Albert Einstein Biography

Albert Einstein (March 14, 1879 - April 18, 1955) was a theoretical physicist, with considerable applied mathematical abilities, who is widely regarded as the greatest scientist of the 20th century. He proposed the theory of relativity and also made major contributions to the development of quantum mechanics, statistical mechanics and cosmology. He was awarded the 1921 Nobel Prize for Physics for his explanation of the photoelectric effect and "for his services to Theoretical Physics".

After his general theory of relativity was formulated, Einstein became world-famous, an unusual achievement for a scientist. In his later years, his fame exceeded that of any other scientist in history, and in popular culture, Einstein has become synonymous with someone of very high intelligence or the ultimate genius. His face is also one of the most recognizable the world-over. In 1999, Einstein was named "Person of the Century" by Time Magazine. This popularity has also lead to a widespread use of Einstein in advertisement and merchandising, eventually including the registration of Albert Einstein as a trademark.

In his honor, a unit used in photochemistry, the einstein, as well as the chemical element einsteinium were named after him.

Einstein was born in 1879 at Ulm in Württemberg, Germany, about 100 km east of Stuttgart. His parents were Hermann Einstein, a featherbed salesman who later ran an electrochemical works, and his wife Pauline, née Koch. Although from a non-observant

Jewish family, Albert attended a Catholic elementary school and, at the insistence of his mother, was also given violin lessons during his youth. At five years of age, his uncle showed him a pocket compass, and he realized that something in "empty" space acted upon the needle. He built models and mechanical devices for fun, but was considered a slow learner as a child by some, possibly due to dyslexia or simply because of his shyness. (He later credited his development of the theory of relativity to this slowness, saying that by pondering space and time later than most children, he was able to apply a more developed intellect.) He began to learn mathematics at about age twelve. There is a recurring rumor that he failed math later on in his education, but this is not true; it was caused by a change in the way grades were assigned leading to confusion years later. Two of his uncles fostered his intellectual interests during his late childhood and early adolescence by suggesting and providing books on science and math.

Following the failure of his father's electrochemical business, in 1894 the Einsteins moved to Pavia, Italy (near Milan) from Munich. Albert remained in Munich to finish school. He completed a term by himself and then moved to Pavia to join his family. In 1895, Einstein took an exam for the Eidgenössische Technische Hochschule (Federal Swiss Polytechnic University, in Zurich), but failed the liberal arts portion of the test. He was sent by his family to Aarau, Switzerland to finish secondary school. In 1896, Einstein received his diploma from high school.

He subsequently enrolled at the Eidgenössische Technische Hochschule. That same year, Einstein renounced his German citizenship, becoming stateless. In 1898, Albert met Mileva Maric, a Serbian classmate (who was also a friend of Nikola Tesla), and fell in love with her. In 1900, Einstein was granted a teaching diploma by the Eidgenössische Technische Hochschule. He was accepted as a Swiss citizen in 1901. During this time Einstein discussed his scientific interests with a group of close friends, including Mileva. He and Mileva had an illegitimate daughter, Liserl, born in January 1902.

Work and doctorate

Upon graduation, Einstein could not find a teaching post, due mostly to the fact that his brashness as a young man had apparently irritated most of his professors. The father of a classmate helped him obtain employment as a technical assistant examiner at the Swiss Patent Office in 1902. There, Einstein judged the worth of inventors' patent applications for

devices that required a knowledge of physics to understand. He also learned how to discern the essence of applications despite sometimes poor descriptions, and was taught by the director how "to express myself correctly." He occasionally rectified their design errors while evaluating the practicality of their work.

Einstein married Mileva, on January 6, 1903. Einstein's marriage to Mileva, who was a mathematician, was both a personal and intellectual partnership: Einstein referred lovingly to Mileva as "a creature who is my equal and who is as strong and independent as I am". Abram Joffe, in his biography of Einstein, argues that Einstein was assisted by Mileva. This largely contradicts Ronald W. Clark who, in his biography, claims that Einstein depended on the distance that existed in his and Mileva's marriage in order to have the solitude necessary to accomplish his work.

On May 14, 1904, Einstein's son Hans Albert Einstein was born. In 1904, Einstein's position at the Swiss Patent Office was made permanent. He obtained his doctorate after submitting his thesis "On a new determination of molecular dimensions" in 1905.

That same year, he wrote four articles that provided the foundation of modern physics, without much scientific literature to refer to or many scientific colleagues to discuss the theories with. Most physicists agree that three of those papers (Brownian motion, the photoelectric effect, and special relativity) deserved Nobel prizes. Only the photoelectric effect would win. This is something of an irony, in that Einstein is far better-known for relativity, but that the photoelectric effect is all quantum, and Einstein became somewhat disenchanted with the path quantum theory would take. What makes these papers remarkable is that, in each case, Einstein boldly took an idea from theoretical physics to its logical consequences and managed to explain experimental results that had baffled scientists for decades.

He submitted these papers to the "Annalen der Physik". They are commonly referred to as the "Annus Mirabilis Papers" (from Latin: Extraordinary Year). The International Union of Pure and Applied Physics (IUPAP) has planned to commemorate the 100th year of the publication of Einstein's extensive work in 1905 as the 'World Year Of Physics 2005'.

Brownian motion

The first article in 1905, named "On the Motion—Required by the Molecular Kinetic Theory of Heat—of Small Particles Suspended in a Stationary Liquid", covered his study of Brownian motion. Using the then-controversial kinetic theory of fluids it established that the phenomenon—lacking a satisfactory explanation decades after being observed—provided empirical evidence for the reality of atoms. It also lent credence to statistical mechanics, which was also controversial.

Before this paper, atoms were recognized as a useful concept, but physicists and chemists hotly debated the question of whether atoms were real things. Einstein's statistical discussion of atomic behavior gave experimentalists a way to count atoms by looking through an ordinary microscope. Wilhelm Ostwald, one of the leaders of the anti-atom school, later told Arnold Sommerfeld that he had been converted to a belief in atoms by Einstein's complete explanation of Brownian motion.

Photoelectric effect

The second paper, named "On a Heuristic Viewpoint Concerning the Production and Transformation of Light", proposed the idea of "light quanta" (now called photons) and showed how they could be used to explain such phenomena as the photoelectric effect. The idea of light quanta was motivated by Max Planck's earlier derivation of the law of black-body radiation by assuming that luminous energy could only be absorbed or emitted in discrete amounts, called quanta. Einstein showed that, by assuming that light actually consisted of discrete packets, he could explain the mysterious photoelectric effect.

The idea of light quanta contradicted the wave theory of light that followed naturally from James Clerk Maxwell's equations for electromagnetic behavior and, more generally, the assumption of infinite divisibility of energy in physical systems. Even after experiments showed that Einstein's equations for the photoelectric effect were accurate, his explanation was not universally accepted. However, by 1921, when he was awarded the Nobel Prize, and his work on photoelectricity was mentioned by name, most physicists thought that the equation ($hf = ø + Ek$) was correct and light quanta were possible.

The theory of light quanta was a strong indication of wave-particle duality, the concept that physical systems can display both wave-like and particle-like properties, and that was used as a fundamental principle by the creators of quantum mechanics. A complete picture of the photoelectric effect was only obtained after the maturity of quantum mechanics.

Special relativity

Einstein's third paper that year was called "On the Electrodynamics of Moving Bodies". While developing this paper, Einstein wrote to Mileva about "our work on relative motion", and this has led some to ask whether Mileva played a part in its development. However, it is possible, and perhaps likely, that, having already mentioned this momentous work to his wife, he was simply referring to it in an endearing manner. This paper introduced the special theory of relativity, a theory of time, distance, mass and energy (which was consistent with electromagnetism, but omitted the force of gravity). Special relativity solved the puzzle that had been apparent since the Michelson-Morley experiment, which had shown that light waves could not be travelling through any medium (other known waves travelled through media - such as water or air). The speed of light was thus fixed, and not relative to the movement of the observer. This was impossible under Newtonian classical mechanics.

It had already been conjectured by George Fitzgerald in 1894 that the Michelson-Morley result could be accounted for if moving bodies were foreshortened along the direction of their motion. And some of the paper's core equations—the Lorentz transforms—had been introduced in 1903 by the Dutch physicist Hendrik Lorentz, giving mathematical form to Fitzgerald's conjecture. But Einstein revealed the underlying reasons for this geometrical oddity. His explanation arose from two axioms: one was Galileo's old idea that the laws of nature should be the same for all observers that move with constant speed relative to each other; and the other was that the speed of light is the same for every observer. Special relativity had several striking consequences because the absolute concepts of time and size are rejected. The theory came to be called the "special theory of relativity" to distinguish it from his later theory of general relativity, which considers all observers to be equivalent.

The theory abounds with apparent paradoxes, and appears to make little sense, landing Einstein substantial ridicule; but he managed to work out the apparent contradictions and solve the problems eventually.

Energy equivalency

A fourth paper, titled "Does the Inertia of a Body Depend Upon Its Energy Content?", published late in 1905 showed one further deduction from relativity's axioms, the energy-mass relation, originally written by Einstein as $m = L/c^2$. That deduction, rewritten, was the famous equation that rest energy (E) equals mass (m) times the speed of light (c) squared:

E = mc2

Einstein considered this equation to be of paramount importance because it showed that matter and energy are simply different forms of the same substance. Nevertheless, many scientists regarded the equation (and special relativity) as fascinating but insignificant until the 1930s.

The equation is associated with nuclear weapons and is used to explain how they produce such phenomenal amounts of energy. The exact connection between the equation and nuclear weapons is less well known, however. By measuring the mass of atomic nuclei and dividing them by their atomic number, both of which are easily measured, one can calculate the binding energy which is trapped in different atomic nuclei. This allows one to figure out which nuclear reactions will release energy and how much energy they will release. A simple calculation using the mass of the uranium nuclei and the masses of the products of nuclear fission reveals that large amounts of energy are released upon fission, and this led physicists in the 1930s to begin to consider the possibility of a nuclear weapon.

According to Umberto Bartocci (University of Perugia historian of mathematics), the famous equation was first published two years prior by Olinto De Pretto, who was an industrialist from Vicenza, Italy. Though De Pretto introduced the formula, it was Einstein who connected it with the Theory of Relativity.

Middle years

In 1906, Einstein was promoted to technical examiner second class. In 1908, Einstein was licensed in Berne, Switzerland, as a teacher and lecturer (known as a Privatdozent), who

had no share in the university government. Einstein's second son, Eduard, was born on July 28, 1910. In 1912, Einstein starts to refer to the fourth dimension as time.

Einstein divorced Mileva on February 14, 1919. Einstein married his cousin Elsa Loewenthal (née Einstein: Loewenthal was the surname of her first husband, Max) on June 2, 1919. Elsa was Albert's first cousin (maternally) and his second cousin (paternally). She was three years older than Albert, and had nursed him to health after he had suffered a partial nervous breakdown combined with a severe stomach ailment. There were no children from this marriage.

The fate of Albert and Mileva's first child, Lieserl, is unknown: some believe she died in infancy and some believe she was given out for adoption. As for the two boys: one was institutionalized for schizophrenia and died in an asylum. The other moved to California and became a university professor, and had little interaction with his father.

In 1914, just before the start of World War I, Einstein settled in Berlin as professor at the local university and became a member of the Prussian Academy of Science. His pacifism and Jewish origins irritated German nationalists. After he became world-famous, nationalist hatred of him grew, and, for the first time, he was the subject of an organized campaign intended to discredit his theories.

From 1914 to 1933 he served as director of Kaiser Wilhelm Institute for Physics in Berlin, and it was during this time he received his Nobel Prize and made his most groundbreaking discoveries. In 1922, Einstein and his wife Elsa boarded the S.S. Kitano Maru bound for Japan. The trip also took them to other ports including Singapore, Hong Kong and Shanghai.

General relativity

In November 1915, Einstein presented a series of lectures before the Prussian Academy of Sciences in which he described his theory of general relativity. The final lecture climaxed with his introduction of an equation that replaced Newton's law of gravity. This theory considered all observers to be equivalent, not only those moving at a uniform speed. In general relativity, gravity is no longer a force (as it was in Newton's law of gravity) but is a

consequence of the curvature of space-time. The theory provided the foundation for the study of cosmology and gave scientists the tools for understanding many features of the universe that were not discovered until well after Einstein's death. General relativity becomes a method of perceiving all of physics.

The theory was derived with mathematical reasoning and rational analysis, not with experimentation or observation, leading scientists to skepticism. But his equation enabled predictions and tests to be made, and when it was tested by measuring how much the sun's rays were bent by gravity during a solar eclipse, it proved correct. On November 7, 1919, The Times reported the confirmation, and from there on, the theory cemented Einstein's fame, revolutionized physics, and "passed" more tests. (In fact, unlike many other scientific theories, general relativity has held true in every case so far.)

Einstein's relationship with quantum physics was quite remarkable. He was the first, even before Max Planck, the discoverer of the quantum, to say that quantum theory was revolutionary. His idea of light quanta was a landmark break with the classical understanding of physics. In 1909, Einstein presented his first paper to a gathering of physicists and told them that they must find some way to understand waves and particles together.

In the early 1920s, Einstein was the lead figure in a famous weekly physics colloquium at the University of Berlin. On March 30, 1921, Einstein went to New York to give a lecture on his new theory of relativity. In the same year, he was finally awarded the Nobel Prize for his work.

Copenhagen interpretation

In the mid-1920s, as the original quantum theory was replaced with a new quantum mechanics, Einstein balked at the Copenhagen interpretation of the new equations because it settled for a probabilistic, non-visualizable account of physical behavior. Einstein agreed that the theory was the best available, but he looked for an explanation that would be more "complete," i.e., deterministic. His belief that physics described the laws that govern "real things" had led to his successes with atoms, photons, and gravity. He was unwilling to abandon that faith.

Einstein's famous remark, "Quantum mechanics is certainly imposing. But an inner voice tells me it is not yet the real thing. The theory says a lot, but does not really bring us any closer to the secret of the Old One. I, at any rate, am convinced that he does not throw dice," appeared in a 1926 letter to Max Born. It was not a rejection of probabilistic theories per se. Einstein had used statistical analysis in his work on Brownian motion and photoelectricity. In papers published before the miraculous year of 1905, he had even discovered Gibbs ensembles on his own. But he did not believe that, at bottom, physical reality behaves randomly.

There is currently (August 2004) some doubt over the validity of the Copenhagen interpretation due to Shahriar Afshar's 2004 contradictory result using a variation on the double-slit experiment. The results have yet to be peer-reviewed, but if verified would indicate that Einstein's doubt over the interpretation was justified.

Bose Einstein statistics

In 1924, Einstein received a short paper from a young Indian physicist named Satyendra Nath Bose, describing light as a gas of photons, and asking for Einstein's assistance in publication. Einstein realised that the same statistics could be applied to atoms, and published an article in German (then the lingua franca of physics) which described Bose's model and explained its implications. Bose Einstein statistics now describes any assembly of these indistinguishable particles known as bosons. Einstein also assisted Erwin Schrödinger in the development of the Quantum Boltzmann distribution, a mixed classical and quantum mechanical gas model—although he realised that this was less significant than the Bose Einstein model, and declined to have his name included on the paper.

Later years

Einstein and former student Leó Szilárd co-invented a unique type of refrigerator (usually called The Einstein Refrigerator) in 1926. (http://gtalumni.org/StayInformed/magazine/sum98/einsrefr.html) (http://www.uspto.gov/web/offices/ac/ahrpa/opa/pulse/epulse/pulse01101_6.htm) On November 11, 1930, patent number US1781541 was awarded to Albert Einstein and Leó Szilárd. The patent covered a thermodynamic refrigeration cycle providing cooling with no

moving parts, at a constant pressure, with only heat as an input. The refrigeration cycle used ammonia, butane, and water.

After Adolf Hitler came to power in 1933, expression of nationalist hatred of Einstein reached new levels. He was accused by the National Socialist regime of creating "Jewish physics" in contrast with Deutsche Physik -- "Aryan physics." Nazi physicists (notably including the Nobel laureates Johannes Stark and Philip Lenard) continued the attempts to discredit his theories and to politically blacklist those German physicists who taught them (such as Werner Heisenberg). Einstein had already fled to the United States, where he was given permanent residency. He accepted a position at the newly founded Institute for Advanced Study in Princeton, New Jersey. He became an American citizen in 1940 (though he maintained possession of his Swiss citizenship).

Einstein spent the last forty years of his life trying to unify gravity and electromagnetism, giving a new subtle understanding of quantum mechanics. He was looking for a classical unification of gravity and electromagnetism.

Princeton

His work at Princeton focused on the unification of the laws of physics, which he referred to as the Unified Field Theory. Einstein undertook the quest for the unification of the fundamental forces and spent his time at Princeton investigating this. He attempted to construct a model, under the appropriate conditions, which described all forces as different manifestations of a single force. His attempt was in a way doomed to failure because the strong and weak nuclear forces were not understood independently until around 1970, 15 years after Einstein's death. Einstein's goal survives in the current drive for unification of the forces, embodied most notably by string theory.

Generalized theory

Einstein began to form a Generalized Theory of Gravitation with the universal law of gravitation and the electromagnetic force in his first attempt to demonstrate the unification and simplification of the fundamental forces. In 1950, he described his work in a Scientific American article. Einstein was guided by the belief of a single statistical measure of

variance for the entire set of physical laws and he investigated the similar properties of the electromagnetic and gravity forces, as they are infinite and obey the inverse square law.

Einstein's Generalized theory of gravitation is a universal mathematical approach to field theory. He investigated reducing the different phenomena by the process of logic to something already known or evident. Einstein tried to unify gravity and electromagnetism in a way that also led to a new subtle understanding of quantum mechanics.

Einstein assumed a structure of a four-dimensional space-time continuum expressed in axioms represented by five component vectors. Particles appear in his research as a limited region in space in which the field strength or the energy density are particularly high. Einstein treated subatomic particles in this research as objects embedded in the unified field, influencing it and existing as an essential constituent of the unified field but not of it. Einstein also investigated a natural generalization of symmetrical tensor fields, treating the combination of two parts of the field as being a natural procedure of the total field and not the symmetrical and antisymmetrical parts separately. He researched a way to delineate the equations to be derived from a variational principle.

Einstein became increasingly isolated in his research over a Generalized Theory of Gravitation (being characterized as a "mad scientist" in these endeavors) and was ultimately unsuccessful in his attempts at constructing a theory that would unify General Relativity and quantum mechanics.

Final years

In 1948, Einstein served on the original committee which resulted in the founding of Brandeis University. In 1952, the Israeli government proposed to Einstein that he take the post of second president. He declined the offer. On March 30, 1953, Einstein released a revised unified field theory.

He died at Princeton in 1955, leaving the Generalized Theory of Gravitation unsolved. He was cremated the same day at Trenton, New Jersey on April 18 1955. His ashes were

scattered at an undisclosed location. His brain was preserved in a jar by Dr. Thomas Stoltz Harvey, the pathologist who performed the autopsy on Einstein.

Religious views

Einstein's religious views are generally considered deist: he believed in a "God who reveals himself in the harmony of all that exists, not in a God who concerns himself with the fate and actions of men". Einstein wanted "to know how God created the world": After being pressed on his religious views by Martin Buber, Einstein exclaimed "What we (physicists) strive for is just to draw His lines after Him". He summarized his religious beliefs as follows: "My religion consists of a humble admiration of the illimitable superior spirit who reveals himself in the slight details we are able to perceive with our frail and feeble mind."

Einstein's views on God and religion are also reflected in the following quotes:

God does not play dice with the universe. (This is a common paraphrasing. See the full quote earlier in this article.)

God is subtle but he is not malicious.

What really interests me is whether God had any choice in the creation of the world.

I want to know God's thoughts; the rest are details.

God does not care about our mathematical difficulties. He integrates empirically.

Science without religion is lame. Religion without science is blind.

I maintain that the cosmic religious feeling is the strongest and noblest motive for scientific research.

Political views

Einstein considered himself a pacifist (http://www.amnh.org/exhibitions/einstein/peace/index.php) and humanitarian (http://www.amnh.org/exhibitions/einstein/global/index.php). Einstein once said, "I believe Gandhi's views were the most enlightened of all the political men of our time. We

should strive to do things in his spirit: not to use violence for fighting for our cause, but by non-participation of anything you believe is evil." Einstein's views on other issues, including socialism, McCarthyism and racism, were controversial. (see Einstein on socialism). Einstein was a co-founder of the liberal German Democratic Party.

The American FBI kept a 1,427 page file on his activities and recommended that he be barred from immigrating to the United States under the Alien Exclusion Act, alleging that Einstein "believes in, advises, advocates, or teaches a doctrine which, in a legal sense, as held by the courts in other cases, 'would allow anarchy to stalk in unmolested' and result in 'government in name only'," among other charges.

Einstein opposed tyrannical forms of government, and for this reason (and his Jewish background), he opposed the Nazi regime and fled Germany shortly after its institution. He initially favored construction of the atomic bomb, in order to ensure that Hitler did not do so first, and he even sent a letter to President Roosevelt (dated August 2, 1939, before World War II broke out, and likely authored by Leó Szilárd) encouraging him to initiate a program to create a nuclear weapon. Roosevelt responded to this by setting up a committee for the investigation of using uranium as a weapon, which in a few years was superceded by the Manhattan Project.

After the war, though, Einstein lobbied for nuclear disarmament and a world government.

Albert Einstein was a supporter of Zionism, but never without reservations. He supported Jewish settlement of the ancient seat of Judaism and was active in the establishment of the Hebrew University in Jerusalem, to which he bequeathed his papers. However he opposed nationalism and expressed skepticism about whether a Jewish nation-state was the best solution. He may have originally imagined Jews and Arabs living peacefully in the same land. In later life he declined an offer to become the second president of the newly-created state of Israel.

Albert Einstein with Albert Schweitzer and Bertrand Russell fought against nuclear tests and bombs. With the Pugwash Conferences on Science and World Affairs and Bertrand Russell he released the Russell-Einstein Manifesto and organized several conferences.

Personality

Albert Einstein was much respected for his kind and friendly demeanor rooted in his pacifism. He was modest about his abilities, and had distinctive attitudes and fashions—for example, he minimized his wardrobe so that he would not need to waste time in deciding on what to wear. He occasionally had a playful sense of humour, and enjoyed playing the violin and sailing. He was also the prototypical "absent-minded professor"; he was often forgetful of everyday items, such as keys, and would focus so intently on solving physics problems that he would often become oblivious to his surroundings.

Einstein in entertainment

Albert Einstein has become the subject of a number of novels, films and plays including Nicolas Roeg's film, Insignificance, Fred Schepisi's film I.Q., and Alan Lightman's novel, Einstein's Dreams. Einstein was even the subject of Philip Glass's groundbreaking 1976 opera Einstein on the Beach.

He is often used as a model for depictions of scientists in works of fiction; usually these are mad scientists, since his distinctive hairstyle suggests lunacy, eccentricity or electricity and is widely copied or exaggerated.

On Einstein's 72nd birthday in 1951, an unknown UPI photographer was trying to coax him into smiling for the camera. Having done this for the photographer many times that day, Einstein stuck out his tongue instead (http://www.mentalfloss.com/archives/archive2003-03-14.htm). The image has become an icon in pop culture for its contrast of the genius scientist displaying a moment of humor. Yahoo Serious, an Australian film maker, used the photo as an inspiration for the intentionally anachronistic movie Young Einstein.

Commercial usage

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Though the general purpose of Roger Richman Agency — at least in the case of Einstein — is not a purely commercial one, there is some controversy about the licensing of popular names. The agency "owns" numerous other well-recognized names, such as "Sigmund Freud" and "Steve McQueen", and apparently uses the associated rights not exclusively for the protection of the dignity of these symbols. Indeed, the agency's official website advertises its service claiming that "celebrated personalities deliver instant recognition, recall and credibility to your advertising campaign and/or promotional program." On the other hand, various licensed advertisements feature rather a caricature of the scientist. These could be considered as a misuse of Einstein's popularity, since they lead to a further distortion of Einstein's public image instead of displaying him as "one of the most renowned scientists and humanitarians of all time" as advertised on the agency's webpages.

Albert Einstein
Natal Chart
Mar 14 1879 NS, Fri
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Ulm, Germany
48°N24' 010°E00'
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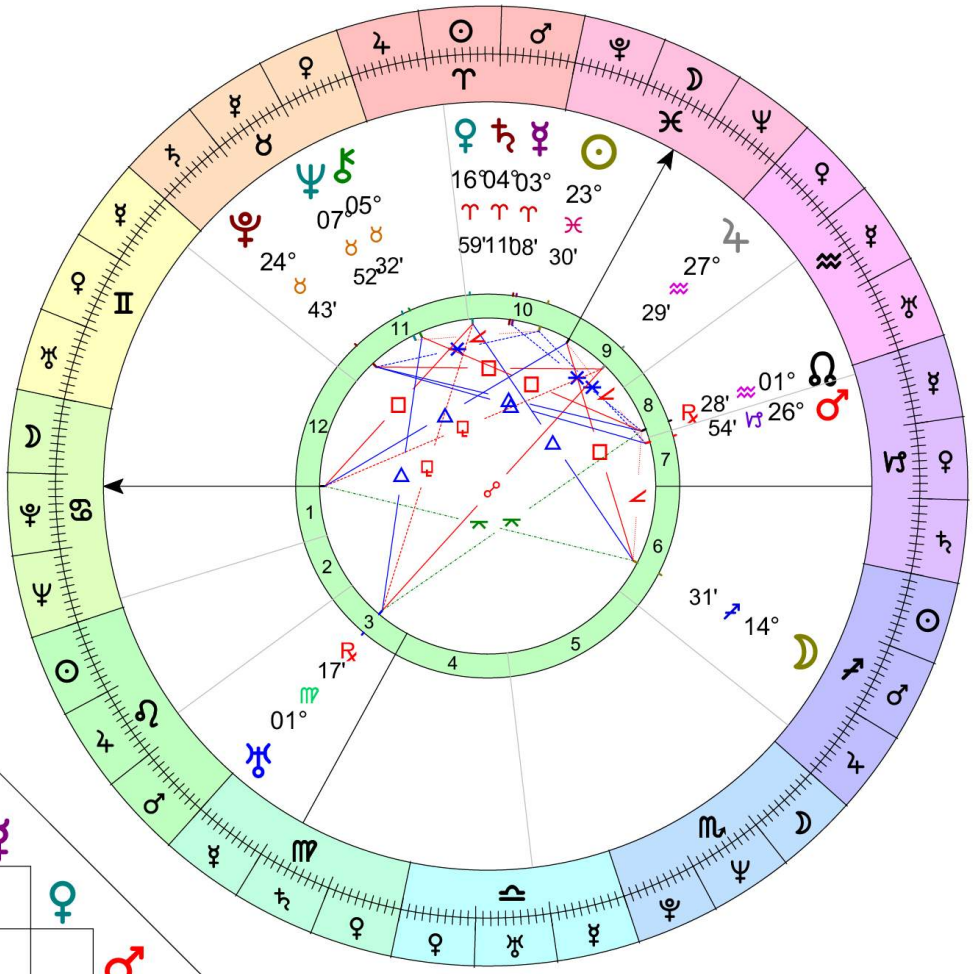

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