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The Evolution of Physicists' Perception of the Universe

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Abstract

In this review article a brief history is given about how the physicist's image of the universe is evolved and developed during centuries starting from the early civilization of mankind up till our present times. This is followed with a proposed model, by the author, for a dual anti-universe to ours and the possible experimental tests to verify and confirm its existence. The model suggests the presence of a primordial *S- Particle* that, following the 'Big Bang', was violently ejected in all spatial directions together with its anti-particle. The hypothesized *S- Particle* differentiates itself from its counterpart 'anti-particle' through its course of rotation (the angular rotation of the *S-particle* is opposite to that of its counterpart). Both particles underwent two-phase transitions in space-time that led to the formation of the known fundamental particles "quarks, electrons, neutrinos...etc., and their anti-particles" and hence, evolving with time forming our universe and its dual anti-universe. The angular rotation of the anti-particle, in accordance with space-time rotation, together with the counter rotation of the *S- particle*, resulted in a time difference in the formation processes of both universes and consequently led to a large distance between the spatial locations occupied by our universe and its dual counterpart in the same space-time continuum. The existence of this anti-matter universe might solve the present mystery of matter anti-matter asymmetry and thus explain why hardly any free anti-matter can be observed in our universe. Moreover, the model implicates the possibility of the presence of a repulsive gravitational force exerted by the clusters of anti-particle in the dual universe upon ours. This repulsive gravitational force could together with the expansion of space-time, influence our universe and might yield more insight on the origin of dark energy.

The evolution of the scientific picture of the Universe

At the dawn of history, civilization first appeared out of the darkness in China and in the valleys of the rivers, the Nile and the Euphrates, of Egypt and Babylonia. The early signs of the rise of astronomy can be traced back as - the third millennium B.C. - at about 2500 years before Christ. The measurement of time began in Babylonia and Egypt where the knowledge of seasons starts as agriculture develops among farmers, where wheat seems to be indigenous in the neighborhood of rivers, also the cultivation of cereal requires seasonal treatment and a lot of water supply. These make a calendar almost a necessity and hence, it is why the beginning of astronomical observation occurred in the basins of the Euphrates and the Nile. The calendar originated by taken the day as a unit of time, then the month and hence the year as 360 days or twelve months. The apparent movement of the sun and the planets among the fixed stars was observed and the naming of seven days after the sun, moon and the five known planets at that time gave the week as another unit of time. The Egyptians and the Babylonians, at that time, pictured the Universe as a rectangular box, with its greater length running from north to south, its floor being the earth and the sky was a flat ceiling supported by four columns or mountain peaks. The periodicity of astronomical events became apparent, till, according to a document of the sixth century B.C., the relative positions of the sun and the moon were calculated in advance, and the prediction of eclipses was made possible [1], which may be regarded as the origin of the scientific astronomy. Two centuries later the astronomical knowledge spread to Greece and then over the known world where it passed into more rational astronomy.

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In Greece during the sixth century B.C., appears a prevalence of the old Olympic mythology on the one hand and the earliest philosophy on the other hand. Orphism religion was thought by Herodotus to have come from Egypt. It incorporated the usual mystic rites to promote fertility by celebrating the annual cycle of life and death. It had a cosmogony that pictured a primordial night from which a world- egg appeared and divided into Heaven and Earth representing the father and mother of life. Out of this primitive world of ideas came two distinct currents of philosophic thought, separated in origin - the Ionian rationalist nature – philosophy of Asia Minor and the mystical Pythagoreanism of southern Italy. The early Greek philosophers drew most of their facts about astronomy, geometry and medicine from Babylonia and Egypt. To these facts they added others, and for the first time in history, subjected them to a rational philosophic examination [2]. Greeks kept in touch with the lore of Babylon and Egypt, conceived the ideas of deductive geometry and the systematic study of nature. Anaximander around 585 B.C., seems to have been the first Greek to make a map of the known world, also the first to recognize that the heavens revolve round the polar star. He draw the conclusion that the visible dome of the sky is half of a complete sphere, at the centre of which the earth lies. It was said that in the same year Thales had predicted an eclipse, probably making use of Babylonian tables. He taught that the earth is a flat disc floating on water, until Thales and Anaximander propounded their new theory, the earth had been imagined as a floor with a solid base of limitless depth. It was represented as a finite flattened cylinder, originally surrounded by envelops of water, air and fire, and floating within the celestial sphere. It was thought at that time, the sun and stars were shattered fragments of the original fiery envelope attached to celestial circles and together with them revolved around the earth, the centre of every thing. Aristotle (384 – 322 B.C.) in physics and astronomy followed too closely the introspective methods of his tutor Plato (428 – 348 B.C.), and he was the greatest exponent of idealism and collector of knowledge at that time. He was also the tutor of Alexander the Great who carried the Hellenistic civilization to the east. Aristotle, too, though accepted the spherical form of the earth, maintained the geocentric theory, which regarded the earth as the centre of the universe, and his authority did much to prevent the heliocentric theory, when put forward by Aristarchus, from being accepted by astronomers till the days of Copernicus seventeen hundred years later [3]. At the beginning of the third century before Chris, the intellectual centre of the world moved from Athens to Alexandria. The Greece's zenith of its philosophical development was reached under Plato and Aristotle at Athens about 350 B.C., while its highest achievements in mathematics and physical science were reached in the third century B.C., following the scientific discoveries of Archimedes of Syracuse (287 – 212 B.C.). He was a Greek Mathematician, Physicist and Astronomer and is considered the greatest Mathematician of ancient history. It was said that he was the first to have recorded multiple solstice (annual astronomical events) dates and times in successive years. Around the year 200 B.C., Claudius Ptolemy (170 - 100 B.C.) at Alexandria introduced a new theory about the motion of the planets and he obtained the zodiac positions of planets on any particular date. His theory of planetary astronomy considered that the earth is stationary in the centre of the cosmos, and for the first time, it became possible to calculate the positions of planets accurately from a geometrical theory. His work can be considered at the end of the creative period of Greek science.

The Romans Empire arose in the first century before Christ and lasts for few centuries after Christ. Although the Romans provided the world with excellent soldiers, lawyers, administrators and advanced art, however, their philosophic power, science and astronomy ceased to advance. In the fourth and fifth centuries A.D. the Roman Empire gradually faded and together with the rise of Christianity, investigating nature with an open mind passed away. Two centuries later, under the stimulus of the Prophet Mohammad guided by the Holy Quran, scientific knowledge spread in the Arabic World and the Arab schools continued to flourish till the thirtieth century. The Abbasid dynasty (750 till 1258) was the Arabic and Islamic golden age, since it marked the period of great scientific, economical and cultural achievements. Harun-al-Rashid (786 – 809), the fifth Abbasid Caliphs, encouraged translations from Greek authors to the Arabic language, thus helped to initiate the great period of Arab learning and to add Arab contributions to the world scientific knowledge. Arabic and Islamic school of thought led to the revivals of the Aristotelian and Ptolemais ideas of the Cosmos. Around 817, Job of Edessa in Baghdad wrote an encyclopedia of philosophical and natural sciences as taught in Baghdad. The translation of Ptolemy's book stimulated Arab and Muslim astronomy. Mohammad al- Batani (c. 850), from his observatory at Antioch, recalculated the precession of the equinoxes and drew up a new set of astronomical tables. About the year, 1000 advances in trigonometry were made and Ibn Junis who might be the greatest of all the Arab astronomers placed observations on solar and lunar eclipses on record at Cairo. He was encouraged by the Caliph al-Hakim, the ruler of Egypt, who founded at Cairo an academy of learning. The most eminent Arab and Muslim physicist, mathematician and astronomer was Hasan Ibn-al-Haytham (965 – 1040), who also worked in Egypt under al- Hakim. An early proponent to the concept that hypothesis must be supported by experiments based on confirmable procedure or mathematical reasoning-an early pioneer in the scientific method five centuries before the Renaissance scientists. He is sometimes described as the world's "first true scientist", he also wrote on philosophy, theology and medicine. His chief work was done in optics where he made revolutionary changes and showed a great advance in experimental methods. Ib-al-Haytham corrected a significant error of Ptolemy regarding binocular vision, and in general he built on and expanded the optics of Ptolemy. In astronomy, he wrote a work criticizing Ptolemy's models in the "Almagest" – treatise on the apparent motions of the stars and planetary paths, written by Claudius Ptolemy –, for violating basic principles of Aristotelian physics. His astronomical studies on the light of the Moon, the form of the eclipses, and the images of the Sun or the Moon seen through a hole in a window in a darkened room (camera obscure) as well as on the problems of optical illusion with regard to celestial and other bodies led him to his substantial studies of optics and to his outstanding work and his book (*Kitab fi el-manazir*). Latin translation of his work on optics had a considerable influence on the development of Western science, especially through Roger Bacone and Johannes Kepler (1571 - 1630). Al-Khwarizmi (780 – 850) in Baghdad, was a mathematician, astronomer and geographer. His principal achievement was in Mathematics where he is considered as the father or the founder of Algebra. His book on Algebra (al-jabr) was written with the encouragement of the Abbasid Caliph al-Ma'mun in the Islamic golden age (8^{th} – 15^{th} century). His book was translated into Latin by Robert Chester in 1145, and was used until the sixteenth century as the principal mathematical text- book of European universities. In addition to his best-known works in mathematics, he revised Ptolemy's Geography, listing the longitudes and latitudes of various cities and localities. He further produced a set of astronomical tables and wrote about calendric works, as well as the astrolabe and the sundial. A lunar impact crater was named for al-Khwarizmi. Abu Rayhan Al-Biruni (973 – 1048) was a philosopher, astronomer and geographer, during the promotion of the astronomical science by the Abbasid Caliph. He was very knowledgeable in physics, mathematics, astronomy and natural sciences too. One of the greatest scientists of the Islamic golden age. He carried out geodetic measurements and determined latitudes and longitudes with some accuracy, moreover, he was the first to be able to obtain a simple formula for measuring the earth's radius. In addition, he thought possible the earth to revolve around the sun and developed the idea the geological eras succeed one another. He corrected the results, by al- Khujandi (940 – 1000) a respected astronomer, on the transit of the sun near the solstices, measuring the latitude of Ravy. He determined the coordinate of locations and for correctly ascertaining the celestial distances between places. In Arabic astronomical books in the Islamic golden age a tabulated parameters used for astronomical calculations concerning the positions of the sun, moon, stars and planets we notice that the medieval zijes were more extensive, including materials on chronology, and the geographical latitudes and longitudes. Other famous zijes are those of the Egyptian astronomer Ibn Yunus (950 – 1009). In one of them -the handbook of astronomical tables- he described with precision, forty planetary connections and thirty lunar eclipses. His astronomical tables give data obtained with very large astronomical instruments and the use of trigonometric identities. One of the al-Biruni's zijes contains a table giving the coordinates of six hundred places, almost all of them measured by al-Biruni himself. The asteroid discovered in 1986 by the Belgian and Bulgarian astronomers at the Rozhen Observatory, was named "9936 al-Biruni" asteroid as an honor of his name.

The rational philosophic theology in the Arabic golden age was founded in the Arabian schools in Spain through the work of Averroes (Ibn-Rushd), a physician, astronomer and philosophic writer, in the twelfth century. The highest point of Arabic learning have been reached in the eleventh and twelfth centuries, but by the close of the thirteenth century the decline of Arabic learning had set down when the Arabic Empire had reached an end due to the internal quarrels and fights in the Arabian societies for political reasons. The most active work in translation from Arabic to Latin went on in Spain, where a succession of translators, busy with many subjects, can be traced from about 1125 to about 1280. It covers texts of Aristotle, Ptolemy, Euclid, Avicenna (Ibn Sina), Ibn al-Haytham, Averroes (Ibn Rushed) and other Arabic mathematicians and astronomers. Next to Spain in importance were translators from Southern Italy and Sicily, whence came also translations both from Arabic and from Greek to Latin.

The current language of scientific literature at that time was Arabic, even of Greek authors, and were highly valued [2]. Through these translations and through contacts with Islamic countries, that mediaeval Europe passed from its earlier outlook (Dark Ages) and old habits to a more rational thinking and more scientific mind. In the thirteenth century, around the year 1225, the University of Paris placed Aristotle's works and Ptolemaic astronomy together with the Arabian books upon the list of books to be studied. Hence, the contemporary knowledge of astronomy, geography, medicine, physics and mathematics were taught in Paris, Rome and by Roger Bacon in Oxford. At that time Bacon pictured the universe as bounded by the sphere of the fixed stars with the earth at the centre. In addition, he became specially interested in light through the study of the work of the Arabian physicist Ibn-al-Haytham. He understood mirrors and lenses and described a telescope, though he does not built one. He also described many mechanical inventions, some known to him and some as possibilities for the future, among the latter mechanically driven ships, carriages and flying machines. One of the signs of his greatness that he realized the importance of the study of mathematics both as an educational exercise and as a basis for other sciences, at that time mathematical treatises translated from the Arabic language were becoming available in the European Universities. They are often contained astronomical and astrological applications. After the thirteenth century (where the period of translations from Arabic to Latin was the highest), there was a continual process of change in the intellectual outlook in Europe as a result of the loosing of scholastic ideas, by the influence of the philosophy of Scotus and William of Occam, and by the revolt against the power of the Church. The spirit of the Renaissance first became apparent in Italy, through the works of Leonardo da Vinci (1452 – 1519), an Italian Renaissance polymath, and soon afterwards spread to the other countries of Europe. Nicolaus Copernicus (1473 – 1543), a mathematician and astronomer was the first to make great change in the scientific picture of the universe after the Renaissance. It was known at that time that the geocentric theory of Hipparchus and Ptolemy, successful in explaining the facts which the observations of the time demanded. According to this theory, the earth was a solid and immovable base towards which all things fall, and people imagined it as a sphere floating in the centre of the universe. Copernicus with his geometrical approach realized that if he shifted the frame of reference for planetary movements from the earth to the fixed stars, this involves a physical as well as mathematical revolution, and will be a destruction of Aristotle's physics and astronomy. Copernicus dwelt on mathematical harmony, and appealed to mathematicians to accept his views, due to the fact (on the ground) that they lead to a simpler scheme than the Ptolemaic cycles and epicycles in which the celestial bodies move round the earth. After finishing and publishing a treatise about his work around the year 1530, the Copernican theory won its way slowly. The Copernican system led to a revolution in astronomy, and in scientific thought about the universe [3]. It moved the scientific picture of the universe from a geocentric picture to a heliocentric one. John Kepler's (1571 – 1630) work on astronomy led to the three prominent statements of planetary motion and served as the foundation of Newton's astronomy. Although Copernicus has initiated a revolution in the physicist's about the universe, Galileo Galilei (1564 – 1642), brought Copernican astronomy, based on an a priori principle of mathematical simplicity, to the practical test of the telescope, thus discovered and established the true method of astronomical science, which is still in use. By means of his telescope, Galileo confirmed the new theory of astronomy, which had been based on mathematical simplicity. He discovered that the surface of the moon, instead of being perfectly smooth and unblemished, as imagined by philosophers, was seen to be covered with markings, which gave all the indications of rugged mountains and desolate valleys. Innumerable stars, hitherto in visible, flashed into sight, solving the age- long problem of Milky Way. He observed (saw) that Jupiter was accompanied in its orbit by 4 satellites with measurable times of revolutions, a visible and more complex model of the earth and its moon moving together round the sun, as taught (envisaged) by Copernicus. Galileo's chief most important work was the foundation of the science of dynamics. He felt that parts of the earth in "local motion" might also move mathematically and he tried to discover why things fall to the earth and according to mathematical relations. He hypothesizes that the speed of bodies increase with the time of fall, and compared them with the results of experiment. He also discovered that the change in the direction of motion of bodies requires an external force. He started to investigate why the planets in its planetary motion kept in motion around the sun without the need of any force. In 1660 the Neo-Platonic movement which gave a philosophic basis for the work of Copernicus and Kepler, and finally by the results by the mathematical and experimental methods of Galileo and his followers. Galileo had proved that the mathematical simplicity, which to Copernicus and Kepler was the underlying meaning of celestial phenomena, could be discovered (applied) also to terrestrial motion. Therefore (thus), scholastic ideas were replaced by time, space, matter and force, about motion (concepts) were used mathematically to discover how things move, and to measure the actual velocities and accelerations of moving bodies. He had also proved experimentally that no continual exertion (continually applied force) was needed to keep a body in motion. He touched the concept of mass and inertia, though he did not define it clearly, his observations on falling bodies were enough, if properly understood, to show its exact relation with weight. The power of the new mathematical method in dynamics became more evident when Christiaan Huygens in the Netherlands (1629 – 1695), a Dutch mathematician, physicists and astronomer, published his work on gravity, the pendulum clock, centrifugal forces and the centre of oscillation in 1673. He was the astronomer who discovered Saturn's brightest moon, Titan. The conception of nature as being fundamentally composed of all matter in the universe, as brought from (after) the old ideas of the ancient Greek philosopher, Epicurus (341 – 270 B.C.), that all bodies in the universe are formed of atoms moving and interacting in empty space, was adopted by Galileo and was realized as the large scale phenomena of dynamics and astronomy. Another Greek concept, which started to play its part in the seventeenth century thought, was that of an inter-planetary aether and Kepler invoked it to explain how the sun kept the planets moving. However, the idea of aether was still confusing at that time, but was used by the mystic school in an attempt to explain the nature of being [4]. In 1642, the year that Galileo died, Isaac Newton was born. Isaac Newton (1642 – 1727), an English mathematician, physicists, astronomer and natural philosopher was born at Wools-Thorpe in Lincolnshire. Sir Isaac Newton was a key figure in the scientific revolution in Europe. He formulated the laws of motion and universal gravity; made seminal contribution to optics; shared credit with the German mathematician Gottfried Leibniz (1646 – 1716), for developing infinitesimal calculus. His pioneering book (Mathematical Principles of Natural Philosophy, "Principia") published in 1687, was illuminating and inspiring to researchers for several centuries to come. It consolidated many previous results and established classical mechanics. Newton used his mathematical description of gravity to derive Kepler's laws of planetary motion, account for tides, the trajectories of comets, the precession of the equinoxes and other phenomena, eradicating doubt about the solar system's heliocentricity. He demonstrated that the motion of objects on earth and celestial bodies could be accounted for by the same principles. Newton's inference that the earth is an oblate spheroid was later confirmed by the geodetic measurements, convincing most European scientists of Newtonian mechanics over earlier systems. From his investigations on the solar system, he found that each planet would be attracted not only by the sun but also by each of the other planets. So the orbit of each planet would therefore not be the sort of simple ellipse that Kepler had calculated earlier. The mutual pulls of the planets on each other, Newton had calculated, inferred that the solar system would inevitably suffer instabilities. He built the first practical reflecting telescope. Newton was a fellow of Trinity College and the second Lucasian professor of mathematics at the University of Cambridge. He was knighted by Queen Anne in 1705, and spent the last three decades of his life in London, serving as Master (1699 – 1727) of the Royal Mint, as well as President of the Royal Society (1703 – 1727). Joseph-Louis Lagrange (1736 – 1813), Italian-French mathematician and astronomer, created the calculus of variations, and systematized the subject of differential equations to be used in solving physical problems. He published work on astronomy, in which he advanced the treatment of the difficult problem of calculating the mutual gravitational effect of three bodies. Pierre-Simon Laplace (1749 – 1827), a French mathematician, physicist, astronomer and philosopher, improved solutions of the problems of attraction by adopting Lagrange's method of potential, and he completed Newton's work in one most important aspect, when he proved together with Lagrange, that the planetary motions were stable, the perturbations produced either by mutual influences, or by external bodies such as comets, being only temporary. In 1796 Laplace published his "Systeme du Monde", which contains a history of astronomy, a general account of the Newtonian system, and the nebular hypothesis, according to which the solar system was evolved from a rotating mass of incandescent gas. Further research showed that the hypothesis is not sound for the comparatively small structure of the sun and planets, but may hold good for the larger aggregates of stars, seen in the process of formation in the spiral nebulae and at a later stage of development in our own stellar galaxy "Milky Way". More work on gravitational astronomy in the eighteenth century did little more than complete the work of Newton and Laplace. A final test of the validity of Newton's hypothesis of attraction was given in 1846, by the prediction of the existence of an unknown planet, a reversal of the method of Newton and Laplace. The perturbations from its orbit of the planet Uranus were not fully to be accounted for by the action of the other known bodies; to explain these irregularities, the influence of a new planet was assumed, and the necessity of finding its position was urgent and hence, it was found independently by the calculations of John Adams of Cambridge and the French mathematician Leverrier. Turning his telescope to the position indicated by Leverrier, the astronomer Galle of Berlin detected a planet to which the name of Neptune was given. The accuracy of Newton's theory proved to be amazing. For two centuries, every fancied discrepancy was resolved, and by the help of the theory, generations of astronomers were able to explain and predict various astronomical phenomena. Lagrange described the "Principia" as the greatest production of the human mind and Newton as the greatest genius that had ever existed.

The nineteenth century marked the growth of our scientific knowledge about nature and its practical applications. Spectroscopic astronomy was initiated during the years 1855 to 1863 by the work of von Bunsen, in conjunction with Roscoe on chemical action of light and in 1859, working with Kirchhoff; he developed the first exact methods of spectrum analysis. They obtained, from the experimental analysis, a dark line invisible in the in the solar spectrum and discovered that sodium is present in the atmosphere of the sun while lithium is almost absent. In 1878, Lockyer observed a dark line in the green of the spectrum of the sun's chromosphere which does not coincide with any known line in terrestrial spectra, predicted jointly with Frankland, the existence of an element in the sun and was called Helium. In 1895 this element was found by Ramsay in the mineral cleveite. The interpretive framework given by Kirchhoff and Bunsen handed new remarkable powers to astronomers. By a comparison of spectral lines in the solar spectrum with laboratory spectra, Kirchhoff identified several terrestrial elements in the sun. Kirchhoff and Bunsen's researches had marked the birth of the science of astrophysics, which is the study of the physics and chemistry of astronomical bodies [4]. Huggins, an amateur astronomer in London, inspected several nebulae spectroscopically when he directed his telescope and spectroscope to the so-called planetary nebula (a name given by William Herschel to nebulae distinguished by their circular shape) in the constellation of Draco. Later on, Huggins and others applying the Doppler effect in their study of the celestial spectra, obtained an immense amount of knowledge of stellar motion and other phenomena. Huggins was a new sort of astronomer, an astrophysicists. He also supplied much of his own equipment, as well as sufficient leisure, to pursue astrophysics. A number of nations quickly established astrophysical observatories and incorporated astrophysics into the activities of their existing astronomical institutions. Around 1880, a new technique in astronomical studies was adopted and that is by using photographic plates, and hence the era of astronomical photography began. This technique enabled astrophysicists to pursue large-scale observing programs on stellar spectra. By the end of the nineteenth century, astronomers had identified about one hundred spiral shaped nebulae. Astronomical knowledge about our universe continued to follow the course of development until the last decade of the nineteenth century and the first decades of the twentieth century when a new era in physics began. The new or modern physics might be said to have been started with the two great discoveries ; namely the theory of relativity by Albert Einstein in (1905, 1915) and Quantum Mechanics which was developed by the works of Heisenberg, Schrodinger, Dirac, Born and Jordan in the years (1925, 1926, 1927). In 1905, Einstein (1976 – 1955), as the basis for his theory of special relativity he proposed two basic postulates; First: the laws of physics are the same in all inertial reference frames i.e. , frames at rest or moving with constant velocities ; Second: the speed of light is the same in all inertial frames. These postulates had dramatic changes (shifts) in the scientific thought about the universe and led to important consequences such as mass-energy equivalence according to the formula $E = mc^2$, where c is the velocity of light; Newton's idea of absolute space and absolute time was dropped and the Galilean transformations of Newtonian mechanics was replaced by Lorentz transformations; the long standing idea by scientists about a hypothesize aether was excluded. In 1915, Einstein developed his general theory of relativity in which he introduced a curved space-time in order to generalize the special (restricted) theory of relativity, and to incorporate gravity in the theory. In this theory, he replaced the Euclidean geometry by the non-Euclidian Riemannian geometry to represent space-time and to include gravitational effects.

Astronomical observations show that stars are most numerous in a band of varying width, called Galaxies (one of them is ours and is named 'Milky Way'), which stretches round the universe in a great circle. In some places, the numbers are so great that star-clouds appear; only to be resolved into individual stars by good telescopes, while interspersed are irregular nebulae, which cannot be resolved. The great plane, which cuts the Milky Way as may be in the middle of the band of stars is called the galactic plane. It may be looked upon as a plane of symmetry in the stellar system. Towards it the stars seem to crowed specially the hotter stars and also fainter stars which are farther away. Our sun (which is considered as a medium size star) lies about $6x10^4$ light years from the centre of the whole system, somewhat to the north of the north of the central plane. Galaxies tend to occur in groups called clusters, each cluster contains from a few to a few thousand of galaxies, while each galaxy is a congregation of about 10^{11} stars bound together by their mutual gravitational attraction. Observation over many years of the apparent movements of stars shows that the sun is travelling towards the constellation called Hercules with a speed of about 13 miles per second. Astronomical investigations point to a definite conclusion, that all stars go through a course of evolution, a process of stellar evolution [4], where each star was thought to begin as a comparatively cool body (interstellar gravitating gas), gradually its temperature increases as a result of the contraction of the gas under gravitational attraction. During contraction, it will give out heat and grow hotter and attain a maximum value of temperature depending on its size, then after burning its fuel, through fusion processes, and loosing the heat energy it becomes cool again. In 1900, Percival Lowel, an American astronomer and the wealthy founder of the Lowell observatory in Arizona, was interested in more than studying the planetary system and asked one of his assistants, Vesto Slipher, to examine the spectra of the spiral nebulae as a clue to the origin of the solar system. In 1912, Slipher had four photographic plates on which he could distinguish not only lines in the spectrum of the Andromeda nebula, but he could also tell that they had been shifted from their usual positions. It was known according to the "Doppler effect" - discovered by the Austrian physicist 'Christian Dopper' in 1842 -, that if a light source is in motion with respect to the observer, the frequency of its spectral lines will shift from the measured value when both the source and the observer were at rest. Slipher noticed that the shift was towards the red side of the spectrum (redshifted) and by using Doppler's formula he obtained the radial velocity of the source (Andromeda nebula) to be 300 Km/s. By 1914, he was able to announce the radial of about fifteen spiral nebulae. In the late 1910's, Curtis an astronomer at the Lick observatory, from his investigations was able to offer new evidence for galaxies in the form of novae in spirals. In 1917, he detected further novae in spirals at the Mount Wilson observatory. Edwin Hubble, an American astronomer, started his graduate work at the university of Chicago's Yerkes observatory in 1914 and joined in 1919, the staff of the Mount Wilson observatory where the most powerful telescope in the world (a100-inch reflector) was situated. He took in the early 1920's, numerous photographs of the Andromeda nebula and other nebulae with the aim of calculating nebula's distance. In 1923, he started to plot the brightness of the 'nova' over time, then he found that it changed its light output in a regular and periodic manner, declining slowly and then brightening rapidly. He found that by measuring the time between the peaks, there was a straightforward means of determining the distance. Calculating distances placed Andromeda nebula as external galaxy far outside the Milky Way. From the results of the redshift measurements of Hubble, astronomers started to realize that the universe is expanding. In 1917, Albert Einstein after introducing his revolutionary theory of gravitation he found, that as a consequence of the theory the universe picture should be shifted from the Newtonian picture of an infinite universe to a finite universe with no boundaries. He also assumed that the universe must be static, and when his equations led to a non- static universe, he added a term, the cosmological constant, to his equations in order to ensure the static nature of the universe. When Einstein calculated the motions of Mercury using the equations of general relativity, he found a very close agreement between theory and observations. A further important test of his gravitational theory was in 1919 related with the observation of the possible deflection of starlight passing by the sun during a solar eclipse. In 1922 and 1924, the Russian mathematician and meteorologist 'Alexander Friedmann' found after analyzing solutions to Einstein's equations of general relativity, that were non-static giving indications for an expanding universe. Soon afterwards, a Belgian mathematician 'Georges Lemaitre' in 1927, published a seminal paper on the expanding universe. The studies by Erwin Hubble and his Mount Wilson colleague Milton Humason about the redshift-distance was published in 1929. This paper was followed in 1931, by a much longer paper, co-authored with Humason, which included a number of redshifts measured by him. With this paper, Hubble and Humason brought to an end the debate over the existence of a redshift-distance relationship and moreover, the relation showed at the first approximation, to be linear. This relation that was considered as a velocity-distance relation was later known as Hubble's law. Hubble's research and findings on the redshift gave a credit to him in astronomy textbooks for the discovery of the expanding universe. The expanding universe led to a scientific debate between astronomers about the age of the universe. If one ran the present expansion back in time and look with no account of a possible speeding up or slowing down of the expansion, Lemaitre suggested that it was only about two billion years ($2x10^9$ yrs.). This was in conflict with the ages of many of the stars, which was estimated to be about three billion years, were longer than the age of the universe. De Sitter, a Dutch astronomer, in order to avoid this problem suggested the beginning of the universe and the stars of its expansion could not be identified as the same event. The galaxies had lasted for longer than 2 billion years, but they had approached to a minimum separation before starting their expansion, so in fact the universe was far older than 2 billion years. Nowadays, the recent advances in astronomical investigations and researches predicted that the life of the universe began at about 13.8 billion years ago [5].

After the second world war, the rise of the US as a leading economic power was reflected by its growing importance in the manufacture and the use of giant instruments. The great 200-inch Hale telescope perched on top of Palomar Mountain in California was completed in 1948 and was the most powerful telescope at that time. Before the second world war, astronomers focused almost entirely on observing the universe in the wavelength of visible light, but during the wartime scientific developments speeded up which led to open new regions of the electromagnetic spectrum to astronomical observations. Soon after the war Bernard Lovell a British physicist, conceived the idea of building a very large radio telescope with a steerable disc to collect radio waves from astronomical bodies. In the early 1950s extensive surveys of the sky at radio wavelengths, it was agreed by astronomers that most of the sources were “radio stars” spread evenly over the sky and located inside our galaxy. In 1952, astronomers at Palomar Mountain used the 200-inch telescope could observe visible objects that might be linked to powerful radio sources. One source seemed to be a remnant of a gigantic stellar explosion, a supernova but the other source, Cygnus A, appeared to be in the location of a galaxy with an odd or peculiar appearance. Optical astronomers had estimated the galaxy to be about 1000 million light years distance. If the identification was correct, and Cygnus A really so far away, then it was producing prodigious quantity of energy in radio wavelengths. Cygnus A became one of the best example of a sort of extragalactic radio source. In 1950 Fred Hoyle, a British astronomer at Cambridge University, delivered a series of radio talks on “the nature of the universe” where he assumed that the universe started its life a finite time ago in a single huge explosion ‘Big Bang’. On this assumption, the present expansion is a relic of the violence of this explosion. The problem of the estimated age of the universe disappeared in the “Steady State Theory” first proposed in 1948 by Bondi and Gold, colleagues of Hoyle at Cambridge University. The three agreed on a never-ending and unchanging universe (at least when viewed on a large enough scale) in which matter is created continuously throughout time and space rather than in one singular event at the start of the universe in a Big Bang. In the steady state theory, the creation of matter in effect drives the expansion, as over all, the density remains constant despite the creation of new matter. By the mid-1950s, astronomers had decided that Hubble’s methods of measuring distances galaxies were undermined by serious errors, such as mistaking clouds of glowing gas for very bright stars. Following these, the age of the universe as a result had been seriously underestimated. A convincing evidence against the steady state theory came quickly by the discovery of the “Cosmic Microwave Background”, CMB. In 1964, two physicists Arno Penzias and Robert Wilson at the Bell Telephone Laboratories in New Jersey, began a series of experiments with an unusual radio antenna and used it to investigate ‘’noise” in satellite communications. They tracked out the sources of noise and they found that it could not be eliminated and it was arriving with equal intensity from all directions in space. Several physicists and astronomers interpreted Penzias and Wilson measurements as a Cosmic Microwave Background Radiation, which remains of an extremely early period in the history of the universe (a kind of relic of a ‘Big Bang’ origin of the universe). At the ‘Big Bang’, the universe was extremely hot at the start of the expansion and gradually cooled to a temperature of about 2.7 degrees kelvins. This discovery was a direct evidence in favour of the ‘Big Bang’ theory and against the ‘Steady State Theory’. In 1978, Penzias and Wilson earned the Nobel Prize in Physics for their distinguished discovery. The development of astronomy from space in the earth’s atmosphere using balloons and above the earth’s atmosphere by the use of rockets and satellites made the images and spectra of astronomical objects far sharper than those taken with ground-based instruments. Space astronomy started in the 1960s and 1970s in the US, by NASA, the National Aeronautics and Space Administration [4]. The NASA missions gave a major boost to solar system studies. In addition to the fly-bys, both the US and Soviet Union set out to land spacecraft on the moon and on planets. By the following decade, the European Space Agency ran a very significant space science program as well as Japan was building and launching space missions. Astronomical instruments carried aboard spacecraft have made some astronomical investigations and discoveries possible which was impossible to be carried from the earth’s surface. X-rays from astronomical objects are absorbed by the earth’s atmosphere and hence to pursue X-ray astronomy, instruments must be sent into space. One major discovery made by X-ray astronomy, i.e. by investigating X-rays emitted from the source 'Cygnus X-1', it was interpreted as the result of emissions from hot gas that had been heated up and being dragged towards a very compact object. Some astronomers proposed the compact object was a 'black hole', a star that had ended its evolution with a great density that not even light can be escape from its surface, and might be detected as X-ray source. It is well known by astronomers, that the hotter an object the shorter the wavelength of the emitted radiation. Our sun with a temperature of about 6000 kelvins radiates most of its energy in the visible wavelengths, while stars at temperatures of 50000 kelvins, for example, emit most of their energy in the ultraviolet region of the spectrum. It was proposed that matter when pulled towards a black hole it accelerates and its energy of motion increases and is converted into heat energy by friction. Very close to the black hole, the acceleration of anybody increases and the temperature is so high that rather than visible light, the matter emits X-rays and ϒ- rays. In 1990, a joint effort of NASA and the European Space Agency, built at a cost of over two billion dollars the "Hubble Space Telescope", a reflecting telescope with a primary mirror of 2.4 meter in diameter (the most expensive telescope ever constructed at that time). The telescope was carried by the space shuttle Columbia that was launched from Cape Kennedy. Observations with Hubble were very important in confirming the observations that led to the rapid acceptance of the idea of the accelerating universe [6]. Moreover, it showed that the velocity of a receding galaxy would speed up with time rather than slow down as everyone had accepted. Saul Perlmutter, Adam Riess, Brian Schmidt, and their research groups had observed in 1998 that very distant supernovae - as supernovae are extremely bright they can be detected to extreme distances – are systematically fainter than expected by comparison with nearby supernovae and so at larger distances than anticipated. The universe is not only accelerating in this picture but it will speed up and expand forever at an even increasing rate driven on by what has been termed 'dark energy'. This remarkable discovery led astrophysicists, Perlmutter, Riess and Schmidt to earn to win, the 2011 Nobel Prize in Physics.

Another remarkable discovery was the observation of gravitational waves for the first time in September 2015. Gravitational waves are ripples in space-time, which are created whenever objects with mass accelerate. For example, rotating massive pairs of black holes or neutron stars produce huge and very intense gravitational waves, after collision and merging together. In 1916, Albert Einstein based on his General Theory of Relativity, predicted the existence of gravitational waves and that they travel with the speed of light. The three American physicists, Weiss, Barish and Thorne together with their teams of researchers, working at the Laser Interferometer Gravitational-Wave Observatory (LIGO project) in California, detected for the first time gravitational waves. These waves originated from the collision, merging of two neutron stars about 130 million years ago, and traveled with the speed of light and have only just reached us. The 2017 Nobel Prize in Physics were awarded to Rainer Weiss, Barry Barish, Kip Thorne, for their contributions to LIGO project and the first observation of gravitational waves [7].

The Dual Universe

In a previous publication by El-Sherbini [8], a model for a dual universe was proposed. The model was based on a hypothesized primordial particle, the so-called '*S- particle*' that following the 'Big Bang' was violently ejected with both linear and angular velocities in all spatial directions [9]. Simultaneously with the ejection of the *S- particle*, its anti-particle was ejected having the same velocities but with its angular rotation in the opposite direction. The structure of the space-time mesh was also created simultaneously with the Big Bang. During the expansion and cooling of the universe the particles were subjected to two geometrical phase transitions that gave them their mass and altered their dynamics of motion, hence leading to the formation of fundamental particles including dark matter and their anti-matter [9]. The dual anti-universe was formed as a result of the course of opposite-rotating part of the primordial *S- particle* and its evolution with time. Both particles, together with the space-time mesh which is rotating with constant angular velocity Ω, in counter-clockwise direction as the anti- *S- particle* rotation, define a symmetrical surface of right angled-cylinder Fig. (1). The co-rotating and the counter-rotating *S- particles*, relative to the space time rotation, follow with time helical paths around the cylindrical surface.

The variational principle as guiding fundamental principle and the "relative space of rotating disks" introduced by Cattaneo [10] and developed by Rizzi and Ruggiero [11] as general physical system of reference were adopted in the study [8]. An approximate time lapse between the two particles in one complete round trip along the helical path $\Delta\tau = \tau_+ - \tau_-$, was calculated [8]. For more round trips the time lapse will increase linearly with the number of round trips, i.e. for n turns $\Delta\tau_n = n\,(\tau_+ - \tau_-)$, where n = 1, 2, …… □. After an infinitesimal fraction of a second from the 'Big Bang' when the universe was filled with S and (anti-) *S-particles,* these primordial particles gave rise to the known fundamental and anti-fundamental particles [9, 12].

The above separation between the particles and their counterpart will lead to the formation of two universes i.e. our universe and its dual universe in different spatial locations. We can assume that the formation of the dual anti-matter universe followed evolutionary stages similar to those of our universe (i.e. formation of anti-atoms from anti-quarks and anti-electrons etc.), but in later time. The expansion and cooling of the anti-matter universe followed a slower rate due to the lagging in time between the formation of the two universes, which is illustrated in Fig. 2.

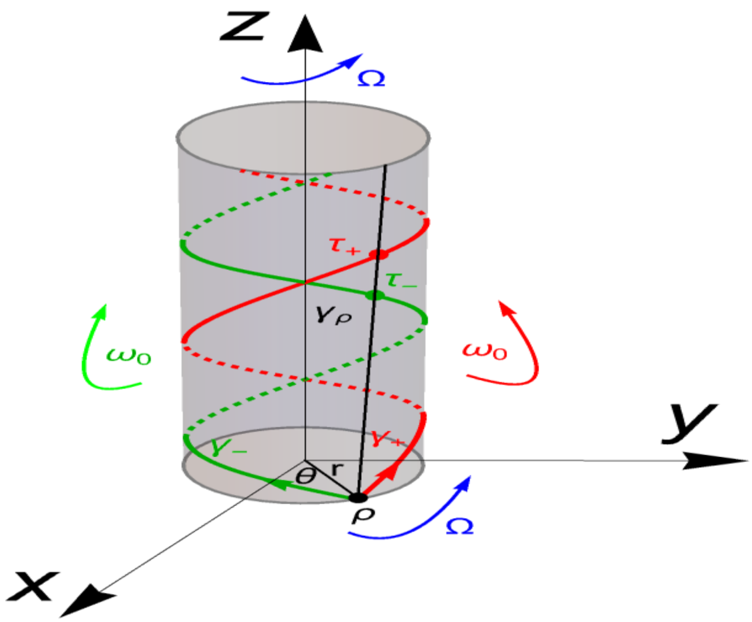

Fig. 1. The world lines of the co-propagating and counter propagating *S- particle* with respect with space-time. Υ_P is the world line of a point P on the rim of the base of the cylinder rotating with the angular velocity of space-time. The first intersection of Υ_+ and Υ_- with Υ_P are shown at time τ_+ and τ_- respectively, for one round trip as measured by an observer at rest in the rotating frame (LCIF) F'.

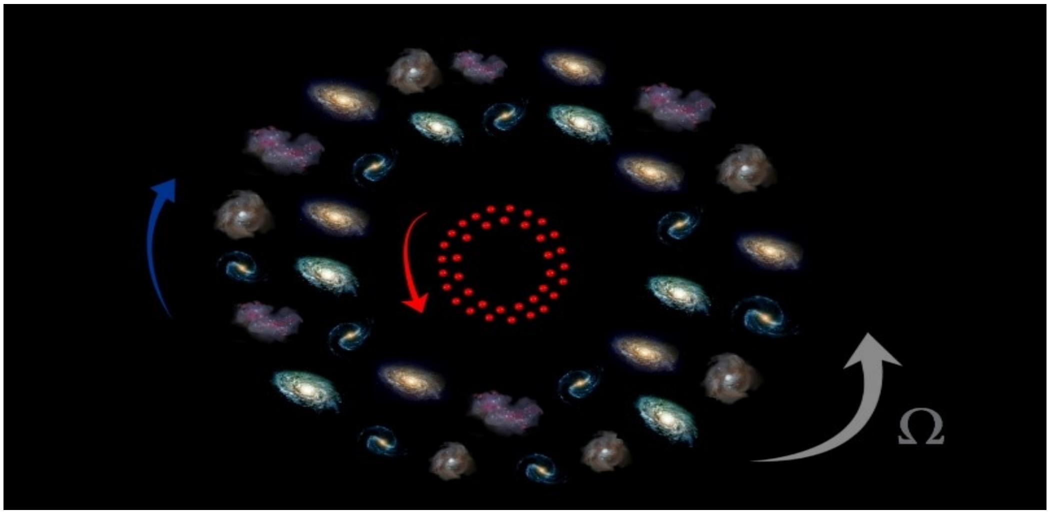

Fig. 2. An artistic illustration of a cross-sectional area for the dual universe with our universe in blue and its antimatter counterpart in red, earth being a mere point in between the (clusters of) galaxies. Ω is the angular velocity of the space-time mesh and as can be seen from the figure, our universe and its dual counterpart are in opposite rotation. The dual universe was initiated about 13.8 billion years ago following the Big Bang, which was located in the middle point in the figure.

Moreover, the counter rotation of the antimatter universe with respect to our universe's rotation formed anti-gravitational waves that have been built up, exerting a repulsive force on our universe. This anti- gravitational force took around eight to ten billion years to be built up to its maximum value, which might explain why at this time the expansion of our universe started to accelerate [6, 13]. This repulsive force together with the force imposed on our universe by the expansion of the space time mesh, which may refer to as caused by an exotic dark energy, will permeate and affect all rotating galaxies, clusters of galaxies or any rotating object in our universe. Before the clusters of antimatter in the antimatter universe started to manifest as exerting a powerful and strong anti-gravitational force upon our universe, pushing it to expand and accelerate away, the expansion showed a slowdown because of the gravitational attraction caused by matter in our universe. The mutual attraction between all matter and dark matter in our universe led to the building up of a force working against the expansion of the space- time mesh and the repulsive force of the antimatter universe that resides in closer proximity in sphere around the so called singular point, Fig. 2.

The idea that the attractive force opposing the expansion would ultimately be striving to stop it, was recently contradicted by clear evidence from observational data collected by NASA's scientists about the behaviour of supernovae [6], which confirmed the accelerated expansion of our universe. Moreover, the data showed that the farthest galaxies from the perspective of our own (Milky Way) galaxy are accelerating at a faster pace than the ones nearer to us. The reason for this may be due to the fact that the density of matter in the outer layers or at the edge of our universe is less, resulting in a weaker attractive force to counteract the repulsive force of the antimatter universe.

It is worth mentioning here that the repulsive anti-gravitational force from the clusters of antiparticles in the antimatter universe as a whole upon our universe and which is due to the opposite course of rotation of the two universes is completely different from the electrostatic repulsive force between similar charged particles. Moreover, it is also different from the force that is due to possible gravitational or anti-gravitational interaction between individual matter and antimatter or particle and its antiparticle that might violate the CPT invariance, the theory of general relativity or the law of conservation of energy. It is rather, a kind of negative gravity that affects our universe as a whole due to the opposite course of rotation of the counter dual anti-universe relative to ours. The effect of this opposite rotation of the dual anti-universe can cause anti-gravitational waves that penetrate our universe interacting with the space-time mesh of the vast voids between and around the galaxies and the cluster of galaxies in our universe, resulting in a transformation from the positive like curvature to a negative- like curvature in the shape of the space around them. This negative curvature pushes the galaxies outward, away from each other, causing the accelerated expansion of our universe. The continuous anti-gravitational waves that permeate and fill our universe might cause a constant background ripples (space-fluctuations) in the space of our solar system that can be experimentally detected. The repulsive force exerted by our dual universe could together with the expansion of space-time, influence our universe and might yield more insight on the origin of the exotic dark energy.

Proposed Experiments

In this section we are going to propose some experiments to testify the existence of the dual anti-matter universe and the repulsive anti-gravitational waves (force) exerted on our universe by the dual universe. As there is no experimental method available through which the antimatter universe and dark energy can be observed directly, the existence can only be verified by detecting and measuring their influence on our universe. In order to detect anti-gravitational waves originating from our dual counter- universe, we could install two of the most sensitive apparatus available for gravitational wave detection (e.g. LIGO type), and direct one of them towards the most distant galaxies in our universe, while positioning the other at 180 angular degrees on the opposite side of the earth, in order to detect vertical (anti-) gravitational waves falling upon them. It is imperative that these detectors are very sensitive in order to register the even weakest signal received by the receptors. In fact the earth, together with its solar system, is a mere point (see Fig. 2) with respect to the size of the universe as a whole. As the dual-antimatter universe is located at a tremendous distance from our planet, the anti- gravitational waves that reach us are very weak, even though these waves as a whole are strong enough to cause a large repulsive force on our universe. Gravitational and anti-gravitational waves are received by our detectors as tiny ripples caused by distortions in the space-time fabric. We seek to detect these minuscule ripples in order to prove the existence of the gravitational and anti- gravitational waves. Subsequently, for the duration of one earth's rotation, signals should be collected simultaneously from both detectors and the data should be compared and analyzed, in order to discover a clear difference in results at a certain instant of time. This might indicate the detection of anti- gravitational waves arriving from our universe's dual counterpart. The falling of these waves on the interferometer detector at the observatory causes differential changes in the lengths of the arms of the interferometer, which are placed perpendicular to each other. These differential changes can be sensed most accurately by laser interferometers. When a gravitational wave falls on one arm of the interferometer it is contracted in length while the second arm is stretched (its length is increased). In the case of an anti- gravitational wave the opposite happens as the first arm is stretched while the second is contracted, therefore the measurements should be taken simultaneously. The change in the length of the passage of the two optical beams, causes a phase shift which is detected by the interferometer optical detector. An experiment could be carried out with similar ground-based interferometers, but with higher sensitivities, in order to detect a possible background space fluctuations and hence, confirm the existence of a universe counter to ours. In this case, the wavelengths of the anti-universe waves received should have different values than those detected by the LIGO team for gravitational waves in the 2015 experiment [7]. The project "Laser Interferometer Space Antenna (LISA)" which is intended for building a space- based gravitational wave interferometer, will be completed and launched in the 2030's. The gravitational interferometer will fly along an earth- like heliocentric solar orbit with flexible length arms (about 2.5 million kilometer long), which would enable the detection of space disturbances caused by a gravitational or anti-gravitational wave passing the interferometer with much more sensitivity (about one part per 10^{20} strain sensitivity) than any ground- based gravitational wave interferometer, while covering the low frequency band of gravitational wave spectrum. A careful and accurate analysis of the intensities of signals that might be received from (anti-) gravitational waves by ground and space- based interferometers, could shed a light upon the origin of the constant disturbances in the space-time fabric received from our dual universe and could provide information on the distance between our universe and its dual counterpart. An experiment (a particle anti-particle collision experiment at very high energies), could be done at CERN, to detect and confirm the existence of the hypothesized '*S- particle'* and its anti-particle, that were created in the very early universe immediately following the 'Big Bang'. In conclusion, the presence of a dual (anti-) universe to ours might exert a repulsive anti-gravitational force upon our universe that, together with the space-time expansion can shed light on the origin of the exotic dark energy. This continuous anti-gravitational force might also cause a constant background of space fluctuations in our universe. Moreover, the proposed model for a dual universe might participate in solving two of the greatest mysteries in physics and astrophysics of our times, namely the question why our universe is composed almost entirely of ordinary matter while hardly any free anti-matter is observed?, and the question of the origin of dark energy.

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