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# Astronomical Observatories in the Ottoman Period; Case of Study (Helwan Observatory)

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## ABSTRACT

The Ottoman Empire was founded in 699AH\1299AD, after the death of Ertugrul, that started with his successor Othman, who established the Empire, which lasted more than 600 years until it ended in1341AH\1922. So, during those centuries, Ottomans had contributed to many fields of knowledge, science and astronomy. They were in a great deal of creativity, innovation and scientific production. They paid attention to what other predecessors of the other nations had studied. Also, wrote many unique works that became essential references for all the world. They did not stop there; but built observatories and invented machines. As well as developing the astronomical observatories in their time for noticing the planets, stars and drawing their positions.

This study examines the interest of astronomy in the Ottoman period, and the role played by astronomical observatories in that period as a kind of Muslims heritage, also the famous astronomical observatories during that period, especially Helwan Observatory.

Furthermore, the present study investigates the importance of Helwan Observatory in discovering many natural phenomena. The current study discussed the location of Helwan Observatory, the architectural design of the historical building, and its museum, as many rare and historical pieces joined to the Tourism and Antiques Ministry.

The study applies historical, descriptive and analytical approaches, as it focuses on the history of the observatories during the Ottoman period. As well as the great role of Helwan Observatory in discovering important natural phenomena and the description of the architecture design of the historical building.

## 1. Introduction

It is well known that interest of Astronomy started a long time ago, Ancient Egyptians, Assyrians and Greeks paid attention to weather phenomena. Egyptians are considered as one of the oldest nations studied astronomy and they were able to calculate the solar calendar by observed the continuous monitoring of the stars. The Pyramids at Giza (4$^{th}$ Dynasty), Abu Simbel Temple (21$^{st}$ Dynasty) and the zodiac at the Temple of Denderah (Ptolemaic), all bear distinct evidence that Egyptians were

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very much preoccupied with observing heavenly bodies and their motion, with unrivalled skill (Gamal et al., 1990, pp. 49-50). During the Arab period, astronomical sciences had a great interest by the rulers in various countries. Even before Islam, the names of planets were mentioned in Arab poems, but astronomy wasn't known in its scientific capacity which based on astronomical experiments till the Abbasid period (Ibrahim & Edrees, 2022, p. 347). The history of Islamic observatories reflects the rich tradition of scientific inquiry during the Islamic Golden Age (8th to 14th centuries) and beyond. Islamic astronomers made significant advancements in observational astronomy, instrument design, and the development of astronomical tables. *Al-Manṣūr* (754‑775AD) was the first caliph interested in the study of the cosmos, and most succeeding rulers followed him in this regard. He was keen on converting Indian and Persian books into Arabic. Muslim scholars were not satisfied with the conversion, but they corrected many errors in those books and added many things to them. There was an astronomical Observatory in most of the Muslim countries during that period in Baghdad, Cairo, Samarkand, Toledo, and Granada (HİLAL, 2019, p. 224). It wasn't until the reign of the ʿ Abbāsid caliph *al-Maʾmūn* (813‑833AD), however, that systematic astronomical observations began (Angel & Alberto, 2019, p.100).

Maragha observatory located in present-day Iran. This Observatory was one of the most advanced astronomical institutions of its time. It was established by the Persian polymath Nasir al-Din al-Tusi under the patronage of the Mongol ruler Hulagu Khan. The observatory included sophisticated instruments such as an armillary sphere, a mural quadrant, and a large observatory dome. Al-Tusi developed the "Tusi couple," a mathematical model that provided a more accurate representation of planetary motion (Encycclopaedia, 1993, pp. 306-307).

Additionally, Samarkand observatory built by Ulugh Beg, a Timurid ruler and a prominent astronomer, founded the Samarqand Observatory in Uzbekistan. The observatory was equipped with large instruments, including a massive meridian arc used for measuring celestial angles (Cohen, 2010).

The Ottoman Empire was founded in 699AH\1299AD, after the death of Ertugrul, that started with his successor Othman, who established the Empire, which lasted more than 600 years until it ended in 1341AH\1922AD. Within two centuries, they had established an Empire that encompassed not only the former Byzantine lands of Southeastern Europe and Anatolia, but also Hungary and the Arab world. So, during those centuries, Ottomans contributed to many fields of knowledge and science (Douglas, 2017, pp. 23-24).

## 2. Ottomans Interest of Astronomy and Observatories

**Astronomy** or *ʿilm-i hayʾa* has attracted attention in the Islamic world since the eighth century (Angel & Alberto, 2019, p.100).

The word **Observatory** comes from an Arabic word *raṣad* and the place of observation was known in the Islamic civilization as *raṣadnakha*, *bayt al-raṣad* or *marṣad*. Greeks used *raṣadkhana* for the purpose of performing regular astronomical observations and mathematical studies, that involved large, elaborate measuring instruments, built by Muslim scholars (Emilie, 1995, pp. 67: 110).

Astronomical observatories are considered a pivotal human heritage in building civilizations and leading towards the progress. So, they were built in order to be able to monitor slow and precise changes in the position of distant celestial bodies, thus it becomes a local and international

archaeological heritage. Astronomical observatories around the world operate within an international cooperative and complementary framework sponsored by the International Astronomical Union, which includes 12,664 members from 96 countries, including Egypt. As well as Astronomical observatories considered as an important economic source that generates national income for the countries that built, through astronomical tourism to witness astronomical phenomena. Astronomical observatories also contribute to ensuring the national security of the countries that host it, by providing early warning of space threats in times of peace and war (Fathy, 2023).

Ottomans interested in astronomy and the astronomers influenced with their Islamic predecessors. The Ottoman astronomers invented many astronomical instruments, wrote astronomical theories and calendar computing methods. Both Maraga and Samarkand observatories affected Ottoman astronomers till the 18th century. Moreover, Sultan Muhamed II (Ágoston & Masters, 2009 pp.364: 367)[1] had interested of astronomy and invited many astronomers from Samarkand to teach Ottoman astronomers, also the Ulugh Beg's (Hobden, 1999, pp. 3:9) tables still used till the 18th century (Ágoston & Masters, 2009, p. 507).

During the 19th century, the interest of astronomy and Observatory was completely changed because of the global ambition and the increased resources of the Ottoman Empire (Stolz, 2018, p. 3). Egypt during that period, had a great knowledge in astronomical observatories, Al-Azhar scientists were famous as astronomers, like; Sheikh *Hassan Al-Jabarti*. Egypt also knew the first nucleus of an astronomical Observatory when French scientists established a small Observatory during the French invasion of Egypt. Muhammad Ali was interested in sending a number of students to Europe to study and manufacture engineering instruments. It has been mentioned that the mission of 1825 AD, included both Omar Effendi and Muhammad Effendi, who were sent to England to learn the manufacture of compasses, thermometers, binoculars, and dimension gauges, then they returned to Egypt with a different experience. Data issued by the General Meteorological Authority indicate that meteorological activity began in Egypt in 1829 AD (Al-Desouki, 2012, p.53).

Many Egyptian astronomers wrote astronomical manuscripts that affected on astronomy during the late Ottoman period, like Muhammed A-Khudari who wrote a famous manuscript entitled *Sharh al- Lamʿa fi Hall al-Kawakib al- Sabʿa* "The Brilliancy of the Solution of the Seven Planets." (Stolz, 2018, 1: 316).

### 2.1 Istanbul Observatory

Istanbul Observatory was the first Observatory of the Ottoman Empire founded in Istanbul by *Taqī al-Dīn (*Kose, 2016)[2], Despite its achievements, the observatory had a short lifespan. In 1580, the observatory was destroyed by order of Sultan Murad III, reportedly due to pressure from religious leaders who were skeptical of its purpose and value. It was destroyed in 1580 AD just after two years of its establishment (HİLAL, 2019, p. 225). This Observatory was founded on the reign of Sultan Murad III (Ágoston & Masters, 2009, p..401)[3] who interested in astronomy and provided all the financial assistance which project needed and ordered to construct the

[1] He was the seventh Ottoman sultan born in 1432 AD and died in 1481 AD. He conquest Constantinople in 1453 AD.

[2] His name as Taqi a-Din Ibn Ma'ruf, born in Damascus in 1526 and died in 1585. Has many books in astronomy, engineering, mathematics, and natural philosophy. One of his famous books is *Al-Turuq al-Saniyya al-Alat al Ruhaniyya*, for more information

[3] He was born in 1546AD and ruled in 1574AD-1595AD, his father was the sultan Selim II. He was the ruler of Anatolia in 1558AD.

Observatory on a high location at Tophane in Istanbul on the European side of Bosporus (Tekefi, 2005, p. 2) [4]. Unfortunately, the climate of fanaticism that was spreading during that period affected people's thinking, and the Sheikh of Islam wrote a fateful fatwa stating that learning about the secrets of the universe is a dangerous matter and its consequences will be severe. Therefore, Sultan Murad III ordered to fire the Observatory by cannons and destroyed it on January 22, 1580 AD/ Dhul-Hijah 4, 987 AH. So, the only and oldest Observatory in the Ottoman Empire was destroyed, and no other Observatory was established until the end of the nineteenth century (Fig.1) (Uğly, 2021, pp. 270-271).

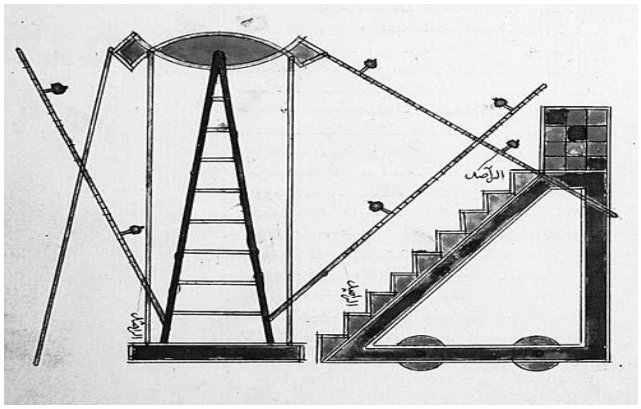


Fig.1: One of Astronomical instruments at Istanbul Observatory

After: (Ágoston& Masters, 2009: 509)

### 2.2 Egyptian Observatories

The modern astronomical renaissance in Egypt is divided into two stages before Helwan Observatory:

#### 2.2.a Observatory of Bulaq "*Raṣadkhana"*

In the year 1839 AD, Muhammad Ali Pasha (Cattaui, 1950, p. 27)[5] ordered the establishment of the first Observatory in Bulaq, its purpose was to raise the scientific level of the nation. Muhammad Ali decided to establish an astronomical Observatory modeled on the European astronomical observatories, so he ordered *Diwan al-Madars* "the director of the schools" to start establishing an "Observatory." After discussions, he issued an order to establish *raṣadkhana* at Al-Jazira region. Then it was decided to ignore the construction of a new building for the Observatory and be satisfied with the tower that the French had built as an astronomical Observatory next to Bulaq, that was next to *MuhandesKhana* "Engineer School" (Ālʿdl, 2017, p. 62).

At first, the tower contained a cannon and was suitable for observational purposes, it did not need new constructions, therefore it didn't need additional fees. Muhammad Ali Pasha worked to provide the Observatory with modern machines and equipment that help scientists to perform their tasks. It included an astronomical clock to measure astronomical times, lamps, and other machines used in operations (Ālʿdl, 2005, p. 62). In 1859AD, Muhammad Saeed Pasha (Fahmy, 2017, p. 57)[6] ordered Mahmoud Pasha al -Falaki, to complete the Observatory's equipment, and in 1864AD, the equipment arrived, with the exception of the equatorial telescope, which arrived in 1872AD (Khalil, 1949, p. 6).

#### 2.2.b Observatory of Abbasia "*Raṣadkhana"*

The Observatory in Bulaq deteriorated, due to the lack of regular restoration and poor storage of machines and equipment, which exposed it

[4] Bosporus: Also called Bosphorus, it's a strait that united the Black Sea and Sea of Marmara and it separates between parts from European Turkey and Asian Turkey. See,

Worldatlas, Map Of Bosporus Strait - World Straits, Bosporus Map, Location, https://www.worldatlas.com/aatlas/infopage/bosporus.htm, last access 14\2\2024, 1:34M

[5] He was the ruler of Egypt; he came to the power as soon as the French left Egypt. At the beginning of his rule, the chaos prevailed in Egypt again, between the years (1801 and 1805AD). Egypt witnessed a state of chaos due to the struggle of the three forces over power (the English, the Mamluks, the Turks). Muhammed Ai believed in the Egyptian people and their power, so he became the beloved ruler.

[6] He was the son of Muhammad Ali Pasha, born in Alexandria in 1237 AH\ 1822AD. He interested of science, eastern languages, mathematics, and painting, and spoke French well. In 1270 – 1854, he assumed power in Egypt after 'Abbas Pasha I died under the Ottoman Sultan and was interested in administrative reform. He was a lover of justice and virtue, and he modified taxes.

to damage. Also, the Observatory staff were not qualified to work there, that caused the machines to theft, loss, and neglect (Ālʿdl, 2005, p. 64). Khedive Ismail (Zidan, 2017, p. 49)[7] ordered Mahmoud Pasha Al-Falaki (Zidan, 2017, pp. 186-187)[8] to establish another Observatory in Abbasia. The place was known as *raṣadkhana*, which contains the military signals tower, where the telescope was set up and began taking observations at the Abbasia Observatory (pl.1) in 1868 AD (Khalil, 1949, p.7) but the actual date of construction was in 1865AD. When the scope of the Observatory's work expanded and included special observations of terrestrial magnetism, and since its equipment must be far from external influences, it was decided to transfer to Helwan, in 1903, 25 km south of Cairo (Shears &Shaker, 2013, p. 3)

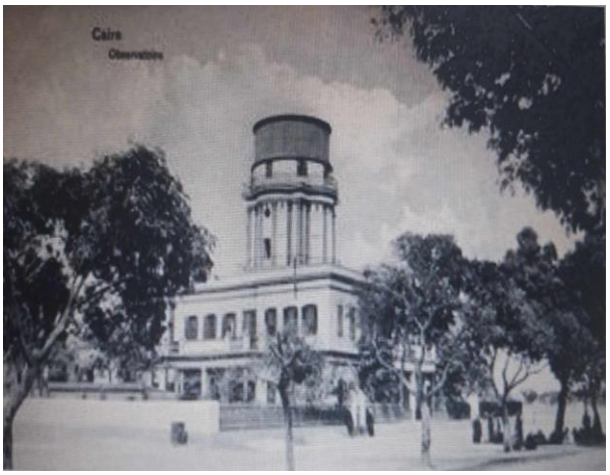



Plate. 1: The Original Observatory in Abbasia in 1906AD

After: Shears& Shaker, 2013: 28)

[7] He is Ismail bin Ibrahim Basha, born in 1830AD. At Al-Musafer Palace Khanah, Al-Jamaliyah neighbourhood, Ismail was raised under his father's care and educated close his grandfather's surroundings because his grandfather created a school for his children and grandchildren in royal Palace with a selected of teachers in which Ismail received the principles of Arabic, Turkish, and Persian languages. At the age of 16, his grandfather sent him with his late sons, Princes Halim Pasha, Hassan Pasha, and Ahmed Pasha to the Paris School to attend the Egyptian diplomatic mission, in Paris.

[8] EI-Falaki (the Royal astronomer): He was born in 122-AH in Gharbia Governorate and received his education in Alexandria, then competed it in Egyptian Royal schools. He had a rank of Saghqul Aghas by the order of Muhammed Ali, then he was sent to Europe in 1851 AD to compete his astronomical studies. He passed away in 1303AH.

## 3. Helwan Observatory

The Observatory went through three stages:

### The First Stage

The Observatory founded at the reign of the Ottoman Sultan Abd al-Aziz (Bwrābh & Bwknh, 2016, pp. 16:19), [9] and Khedive Ismail, because of the growth of Cairo which caused encroach upon the Observatory, the Observatory of Abbasia was transferred to Helwan in 1903AD and was built on top of a limestone plateau (150 m above sea level), on the eastern side of Helwan city. The new site was chosen carefully, and Helwan was a touristic site because of its Sulphur springs nature, in addition to the remains of the ancient Memphis on the opposite side. The new Observatory in Helwan was inaugurated on 1 January 1904AD under the supervision of the Ministry of Finance, department of survey (Pl. 2) (Shears &Shaker, 2013, p. 3).

Pate. 2: Helwan Observatory with its two floors, photographed by the Researcher

### The Second Stage

This stage started in 1905AD by establishment of a large telescope by the wealthy British philanthropist John Henery Reynolds, who visited Egypt in 1902AD and he was impressed by its climate which is suitable for observational astronomy comparing with

[9] He was born in 1246AH/1830AD, and his father was the Sultan Mahmoud II. He Ascended to the throne after his brother's death Sultan Abdulmecid I in 1277AH/ 1861AD.

England. In 1904AD, he returned again to Egypt to study if he could establish his large telescope there, he found the Observatory of Hewan would be ideal. After the acceptance of the Egyptian government, he offered a 30-inch reflector telescope as a gift which is known after that as "the Reynold Telescope (Pl.3)" (Khalil,1949, p. 7).

Plat.3: Telescope of Reynold

After: (Shears& Shaker, 2013: 31)

Many astronomical phenomena were discovered by the Observatory of Helwan like; Halley's Comet (Pl.4) which Helwan telescope help in its search and many photos were taken for 632 days, the last of them was on 18 May 1908AD. Naturally, just in one day in 1911, the Observatory discovered five other comets called Borelly (Pl.5), Quenisset, Wolf, Beljawski and Brooks. Over years, the Observatory of Helwan could track many famous comets in 1913AD and 1915AD called Neujmin and Melish (Shears &Shaker, 2013, pp. 6-7).

As well as many national services were introduced by the Observatory, as in 1906ADThe Egyptian-Turkish border between Egypt and the Hejaz State has been demarcated. The Observatory has prepared a map of the eastern bordered lands located between Egypt, the Ottoman Empire and Hijaz lands (Pl.6). The work was completed within two months. As a result, a convention was signed in 1906 AD and the Observatory scientists were honored by the King of England, the Ottoman Sultan, and Khedive Abbas Hilmi II. The convention had a great role in Egypt's recovery of the Taba region, according to the ruling of the arbitration court in 1988AD (Shaker, 2019, p.5).

**The Third Stage**

This stage is out of the research period and after the end of the Ottoman Empire rule, it started in 1944AD, when a royal order was issued to include this Institute under its patronage, and the government approved the necessary funds to provide it with the latest scientific equipment, including a large reflecting telescope with a mirror diameter of about 2 meters. The Observatory became a Royal Observatory, and in 1947 AD, a royal decree was issued to join the Observatory to Fouad I University as an independent unit (M.R, 1951, P.3).

Pl.4: Photo of Halley's Comet in 1910AD

After: (Shears& shaker, 2013:33)

Pl.5: Photo of Borelly Comet in 1911AD

After: (Shears & shaker, 2013: 35)

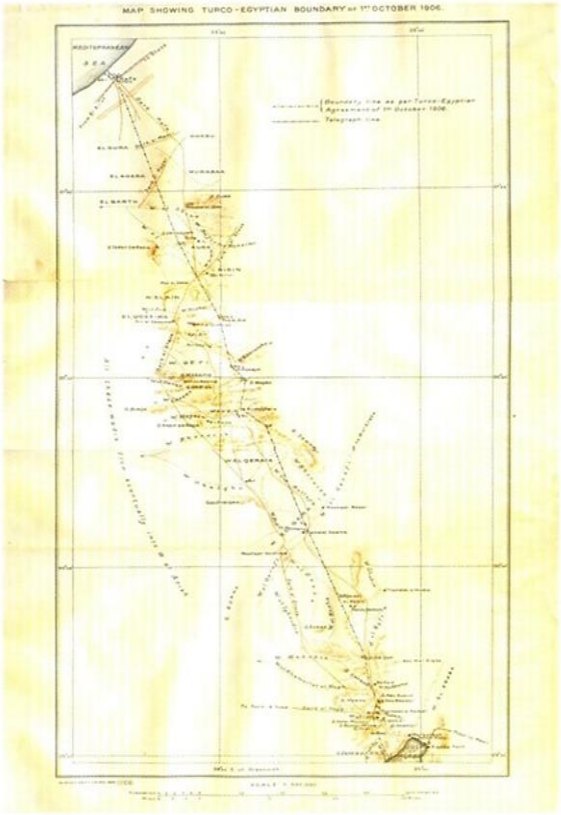
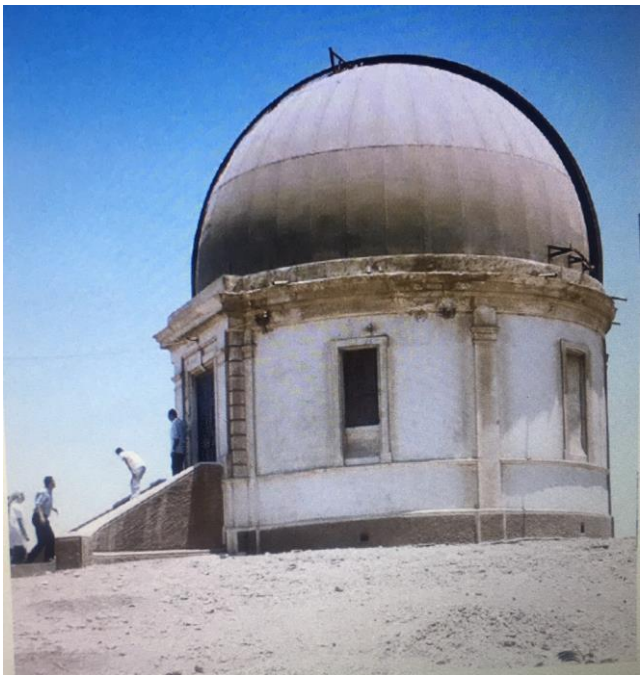



Plate. 6: The map of the eastern bordered lands located between Egypt, the Ottoman Empire and Hijaz
After: (Shaker, 2019: p. 5)

Many photos were taken of different nebulae starting from 1909AD and about 322 nebulae were photographed in the period between 1909 to 1922AD. Furthermore, new moons of Jupiter were discovered by the Observatory such as; Himalia, Elara and Pasiphae in the period between 1904-1911AD (Shears &Shaker, 2013, PP. 7:9)[10].

### 3.1 Architecture Design

First in Abbasia, the Observatory had a cylindrical dome housing 6-inch refractor. Then after its reconstruction at Helwan, the dome became 11m which initially housed an 8 inch refactor (Pl. 2). The building is consisting of two floors (Pl.7) with many offices of a library, laboratory, photographic dark-rooms and chronometer rooms, as well as a courtyard in the center (Shears &Shaker, 2013, PP.3-4).



Plat. 7: The dome of the telescope at Helwan Observatory
After: (Jeremy& Ashraf, 2013: p. 4)

### 3.1. a The Historical Building

According to Wafaa Zakaria, the area in which the Observatory was established contains the historical building with the observation tower and next to it is the mosque. In front of the mosque is a dome that contains the telescope. In front, is the administrative building, and on the opposite side, there is a Museum of the National Institute for Astronomical and Geophysical Research (Pl.8). The main building of the Helwan Observatory, which is currently called the historical building, consists of two stories that have the observation tower. The ground floor contains a group of rooms that were occupied by administrative offices until 2019 AD. They were transferred to the opposite building near the observation tower, which was previously the Scientists' Building. The building has been closed since this period and was opened again by the director of the National Institute for Astronomical and Geophysical Research on February 12, 2024 AD. The second floor

contains a historical library containing six thousand books related to the institute's various specializations (astronomy, engineering, geophysical sciences, etc.).

Plate.8: Photo of the museum of Helwan Observatory, taken by the Researcher.

### 3.1.b The Museum

Originally, the museum was a residential villa for the directors of the Observatory throughout the ages till 1952 AD. It was closed and neglected and became a warehouse from the period between 1952- 1997 AD. Then it was opened by the director of the Institute at that time to be a museum, that includes many ancient and modern monitoring devices that registered by the Ministry of Tourism and Antiquities (Zakaria).

Ashraf Shaker stated that, the museum consists only one floor with 6 rooms. The museum occupies two rooms and four rooms for administrative offices and a garden with many trees on display. The construction of the building was during the Ottoman period, but its reopening was in 2024.

The Museum consists of some rare and historical antiques like, a sundial: it is a daytime device, this one is considered as one of the oldest machines that dated back to 3500 BC. It is the first sundial invented by Arabs and Muslims, who used it to determine prayer times, as it depended on the sun and the angle of declination (Pl. 9). There is also a Water clock: it is an ancient Egyptian clock engraved with twelve vertical lines inside and eleven holes, the distances between which vary to suit the twelve hours of the night (Pl. 10).

In addition to, a wind vane was used to measure wind speed, which consists of three cups that rotate with the wind and a unit of measurement (Pl.11), The atmospheric brightness thermometer is used to measure temperatures in the upper layers of the atmosphere (Pl.12), Devices of Measurement of solar radiation and optical devices used to measure horizontal angles and others.


Plate.9: A sundial at the museum of Helwan Observatory dated back to 3200 BC, photographed by the Researcher after the permission of Helwan Observatory.


Plate.10: An old water clock from ancient Egypt, photographed by the Researcher after the permission of Helwan Observatory.


Plate. 11: A wind vane used to measure wind speed, photographed by the Researcher after the permission of Helwan Observatory.


Plate. 12: The atmospheric brightness thermometer is used to measure temperatures in the upper layers of the atmosphere, photographed by the Researcher after the permission of Helwan Observatory

## 4. Conclusion

Despite the interest of the Ottoman sultans in astronomy and astronomers, as they introduced gifts and high ranks to astronomers like *Saghkol*, and despite the continuation of Ottoman rule for more than 600 years; there was no real interest in building observatories until the eighteenth and nineteenth centuries: as the only Observatory that Built in the sixteenth century "Istanbul Observatory", was demolished just two years later.

Family of Muhammad Ali also gave a special importance to astronomers and the construction of astronomical observatories, they sent missions to Europe to increase astronomers' knowledge and return with more experience to Egypt. They also established the Bulaq and Abbasiya Observatories, then the Helwan Observatory.

Helwan Observatory discovered many cosmic phenomena like Halley's Comet, and it could discover just in one day five other comets in 1911AD. Also it helped in demarcating borders of Eyptian-Ottman lands and Hijaz lands, which helped in the return of Taba to Egyptian lands.

The Observatory contains a historical building and a scientific building. The historical building consists of two floors havingg many rooms such as a library, which contains 6,000

## 5. Recommendation for Developing the Helwan Observatory's Museum as a tourist destination :

- Interactive Exhibits: create hands-on displays where visitors can learn about astronomy and meteorolgy through interactive activities.
- Guided Tours: Offer guided tours led by knowledgable guided who can share the history and significance of he observatory.
- Stargazing Nights: Host regular stargazing events where visitors can observe the night sky through telescopes.
- Educational Workshopes: Organize workshops and seminars on topics like astronomy, meteorolgy, and space exploration.
- Virtual Reality Experiences: Use VR technology yo provide immersive experiences, such as virtual tours of the solar system or simulations of space missions .

- Special Exhibitions: Rotate astronomy and meteorolgy to keep the content fresh and engaging.
- Collaborations with schools: Partner with local schools to offer educational field trips and special programs,
- Community Events : Organize events like astronomy talks, meteor shower viewings, and science fairs to engage the local comunity.
- Merchandise Shop: Open a gift shop selling astronomy- related items like star charts, telescpoes, and educational kits.
- Membership Programs: Introduce membership porograms with benefits like exclusive events, discounts on workshops, and early Access to exhibitions.
- Astronomy Festivals: Organize annual or seasonal astronomy festivals with activities, guset speakers, and special exhibits.
- Interactive Space Maps: Develop digital space maps that visitors can explore to learn about different constellations and celestial bodies.
- Celestial Concerts: Host live music performances under the stars, combinig astronomy with cultural events.
- Childern's Programs: Create Special programs and interactive activities designed specifically for younger visitors tos park their unterest in astronomy.
- Observatory Nights: Offer exclusive night- time Access to the observatory for a unique stargazing experience.
- Astronomy Literature Corner: set up a corner with books and literature on astronomy for visitors to read and purchase.
- Solar Observation: Provide safe equipment and guide sessions for visitors to observe the sun and solar activites during the day.
- Cultural Partenerships: Collaborate with cultural institutions and artists to integrate astronomy into broader cultural contexts.

## 6. References


- Ágoston, G. & Masters B, (2009), *Encyclopedia of the Ottoman Empire*, Facts On File.
- Ahmed Shaker, A. (2019), The National Institute for Scientific Research and Geophysics and Two Centuries of Scientific Researchers, Cairo.
- Ālʿdl, S. *(2017),* Āwl mrṣd fy mṣr ālḥdyṯh tʾsst fi1839 "The first Observatory in modern Egypt was established in 1839 AD", Science and Life Magazine *"Scientific Culture Magazine"*, Issue file Nuclear Energy, third edition, Cairo, No.2.
- Angel, A. Castro Tirado, Alberto J. & Tirado, C. (2019) 'The Evolution of Astronomical Observatory Design', *Journal of the Korean Astronomical Society*, Vol. 52, pp. 99:108.
- Aydın, S. (1960), 'The Observatory in Islam and Its Place in the General History of the Observatory', *Ankara: Turk Tarih Kurumu Basımevi*, pp. 67:110
- Brill, E. J. (1993), *First Encycclopaedia of Islam 1913-1936*, Leiden. New York. Kolen, Vol.v, pp. 306:307.
- Bwrābh, N. & Bwknh, H. (2016), *ālslṭān ʿbd ālʿzyz byn ālāṣlāḥāt wālmuʿārḍh* (1277-1293AH/ 1861-1867AD) "Sultan Abdul Aziz between Reforms and Opposition" Thesis for Master degree, Yahia Fres University, Humanities and Social Sciences.
- Cattaui, G. (1950), *Mohamed-Aly ET L' Europe*, Orientalist Paul Geuthner, Paris.
- Cohen, R. (2010), *Chasing the Sun "The Epicc Story of the Sttarr that Gives us Life",* Simon &Schuster, London.
- Daniel A. Stolz, (2018), *'The Lighthouse and the Observatory, Isam, Science, and Empire in Late Ottoman Egypt'*, Cambridge University.
- Douglas A. & Howard, A. 'History of the Ottoman Empire', *Cambridge University Press*, 2017, pp. 23-24.

- Fahmy, Z. (2017), *Ṣfwt ālʿṣr fy tāryḫ wa rswm mšāhyr rğāl* mṣr "The Elite of the era in the history and portraits of Egyptian renewed figures", Hindawi Publishing Corporation.
- Faty D. et al., ālmsūwlyh ālmdnyh ʿn ālāḍrār ālnātğh ʿn āltlwṯ ālḍwʾy bāltṭbyq ʿlā ālmrāṣd ālflkyh (mrṣd ḥlwān- mrṣd ālqtāmyh) " Civil Liability for Damages Caused by Light Pollution with Application to Astronomical Observatories (Helwan Observatory, (Helwan Observatory - Katameya Observatory)", *Environmental Sciences Journal*, College of Graduate Studies and Environmental Research, Ain-Shams University, 2023, Vol. 52, No. 4.
- HİLAL, M. Ahmet. (2019), İSMAİLOĞLU, 'Contribution of Arabs and Muslims in Astronomy', *Kırıkkale University Journal of Social Science*, Vol. 9, No. Special, pp. 219:228
- Hobden, H. (1999), *Ulughbek and his Observatory in Samarkand*, British Library.
- Ibrahim Al-Desouki, W. (2012), *āltāryḫ ālṯqāfy lmṣr ālḥdyṯh "ālmūʾssh ālʿlmyh wālṯqāfyh fy ālqrn āltāsʿ ʿšr"* "The Scientific and Cultural Institution in the Nineteenth Century", Egyptian National library and Archives, Cairo.
- Ibrahim, H. &Suliman Edrees, S. (2022), 'The Aesthetics of Astronomy as an Introduction to Creating Contemporary Jewelry Designs', *Journal of Design Sciences and Applied Arts*, Vol. 3, No. 2, p. 347.
- Ihsan Uğly, Ā. (1443AH\ 2021AD*), al-Tūrāṯ al-ʿLmy al-ʿṮmāny* "Ottoman Scientific Heritage", translated by Magda Maḫloūf, Institute of al-Fūrqān lltrāṯ al-ʿLmy, 1st edition.
- Jeremy Shears, J. & Ahmed A. (2013), 'Harold Knox-Shaw and the Helwan Observatory', *Journal of the British Astronomical Association*.
- Kose, S. (2016), Taqi al-Din ibn Ma'ruf (Damascus, 1526–Istanbul, 1585)', *Bulletin of Clinical Psychopharmacology*, Vol. 26, No. 2.
- M. R, (1951), Madwar bey, F.R.A.S, F.R.S.E, Annual Report, Government press- Cairo.
- Mohammed Gamal Afandy, M., Khairy Ai, M. & Fahim Mahmoud, M. (1990), 'tāryḫ ālḥrkh ālʿlyh fy mṣr ālhdyṯh (ālʿlum ālāsāsyh- ālārṣād ālgwyh wālflkyh wālfyzyqyh)', *Academy of Scientific and Technological Research*, Cairo, pp. 49-50.
- Smith, S. Emilie, (1995) 'Attitudes toward Dissection in Medieval Islam', *Journal of the History of Medicine and Allied Sciences*, No. 50.
- Tekefi, S. (2005), 'The Observational Instruments of Istanbul Observatory', *Foundation of Science Technology and Civilization*.
- Worldatlas, Map Of Bosporus Strait - World Straits, Bosporus Map, Location, https://www.worldatlas.com/aatlas/infopage/bosporus.htm, last access 14\2\2024, 1:33AM.
- Zaki Khali, M. (1949), *ālmrṣd ālmlky bḥlwān* "Royal Observatory in Helwan", Fouad I University Press.
- Zidan, J. (2017), *trāğm mšāhyr ālšrq fy ālqrn āltāsʿ ʿšr* "Biographies of famous Eastern Celebrities in the 19th century", Hindawy, *Cairo*.