louis d'Arrest), working from Le Verrier's calculations. It was a sensational moment of 19th century science and dramatic confirmation of Newtonian gravitational theory. In François Arago's apt phrase, Le Verrier had discovered a planet "with the point of his pen."

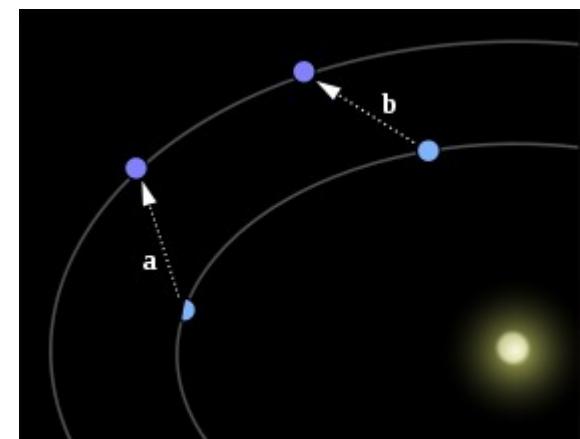
In retrospect, after it was discovered it turned out it had been observed many times before, but not recognized, and there were others who made various calculations about its location, which did not lead to its observation. By 1846, the planet Uranus had completed nearly one full orbit since its discovery by William Herschel in 1781, and astronomers had detected a series of irregularities in its path which could not be entirely explained by Newton's law of gravitation. These irregularities could, however, be resolved if the gravity of a farther, unknown planet were disturbing its path around the Sun. In 1845, astronomers Urbain Le Verrier in Paris and John Couch Adams in Cambridge separately began calculations to determine the nature and position of such a planet. Unfortunately, Le Verrier's triumph also led to a tense international dispute over priority, as, shortly after the discovery, George Airy, at the time British Astronomer Royal, announced that Adams had also predicted the discovery of the planet.^[2] Nevertheless, the Royal Society awarded Le Verrier the Copley medal in 1846 for his achievement, without mention of Adams.^[3]

The discovery of Neptune led to the discovery of its moon Triton by William Lassell just seventeen days later.^[4]



New Berlin Observatory at Linden Street, where Neptune was discovered observationally.

At position *a*, the outer planet gravitationally perturbs the orbit of Uranus, pulling it ahead of the predicted location. The reverse is true at *b*, where the perturbation retards the orbital motion of Uranus.



Clyde William Tombaugh

Iz Wikipedije, proste enciklopedije

Clyde William Tombaugh [klájd víljem tombó], ameriški astronom, * 4. februar 1906, Streator, Illinois, ZDA, † 17. januar 1997, Las Cruces, Nova Mehika, ZDA.

Vsebina [skrij]

- 1 Življenje in delo
- 2 Priznanja
- 3 Navedki
- 4 Zunanje povezave

Življenje in delo

[uredi]

Njegovi starši so bili prrevni, da bi ga poslali na kolidž. Mladega Clyda je astronomija zelo zanimala. Delal je s 230 mm daljnogledom, narejenim iz delov starih strojev, ki so se valjali po očetovi kmetiji. Družina se je leta 1922 preselila v Burdett v Kansasu. Tu je leta 1925 končal srednjo šolo. Svoje risbe opazovanj Jupitra in Marsa je pošiljal na Lowellov observatorij v Flagstaffu, Arizona. Leta 1929 so mu na observatoriju ponudili službo pomočnika, kjer je ostal do leta 1945.



Utrijalni mikroskopski komparator, ki ga je uporabljal Tombaugh

Pod vodstvom Vesta Melvina Slipherja so še vedno iskali Lowellov in Pickeringov planet X, katerega tirmica naj bi bila še bolj oddaljena od Neptunove. Tombaugh se je lotil dela z veliko vnemo. Vedel je, da bo svetloba z novega planeta, če obstaja, tako šibka, da bo v polju daljnogleda hkrati z njim še poplava drugih šibkih zvezd. Seveda se planet razlikuje od preostalih zvezd v ozadju po svojem gibanju, vendar je bilo zaradi velike oddaljenosti planeta od Zemlje in od Sonca pričakovati le zelo počasno navidezno gibanje. 18. februarja 1930 je po skoraj letu natančnih preiskav v ozvezdju Dvojčkov odkril Pluton pri pregledovanju fotografskih plošč, posnetih januarja istega leta. Novi planet je opazoval še mesec dni, nato pa je na dan, ko bi bil Lowell star 75 let (13. marec 1930), objavil odkritje. Za lov na neznani planet so Lowellov observatorij opremili z novim 330 mm refraktorjem, (ki se sedaj imenuje Plutonov daljnogled (Pluto Telescope)). Naloga je bila videti skoraj nemogoča. Tombaugh je posnel po dve fotografiski plošči istega predela neba v razmiku nekaj dni. Pare plošč je primerjal z napravo, ki se imenuje utrijalni mikroskopski komparator (angleško blink-microscope comparator). Vanjo je natančno vložil dve plošči istega zvezdnega polja, posneti ob različnih časih. S pomočjo komparatorja je izmenično gledal sliko zdaj z ene zdaj z druge plošče. Vsako telo, ki je le za malenkost spremenilo svojo lego, se je jasno pokazalo na stalnem ozadju zvezd. Kljub temu je bilo odkritje majcenega premika novega planeta med ogromnim številom zvezd spoštovanja vreden izviv. Na ploščah je bila mejna magnituda 17,5^m in potrebno je bilo skrbno pregledati vsak kvadratni milimeter. Število zvezd na posamezni plošči je bilo gromozansko. Na predelih, ki so daleč od središča naše Galaksije (Rimske ceste), jih je bilo od 40.000 do 60.000 (na eni plošči!), na območjih okoli Strelca pa tudi čez milijon. V prvem primeru je pregledovanje plošče trajalo tri dni, v drugem tri do štiri tedne. Kadarkoli je naletel na kaj sumljivega (in asteroidi so bili sumljivi), je posnel še tretjo ploščo in jo primerjal s prvo dvema. Po navidezni hitrosti gibanja osumljjenega telesa je lahko hitro sklepal, ali gre za asteroid ali pa morda za neznani planet. Ker je Lowell v svojih računih predvidel približno oddaljenost neznanega planeta, je lahko Tombaugh iz tretjega Keplerjevega zakona ocenil navidezno hitrost telesa, ki ga je iskal. Po odkritju Plutona se je dve leti kasneje iskanje »še kakšnega planeta« za Neptunom nadaljevalo vse do leta 1945, saj se je zdelo, da je novoodkriti planet premajhen, da bi motil velikana, kot sta Uran in Neptun.

Vsega skupaj je Tombaugh prefotografiral 70 odstotkov neba in pregledal 90.000 kvadratnih stopinj fotografiskih plošč. Pri tem je opazil 3969 asteroidov, 1807 spremenljivih zvezd in en komet. Na ploščah je prešel 29.548 galaksij in odkril novo kroglasto kopico. Še enega planeta ni odkril. Tombaugh je potreboval 7000 ur, da je pregledal vse posnete plošče, celotna naloga pa je trajala 14 let. Ob 60-letnici odkritja Plutona je izjavil: »S svojimi očmi sem videl vsako od 90 milijonov zvezdic na 362 ploščah, ki sem jih pregledal. Plošče pokrivajo predel neba od deklinacije +60 stopinj do -50 stopinj. Pregledal sem celo področje okoli Kanopa (α Gredija (α Car)) in kroglasto kopico w Kentavra (w Cen).«

Ime devetega planeta so 1. maja 1930 uradno objavili v cirkularju Lowellovega observatorija in ga izbrali po rimskegom bogu podzemlja Plutonu, ki imel zmožnost biti neviden, in v Lowellovo čast. Izkazalo se je, da je Pluton nenavadni planet. Od vseh planetnih tirmic je njegova najbolj izsredna in najbolj nagnjena k ekliptiki. Kuiper je pokazal, da je Pluton mnogo manjši od drugih zunanjih planetov. Nekateri astronomi sklepajo, da ni pravi planet, temveč je bil nekoč Neptunov naravni satelit, ki je ob neznani katastrofi moral na svojo neodvisno tirmico.



Friedrich Bessel

From Wikipedia, the free encyclopedia

Friedrich Wilhelm Bessel (22 July 1784 – 17 March 1846) was a German mathematician, astronomer, and systematizer of the Bessel functions (which were discovered by Daniel Bernoulli). He was a contemporary of Carl Gauss, also a mathematician and physicist. The asteroid 1552 Bessel was named in his honour.

Bessel was born in [Minden](#) in [Minden-Ravensberg](#), the son of a civil servant. At the age of 14 Bessel was apprenticed to the import-export concern [Kulenkamp](#). He soon became the company's [accountant](#). The business's reliance on cargo ships led him to turn his mathematical skills to problems in [navigation](#). This in turn led to an interest in astronomy as a way of determining [longitude](#).

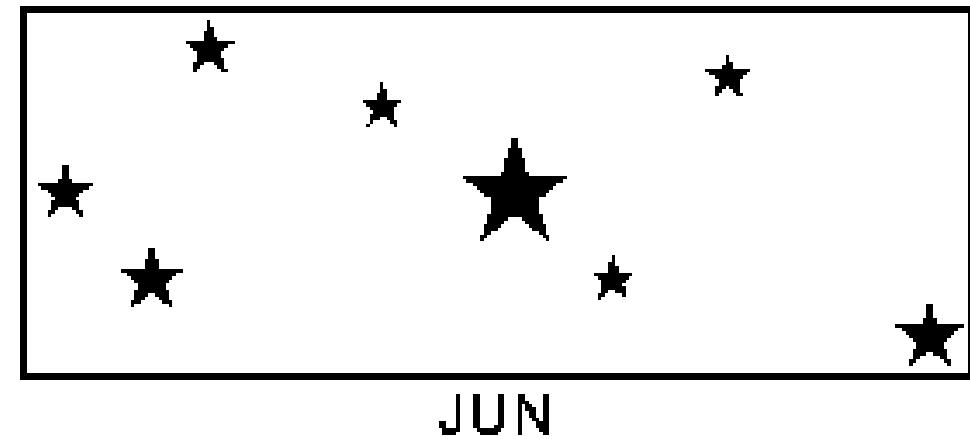
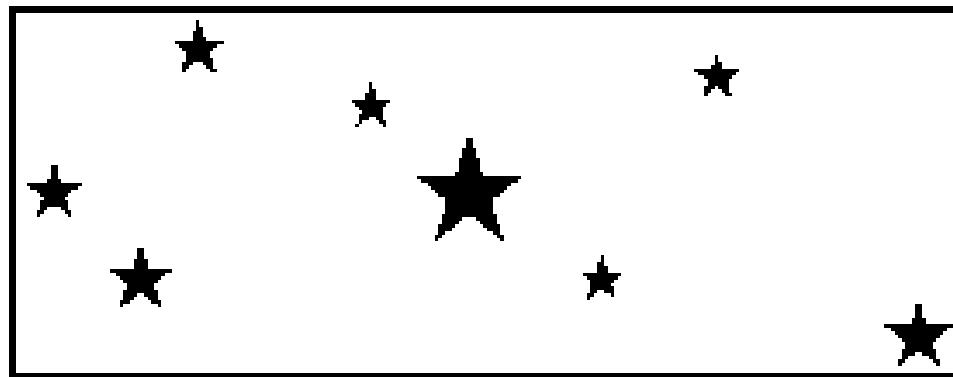
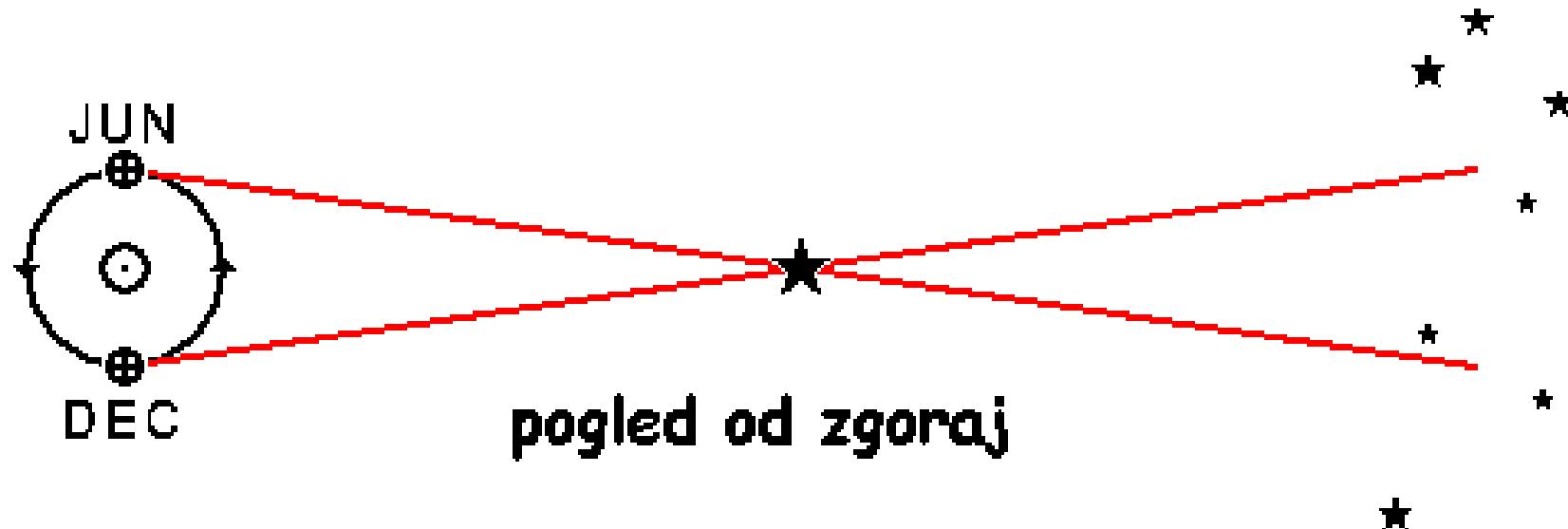
Bessel came to the attention of a major figure of German astronomy at the time, [Heinrich Wilhelm Olbers](#), by producing a refinement on the orbital calculations for [Halley's Comet](#). Within two years Bessel had left Kulenkamp and become an assistant at [Lilienthal Observatory](#) near [Bremen](#). There he worked on [James Bradley](#)'s stellar observations to produce precise positions for some 3,222 stars.

This work attracted considerable attention, and in 1810, at the age of 26, Bessel was appointed director of the [Königsberg Observatory](#) by King [Frederick William III of Prussia](#). There he published tables of [atmospheric refraction](#) based on Bradley's observations, which won him the [Lalande Prize](#) from the [French Academy of Sciences](#) in 1811. Bessel was able to pin down the position of over 50,000 stars during his time at [Königsberg](#).

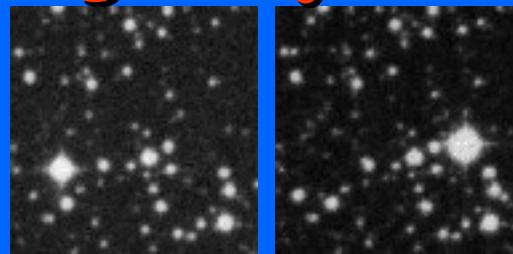
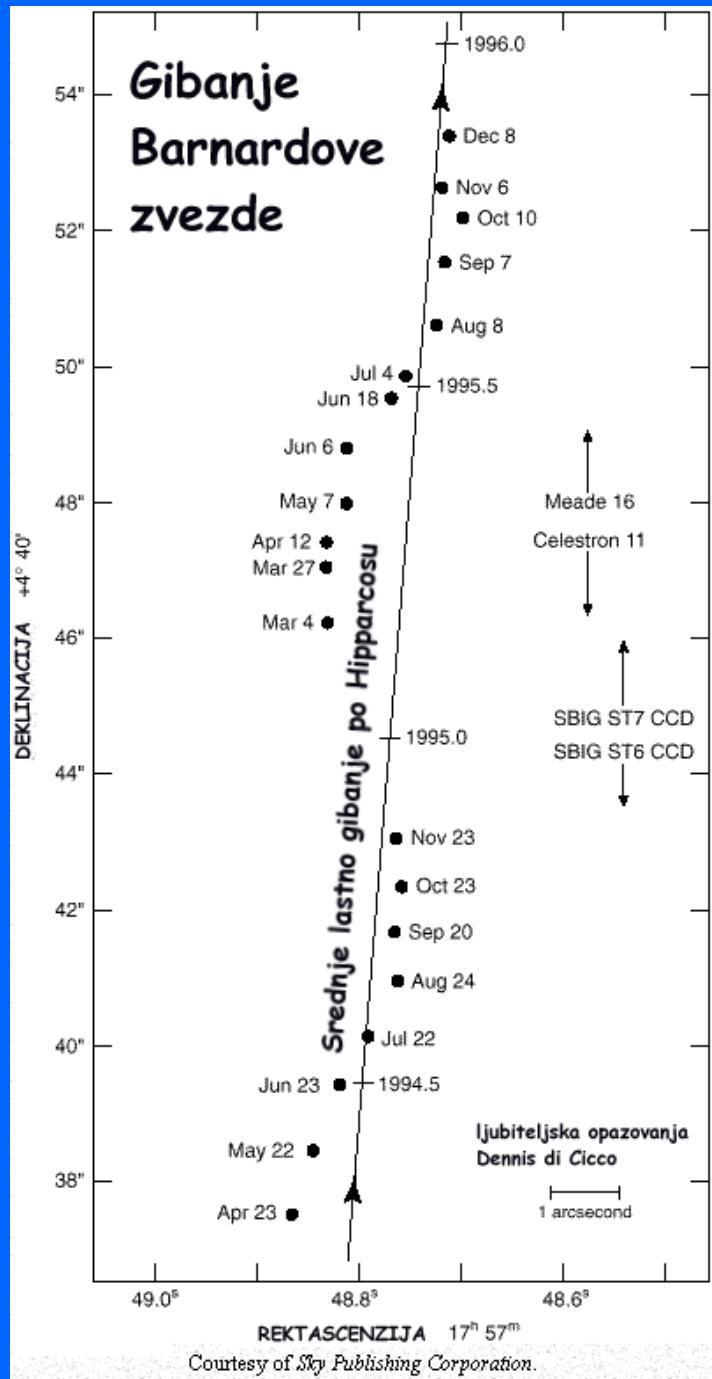
With this work under his belt, Bessel was able to achieve the feat for which he is best remembered today: he is credited with being the first to use [parallax](#) in calculating the [distance](#) to a [star](#). Astronomers had believed for some time that parallax would provide the first accurate measurement of interstellar distances—in fact, in the 1830s there was a fierce competition between astronomers to be the first to measure a [stellar parallax](#) accurately. In 1838 Bessel won the race, announcing that [61 Cygni](#) had a parallax of 0.314 [arcseconds](#); which, given the diameter of the [Earth](#)'s orbit, indicated that the star is 10.4 ly away. If the currently accepted figure of 11.4 ly (see [61 Cygni](#) and discussion page) is correct, Bessel's figure had an error of 8.8%. He narrowly beat [Friedrich Georg Wilhelm Struve](#) and [Thomas Henderson](#), who measured the parallaxes of [Vega](#) and [Alpha Centauri](#) in the same year.

As well as helping determine the parallax of 61 Cygni, Bessel's precise measurements allowed him to notice deviations in the motions of [Sirius](#) and [Procyon](#), which he deduced must be caused by the gravitational attraction of unseen companions. His announcement of Sirius's "dark companion" in 1844 was the first correct claim of a previously unobserved companion by positional measurement, and eventually led to the discovery of [Sirius B](#).

Razdalje do zvezd s paralakso

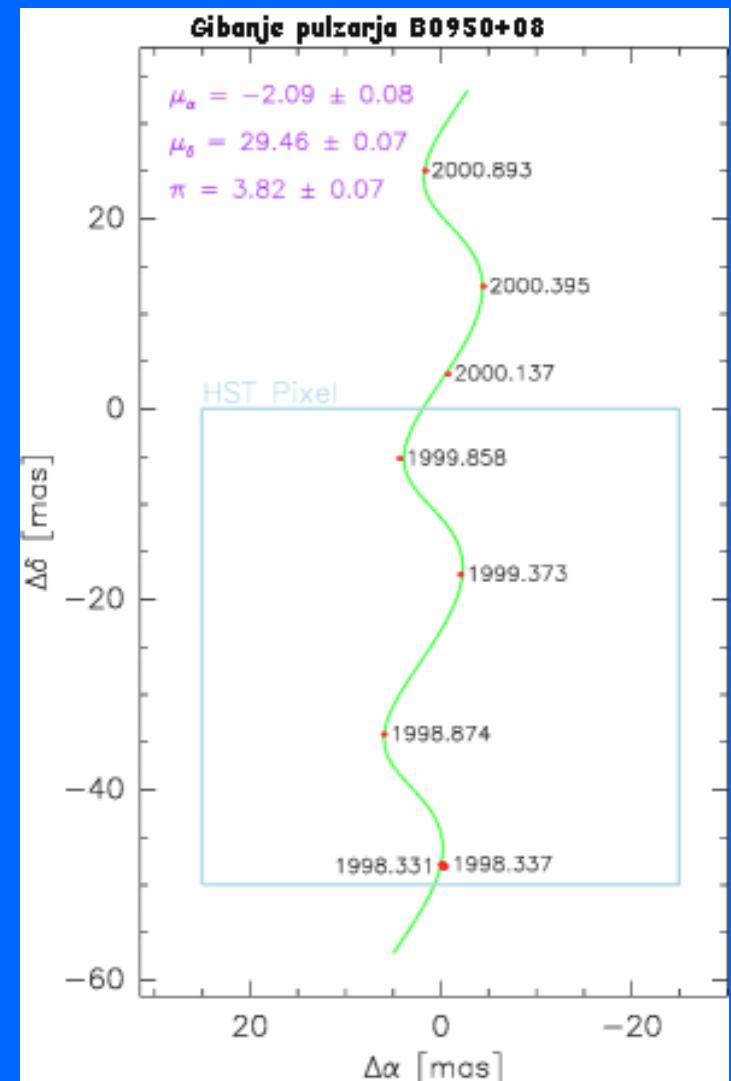


Paralaksa in lastno gibanje



Lastno gibanje Proksime Kentavra med letoma 1976 (levo) in 1993 (desno).

Gibanje Barnardove zvezde v vidni svetlobi (levo) in pulzarja B0950+08 v radijski svetlobi (desno).



Heliocentrični sistem: kritične meritve v zgodovini

- Sonce je največje: Eratostenes, Aristarh
- Sonce je vir svetlobe: Lunine mene, mene planetov, izgled (repi...) kometov
- Planeti so kot Zemlja: njihove mene, obstoj lun planetov
- Paralaksa in kotna velikost planetov, moderne meritve njihove razdalje
- Položaji planetov, vključno z medsebojnimi perturbacijami
- Radialna hitrost planetov in zvezd
- Aberacija svetlobe
- Zvezdna paralaksa in lastno gibanje
- Potovanja v Osončju
- ... za „nove“ teorije Osončja ni prostora

Zgodovina odkrivanja našega Osončja

- do 1600: Zemlja, Sonce, Luna, Merkur, Venera, Mars, Jupiter, Saturn
- 17. stoletje: 9 Jupitrovih in Saturnovih lun
- 18. stoletje: Uran in 2 njegovi luni, 2 Saturnovi luni
- 19. stoletje: Neptun, še 8 večjih lun, asteroidi (464)
- 20. stoletje: Pluton, z vesoljskimi sondami in uporabo CCD kamer
število odkritij malih objektov “eksplodira”
- 21. stoletje: Plutona ni več med planeti