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Editorial Article

An Overview of the Latest Developments in Astronomy and Astrophysics

Salah H. R. Ali*

Editorial Member

Prof. of Precision Engineering, National Institute of Standards (NIS), Egypt

Vesting Prof. in Misr University for Science and Technology (MUST), Egypt

Vesting Prof. in Pyramids Higher Institute of Engineering and Tech (PHI), Egypt

Corresponding Author:
Professor Salah H. R. Ali, Length and Precision Engineering Division, National Institute of Standards, Egypt.

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Abstract

Background

Astronomy and its astrophysics extension are among the oldest and most recent natural sciences, due to directly linked to human behavior since the beginning of the universe and throughout our daily lives. With the growth of populations and the diversification of their abilities and activities on Earth, in the sky, and in between, the climate changes, requiring continued attention to astronomy and astrophysics.

Introduction

From time to time, some astronomical phenomena occur in celestial bodies, especially our planet within our Milky Way galaxy, which must be studied and understood to avoid confusing the world.

Objective

This editorial paper aims to provide a brief historical overview of astronomy and astrophysics to enhance the scientific background of researchers, students, interested parties, and amateurs, enabling them to understand the dynamics of planet Earth in a simple and easy manner, while documenting a glimpse of the latest developments in the natural phenomena of our planet that the world is currently observing: the phenomenon of "Earth's acceleration".

Methodology

A simple method combining description and analysis of the past and present was used to investigate the phenomenon of Earth's acceleration in light of several scientific considerations.

Analysis and Conclusion

It has been confirmed that the Earth's rotation has accelerated over the past five years, and that this recurrence is due to several reasons that can be considered mere speculation until proven true, to avoid confusing people. Therefore, this paper provides systematic and sustainable solutions have been developed to unify efforts to monitor and track the phenomenon with greater accuracy in light of global developments. Most important among these is the need for cooperation among relevant international bodies to maximize the use of the latest technologies, such as Attosecond and light clocks, in monitoring and informed interpretation, to deepen our understanding of the phenomenon and foresee the future.

Ancient

Astronomy was one of the earliest natural sciences on Earth. Astronomy focused on space, the origins of the universe, and its development, both in and outside the Earth's atmosphere. It emerged with the emergence of humanity, as it was a necessity because it was linked to meteorology and people's lifestyles with the alternation of day and night, summer and winter, for the purpose of living and moving in prehistoric and ancient times under the theories of Ptolemy. In the Middle Ages and modern times, astronomy advanced and focused on the study of celestial bodies through the efforts of Muslim scholars, most notably: Al-Khwarizmi, Ibn Yunus, Al-Battani, Al-Farghani, Al-Sufi, Al-Biruni, Ibn Tufayl, Ibn Rushd, Al-Bitruji, and Ibn Al-Shatir [1]. The astronomer and mathematician Abu Abdullah Muhammad ibn Musa Al-Khwarizmi (781-847 AD) worked in the House of Wisdom in Baghdad, Iraq, and authored numerous works in Arabic.

Among his most famous achievements in astronomy are the invention of a timekeeping instrument, the first to invent an instrument for measuring altitude, the first to invent the sine quadrant used in astronomical calculations, the first to invent the thermal quadrant for determining latitude, and the invention of the quadrant control. Among his most famous books are "Working with the Astrolabe" and "Addition and Difference in Indian Calculation." The Egyptian Arab scholar Abu al-Hasan Ali ibn Abd al-Rahman ibn Ahmad ibn Yunus ibn Abd al-A'la al-Sadfi (950-1009 AD), known as "Ibn Yunus," was called the "Father of Astronomy" due to his accurate and documented astronomical observations. He made significant contributions to trigonometry and the development of astronomy through his famous book, "Al-Zij al-Hakimi". The astronomer Muhammad ibn Jabir ibn Sinan al-Battani (858-929 AD) from Harran, Turkey, wrote important works on astronomy, planetary motion, and accurate astronomical tables. The astronomer and engineer Ahmad ibn Kathir al-Farghani (798-865 AD) was born in Fergana, now Uzbekistan, and later moved to Baghdad. He is famous for determining the diameter of the Earth and the diameters of the planets. He authored a reference book called "The Compendium of Astronomy and Celestial Movements". The scientist Abd al-Rahman ibn Umar al-Sufi (903-968 AD) was born in Rayy, Persia, and was famous for observing the stars and determining their positions. He authored a reference book called "The Images of the Fixed Stars". He was also one of the first scientists to recognize the sphericity of the Earth. Abu Rayhan Muhammad ibn Ahmad al-Biruni (973-1048 AD) is considered one of the greatest astronomers in history, famous for his precise measurement of the Earth's circumference. He was also the first to deduce that the Sun is larger than the Moon and the Earth, determine the direction of the Qiblah (The Muslims' Qiblah is the Holy Kaaba), and approximate the approximate ratio (π) to the nearest number used today, which is 3.14183.

He also proved that the sun is not responsible for the difference between day and night, but rather that the Earth rotates on its axis. This is in addition to his contributions to arithmetic and geography. Both Ibn Tufayl (1105-1185 AD) and Ibn Rushd (1126-1198 AD) were interested in astronomy and had innovative views, offering new contributions, theories, and books on astronomy. Ibn Tufayl and Ibn Rushd were two Muslim philosophers, physicians, and scientists from Andalusia. Ibn Rushd mentioned in one of his books that Ibn Tufayl had brilliant theories about the structure and movements of celestial bodies. Abu Ishaq al-Bitruji was also an Andalusian astronomer. He was born in the twelfth century AD in Morocco and settled in Seville, Andalusia, until his death in 1204 AD. He was a student and follower of Ibn Tufayl and a contemporary of Ibn Rushd. He is best known for his criticism of the Ptolemaic astronomical system and his development of planetary motion. Al-Bitruji was the first to suggest that the motion of the planets is elliptical and not circular, as was previously believed during the era of classical physics that planets revolve around the sun in circular orbits. However, this was not proven until the beginning of the seventeenth century AD, when the German scientist Johannes Kepler confirmed that these orbits are not perfectly circular, but rather show a slight indentation, or what is known as oblateness, making them appear oval and elliptical in shape. Among his most important works is "The Book of Life", which was translated from Arabic into Hebrew and then into Latin. It was printed and preserved as an astronomical reference in Vienna in 1531. Al-Bitruji is known in the West as Alpetragius, and the volcanic crater Alpetragius on the surface of the moon is named in his honor. The scholar Ibn al-Shatir is Abu al-Hasan Ala al-Din Ali ibn Ibrahim ibn Muhammad al-Ansari (1886-1955 AD), born in Damascus, Syria. Among his most important achievements in astronomy are the invention of the astrolabe, the explanation and criticism of Ptolemy's theories, and the correction of the sundial. Among his most important works is the book "Al-Zij al-Jid". Over time, specialized schools and research centers were established in countries around the world, and studies, research, and discoveries in astronomy and physics continued to be published.

Modern Astronomy: Astronomy is no longer limited to the study of celestial bodies such as planets, asteroids, stars, comets, nebulae, star clusters, galaxies, and other objects in the universe. Rather, astronomy has recently, specifically over the past hundred years, deepened its scope, focusing on the study and interpretation of the origin and evolution of celestial phenomena, such as stellar explosions, pulsars, black holes, cosmic microwave background radiation, and other phenomena that occur in space, within the Earth's atmosphere or outside the Earth's atmosphere. Therefore, modern astronomy has focused on all life sciences, such as mathematics, philosophy, chemistry, and engineering, which have contributed to enabling scientists and researchers to achieve their goals of serving the environment for humanity. Modern astronomy can then be divided into several basic branches, the most important of which are: astrophysics, observational astronomy, theoretical astronomy, planetary science, astrobiology, galactic astronomy, solar astronomy, stellar astronomy, asteroid and cometary astronomy, X-ray astronomy, radio astronomy, infrared astronomy, particle astronomy, and geodesy. Geodesy contributes to the study of the Earth's shape, size, and gravitational changes using precise measuring instruments to determine changes in the force of gravity on its surface, which may be related to factors such as the distribution of masses on Earth and its rotation. Meanwhile, interest in astrophysics has grown as one of the most important branches of astronomy due to its direct connection with the development of telescope systems and other specialized optical and engineering tools for studying and understanding the motion of celestial bodies that cannot be seen with the naked eye. This has contributed to our understanding of gravity as a fundamental force affecting the motion of planets and celestial bodies, and to measuring the Earth's acceleration, leading to days being only a fraction shorter than 24 hours.

Thanks to the structure established by early Greek, Arab, and Muslim astronomers, as well as new scientists from around the world, including Yoshihide Kozai (1928–2018), a Japanese astronomer who specialized in celestial mechanics. He is best known for his studies of the motions of Saturn's moons, satellites, and asteroids, including his discovery of the Kozai mechanism (in conjunction with Michael LeDove), for which he received the Imperial Prize of the Japanese Academy in 1979. As a result of Prof. Kozai's passion for the search for truth, he attended a scientific conference on the scientific miracles of the Holy Qur'an in Cairo before his death. He submitted to Allah after hearing a Qur'anic verse that confirmed to him the greatness of the Qur'an's scientific miracles in astronomy. He said in his famous speech: "I say, I am very much impressed by finding true astronomical facts in the Qur'an... For us modern astronomers have been studying a very small piece of the universe... By reading the Qur'an... I think I can find my future path for investigating the universe". Saleh Al-Ajery (1920-2022 AD): The first Kuwaiti Arab astronomer, he obtained a diploma in astronomy in 1946 from Egypt.

He also obtained a second astronomical scientific certificate from the Supreme Astronomical Committee of the Egyptian Astronomical Union in 1952. He has numerous publications and research papers in astronomy, such as astronomical calculations, prayer times, and the crescent moon in Kuwait and the Arab region. He is also the founder of the Al-Ajery Astronomical Observatory in Kuwait. Farouk El-Baz is a prominent Egyptian-American space scientist and geologist. He was born in 1938 in Zagazig. He worked with NASA to plan scientific exploration of the moon and train astronauts to select lunar soil samples and bring them back to Earth for analysis and study. He is known for his role in the Apollo program, particularly in selecting landing sites and training astronauts. Munir Nayfeh: A Palestinian-Jordanian atomic physicist, born in 1945 in Tulkarm and holding American citizenship, he is known for his research in atomic physics and laser science. He holds numerous patents in this field and has authored more than 130 research papers and books on lasers, magnetism, and electricity, all of which serve astronomy.

Essam Heggy: An Egyptian-Arab scientist, born in Tripoli in 1975, he specializes in space science and remote sensing. He works as a researcher at the California Institute of Technology (Caltech). He has participated in several important space projects related to astronomy, including the Curiosity rover mission to Mars, which aims to determine whether conditions were suitable for microbial life (bacteria) on Mars, either in the past or present. He also explores the Martian surface and analyzes the composition of rocks, soil, and atmosphere, searching for evidence of aquatic environments and conditions suitable for life. British astronomer and Emeritus Prof. of Cosmology and Astrophysics at the University of Cambridge, Martin Rees, were born in 1942 in York, England. He is known for his research on early galaxies and the evolution of the universe.

Recently, the Nobel Prize in Physics is sometimes awarded for achievements in astrophysics. Among the Nobel laureates in Physics who have made significant contributions to astronomy are Masatoshi Koshiba (1926–2020), a Japanese astrophysicist who received the Nobel Prize in 2002, jointly with Riccardo Giacconi and Raymond Davis, for his pioneering research in astrophysics, particularly for demonstrating the existence of the elementary particle called the neutrino. He was also one of the founders of neutrino astronomy. Neutrino astronomy is a very modern branch of astrophysics concerned with the study of celestial objects using neutrino detectors. Neutrinos are elementary particles that have weak interactions with matter, allowing them to travel long distances through the universe without being affected by magnetic fields or absorbed by matter. This makes them unique tools for observing cosmic processes that may be invisible to conventional optical telescopes, allowing for deeper observations of the universe. This is the result of the work of James Peebles (2019) for his theoretical work in physical cosmology, and Michel Mayor and Didier Queloz (2019) of the University of Geneva for their discovery of an exoplanet orbiting a primary Sun-like star (a close relative of the type G 51 Pegasi).

Among the methods used to detect exoplanets, the radial velocity technique, which relies on the Doppler effect of optical wavelengths, can be used to infer that a planet is in a circular orbit around the star. The transit technique, which measures the change in a star's brightness over time, can also be used. Sir Roger Penrose (England) shared the 2020 Nobel Prize in Physics for his discovery of the formation of black holes, which is a strong prediction of the theory of general relativity. The other half of the 2020 prize was shared by Reinhard Genzel and Andrea Ghez (Germany) for their discovery of a massive, extremely dense object at the center of our Milky Way galaxy, which is believed to be a black hole. They also tracked the motion of stars near this object and observed that they revolved around it at high speeds, indicating the presence of tremendous gravitational force. Their research later proved that this object was not just a massive star, but a supermassive black hole. A black hole is a region in space where gravity is so strong that even light cannot escape.

A black hole is described as supermassive, meaning its mass is 100,000 times greater than that of the sun. The mass of the sun is 10^{30} x 1.9891 kg. All of these great scientists and explorers, and many others, contributed significantly to the development of astronomy and astrophysics and left a great scientific legacy to the world. The universe is vast and expansive: full of worlds, phenomena, and astronomical mysteries, some of which we know (observable) and others we don't yet know. According to the Big Bang Theory, a massive explosion occurred about 13.75 billion years ago, marking the beginning of the universe.

The observable universe consists of about 10 million superclusters of galaxies. A supercluster includes hundreds or thousands of smaller clusters and groups of galaxies. Each supercluster contains hundreds or thousands of galaxies. The Laniakea Supercluster is the largest known supercluster in the universe and contains many clusters of galaxies, including the Virgo Supercluster. The Virgo Supercluster, also known as the Local Group, is a massive, irregular collection of galaxies. This supercluster contains hundreds of clusters of galaxies, including the Local Group. The Local Group includes three large spiral galaxies, the largest of which is the Andromeda Galaxy (M31), the Milky Way (our own galaxy), and the Triangulum Galaxy (M33). Other smaller galaxies include the Sombrero Galaxy and the Pinwheel Galaxy, as well as about 100 dwarf and smaller galaxies. The Laniakea Supercluster spans an area of about 110 million light-years and is one of the largest known clusters in the visible universe.

A galaxy is a vast collection of stars, planets, moons, asteroids, and meteoroids, as well as cosmic dust, dark matter, and dark energy, all bound together by gravity. The Milky Way is a galaxy containing hundreds of billions of stars, as well as gas and dust, including our solar system. Astronomers believe that the solar system formed about 4.54 billion years ago from a vast cloud of gas and dust known as the solar nebula. In contrast, life on Earth has only appeared in the last billion years. Our solar system consists of the sun and eight planets orbiting it. The eight planets, in order of their distance from the sun, are: Mercury, Venus, Earth, and Mars (the terrestrial planets); and Jupiter, Saturn, Uranus, and Neptune (the gas giants). Non-dwarf planets are those that meet the definition of a full planet: Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, and Neptune. Dwarf planets are Pluto, Ceres, Eris, Haumea, and Makemake. The main difference between them is that dwarf planets have not yet cleared their orbits of other objects. Therefore, our Earth is a large (non-dwarf) planet within a very small planetary system in our solar system, part of our Milky Way galaxy, part of the Local Group, the Local Supergroup, the Virgo Supercluster, the Laniakea Supercluster, and one of millions of superclusters in the observable universe. Our solar system is a heliocentric system with the sun as the central star (its mass is 99.9% of the solar system's mass), and all objects orbiting it due to gravity, including Earth and other non-dwarf and dwarf planets, moons, asteroids, comets, and gas and dust (interplanetary medium). Our solar system also orbits the center of the Milky Way galaxy approximately every 225 to 250 million years.

The Earth is a planet, the Sun is a star, and the Moon is a moon. They are all very small parts of the vast, visible universe, but each has different physical properties. Scientifically speaking, a planet, as defined by the International Astronomical Union (IAU), is a celestial body orbiting the Sun, with sufficient mass to assume a hydrostatic or spherical shape due to gravity and able to clear its orbit of space debris. The Earth consists of a core, mantle, and crust, and its atmosphere has a magnetic field. The Earth may still be gaseous internally and solidifying or it may remain so for a period of time, like Jupiter, Saturn, Uranus, and Neptune, or it may have become solid, like Mars, Mercury, and Venus. According to NASA, the volume of the Earth is approximately 1.08321×10^{12} km³ and its mass is $10^{24}\times5.9722$ kg (5.9722 rungs). The runagram is a new international standard unit added into the ISO system in 2022, equal to 1027 grams. The average density of the Earth is 5.513 grams/cm³. The Sun, on the other hand, is a body that emits light and produces thermal energy. It consists of hot plasma, primarily hydrogen and helium gases, resulting from nuclear reactions occurring in its core. Not every star is called the Sun, unless it is the central star in its planetary system, i.e., located in the center of the solar system, like our Sun. Scientists believe that the Sun is a massive celestial body currently in a stable state, but over time, it will transform into a red giant in about 5 billion years. The Sun's volume is 1.412×10^{27} meters³ (equivalent to 1.3 million times the volume of Earth). Its mass is $10^{30}\times1.9891$ kg (equivalent to 333,000 times the mass of Earth). Its average density is $10^{3}\times1.408$ kg/m³. The Moon is a large celestial body, about 27% the size of Earth and one-sixth the gravity of Earth.

It rotates on its axis once per day, just as it orbits both Earth and the Sun in a specific astronomical system. It is believed that the Moon was formed as a result of a collision between a large body (the size of Mars) and Earth. Mars is about 15% the size of Earth, and its mass is about 10.7% of Earth's mass. Mars' density is less than Earth's. This then created a cloud of vaporized Earth rock and rock from this body. This cloud orbited Earth until it cooled and became the moon we see (the so-called giant impact). As a result, it appears to be riddled with craters that have not been eliminated over the years due to the lack of weather on its surface. The Moon derives its light from the Sun. The Moon's volume is about 22 billion km³, its mass is 10^{22} x 7.3477 kg, and its density is 3.34 g/cm³.

Planet Earth, home to living organisms and humans: Earth is one of the eight planets that revolve around the sun in an elliptical orbit. Earth is the largest planet in the solar system in terms of diameter, mass, and density, and is the third planet from the sun after Mercury and Venus. The solar system itself is one of hundreds of billions of stars that make up the Milky Way galaxy. The Milky Way is the Arabic name for the galaxy, taken from its shape, which resembles the white path formed by the hay falling from the backs of animals. The Milky Way is another name for the same galaxy, due to its resemblance to "milk" or "milk" scattered across the sky. The Earth is an oblate oval (flattened and flattened). Its maximum (equatorial) radius is 6,378 km, while its minimum (polar) radius is 6,357 km. Its circumference at the equator is 40,075 km, and its circumference along the polar meridian is 40,008 km. Its surface area is approximately 510,072,000 km^2. The maximum surface temperature is 57.8°C and the minimum is -89.2°C. Earth is the only planet known to support life in the universe. Therefore, it is home to millions of species of living organisms, including humans. The Earth's biosphere has enabled the proliferation of organisms that survive only in the presence of oxygen. The ozone layer, which works with the Earth's magnetic field to block harmful radiation, allows life to exist on the Earth's surface. The ozone layer blocks ultraviolet radiation, and the Earth's magnetic field deflects and deflects elementary charged particles coming from the Sun at great speeds, moving them into outer space far from Earth, so they do not cause harm to living organisms.

Earth's dynamics from an astronomical perspective deals with the movements, or rather the rotation, of bodies and their impact on various astronomical phenomena. It also includes the Earth's rotation around its axis, its rotation around the sun, and the tilt of its axis. The Earth rotates around its axis at a tremendous speed of 1,670 km per hour counterclockwise (from west to east when viewed from the North Pole). At the same time, the Earth revolves around the sun in an elliptical orbit, rotating once every approximately 365.25 days (the length of a solar year). This means that the distance between the two changes throughout the year. Because the shape of this orbit is elliptical, the Earth does not remain at the same distance from the sun.

In fact, the distance between the Earth and the sun varies by more than five million kilometers between their closest and farthest points. During this time, the Earth's rotational speed also changes. The closer the Earth is to the sun, the faster it moves, and the further it moves away, the slower it slows down. This is due to the increase or decrease in the gravitational force acting on it. However, the average speed is 107,000 km/h, with the Earth traveling 940 million km/year. The Earth's axis is tilted at an angle (called the precession angle) from the vertical line of its orbit around the sun. It is currently about 23.4 degrees. This tilt is responsible for the four seasons on Earth. The Earth reaches its farthest point from the sun (aphelion) in early July each year, and its closest point (perihelion) in early January each year. It may be difficult to imagine the Earth so far from the sun on a hot summer day, but "seasonal changes in temperature arise from the changing direction of the Earth's axial tilt, as opposed to our distance from the sun," explains Vaughan. Because Earth's orbit is not circular, that is, elliptical, this is why we experience apogee and perigee. Although these changes in distance do not cause the seasons, they do affect their length.

For example, summer is longer when Earth is farther from the Sun. A day on Earth also takes approximately 86,400 seconds (24 hours), which is the time it takes the planet to complete a full rotation on its axis from a solar perspective. The Earth rotates once every 23 hours, 56 minutes, and 4 seconds (from a stellar perspective). Therefore, it can be said that our planet Earth, like the other planets in the solar system, rotates in three phases: rotating on its axis, orbiting the Sun, and, thirdly, orbiting with the rest of the solar system around the center of our galaxy, the Milky Way. The solar system takes approximately 220 to 225 million years to orbit the center of our galaxy, at a speed of about 250 km/s. Scientists also believe that the dynamics of planet Earth also represent the actual time it takes for the Earth to complete a full rotation, which depends on several factors, including the positions of the sun and moon relative to Earth, and Earth's gravitational field. In terms of position, the Earth, sun, and moon all revolve around each other, as we mentioned earlier.

The moon orbits Earth once every 27.3 days, affecting the tides. The motion of the Earth and moon is also affected by the effect of the sun's motion on each other through Earth's gravitational forces. From an astronomical perspective, Earth's gravitational field is a region of space (called a gravitational field) in which Earth exerts a gravitational force on other objects, causing them to be attracted toward the center of the Earth. In modern astrophysics, space and time are viewed as a single, interconnected entity called spacetime. Earth's gravity results from the curvature of spacetime (the combination of space and time) due to the mass of Earth and its interior. This curvature causes objects to deviate, creating the gravitational effect we feel. Simply put, objects with significant mass, such as Earth, alter or distort the spacetime around them, and this distortion is what we perceive as gravitational force.

The Earth's interior also plays a vital role in determining the force of gravity. The force of gravity is greatly influenced by the distribution of mass within the Earth. Consequently, the distribution of various materials (crust, mantle, core) within the Earth's interior affects the force of gravity at its surface. So, it can be said that gravity is the fundamental force that maintains the stability of the planetary motion in their orbits, including Earth around the sun, as well as the rotation of the moon around it. Gravity is one of the four fundamental forces in the universe, along with electromagnetic forces and the weak and strong nuclear forces. Gravity is the mutual attraction between Earth and any other body with mass, according to Newton's law of universal gravitation, which describes gravity as a force directly proportional to the product of two masses and inversely proportional to the square of the distance between them. In other words, gravity is the force that attracts objects toward the center of the Earth. It is responsible for maintaining the atmosphere, objects on Earth's surface, and satellites in their orbits. It also maintains the integrity of Earth's rotation around its axis and around the sun, leading to the formation of Earth's surface. Gravity exists between Earth's atmosphere and outer space.

Beyond the layers of Earth's atmosphere, the outer space region begins, separated by the Kármán line, which is 100 km above sea level. Earth's atmosphere consists of five layers, from closest to farthest from Earth: The troposphere: This is the layer where most weather phenomena occur, according to the UCAR Center for Science Education. The stratosphere contains the ozone layer, which protects Earth from harmful ultraviolet radiation, according to NIWA. The mesosphere: This is the layer where most meteors and asteroids burn up, according to the UCAR Center for Science Education. The thermosphere: This layer is hotter and includes the ionosphere, according to the Royal Belgian Institute for Space Aeronomy. The fifth and final layer is the exosphere, which gradually disappears into interplanetary space, according to the UCAR Center for Science Education. After the exosphere, the space between the planets and worlds of the vast universe begins.

A Glimpse into the Latest Developments

As a result of the development of astronomy and astrophysical systems, scientists have discovered the acceleration of the Earth among the physical phenomena in the universe, including the movement of celestial bodies and the laws of gravity that govern them [2-3]. Over the past few billion years of Earth's life, Earth's rotation has slowed, and scientists believe this is largely due to the gradual drift of the Moon away from Earth. Conversely, approximately five years ago, on July 19, 2020, and on July 9, 2021, scientists observed that atomic clocks recorded days that were 1.47 milliseconds shorter, indicating a slight acceleration in the Earth's rotation on its axis than usual.

On Wednesday, June 30, 2022, Earth completed its rotation in less than 24 hours, with a time of 1.59 milliseconds, as NASA announced [4]. As for 2023, a very slight slowdown is observed, without setting records. However, 2024 turned the tables, recording several days with durations of less than 24 hours. On Friday, July 5, 2024, the Earth accelerated and recorded the shortest day since measurements began, reaching 1.66 milliseconds, making it the fastest-growing year for Earth's rotation since observations began in the 1970s. However, about a calendar year later, specifically on the ninth day of this month (July 9, 2025), the day became shorter by about 1.3 milliseconds than usual. About two weeks later, on the twenty-second of the same month (July 22, 2025), the day became shorter by about 1.4 milliseconds than usual. While scientists expect August 5th of next month to be about 1.5 milliseconds shorter, as the moon will be at its farthest point from the equator, changing the effect of its gravity on the Earth's rotation, increasing its speed. According to a recent announcement by the NANSA, this is due to the Earth being exposed to several influences that change the length of its day. As of now (Tuesday, July 22, 2025), I, the author, await the arrival of next Tuesday, August 5th, 2025, to witness and document what history will record about the acceleration of our planet Earth.

Although we are talking about milliseconds and a little more, as it is a very small fraction of time that most of us do not realize, this is a noticeable and significant change in the standard of time as a global reference standard, known as Coordinated Universal Time (UTC). UTC uses standardized seconds defined by the Universal Atomic Time standard in the International System of Units (SI), which relies on approximately 450 atomic clocks distributed and operating in approximately 85 laboratories worldwide. The atomic clock measures the vibrations, or frequencies, of atoms in a vacuum, typically a cesium-133 atom (1 second equals 9,192,631,770 complete oscillations of a cesium-133 atom). Universal Time 1 (UT1) is used for highly accurate timekeeping. UT1 is a measure of time based on the Earth's rotation around its axis.

UT1 is a measure of mean solar time, representing the actual astronomical time that passes based on the Earth's rotation. UT1 is simply the equivalent of modern-day Greenwich Mean Time (GMT), but corrected for the Earth's polarity. Conventional atomic clocks: These use microwaves to monitor cesium frequencies, with an accuracy of nanoseconds (10^{-9} seconds). Optical clocks have also evolved to use ultra-fast lasers to measure much higher frequencies (such as aluminum or ytterbium, reaching an accuracy of femtoseconds (10^{-15}). Research efforts are still underway to develop so-called optical clocks, which operate with an accuracy of up to Attoseconds

(10^{-18}). It is worth noting that the national frequency and time laboratories in Egypt participate in a comparison with countries around the world to estimate the difference between international time and national time, and thus the national laboratories of each country can calculate the differences between them. These clocks serve as a standard time reference upon which phones, computers, and technical systems around the world rely. They are directly related to servers, computers, the Global Positioning System (GPS), banking systems, large telescopes, and electricity and internet networks around the world, which rely on extremely precise synchronization during their operation, because every millisecond is important, especially in navigation, aviation, defense, security, and other systems.

With the acceleration of the Earth's rotation, a difference has begun to appear between atomic time and the actual time of the Earth's rotation. This prompted scientists to consider an unprecedented step: removing a second from time! When this happens, global timekeepers at the International Earth Rotation and Reference Systems Service (IERS) will add a leap second. The IERS, the organization responsible for maintaining universal time standards and reference frames, is responsible for adding a leap second [5]. As with leap years, leap seconds are added to clocks to compensate for differences in astronomical time, based on the Earth's rotation and UTC, currently based on atomic clocks, or in the future, optical clocks.

Conclusion

By integrating the principles of astronomy, astrophysics, and geodesy, it is possible to understand the history and concept of Earth's dynamics relative to celestial bodies, as well as the time differences in the phenomenon of Earth's acceleration. The editorial paper also highlighted the need to study this phenomenon, given its importance and direct relationship with Universal Time (UTC). This phenomenon has a direct impact on modern systems, particularly in the G7 and their shared relationships in security, defense, and other areas.

Therefore, We Can Draw the Following Recommendations

• It is noted that the acceleration of Earth's rotation has always occurred during the summer months over the past five years. It may also be an indicator of the extent of ice melting in the Arctic, which affects the Earth's tilt and speed.

• Earth's gravity and the developments and accumulations of human activities throughout history—in other words, it may be a result of changes in the distribution of Earth's mass—playing a fundamental role in Earth's dynamics and the phenomenon of its acceleration. It is also possible to expect the presence of internal factors, perhaps something occurring in the Earth's core or lower layers for unknown reasons related to summer. Tidal forces acting on the Moon's pull on Earth's waters could also accelerate its rotation. This could also happen as a result of severe earthquakes and volcanoes, which alter the distribution of mass within Earth and affect its acceleration. However, let me, as an author, pose the following question: Why do we expect our Earth to have accelerated, but not our galaxy? Therefore, we recommend the following

• The current necessity requires including the phenomenon of the acceleration of the Earth's rotation around its axis in the summer as a priority on the agenda of the first meeting of the Technical Committee for Time and Frequency Metrology, coordinated by the BIPM Institute in Paris, as well as the International Terrestrial Rotation and Reference Systems (IERS), which operates in the United States, Europe, and Australia.

• The importance of studying the possibility of developing a forward-standard metrology and reviewing the operational efficiency of atomic clocks. While it has now become imperative for engineers and physicists, along with those responsible for laboratories that use atomic clocks and have highly accurate laser sources, to consider partnering to design and manufacture highly accurate optical clocks that can measure time differences at the Attosecond level, this would represent a scientific leap in this field. In other words, modern astrophysics, including laser and Attosecond systems, could contribute to the development of more accurate time measurement tools, which in turn could be used to monitor the Earth's rotation and subtle changes throughout the day.

• The importance of unifying international protocols and comparisons, to facilitate a unified language for dealing with related systems, technologies, and joint projects.

• The importance of continuous monitoring to establish a relationship between the acceleration of our planet and the rest of our galaxy, such as the Sun and Moon. In the near future, we may witness the first attempt to create a "Negative leap second".

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