**Anaxagoras**

Science started in the shadow of prison bars. Anaxagoras, who was born on the western shore of Asia Minor about the year 500 before the present era, taught “the moon has a light which is not its own, but comes from the sun.” From this it followed: “The sun is eclipsed at the new moon through the interposition of the moon.” [(1)](http://www.varchive.org/ce/orbit/anax.htm#f_1)

“He was the first to set out distinctly the facts about the eclipses and illuminations,” wrote Hippolytus, a father of the Church, in his *Refutation of All Heresies.*

In the first century of the present era Plutarch gave this account:

Anaxagoras was the first to put in writing, most clearly and most courageously of all men, the explanation of the moon’s illumination and darkness. . . . His account was not common property, but was [still] a secret, current among only a few . . . For in those days they refused to tolerate the physicists and stargazers, as they were called, who presumed to fritter away the deity into unreasoning causes, blind forces, and necessary properties. Thus Protagoras was exiled, and Anaxagoras was imprisoned and with difficulty saved by Pericles.[(2)](http://www.varchive.org/ce/orbit/anax.htm%22%20%5Cl%20%22f_2)

Anaxagoras was accused of impiety and sentenced for holding that the sun is a red-hot stone and the moon is of earthy nature. This was in disagreement with the view that these luminaries were deities. He taught: “The sun, the moon, and all the stars are stones of fire, which are carried round by the revolution of the aether.” [(3)](http://www.varchive.org/ce/orbit/anax.htm#f_3)

Anaxagoras was put in prison and was marked for death, but Pericles barely succeeded to release him from the death house and set him free.[(4)](http://www.varchive.org/ce/orbit/anax.htm%22%20%5Cl%20%22f_4) According to another account he was fined the heavy fine of five talents of silver and banished.[(5)](http://www.varchive.org/ce/orbit/anax.htm%22%20%5Cl%20%22f_5) Possibly, the fine and expatriation were imposed upon him in lieu of capital punishment, by Pericles’ endeavor.

According to Theophrastus, Anaxagoras held that the moon was sometimes eclipsed by the interposition of other bodies (besides the earth) traveling below the moon.[(6)](http://www.varchive.org/ce/orbit/anax.htm%22%20%5Cl%20%22f_6) Modern science does not know of such occultations of the moon and therefore denies such an explanation. Only large swarms of meteorites or comets, if interspersed between the earth and the moon, could cause the phenomenon.

Anaxagoras taught also that the terrestrial axis changed its direction in the past.[(7)](http://www.varchive.org/ce/orbit/anax.htm%22%20%5Cl%20%22f_7) But if to give credence to Hippolytus, he thought that “the earth is flat in form.” [(8)](http://www.varchive.org/ce/orbit/anax.htm#f_8) However, he believed that there are many earths like ours. According to a fragment of his,

Men were formed and other animals which have life; the men too have inhabited cities and cultivated fields as we do; they have also a sun and a moon and the rest (of the stars) as we have, and their earth produces for them many things of various kinds.[(9)](http://www.varchive.org/ce/orbit/anax.htm%22%20%5Cl%20%22f_9)

In this there was already an initial departure from the belief in the uniqueness of the earth and its central position in the universe.

 **References**

1. Hippolytus, *Refutatio Omnium Haeresium,* I. 8. 6.
2. Plutarch, *De Placitis Philosophorum, “Anaxagoras.”*
3. Diogenes Laertius, *Lives of the Philosophers* II. 8.
4. *Ibid.,* II. 13.
5. *Ibid.,* II. 12.
6. Theophrastus
7. *Diogenes Laertius*, II. 9.
8. Hippolytus, *Refutatio Omnium Haeresium,* I. 8. 3.
9. Fragment 4 (H. Diels ed., *Die Fragmente der Vorsokratiker* [Berlin, 1952] II. 59).

# Aristarchus

The first of the Greek philosphers and mathematicians to unravel the celestial plan and announce the discovery was Aristarchus of the isle of Samos. Others before him assumed that the Earth is a sphere and that it moves, but he was the first to formulate plainly the heliocentric theory, the scheme which has the Sun in the center.

Aristarchus lived from about the year 310 before the present era to about 230, and among the geometers he succeeded Euclid and preceded Archimedes. In -288 or -287 he followed Theophrastus as the head of the Peripatetic School established by Aristotle.

Aristarchus’ only extant treatise is “On the Sizes and Distances of the Sun and Moon.” In it he calculated the diameter of the Sun as about seven times the diameter of the Earth, thus estimating the Sun’s volume as about 300 times the volume of the Earth (the actual diameter of the Sun is about 300 times the diameter of the Earth; the solar volume is equal to 1,300,000 volumes of the Earth). In this work of Aristarchus there is nothing indicating his heliocentric theory. It was probably this his realization of the superior mass of the Sun that brought him to his discovery. Or should a celestial body three hundred times larger than the Earth revolve around it each day?

Aristarchus’ book on the planetary system with the Sun in the center did not survive, and we know of it only through references to its content, chiefly by Archimedes. Archimedes, who was twenty-five years his junior, wrote: “Aristarchus brought out a book consisting of certain hypotheses. . . . His hypotheses are that the fixed stars and the Sun remain unmoved, and that the Earth revolves about the Sun in the circumference of a circle, the Sun lying in the middle of the orbit.” He also added that according to Aristarchus who is in contradiction to “the common account” of astronomers, the universe is many times larger than generally assumed by astronomers, and the fixed stars are at an enormous distance from the Sun and its planets.[(1)](http://www.varchive.org/ce/orbit/arisam.htm%22%20%5Cl%20%22f_1) Aristarchus regarded the Sun as one of the fixed stars, the closest to the Earth. “Aristarchus sets the Sun among the fixed stars and holds that the Earth moves round the sun’s circle (i.e., ecliptic)” referred another author, centuries later.[(2)](http://www.varchive.org/ce/orbit/arisam.htm#f_2)

As Archimedes said, the view of Aristarchus conflicted with the common teaching of the astronomers, and he also quoted it only to put it aside disapprovingly. One of the contemporaries of Aristarchus, Cleanthes, wrote a treatise “Against Aristarchus.” [(3)](http://www.varchive.org/ce/orbit/arisam.htm#f_3) Whatever his scientific argument may have been, he accused Aristarchus of an act of impiety. Plutarch wrote in his book *Of the Face in the Disc of the Moon* *(De facie in orbe lunae)* that Cleanthes “thought it was the duty of the Greeks to indict Aristarchus of Samos on the charge of impiety for putting in motion the Hearth of the Universe, this being the effect of his attempt to save the phenomena by supposing heaven to remain at rest and the Earth to revolve in an oblique circle, while it rotates, at the same time, about its own axis.” [(4)](http://www.varchive.org/ce/orbit/arisam.htm#f_4)

We do not know whether there was any actual court action and verdict; however, we know that a verdict of judges, even if unanimous, could not make the Sun a satellite of the Earth. Not even a scientific tribunal can do this, not even if it is presided over by Archimedes and the most illustrious men of the generation sit as judges.

The spokesman of the scholarly world was Dercyllides, who announced that “we must assert the Earth, the Hearth of the house of the Gods, according to Plato, to remain fixed, and the planets with the whole embracing heaven to move and reject the view of those who brought to rest the things which move and set in motion the things which by their nature and position are unmoved, such a supposition being contrary to the theories of mathematicians.[(5)](http://www.varchive.org/ce/orbit/arisam.htm#f_5)

Aristarchus had no followers in his generation, nor in the next generation. About a century after Aristarchus, Seleucus, a Chaldean of Seleucia on the Tigris, who lived and wrote about the year 150 before the present era, adopted the teaching of Aristarchus.

Hipparchus was a contemporary of Seleucus. Hipparchus is thought to be the greatest astronomer of antiquity, and even today there are worshippers of his among the menbers of the faculties. But he rejected the heliocentric system of Aristarchus, and this he did not on a religious ground, but on a scientific one. A system with the Sun in the center of circular orbits could not account for the peculiarities in the visible motions of the planets, but the theory of epicycles could, and this theory had the Earth immobile in the center of the universe.

Thus the religious dogma and the mathematical analysis, both, condemned Aristarchus and his teaching that the Earth circles around the Sun.

 **References**

1. Archimedes, ed. Heiberg, vol. II, p. 244 *(Arenarius* I. 4-7); *The Works of Archimedes,* ed. Heath, pp. 221-222. See Heath, *Aristarchus of Samos,* (Oxford University Press, 1913) p. 302.
2. Aetius (ii.24.8) *Dox. Graec.* p. 355.19 Bekker. See Heath, *Aristarchus of Samos,* p. 305.
3. Diogenes Laertius, *Lives of the Famous Philosophers,* mentions such a tract among the works of Cleanthes. Cf. Th. Heath, *Aristarchus of Samos* (Oxford, 1913), p. 304.
4. *De facie in orbe lunae* ch. 6, pp. 922F-923A; cf. Heath, *Aristarchus of Samos,* p. 304.
5. Theon of Smyrna (ed. Hiller) p. 200, 7-12. Cf. Heath, *Aristarchus of Samos,* p. 304.

# Plato

In -399 Socrates was made to drink poison to expiate his crimes by the verdict of an Athenian court. Following his death, Plato, his disciple then about twenty-eight years old, left Athens for a short sojourn at Megara, followed by a longer stay in Italy and Sicily (Syrause); he also traveled to the Middle East. Only very little is known of this travel.

When a boy of about ten, Plato heard the story of Atlantis from his friend and playmate Critias the younger, what the latter was told by his grandfather, Critias the older, who in his turn had heard it from his friend Solon, who came to Sais in Egypt to learn wisdom and hear the ancient lore. From a very old priest he learned that in the past there had occurred several global catastrophes; in one of them Atlantis was swallowed by the waters of the Atlantic Ocean; in another—the one which the Greeks associated with Phaethon—there was a great conflagration caused by “a deviation of the bodies that revolve in heaven round the earth.” [(1)](http://www.varchive.org/ce/orbit/plato.htm#f_1)

On his travels, Plato, too, endeavored to learn wisdom from the wise men of the East. But since the time of Solon’s visit in Egypt that country went through a spiritual debasement and it is questionable whether anyone of the priesterly class there could be counted as a spiritual peer of Ezra, or a worthy teacher of Plato in search of wisdom.

Later Greek philosophers regarded Plato as influenced by Mosaic teaching. “Plato derived his idea of God from the Pentateuch. Plato is Moses translated into the language of the Athenians,” wrote Numenius and was quoted by Eusebius.[(2)](http://www.varchive.org/ce/orbit/plato.htm#f_2)

If one considers Plato’s monotheism, his concept of an invisible and supreme spiritual Being, so different from the prevalent polytheism of other Greek philosophers and so remote from the pantheon of Homer and its scandalous Olympians with their permanent strife and marital and extra-marital affairs with mortal women, one is inclined to think that Plato, at the time of his travel to Egypt thirty years old, happened to sit at the feet of Ezra. A late Greek tradition has it that Aristotle on his travel to the lands of the eastern Mediterranean met a very wise Jew from whom he learned much wisdom.[(3)](http://www.varchive.org/ce/orbit/plato.htm%22%20%5Cl%20%22f_3) However, it is not known whether Aristotle ever went to Palestine and Egypt. Besides, in Aristotle, a pupil of Plato, one feels a return to a polytheistic astral religion. Could it be that the indebtedness of Greek thought in the days of Plato to the Semitic idea of one and single invisible Creator stemmed from Ezra? We also don’t know of any “wise and knowledgeable man” approximating Ezra’s stature in the next few generations. All this belongs to the realm of the possible but unproven, and the probable presence of Ezra in Jerusalem after -398 (in the days of Artaxerxes II) is of interest for this intriguing problem.[(4)](http://www.varchive.org/ce/orbit/plato.htm#f_4)

 **References**

1. Plato, *Timaeus 22 C-D, 25 A, D.*
2. Eusebius, *Preparation for the Gospel* (transl. Gifford), XIII, 12.
3. Clearchus of Soli, quoted in Theodore Reinach, *Textes d’auteurs grecs et romains relatifs au Judaisme* (Paris, 1895), pp. 10-11.
4. See *Peoples of the Sea, “*Ezra.”

**Cicero and Seneca**

Cicero in the last century before the present era, the statesman and philosopher of republican Rome, declared the stars to be gods. The divinity of the planets he explained by their occupying the sublime positions and by their following unerringly their paths.

Since the stars come into existence in the aether, it is reasonable that they possess sensation and intelligence. And from this it follows that the stars are to be reckoned as gods. For it may be observed that the inhabitants of those countries in which the air is pure and rarefied have keener wits and greater powers of understanding than persons who live an a dense and heavy climate. . . . It is therefore likely that the stars possess surpassing intelligence, since they inhabit the ethereal region of the world.

Again, the consciousness and intelligence of the stars is most clearly evinced by their order and regularity . . . the stars move of their own free will and because of their intelligence and divinity. . . . Not yet can it be said that some stronger force compels the heavenly bodies to travel in a manner contrary to their nature, for what stronger force can there be? It remains therefore that the motion of the heavenly bodies is voluntary. . .

Therefore the existence of the gods is so manifest that I can scarcely deem one who denies it to be of sound mind.

This dogmatic thinking, changing the statute of faith but not the mode of thinking, existed in all ages: in the Rome of Cicero and Caesar, in the Rome of the Catholic Church, in modern observatories. The categorical manner in which the dissidents are castigated as being of unsound and vicious mind can be seen again in the burning of Giordano Bruno, in the compelling of Galileo to recant on his knees, in the coercing of the publisher of *Worlds in Collision* to give up the publication.

The notion expressed by Cicero that planets are divine bodies endowed with divine intelligence was deduced not fron the fact of their occupying the ethereal heights and moving unerringly—these attributes were only called upon to prove the existing idea of planets and stars being gods. And the source of this belief, deep-rooted and widespread, was in natural phenomena and extraordinary events of the past that grew dimmer with every passing generation.

Pliny, the Roman naturalist of the first century, knew to tell of interplanetary discharges: “Heavenly fire is spit forth by the planet as crackling charcoal flies from a burning log.” Interplanetary thunderbolts, according to him, have been caused in the past by each of the three upper planets—Mars, Mercury and Saturn.

Seneca, the contemporary of Pliny, mentor of Nero and philosopher, was no mathematician and no astronomer; however, he rose to a clearer concept of comets as members of the planetary system. The prevailing view was that of Aristotle, according to whom the comets are exhalations of the earth in sublunar space, something of the nature of rainbows. Seneca regards them as bodies akin to planets, yet not planets, on very elongated orbits, and he knows that the Chaldeans have determined their orbits: “Apollonius of Myndus asserts that comets are placed by the Chaldeans among the number of the wandering stars (i.e., planets) and that their orbits have been determined.” [(1)](http://www.varchive.org/ce/orbit/cicero.htm#f_1) He knows that comets are seen only when they come close to the sun, or when they reach the lowest portion of their course. He opposes the view that the comets are unsubstantial bodies; the argument is brought forward that the sight can penetrate through comets and see the stars behind; Seneca answers that this is the case with the tails of the comets, not with their heads, through which one cannot see. He knows the view expounded by Artemidorus that “the five planets are not the only stars with erratic courses, but merely the only ones of the class that have been observed. But innumerable others revolve in secret, unknown to us, either by the faintness of their light, or the situation of their orbit being such that they become visible only while they reach its extremities.”

“The day will yet come,” wrote Seneca in his treatise *De Cometis,*

when the progress of research through long ages will reveal to sight the mysteries of nature that are now concealed. A single lifetime, though it were wholly devoted to the study of the sky, does not suffice for the investigation of problems of such complexity. And then we never make a fair division of the few brief years of life as between study and vice. It must, therefore, require long successive ages to unfold all. The day will yet come when posterity will be amazed that we remained ignorant of things that will to them seem so plain. The five planets are constantly thrusting themselves on our notice; they meet us in all the different quarters of the sky with a positive challenge to our curiosity.

The man will come one day who will explain in what regions the comets move, why they diverge so much from the other stars, what is their size and their nature.

Many discoveries are reserved for the ages still to be when our memory shall have perished. The world is a poor affair if it does not contain matter for investigation for the whole world in every age . . . Nature does not reveal all her secrets at once. We imagine we are initiated in her mysteries. We are, as yet, but hanging around her outer courts.

Seneca was compelled to take his own life when accused of plotting against Nero, his pupil. He was born in the same year as Jesus of Nazareth. In less than three hundred years Rome was to become the citadel of the new religion. Three forces kept science from progressing and brought about the dark ages: the invasion of the hordes coming from the east and north; the influence of the Church that imposed dogmas and made the human spirit unfree; and the scientific dogma that petrified itself in a thousand-year-long worship of Aristotle—through all the years of the Middle Ages, with their crusades, scholasticism, and Black Death.

A strange amalgam of the Christian dogma and Aristotelianism becamem the credo of the Church, that regarded the world as finite, the earth as the center of the universe, and also immovable. The codification in the science of astronomy was performed by a distant pupil of Aristotle, Claudius Ptolemy, an Alexandrian astronomer and mathematician, the greatest authority in those sciences for his own age—he lived in the second century—and for all successive centuries until the time of de Brahe and Kepler, almost fifteen hundred years later, it was the undisputed dogma.

References

1. *Quaestiones Naturales,* tr. Clarke, p. 275.

# Newton

In the year Galileo died (1642), Newton was born. At the age of twenty-four, when a plague was ravaging the cities of England, he secluded himself at his parental home in Lincolnshire and there contemplated the motions of the heavenly bodies. This work of his was put aside for two decades; it was not until the year 1686 that the first edition of *Philosophiae Naturalis Principia Mathematica* was published. A testimony is preserved that says the figures Newton had of the size of the earth and thus of the terrestrial radius were rather inexact—and consequently his computations of the Earth’s gravitational pull did not agree with observations. And, it is said, when the French savant, J. Picard upon measuring the meridian in Lapland, came to the correct result, that Newton became confident of his formula for inertia and gravitation.[(1)](http://www.varchive.org/ce/orbit/newton.htm#f_1)

Life—claims (Hooke, Flamsteed, Leibnitz). Light corp.; space empty; how does gravitation act? nature of gravitation; law of simplicity.

When explaining his theory of celestial mechanics, Newton used the following example. A projectile—a stone—is thrown horizontally from the top of a high mountain; because of its weight it is

forced out of the rectilinear path, which by the initial projection alone it should have pursued, and made to describe a curved line in the air; and through that crooked way is at last brought down to the ground; and the greater the velocity is with which it is projected, the farther it goes before it falls to the earth. We may therefore suppose the velocity to be increased, that it would describe an arc of 1, 2, 5, 10, 100, 1000 miles before it arrived at the earth till at last, exceeding the limits of the earth, it should pass into space without touching it.[(2)](http://www.varchive.org/ce/orbit/newton.htm#f_2)

At a very definite curve, the result of a very precise and definite velocity of projection, the stone would follow the circumference of the earth and “return to the mountain from which it was projected” without falling to the ground or flying off into space.

For the sake of this example, “let us suppose that there is no air about the earth or at least that it is endowed with little or no power of resisting,” and that only the weight of the projectile causes it to bend its path.

One can observe that these two figures differ by seven percent, and that therefore complete correspondence is an exaggeration. There are other, much more close correspondences involving our moon, and they still belong in the domain of coincidences. The moon, for instance, is placed so on its orbit that it appears nearly the same size as the sun, and actually, during the full eclipses, the moon chances so to cover the sun that only the solar corona is seen over the dark zone of the moon. Also the already mentioned fact that the moon’s mean distance is very nearly equal to sixty terrestrial semi-diameters, the number of seconds in a minute; or the fact that light travels 186,000 miles in a second, and the diameter off.

At the age of fifty, when the biological process of involution generally sets in in man, Newton became ill and depressed. The excessive exploitation of his brain, his unrelenting search for answers to nature’s unsolved problems undermined and disturbed the mental balance of the genius. When Newton was forty-five years old, his *Principia* was published. Then he worked on optics. The story goes that he left his manuscript on the table close to a burning candle and went out of the room to look at a procession; a pet overturned the candle and the manuscript burned. This misfortune started his depression. It is questionable whether this is a true story. In a young man mental depression usually sets in when the person faces a big task and is afraid to fail; in the second half of life, the person becomes depressed mostly as the result of slighting and humiliation. It would be wrong to think that a person who is great is protected by his greatness from the feeling of slighting and humiliation. Newton’s experiences with Hooke, with Leibnitz, and with Flamsteed could have been the real cause.

Edlestone, *Correspondence, p. LXIII.*

Brewster, *Life of Newton,* II, 142.

Dr. Ferd. Rosenberger, *Isaac Newton und seine physikalischen Prinzipei* (Leipzig, 1895).

Letter to Pepys (p. 278 in Rosenberger)

It is possible and even probable that if Newton lived in our time he would not support his theory of the mechanical movement of the planets. At the end of the *Principia* he wrote:

But hitherto I have not been able to discover the cause of those properties of gravity from phenomena, and I have no hypotheses; for whatever is not deduced from the phenomena is to be called an hypothesis; and hypotheses, whether metaphysical or physical, whether of occult qualities of mechanical, have no place in experimental philosophy.

Thus he felt that he left his theory of gravitation unjustified because he was unable to explain the cause of gravity and the nature of this phenomenon. However, he must have had some intuitive inkling of where to look for explaining gravitation, because on the same page, which is at the end of the third book of *Principia,* he wrote:

References

1. But cf. the comments of F. Cajori in his edition of Newton’s *Principia* (Berkeley, 1946), p. 663. Cf. also the *Mathematical Gazette* 14 (1929), p. 415.
2. Isaac Newton, *The System of the World,* Sec. 3, published with his *Principia* , transl. Motte, ed. F. Cajori (1946).

# Descartes

In 1633 Rene Descartes, philosopher and geometer, then thirty-seven years old, was preparing for publication a great work, *Le Monde et le Traite de l’Homme,* when at the end of November of that year the news arrived at Deventer, Holland where Descartes was staying at that time, of the persecution to which Galileo had been subjected in Rome. Not desirous of coming into conflict with the Catholic Church, Descartes decided against the publication of his work and, being also a practicing Catholic, he wrote to the mathematician Marin Mersenne:

This [the condemnation of Galileo] came as so much of a surprise to me that I have all but made up my mind to burn my papers in their entirety, or at least not allow them to be seen by anyone. For I could not imagine that Galileo would have been prosecuted for anything else but that, no doubt, he must have wanted to establish the motion of the Earth which, I am well aware, was at one time censured by several cardinals; but I thought I heard it said that even afterwards the public teaching of it was not discontinued, not even in Rome; and I confess that if it is wrong, so are the entire foundations of my philosophy, for it [i.e., the motion of the Earth] is demonstrated by them, evidently. And it is so closely tied to all parts of my treatise that I would not know how to separate it without making the rest defective. But since I would not for anything in the world want that from me should come so much as a word disapproved of by the Church, I would prefer to suppress it, rather than to let it appear mangled. . . . I beg you also to send me whatever you know about the Galileo affair.

Descartes never again picked up the manuscript, and it was not published until decades later, long after his death. Instead, in 1644, Descartes published his *Principes de la Philosophie,* in which he developed his theory of the mechanism of planetary motions. The universe is filled with subtle matter, some kind of effluvium, not much different from the ether of later authors; the sun by its rotation causes this effluvium to be concentrated in vortices that carry the planets around the sun on their orbits.

Whatever was the manner whereby matter was first set in motion, the vortices into which it is divided must now be so disposed that each turns in the direction in which it is easiest for it to continue its movement for, in accordance with the laws of nature, a moving body is easily deflected by meeting another body.

Descartes’ theory of vortices soon became the accepted teaching about the mechanism of the solar system.

Descartes himself proved, however, that philosophers who solve the mysteries of the world can commit fatal mistakes. After some deliberation and wavering, he accepted the insistent invitations to teach philosophy to Queen Christina of Sweden. As so many shallow persons, she was flattered to have the most famous philosopher of Europe at her feet—and actually at her bedside—for she ordered him to appear every morning at five to start the lesson. He cared for nothing more in his habits as for a late rising. The cold nights and early morning hours in the winter of Sweden broke his health, and four months after arrival in Sweden he died there from pneumonia.

Cartesian philosophy finds many followers until today. But his scheme of things celestial has long been regarded as discredited: this teaching prevailed on the continent in his lifetime and still in the lifetime of Newton, but not much longer.

# Laplace

On February 10, 1773, Pierre Simon Laplace, a twenty-three years old scientist, read before the Academy of Sciences in Paris a paper in which, on the basis of the Newtonian theory of gravitation, he announced the invariability of planetary mean motions. “This was the first step in the establishment of the stability of the solar system,” says the *Encyclopaedia Britannica* (14th ed.). A mathematical genius, Laplace showed in a mathematical analysis that the planets must proceed on their paths to the end of time and that, accordingly, they have been on their present orbits since the very beginning. In a series of papers Laplace and Lagrange, another mathematical genius whose ideas went in the same direction, vied in a complete substantiation of this thesis of invariability of the planetary mean motions. No planet could ever have joined the family of the planets; no planet has ever changed its orbit. It was a work of stability in the cosmos carried through to the very eve of the French Revolution. In 1796, in a note to the *Exposition du systeme du monde,* Laplace offered his idea of the origin of the solar system. it was a large nebula, it rotated, and because of the gravitation of the mass to its center, a sun formed itself in the middle, and condensed. The outer parts of the nebula broke into rings, and the rings rolled themselves into globes—the planets. He insisted that there could be no accident in the fact that the sun, all known planets, all known satellites, roll in the same direction, counterclockwise. And, being a master of the theory of probabilities, he concluded that there are four billion chances against one that this plan is not the result of chance. Even the best known historical events have not been authenticated at the same ratio of four billion against one. By today we known that Laplace was wrong: with the discovery of the first retrograde satellite—and today more than ten retrograde satellites are known. The rotation of Venus is also retrograde, as is that of Uranus, discovered in 1781. The four billion against one odds became zero against one: there may still be a common plan in the arrangement, but this plan was no more evident.

Nevertheless, the estimate of the twenty-three year old Laplace that the planetary orbits are eternal became the pricipal statute of faith, or the supreme dogma of the astronomers of the nineteenth and twentieth centuries. On it is based the astronomy of today.

According to Laplace, gravitation, in order to keep this system together, must propagate with a velocity that, compared to the velocity of light, is at least fifty million times greater. And since light propagates with the velocity of 300,000 kilometers in a second (186,000 miles), the velocity with which gravitation must propagate in order that the solar system should not fall apart must be infinite, or instantaneous. This last postulate of Laplace was sometimes silently dropped out of his theory; and the permanency of the celestial orbits remained, and served as alpha and omega of all subsequent thinking.

# Voltaire

Francois Marie Arouet de Voltaire (1694-1778), wit, liberal, and freethinker, at the age of thirty-one was insulted by Chevalier de Rohan and answered with a biting sarcasm. A little time later, when dining at the table of the Duc de Sully, he was asked to step out and was beaten by the servants of Rohan, who looked on. For three months Voltaire postponed to challenge Rohan to a duel; then he challenged, but on the morning set for the encounter, he was arrested and put into the Bastille; after two weeks there he, in accordance with his own wish, was deported to England. there he stayed for three years, from 1726-1729.

When Voltaire returned to France, he was a self-appointed agent of all things British. In the world of thought the supreme point of difference between the French and the British lay in the conflict of views of Descartes and Newton on the mechanics of the universe. Descartes was long dead, and Newton died in 1727, during Voltaire’s stay in England. The French scientists in general kept to the teaching of Descartes about the vortices that compel the planets to follow their paths; the British scientists adopted the Newtonian teaching of universal gravitation, and the debate was going on upon Voltaire’s return to France. In the years that Voltaire spent at Cirey as a guest of Madame du Chatelet, he wrote, with her assistance, a long treatise on the Newtonian system of the world. The singular influence Voltaire gained in France, in Germany, and in the rest of Europe was responsible for the early acceptance of the Newtonian system and the rejection of the Cartesian. Although himself no mathematician, Voltaire set himself up as the supreme judge and decided in favor of Newton and against his compatriot. He actually stopped the debate. His influence was also responsible, more than anything else, for making the deeply Catholic France into a nation of freethinkers, thus paving the road to the French Revolution of 1789, that took place eleven years after his death.

# Nicolas Boulanger

The name Nicolas Boulanger is not found in most encyclopedias and is known only to a few scholars. He was a contemporary of Jean-Jacques Rousseau, Voltaire, and Diderot, illustrious names in the history of French letters. He lived only thirty-seven years, from 1722 to 1759. I came across the name very late in my research,[1](http://www.varchive.org/ce/orbit/boulanger.htm%22%20%5Cl%20%221) actually in 1963 and read in his works a few years later. I found that in some aspects he was not only my predecessor, but also a predecessor of Jung and Freud, actually solving the problem Freud and Jung left unsolved. Namely, he understood that the irrational behavior of the human species together with all the heritage of religious rites and much of the political structure of his own and other ages, were engendered in cataclysmic experiences of the past, in the Deluge, or deluges, of which there could have been more than one.

In Boulanger’s time geology as a science was in a prenatal stage. But as a road engineer he made observations in the valley of the Marne that made him draw conclusions which he substantiated in reading the then existing books of folklore and sacred writings; also classical writers were available to Boulanger, either in originals or in translation. He was convinced that the Deluge was a global occurrence, but this was no innovation on his part, because it was an accepted notion in his time: actually, he was the author of the entry “Deluge” in the great French *Encyclopédie*, edited by Diderot. In his books he referred sometimes to the Deluge as to a singular occurrence, but then he spoke of multiple cataclysms. He seems not to have had an idea from where the water of the universal flood could come, and did not show awareness of any extraterrestrial agent as causing the world-wide calamity. Thus Saturn does not figure as connected with the upheaval. Human beings witnessed the catastrophes and the human race suffered one or several traumatic experiences; the scars the human psyche sustained are buried deep in the souls of all of us.

“We still tremble today as a consequence of the deluge and our institutions still pass on to us fears and the apocalyptic ideas of our first fathers. Terror survives from race to race... The child will dread in perpetuity what frightens his ancestors.”[2](http://www.varchive.org/ce/orbit/boulanger.htm%22%20%5Cl%20%222)

Boulanger’s works were published after his premature death by Diderot, but his geological observations were not included in the printed volumes; extracts from these observations and selections appear in a recent work on Boulanger,[3](http://www.varchive.org/ce/orbit/boulanger.htm%22%20%5Cl%20%223) and do not impress as compelling. But one has to keep in mind that the age of geology as a science did not start but after Boulanger’s death. In the broad realization that our society as well as the savage society still lived in the shadow of the traumatic experience of the past, Boulanger not only preceded Jung and Freud but also spelled out the nature of the traumatic experience or experiences that caused the memory of them to submerge in the racial mind.. Thus he not only could claim priority in the understanding of the phenomenon of racial memory and collective amnesia, but also could claim the fact, unrecognized by Freud, that catastrophic events served as the trauma. Neither Jung nor Freud knew anything of Boulanger, and his name is not found in the psychological literature. Not so much his claim that catastrophic events took place in the past deserves attention—such view was already found in the writings of William Whiston; again, Buffon, Boulanger’s contemporary thought that a massive comet hit the sun and caused the origin of the planetary family; and after Boulanger the scientific thought of the eighteenth century and of the first half of the nineteenth again and again sought for the cause of the global upheavals. However Boulanger’s distinction lay in his contemplating the consequences of such upheavals for the human psyche.

 **References**

1. First in the paper by Livio Stecchini, “The Inconstant Heavens,” included in the September 1963 issue of the *American Behavioral Scientist* (Vol. VII, no. 1, p. 30).
2. *L’antiquité devoilée par ses usages, ou examen critique des principales opinions cérémonies et institutions religieuses et politiques Des différens peuples de la terre* (Amsterdam, 1766).
3. John Hampton; *Nicolas-Antoine Boulanger et la science de son temps* (Geneva-Lille, 1955).

# Adams

The greatest triumph of the celestial mechanics built on gravitation and inertia to the exclusion of any other forces took place in 1846 when Neptune was discovered in the place in the sky calculated by Adams and Leverrier independently of each other; they indicated the direction where the planet would be found with the exactness of one degree; they calculated its position by considering the unaccounted for perturbations of Uranus. The story of its discovery is an exciting chapter in the history of astronomy: how the poor student Adams stood in the antechambers of the Royal Astronomer Airy and was sent away by the valet because Sir Airy was at the table, and how he tried to convince the powerful astronomer of the existence of an eighth planet by sending in his calculations; and how the Frenchman Leverrier was much more fortunate by having performed very similar calculations and by having sent them to the observatory at Potsdam where the young astronomer Gale, the very first night at the very first look at the indicated direction found the new planet. The excited scientific community in Europe was soon plunged into the debate who of the two was the true discoverer, or better prognosticator, since Gale was the discoverer of the planet; the passions were divided by the national line, with the French and British rivalries inflamed, and the Royal Astronomer had to defend his behavior; there exists quite a literature on the subject. The French insisted on their priority and even named the new planet “Leverrier,” and it took some time before its new name Neptune prevailed. Till today the case is debated and the pride of Britannia, in any event deprived of priority, of the greatest discoveries, is still not completely healed.

The discovery was hailed by the British and the French—and by everyone—as the greatest triumph of the Newtonian theory of gravitation. Uranus showed certain irregularities in its motion unaccounted for by the gravitational pull of the known planets, and the existence and the position of a planet not yet seen was claimed by Adams and Leverrier alike. This was possibly the best prognostication in the annals of science. But was it really so precise and was it such a triumph for Newton as always asserted?

The so-called Bode’s Law is the empirically established regularity, covered by a simple formula, in the mean distances of the planets from the sun. This regularity can be traced through the planetary system from Mercury to Uranus (the one vacant place, between the orbits of Mars and Jupiter, was filled in, when in the first night of the nineteenth century Ceres, the first of the many asteroids was discovered by Piazzi Smyth). Adams and Leverrier alike assumed that the planet which causes unaccounted perturbations in Uranus must be located at a distance dictated by Bode’s Law. And since Saturn, the sixth planet, is smaller than Jupiter, the fifth, and Uranus, the seventh, is smaller than Saturn, it would be quite logical to expect a planet smaller than Uranus at a distance of 1,750,000,000 miles from its orbit. But next the calculations showed that the distance of the two planets when in conjunction is not 1,750,000,000 miles but only roughly 1,000,000,000; and with the gravitational attraction decreasing with the distance as the inverse square of the latter, the mass of the newly discovered planet was grossly overestimated: it was supposed to exert the influence from a much greater distance than one actually found. It was not enough to show the direction where the planet would be found; it was necessary, in order that the prediction should be true, that the planet would be at the distance predicted, and it was not with Adams, nor with Leverrier, both of whom committed the same error. Therefore, when the great controversy raged between the supporters of Adams and those of Leverrier, some voices were heard that neither of them was a true prognosticator and there was no point in the rivalry. To make a distance error of 75 percent was equal to a threefold overestimate of the mass of the planet. In order to produce the effects from its true distance Neptune needed to be three times as massive as it actually is. Bode’s Law broke down with the discovery of Neptune. And though Neptune is a little more massive than Uranus, the discrepancy between what was expected and what was found in no manner can be regarded as a rigid confirmation of the Newtonian celestial mechanics with an exact formula of attraction between masses at changing distances. The story is not yet at its end, and we need to tell of the discovery of Pluto, the ninth planet, which should have explained what Neptune left unexplained, but failed to do so, either, and by a still larger margin.

Yet in 1846 the discovery of Neptune was acclaimed, and because of the inertia of the human mind, is still acclaimed as the greatest proof of the truth of Newtonian celestial laws of gravitational mechanics.

**Nicola Tesla**

In the beginning of this century a Croatian\* engineer, emigrant to America, Nikola Tesla, measured the electrical charge of the planet Earth and found it of a very high potential. He made his observation during thunder storms.

My instruments were affected stronger by discharges taking place at great distances than by those near by. This puzzled me very much. . . . No doubt whatever remained: I was observing stationary waves. As the source of the disturbances [thuderstorm] moved away, the receiving circuit came successively upon their nodes and loops. Impossible as it seemed, this planet, despite its vast extent, behaved like a conductor of limited dimensions. The tremendous significance of this fact in the transmission of energy by my system had already become quite clear to me. Not only was it practicable to send telegraphic messages to any distance without wires, as I recognized long ago, but also to impress upon the entire globe the faint modulations of the human voice, far more still, to transmit power, in unlimited amounts, to any terrestrial distance and almost without loss.[(1)](http://www.varchive.org/ce/orbit/tesla.htm#f_1)

Nikola Tesla was a pioneer in many fields of electrical theory and technology. He was the first to utilize alternating current, conceiving an effective system for its generation, transmission, and utilization. Edison appealed to the public, warning that the alterating current of Tesla would cause great harm to its users, being dangerous, and that only direct current can be harmlessly used. Tesla referred to Edison as an inventor, to himself as a discoverer. Today everyone knows that alternating current, with the help of the polyphase induction motor, can be converted into mechanical energy more effectively and economically than direct current. He invented new forms of dynamos, transformers, condensers, and induction coils. He discovered the principle of the rotary magnetic field, upon which the transmission of power from the Niagara Falls and other waterfalls and dams is carried on. A regal recluse, he despised the short-seeing men of science. Many of his pioneer inventions he carried with him to his grave. But he believed in the destiny of man who, in his words, “searches, discovers and invents, designs and constructs, and covers with monuments of beauty, grandeur and awe, the star of his birth.”

This teaches us that not only have the contempories of a revolutionary idea in science repeatedly rejected the idea, but also that a rejection of such an idea even by the best qualified men in the field in the generation of the revolutionary, and often still in the following generations, has occurred not once or twice, but many times. Archimedes rejected the heliocentric system of Aristarchus; Brahe rejected the system of Copernicus; and Galileo was deaf and blind to the discoveries of Kepler, just as Edison warned against the alternating current developed by Tesla. And who was more competent to judge than Archimedes, in his time, Brahe in his, Galileo in his, and Edison in his?

 **References**

1. *Electrical World and Engineer* May 5, l904; see also *Century,* June 1900. Quoted from J. J. O’Neill, *The Prodigal Genius: Life of Nikola Tesla,* 1944, p. 181.

\* [Tesla was in fact a Serb who was born in the Croatian village of Smiljane in the Lika region, which at the time was part of Austrian monarchy. His father was an orthodox priest.— Eds.]

# Einstein

Einstein was born in 1879, the year Maxwell died. It was the year when Michelson made the first in the series of his experiments in investigating the velocity of light. Einstein was born in Ulm, the town in which Kepler, his favorite scientist of earlier times, had spent some of the last months of his life, before dying in 1630. In high school the geography teach declared Einstein to be moronic; in the Zurich Polytechnic his physics professor, as Einstein told me, once said to him: “In this college the poorest class is of experimental physics, and the poorest pupil are you.” Upon graduation he was unable to secure a teaching position and, after years of private tutoring of students deficient in mathematics, he was happy to receive the position of a patent examiner in the Bern Patent Office. There he profited in learning to express himself in short and exact terms. At the age of twenty-six, in 1905, he offered the theory of relativity, later called the “special” or “restricted” theory of relativity, in distinction from the theory he offered eight years later, the “general” theory of relativity.

Should I try to put into one single sentence the gist of the theory in 1905, I would do it thus:

Space and time, regarded as absolute and unvariable entities (hour is always an hour, a meter is everywhere a meter), were declared to be relative, or changing, entities; the speed of light in a vacuum, thought to be a relative quantity (depending on the relative motion of the light source and the observer) was declared to be an absolute, unvarying entity.

A second is no longer a second for all observers. A second of time is of different duration for observes in motion and at rest; but 186,000 miles per second, whatever miles or whatever seconds, was always true.

A mile-long spaceship travels and overtakes our earth. A light signal is sent in the very middle of the spaceship; for the traveler in the spaceship the light will arrive simultaneously at both of its ends; for the observer on earth (assuming he could observe such small differences) the light will come first to the rudder that travels toward the light and then to the bow that travels away from the light. Thus the very notion of simulataneity was emptied of real content.

The theory of Fitzgerald made the matter shorter when crossing through ether and thus masked the change in velocity of light; Einstein, however, made the velocity of light in a vacuum an immutable quantity, or a constant for all observers in whatever relative motion to the source of light they might be.

This is a sentence that can be expressed mathematically; but it is not easy to visualize it by reason. A light leaves its source and whatever object it meets in motion, toward or away from the source of light, the relative velocity of light and the object is always 186,000 miles per second.

Thus a ray of light speeds from the place of explosion in Coventry with the velocity of 186,000 miles per second to Birmingham and with the same velocity in the opposite direction toward Rugby; but the two photons of light speeding in opposite directions have a relative speed of 186,000 miles per second, not of 392,000 miles per second: nothing can be swifter than 186,000 miles per second, the velocity of light.

In those early years of Einstein’s career, he spent often his time in discussions with another mathematical genius, W. Ritz. The latter could not see that the velocity of the source would not add itself to the velocity of light: in mechanics, a stone thrown by a passenger in a train acquires not only the velocity of throw but also the velocity of the train that carries the passenger. Ritz printed a paper to oppose the notion of Einstein. De Sitter answered Ritz and proved his point on an astronomical reasoning. There are double stars so placed in space that one partner eclipses the other at regular intervals. If the velocity of the retreating star would reduce from the speed of light reaching the observer and the velocity of the advancing star would add to the speed of light emitted by it, the system would appear to deviate from Keplerian motions. Such is definitely not the case.[(1)](http://www.varchive.org/ce/orbit/einorb.htm#f_1) the earth would be such that the reduction in the speed of light would let the light of one star of the binary arrive to the earth when the star would appear to be in the same place where its companion would appear at the same time. [phrase better].

The special theory of relativity explained why an ether drift cannot be detected through the experiment with the velocity of light; but it went a step farther and disclaimed any necessity of an ether. This makes a very great difference—probably the next question after the perennial “Is there a God?” is “Does a medium fill all space or is space between the material masses empty?” And not just *between* material masses—ether is supposed to fill everything, all space and all matter. Between the electrons and protons of an atom there is comparatively very wide space, as it is between the sun and the planets. Is the space all filled or is it empty?

References

1. W. Ritz, “Das Prinzip der Relativitaet in der Optik,” *Gesammelte Werke* (Paris, 1911).