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الحوار بين الفن والعلم في القرن السابع عشر، أثر علوم غاليليو في فن النهضة والباروك أنموذجا

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17th Century Dialogue between Art and Science: The effect of the Scientific Contributions of Galileo on Late Renaissance and Baroque Art

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الملخص

بعد سبات علمي وثقافي عميق شهدته الساحة الأوروبية طيلة قرون العصور الوسطي المظلمة قمعت خلالها بفعل الهيمنة الدينية المسيسة الحرية الإبداعية للإنسان في شتى مناحي الحياة، انطلق عصر النهضة الأوروبية في القرن الخامس عشر بكل ما حمله من أفاق ومكتشفات علمية وإنسانية كان لها دور كبير في إثراء الثقافة والفن وتحديث بنيتهما وفلسفة خطابهما منذ ذلك العصر وحتى يومنا هذا، ولم يكن لذلك ان يتأتى لولا سواعد علماء ومفكرين إنسانيين برزوا منذ عصر النهضة والباروك وعملوا على تأسيس نظرة جديدة موضوعية وعلمية في تناول مسائل الحياة وسبر غورها بروح إنسانية توفق بين ما هو قدسي ودنيوي. ومن أبرز هؤلاء العلماء (غاليليو غاليلي) الذي يرجع له وضع اللبنات الأساسية ليس فقط لولادة العلم الحديث بل لولادة الفن الحديث. حيث استثمر الفن في تلك الحقب الرؤى والأفكار العلمية للعلم غاليليو ومن أهمها استثمار النظرة التلسكوبية الدقيقة وروح الملاحظة والتجريب في كشف ماهية الطبيعة والعالم والكون، والتي انعكست في الرؤى والبنى الجمالية والفنية لدى فناني عصري النهضة والباروك وما تلاهما من تيارات لاحقة، حيث اتسمت خلالها أعمالهم الفنية برغبة جامحة شديدة الملاحظة في محاكاة الواقع وتصويره بروح علمية وتجريبية وإنسانيه بآن واحد. ولغاية الربط بين النظرية والتطبيق؛ ستستعرض هذه الدراسة نماذج من الأعمال الفنية الهامة التي تجلت فيها بوضوح أبرز ملامح تأثير علوم غاليليو في الفن البصري وفي فن التصوير بشكل خاص، حيث أضافت له ثراء جماليا وموضوعيا شكلا وموضوعا.

الكلمات المفتاحية: غاليليو، فن، علم، علم الفلك، الفضاء

Abstract

After a deep scientific and cultural hibernation throughout the Middle Ages, during which politicized religious domination suppressed the creative freedom of humankind in all areas of life, the European Renaissance in the fifteenth century brought scientific and human prospects and discoveries that played a vital role in enriching culture and art and modernizing their structure and philosophy. This would not have been possible without the help of humanistic scientists and other thinkers who emerged during the Renaissance and the later Baroque era and developed new perspectives including a scientific approach to addressing life's challenges, exploring them in a spirit that reconciled the holy with the secular. One of the most prominent of those scientists was Galileo Galilei, who is today considered the father of modern science. Galileo was also an artist, and his art incorporated the scientific ideas developed during this time. Among these ideas was the spirit of observation and experimentation, which was incorporated into the studies of nature, the world and the universe. This in turn was reflected in the visions of Renaissance and Baroque artists, whose work was characterized by the desire to simulate reality and to depict it in a simultaneously scientific and human spirit, and of subsequent artistic schools. This study will examine examples of the important works that illustrate the most prominent features of Galileo's influence on visual art - particularly representational art - and the aesthetic value of that influence.

Keywords: Galileo, Art, Science, Astronomy, Space.

Introduction:

The dialogue between science and art was not a new phenomenon, although it crystallized decisively during the Renaissance in the fifteenth century. Both science and art have played an important role in shaping culture, enriching artistic visions and revitalizing the human creative imagination in all stages of its historical, social and cultural development.

Since the beginnings of the Stone Age, man explored science - even before exploring religion and philosophy - through attempts to manufacture tools for hunting and self-defense, to secure his livelihood and dominion over nature. This progressed to the manufacture of more sophisticated agricultural tools, which required better knowledge of materials as well as better manual skill. Sociologists and cultural historians such as the Canadian Marshall McLuhan and the Italian Renato Barrelli considered the invention of these primitive tools to be the origin of the modern meaning of "culture" as it represents the human and scientific aspects of life (Barelli, 2012: 13).

The use of the term culture - which originated from the verb cultivate, which literally means the plowing of the earth for agriculture - evolved to include all human practices, behaviors, and knowledge, such as science and mathematics as well as art and philosophy. The universal meaning of culture, according to the linguistic explanations mentioned above, clearly demonstrates the early and intimate connection between science and art and its role in shaping successive cultures.

This rich dialogue stimulated and enriched not only the artistic imagination, but also the scientific method. The history of human creativity has witnessed the unification of science and art in brilliant minds, such as the ancient Greek mathematician Pythagoras, who combined philosophy, mathematics and music into a single crucifix, and the artist and scientist Leonardo Da Vinci. Galileo was another Renaissance man who combined scientific thought and philosophy with art. (Finocchiaro 2012, P:104)

In order to document and discuss the implications of the scientific conquests of Galileo on the structure of art in the Renaissance and Baroque eras, we must first briefly review some of the most important historical stations that witnessed the intersection of science and art - beginning with the Greco-Roman period, which was the starting point of much subsequent western artistic development, and following the ups and downs of the religious and scientific contexts of these eras.

The Dialogue Between Science and Art in the Greco-Roman Period

The Greek era is one of the most important periods in which the role of science was clearly manifested in the artistic imagination. In a cultural and intellectual atmosphere in which art, science, religion, and philosophy melted into a single creative mix, the result in the arts was "geometric and computational accuracy, graced with humanistic spirit, without missing vitality, calmness, and sublime beauty" (Pellizzi. F, 2006, 143).

Among the most prominent Greek contributions to science which also influenced art in that era were the scientific, geometric and mathematical theories of Pythagoras, Euclid, Archimedes, and other Greek pioneers of mathematics, engineering, and natural sciences. Pythagoras, for example played a prominent role in the integration of science, art and aesthetics in his numerical and arithmetic theories, especially with regard to the aesthetic significance of music (Tubbs. N, 2014, P12). He also incorporated his mathematical theories and calculations into the field of the visual arts, such as sculpture and architecture. The achievements of Pythagoras and his contemporaries contributed to the building of a scientific legacy that was reconciled with religion and philosophy, which in turn became both a basic building block and a fertile ground for later European cultural achievements. In the Renaissance and Baroque eras, the scientific and humanistic heritage of the Greco-Roman period was revived and enhanced with new ideas without

losing that connection.

The Romans, before Christianity, added to what they inherited from the Greek scientific and cultural heritage in accordance with their materialistic and realistic philosophies of man and existence, as well as with their progressive attitudes. Among the most prominent Greek ideas invested by the Romans in the formulation of their artistic style were the philosophies of Stoicism and Epicureanism (Cunningham, 2009, 11). Stoicism taught the importance of adhering to the laws of science in various areas of life and excluding emotions and imagination in order to seek a purposeful life to cope better with reality. The Epicureans, on the other hand, were inspired by the faith in science and scientific thinking, especially in the material and atomic fields.

Both the Greeks and Romans created what is known as the "classical" style of art, in which science played a major role, and from which successive generations and later periods found an indispensable source used in formulating scientific, artistic and humanistic methods as seen in the Renaissance and Baroque geniuses.

The Middle Ages

The Middle Ages did not enjoy the rich dialogue between science and art compared to past and future eras. This is mainly due to the hegemony of religious authorities and not to Christianity itself, which believes in the importance of science and art in human life. Those in power blocked human, scientific, and spiritual knowledge to serve their own political and authoritarian purposes and to convert this knowledge within theological instructions to its own benefit. (Wolvekamp, H.P, 1974, P:23)

This tension between science and art was reflected negatively in European cultural behavior and lasted for centuries. Along with science, which was treated as heresy, art declined intellectually and aesthetically, and its role was limited to the representation of religious themes as a symbolic mental stimulation. The level of structural aesthetic in the creation of artwork also declined, especially in the fields of drawing and painting, which were characterized by static representation, lack of vitality in form, flattened depth and a disconnect from reality. (Hourihane, C, 2012, 565).

The European community lived through that dark period of its history in a deep slumber that ended with the arrival of the Renaissance at the beginning of the fifteenth century. Scientists such as Da Vinci, Newton, and Galileo initiated a period of scientific discovery in physics, engineering and anatomy that restored vitality, realism, and human aesthetic impulses to the visual arts. This culminated in Galileo's astronomical achievements in the 17th century, which had a significant impact on the enrichment of Western art.

The Dialogue Between Science and Art in the Renaissance

At the time of the Renaissance, European society gradually began to wake up from its centuries-long stagnation. Positive transformations emerged in the form of fruitful relationships between religious and other authorities on one side and science and art on the other, after the Catholic Church began to gradually accept the ideas of scientists (Thompson, 2009, 71).

The beginnings of reconciliation with the church led to the revitalization of the cultural environment and of humanist thought. It led to the enhanced philosophical, experimental and practical thinking of the new Renaissance men after the emergence of philosophers, who called for the importance of science, experimentation and application in addressing the issues of life. The practical ideas of Francis Bacon and Descartes influenced the creations of Renaissance and Baroque artists, who practiced with the minds of highly observant experimental scientists. In addition to these intellectual transformations that influenced the fruitful relationship between science and art, it is

important to mention the important scientific discoveries that emerged in the Renaissance and Baroque - in the fields of optical physics, applications of scientific perspective and space, gravity, movement, astronomy, anatomy, and geography. (Tansey .R et.al, 1980, 630).

These discoveries were made by such diverse thinkers as the architects Alberti and Brunelleschi and the scientist Isaac Newton. Architecture, sculptures and images that drew on them were characterized by their scientific perspective and realistic aesthetic. Arguably, from my point of view, this could not have been achieved by the artists of the late Renaissance and the Baroque era without the discoveries of Galileo.

Galileo: Biography and Dialogue with Art:

Galileo was born in Pisa, Italy, in 1564. He completed his studies in his hometown in 1592 and moved to the northern Italian city of Padua, in the Republic of Venice - one of the few European regions that enjoyed freedom of thought, due to its commercial prosperity and location on the Adriatic coast far from the central religious authority in Rome. Galileo witnessed both the period of religious reform led by Martin Luther in Germany and the counterrevolutionary movement of the Catholic Church, which used all available means - from torture to outright war - to force the reformers to retreat from their reformist ideas. The church feared that the reforms, by opening up the horizons of scientific knowledge and realism among the people**,** (Hall. Paris, 2014, 22) would abolish its teachings and theological instructions that were imposed on artists, scientists, and other intellectuals on their texts and works of art.

Among the most prominent doctrines that conservatives were adamant to adhere to were the idea of the centrality of the flat and fixed earth and its separation from heaven and the inferiority of man as a helpless and inherently flawed creature. The reformists rejected this doctrine and called for liberation from those beliefs to allow the Christian to combine and reconcile the work of man with God's absolute will, through developing knowledge based on science rather than religious metaphysics.

This confrontational climate led to the condemnation of some scholars, most famously Galileo in 1633. He escaped execution by revoking his own scientific theories, based on those of Copernicus, relating to astronomy and the spherical Earth and its rotation. These ideas were feared by conservatives because they gave a precise scientific description of the world based on science and not on metaphysics alone.

It should be noted that despite Galileo's experience with the tension and intense conflict between science and religious authority, he continued to be connected with the cultural and artistic sphere, which influenced his development as both a scientist and an artist. He had grown up in a family that loved art and music, which influenced his research and writing. (Coelho, 1992, 6).

Galileo studied the phenomena of sound vibrations as well as the relationship between their length and their acoustic emissions, indicating an intersection between his interests in science and music (Coelho, 1991, 5). As an expression of his passion for music and its impact on the soul, Galileo wrote to his friend Lodovico Cardi, known as Cigoli, that the appreciation of music would lead the emotional reaction towards compassion and resistance to grief much more than crying would **(Cypess, 2016: 26).** Galileo called for a new understanding of musical beauty where pure melody was capable of arousing the emotions of the listener even in the absence of written text. (Panofsky, 2013, 11).

This also points to the importance of the direct perception of abstracted music, which, according to Galileo, was consistent with reality, rather than being confined to its symbolic signs of religious morality. Galileo's aesthetic view of music was crucially supported by the community of contemporary musicians who were related to his father,

the famous musician Vincenzo Galileo. As for the literary arts, Galileo was deeply interested in Latin literature and classics, in addition to being a poet (Hall, 2013, 20).

And, through his critical appraisals of literary writings, he was interested in issuing his observations about their use of astronomical terms related to celestial bodies. He analyzed those from a scientific perspective, combined with literature and philosophy. Galileo's intimate relationship with philosophy was clearly evident during the time he spent with the Florentine Medici family, sponsors of science and art, who described him as more of a philosopher than a mathematician **(Hall, 2013: 60).** At that time, he devoted much of his attention to uncovering weaknesses in the narratives of philosophers (Hall, 2013, 61).

Galileo's interest in the field of the visual arts was no less important than that in those of the others. He was in constant contact with artists and exchanged aesthetic and art critique with them. One of the most prominent examples was his friend Ludo Cardi, also known as Cigoli. Cigoli asked Galileo to defend painting against opinions that it was inferior to sculpture, which was then more popular among connoisseurs. In defense of his friend against those who believed that the three-dimensional sculpture is superior to the two-dimensional painting, Galileo emphasized his rejection of the distinction between paintings and sculpture. The statue's being, in its three dimensions, is limited to the generation of aesthetic sensibility through tactility, while the two-dimensional painting creates beauty through the sense of sight. (Da Silva, 2015, 14).

Galileo therefore attributes to the painter an equal or greater expressive power than the sculptor. The critical attitudes that Galileo exchanged with his contemporaries were not limited to his position on the question of comparison between drawing and sculpture, however. In another letter sent by Galileo to Cigoli, and published in the articles of the scientist and art historian Erwin Panofsky in 1954, Galileo expressed his discontent with the style of Mannerism, led by the painter Caravaggio at the end of the sixteenth century, due to the fact that this method was characterized by exaggeration in form and content at the expense of documenting visual reality in the scientific manner recommended by Galileo (Reeves, 1999, 18).

Additionally, in light of the intimate relationship between Galileo and the artists of his time, in which he stimulated in them the scientific spirit and the natural expression of art, many of them expressed their friendship and gratitude by painting portraits that exemplified his enlightened qualities and unbridled desire to scientifically explore the universe. One of the most famous of these portraits is the 1634 painting by the Dutch artist Justus Sustermans, in which Galileo appears with illuminated face contrasting with a dark background, looking up, symbolizing his quest for the scientific truths of nature (Fig. 1).

Galileo was also an excellent painter and designer himself.**(Greco, 2018: 155).** In fact, his autobiography suggests that he was more inclined to the study of the visual arts than to that of mathematics. His famous pictures of the of the moon in 1609 (Fig. 2) attest to his skill in both drawing and watercolor **(Greco, 2018: 156).** In these drawings, he vividly documented the shifts of shadow and light and the texture of the surface of the moon (Greco, 2018, 157) as he observed it through his telescope.

Fig. 1. Justus Susterman, Portrait of Galileo Galilei, 1636.

Fig :2 .Galileo's drawings showing the phases of the moon, ,(1609)from his manuscripts preserved in the National Library of Florence.

The influence of Galileo's scientific ideas on artists

Due to the influence of Galileo's scientific conquests on artistic culture throughout the seventeenth century and beyond, accurate representation of nature, people and objects in art became a major goal. At that point, artists had more space to express themselves freely – not only those who had personal relationships with Galileo, but also other European artists who were inspired by his ideas. Galileo's influence on the work of these artists was reflected in two main ways: the simulation of his scientific and astronomical discoveries in direct representational art, and the imitation of the new technical vocabulary resulting from those discoveries. These were clearly manifested in the structure and elements of the figurative painting of light and tactile values as well as the manner of representation of motion, space and mass. Below are examples of Galileo's influence on his contemporaries.

- **Cigoli, The Assumption of the Virgin**

This famous fresco (Fig. 3), which was painted in the dome of the church of Santa Maria Maggiore in Rome, depicts the Ascension of the Virgin Mary. The artist expresses his appreciation of Galileo's astronomical ideas by drawing the moon under the feet of the Virgin Mary, This was the first time that the moon was represented as seen through the Galileo's telescope, as published in his book Sidereus **(Greco, 2018: 188),** In the same painting, the Milky Way galaxy is shown extending across the sky above the Virgin's head, (Reeves 20,1999, 19)

Fig. 3. Cigoli (Lodovico Cardi), L'Assunczione della Virgine, 1612.

In addition to its scientific implications, by putting the moon under the feet of the Virgin Mary, Cigoli may have wanted to suggest that the celestial bodies are not transcendent or beyond our ability to understand (Renn 21, 2001, 210). At the same time, he painted the Moon with the same importance, aesthetic magnificence and transparency of the light used to paint the Virgin (Renn 21, 2001, 210). This is a clear symbol of the

importance of parallelism among religion, nature and man, and rejects the idea of the inferiority of man dictated by religious authority.

This new intellectual perspective of the universe and space, as expressed artistically by Cigoli, would not have been possible had it not been for the discoveries of Galileo that revealed new visions of the universe.

The fresco is considered the first acknowledgment of Galileo's discoveries through art, portraying celestial bodies in perpetual motion through space. In addition, Cigoli employs his discerning eye to paint natural colors shades, in accordance with the telescopic view of space and celestial bodies. It is also noted that the artist painted the figure of the Virgin Mary from a low angle to simulate the view of the telescope – which usually observes objects in space from the bottom up – and at the same time elevating the status of humanity in the universe.

- **Artemisia Gentileschi, Judith Slaying Holofernes**

Fig. 4. Artemisia Gentileschi, Judith Slaying Holofernes, 1610.

Artemisia Gentileschi, another friend of Galileo, is considered to be one of the most enthusiastic adopters of his new ideas, especially in the field of physics. Her painting "Judith Slaying Holofernes" (Fig. 4), completed in 1610, is considered the first realistic depiction of blood flowing from the victim's neck, in accordance with Galileo's equivalent ballistics theory. In addition to the scientific aspects drawn from Galilean theories, this painting reflects the rebellious spirit and the new attitudes and values that emerged during the 17th century, including freedom of expression and women's liberation. (Hillstrom. K ,et.al, 1990, P:630)

The artist was inspired by the Biblical story of the defeat of the despotic general by the heroine Judith to express the triumph of virtue over vice, as well as the power of women to defend themselves against tyranny, rape, and persecution for witchcraft in the Middle Ages. But despite the gruesome and unfeminine nature of the scene, the women in the painting are portrayed with calm, strength, dignity, and self-confidence **(Bal,2006: 6)** The artist used natural lighting and shadow to unite the composition and close the edges of the scene convincingly **(Bianco Oscuro (Bal 2006: 72).** Gentileschi also showed her anatomical skills in the style of her contemporary Baroque artists, who were also influenced greatly by Galileo in directing their artistic methods towards the accurate simulation of reality.

Figure :5 Giovanni Francesco Barbieri (Il Guercino), Atlas Holding Up the Celestial Globe, 1646.

- **Il Guercino, Atlas Holding Up the Celestial Globe**

This painting (Fig. 5) is one of the most important Baroque artworks influenced by Galileo's discoveries. Il Guercino was inspired by themes from ancient Greek myth to express the quest of man to face the realities of the universe and to discover its secrets. To this end, the artist used Atlas who, according to legend, was condemned by the god Zeus to carry the dome of the sky forever. The heroic role of Atlas in carrying the dome of the sky is analogous to that of Galileo's own role of taking the responsibility of observing the universe and uncovering its secrets **(Impelluso, 2003, 38).**

Il Guercino thus gave humanity a heroic and scientific value that explicitly rejected the inferiority of man and his inability to discover the mysteries of the universe, (Salerno.L,1988:9) which had been consecrated by the Christian clergy. Through this painting, he confronted the conservative theologians, who had accused Galileo and other scientists of witchcraft and The artist used aerial perspective as an expression of the infinite breadth of the universe. Additionally, Atlas' body is replete with precise detail, in keeping with Galileo's visual observations **(Ficacci, 1991, 18).**

heresy.

- **Luca Giordano, The Apotheosis of the Medici**

Fig.6. Luca Giordano, The Apotheosis of the Medici, 1683.

Luca Giordano painted this fresco (Fig. 6) on the ceiling of the Medici family palace, shortly after Galileo first observed Jupiter. It is an homage to the Florentine ruling family, which had generously supported both scientists and artists, including Galileo, since the beginning of the Renaissance. In his youth, Galileo was a friend of the most famous member of this family, Cosimo Medici II, and of Giordano. (Avery. C, 1972, P: 622)

Giordano places his beloved friend Cosimo in the center of the fresco - which is part of a ten-part mural - and the rest of the male family members close to him to highlight their importance in a style that almost suggests deification. The artist, through an ingenious plot, employs elements of science, religion and myth. In particular he depicted forms that refer to the planets, emphasizing the scientist along with the Medici family. The planets Mars, Venus and Saturn are shown along with Apollo riding the sun wagon. The fresco also shows Jupiter atop a mountain and surrounded by various personalities, including members of the Medici family, wearing red robes and riding white horses, indicating their spiritual dimensions. (Greco . P, 2018, 193).

Giordano paid as much attention to the technical language and style of the painting as he did to its narrative and symbolic content. For this purpose, he chose visual elements and components that confirmed Galileo's astronomical discoveries, such as celestial objects and planets, orbiting in an endless open space around Cosimo Medici in the center. This is also a metaphorical depiction of Galileo's discoveries relating to the round Earth and its rotation. (Greco. P, 2008, 193)

Note that Giordano painted the planets and characters in the Baroque method, in bright colors and with low angles to make them appear high and expressive of Galileo's greatness and his astronomical discoveries, as well as the prestige of the Medicis.

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Fig.7. Sir Peter Paul Rubens, The Origin of the Milky Way, 1637

- **Peter Paul Rubens, The Origin of the Milky Way**

As the study of astronomy spread throughout northern Europe, Sir Peter Paul Rubens, one of the most famous Baroque Dutch artists, became influenced by it, especially with regard to the movement and rotation of the Earth, (Oppenheimer, 2002, 195). Rubens was captivated with and passionate about astronomy throughout his career in painting and drawing, and he adopted dynamic and active movement in his works, especially in his famous painting "The Origin of the Milky Way" (Fig. 7). In this painting, he chose a theme of striking vitality and a style in which humor was combined with visual sensitivity (Alberti. L.B, 1999, 205).

Rubens personified the Milky Way galaxy, the sun, the earth, and the rest of the solar system as observed by Galileo in the Baroque style, using smooth lights and gradations of color. He drew inspiration from the ancient Greek myth of the birth of the Milky Way: Zeus, wanting to give his son Hercules eternal life, brought him to his wife Hera, who breastfed him the milk of immortality.

Rubens painted milk droplets flowing from Hera's breasts floating in the sky, forming a path of brightly colored stars moving around the earth. From my point of view, In terms of artistic technique and visual construction, Rubens used aerial perspective and realistic depictions of spaces and objects as observed by Galileo.

Fig.8. Adam Elsheimer, The Flight into Egypt, 1609.

- **Adam Elsheimer, The Flight Into Egypt**

German artist Adam Elsheimer's painting of the biblical Holy Family's escape to Egypt (Fig. 8) represents a natural exposition of the night sky and stars, again inspired by Galileo's studies. It depicts the journey of Joseph, Mary and Jesus to Egypt, seeking sanctuary from Roman oppression. Elsheimer completed the painting in 1609, the same year in which Galileo recorded his astronomical observations (Buonanno, 2014, 43).

Elsheimer succeeded in a unique way in merging the holy and the secular. There is a dialogue between the visual components of the religious tale and of the planets and landscape - capturing the new humanistic tendencies in the Renaissance and Baroque towards uncovering the mysteries of nature and the universe and at the same time

reconciling them with human spirituality. He drew detailed and realistic star formations including the Milky Way, which appeared quite differently from earlier representations of the painting: It was seen for the first time not as a silver haze, but as a cluster of distinct stars scattered in the sky, along with moonlight and the light of other stars, so that the scene recalls what Galileo saw through his telescope. (Buonanno, 2014: 42).

Elsheimer employed the Milky Way both scientifically and spiritually. He expressed its appearance not only as a spiritual sign symbolizing the beginning of the road to heaven, but also as a visual scientific fact. This painting is unique in its direct connection to astronomy, including its realistic depiction of the stars and of the moon's surface. (Gall. E, Waetzoldt. W, 1992, 215).

- **Rembrandt van Rijn, Self-Portrait and The Anatomy Lesson of Dr. Nicholas Tulp**

Although Dutch painter Rembrandt, one of the pioneers of the Baroque style, did not deal in his paintings with astronomical subjects in a direct descriptive manner, he did imitate in his works the new visual vocabulary produced by Galilean science, especially in matters of space, shadow and light.

Rembrandt employed light and shade in his images to create masses and spaces. He used this approach not only to represent form in a scientific spirit, but also to add a sense of theatrical atmosphere and dramatic expression in the Baroque style, particularly in his self-portrait, in which the contrast between darkness and light can be clearly seen (Fig 9).

Fig. 9. Rembrandt van Rijn, Self-Portrait, 1628.

In addition to the above, Rembrandt's paintings reflected other effects inspired by Galileo's observations, such as the distinctive "non-linear optical anatomy" in which light plays a key role in distinguishing faces and features. (De Wetering, 2005, 108). Rembrandt also excelled in the use of foggy atmosphere (Sfumato), which added an enchanting effect to the painting through unity of light and color, similar from my point of view, to what Galileo perceived in astronomical space.

As for his treatment of perspective and depth, Rembrandt completely abandoned the lines of the engineering and mathematical perspectives in favor of color gradation and transparency to represent depth and atmosphere (Deutering. E, 2016, 166), this brilliant treatment of depth seemed to match Galileo's view through his telescope.

It should be noted that in addition to their role in the study of physical phenomena, Galileo's scientific principles of experimentation and observation, which formed the basis of the scientific method, became the standard for verification of all hypotheses and theories. Thus, anatomy developed as one of the natural sciences. The development of analytical instruments reached its zenith at the end of the seventeenth century and contributed to the expansion of the study of anatomy. In the context of the new scientific

climate, Rembrandt was an expert in employing verification to reveal the nature of things expressively and metaphorically in his paintings, as well as in revealing the inner psychological states of his subjects, as in his 1632 painting "The Anatomy Lesson of Dr. Nicholas Tulp" (Fig. 10).

Fig. 10. Rembrandt van Rijn, The Anatomy Lesson of Dr. Nicolaes Tulp, 1632.

Here, a doctor gives a lesson in human anatomy by dissecting a cadaver, while a group of men gather around him. The men are portrayed in a way that conveys their intellectual curiosity, which is made plain in their expressions and the intensity of their attention and concentration as they observe the details of the autopsy. (Pescio, 2008: 88).

As in his self-portrait, Rembrandt added dramatic atmosphere to this painting, in which contrasts in light and color highlighted the details and distinguished the key elements of the scene by focusing the light in the center of the painting, where the body lies. This highlights the importance of the dissection process and, symbolically, the importance of scientific knowledge.

Results and conclusions:

This study presents the influence of Galileo's scientific discoveries on artistic culture in the 17th century - especially relating to the accurate representation of nature - as evidenced in the famous works of the late Renaissance and Baroque artists.

These works have proven that artists applied Galileo's scientific insights, which called for the importance of observation, experimentation and an analytical approach to the description and explanation of phenomena, and for the use of deductive hypothesis methodology.

They were characterized by an intense desire to move objects and visual elements in the same way that objects and phenomena appear in nature and the universe according to the scientific foundations that Galileo established by observation rather than through metaphysical and theological perspectives.

This new scientific understanding of the world resulted in fundamental changes in the philosophy and objectives of art. By abandoning the rigid doctrines of the inferiority of humanity which forbade exploring heavenly phenomena, artists gained expressive freedom. They were now expected to understand the why and how of observable phenomena, just as scientists were, and thus they became critical observers rather than skilled technicians.

On a practical and applied level, according to the samples of artwork reviewed in this study, the influence of Galileo’s science on the style of late Renaissance and Baroque artists can be summarized as follows:

1. Artists turned to accurate representation of visual reality through precise scientific observation. In anatomy, artists used light rather than lines to depict and distinguish anatomical details of forms, in imitation of the universe where light and shade play a role to reveal the shapes of celestial bodies.

2. They drew and painted open and extended spaces reflecting the breadth of the boundless universe. They also used planets and stars, such as the Milky Way, in an aerial and misty perspective and in orbital fashion to convey Galileo's scientific ideas related to Earth's spherical nature and the planets' orbital movement.
3. Both human figures and planets were drawn from low angles to elevate them, so as to elevate the importance of humanity in the universe from inferior creatures to important beings interacting with the universe.

Humans were portrayed with real emotional expressions, using contrast and gradation of shadows, light, and color to reveal those inner psychological dimensions.

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