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Astronomy Tourism in Egypt: A New Trend-Ancient Origin

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السياحة الفلكية في مصر: اتجاه جديد - أصل قديم

الملخص العربي

يعود علم الفلك إلى قرون عديدة في جميع أنحاء العالم وخاصة في مصر، حيث يظهر أصله في النصوص المصرية القديمة التي تشير إلى الطبيعة المحيطة واتجاهات المعابد والمناظر على أسقف وجدران المقابر والمعابد والتوابيت. وتتميز مصر بالكثير من عوامل الجذب التي يمكن أن تجعلها رائدة في السياحة الفلكية، حيث تجمع بين الظواهر المختلفة التي يمكن رؤيتها بالعين المجردة أو بالتلسكوبات، وتعد السماء الأفريقية من أنسب وأكبر معامل دراسة علم الفلك حيث تقع القارة تحت سماء الليل الأكثر وضوحًا وظلامًا. تسعى هذه الدراسة الي استكشاف مفهوم السياحة الفلكية، والسفر لأغراض متعلقة بعلم الفلك كظاهرة سياحية مهمة، حيث يمثل هذا الاتجاه الصاعد عرضًا مبتكرًا للسياحة لمصر أثناء وبعد جائحة كوفيد-19. وتتمثل أهداف هذه الدراسة في إلى إلقاء الضوء على سياحة الفلك؛ استكشاف الوضع الحالي لسياحة الفلك في مصر؛ استكشاف الثقافة العامة لسائحي علم الفلك، وتجربة سفرهم الفردية؛ أي نوع من السياحة الفلكية يفضلون، وآفاق التنمية المستقبلية لهذا النمط السياحي في مصر. وتحققت أهداف الدراسة من خلال اعتماد أساليب منهجية مختلطة، والتي اشتملت على تحليلات بحثية ونوعية (مقابلات) وكمية (استبيان). استهدفت المقابلات الشخصية مديري وكالات السياحة والسفر وكذلك مدراء مجموعات السفر عبر الانترنت العاملين في هذا النمط السياحي لفهم وتقييم الوضع الحالي للسياحة الفلكية في مصر وآفاق التنمية المستقبلية. وكذلك أجريت مقابلات أخرى مع مديري المراصد وجمعيات علم الفلك في مصر لاستكشاف الممارسات الحالية وإمكانات السياحة الفلكية في مصر. بينما استهدف الاستبيان السائحين الدوليين والمحليين، مستخدمًا مقياس التحفيز الترفيهي

(LMS) لتقييم العوامل الأكثر تأثيرًا في جذب السياح إلى الأنشطة والأحداث الفلكية. وبناءً على النتائج المستخلصة من الدراسة، يجب أن تحظى السياحة الفلكية في مصر بمزيد من الاهتمام من جميع الجهات المعنية من أجل الترويج لها وتطويرها كاتجاه جديد للسياحة في مصر.

الكلمة المفتاحية: السياحة الفلكية، الرصد الفلكي، سياحة الفلك الأثري، مصر، الدوافع.

Abstract

Astronomy goes back many centuries throughout the world. Especially in Egypt, its origin appears in the ancient Egyptian texts referring to the surrounding nature, temple orientations, and paintings on the ceilings and walls of tombs, temples, and sarcophagi. Further, Egypt combines different phenomena that could be seen either with the naked eyes or the telescopes as African skies remain the most accessible and biggest astronomy laboratories as the continent is situated under the clearest such and darkest night sky. Despite being an innovative offer of tourism to Egypt during and after the covid-19 Pandemic, there is a lack of studies exploring astronomy tourism and its potentials in Egypt. Accordingly, the current study aims at filling this gap through giving insight into astronomy tourism; exploring the current practices and the ongoing construction of astronomy tourism in Egypt; explore the group culture of astronomy tourists, their behaviors and individual travel experience; which category of astronomy tourism do they prefer; and the current situation and the prospects for the future development of astronomy tourism in Egypt. This study made use of mixed methods, which included both qualitative (interviews) and quantitative (Questionnaire) research analyses. The interviews

targeted the tour operators' managers operating this kind of tourism and the admins of online travel groups to gain an in-depth understanding of the current situation of astronomy tourism in Egypt and its future developing prospects. Other interviews were held with the directors of observatories and astronomy societies in Egypt to explore the current practices and the ongoing construction of Astronomy tourism in Egypt. The questionnaire targeted the international and domestic tourists, utilizing the Leisure Motivation Scale (LMS) to make an assessment of the most influential factors that draw tourists to astronomy activities and events. Based on the results, astronomy tourism is alive in Egypt, yet it should gain more attention from stakeholders to be promoted and developed as a new trend in Egypt.

Keywords: Astronomy Tourism, Astronomical Observation, Archaeoastronomy Tourism, Egypt, Motivations.

Introduction

Egypt is considered one of the oldest countries whose people studied astronomy. The celestial phenomena have always been a source of wonder and interest to people, even as long ago as the ancient Egyptians, as evidenced by the architecture and landscape, apparently associated with the observation of cosmic phenomena (Novakovic, 2008). Astronomy tourism started recently to gain more attention. Astronomy tourism is a new phenomenon that is taking hold across the world. Capturing people's inherent interest in the mysterious provides the drive for tourism through the ages. Astronomy provides numerous opportunities to catch the interest of young and old alike (Jiwaji, 2016).

According to the results of research by various authors and based on the authors' research results, astronomy tourism belongs to the category of special-interest tourism (SIT) (Soleimani, et al., 2019), alternatively labeled as niche tourism (Cater et al., 2015). At the same time, some astronomy tourism activities may take the form of professional, virtual or even mass tourism (Ma, et al., 2020). According to (Tadic, 2016) observing the night sky with the naked eye can also be perceived as a part of mass tourism in many destinations.

In a post-covid-19 world, tourists' behavior has changed. They are looking for new experiences in remote safe place. Astronomy offers a way to engage with local people and cultures and experience the awe of nature in an outdoors environment.

The sea, sandy beaches and sightseeing are no longer the only competitive advantage that attracts tourists to a destination, but on the contrary, the hustle and bustle of life force individuals to choose destinations characterized by

purity of air, calm and charm of nature. Hence, the majority of tourists nowadays began to search for niche trends in tourism away from the traditional ones, especially after the Covid-19 Pandemic, they are choosing destinations and products that offer them unique experiences, and astronomy tourism is an excellent option because it presents something different.

Egypt's sky, desert and history gave it distinction in the field of astronomy tourism. Astronomy tourism is now brand new in Egypt, but still not a negligible part of the Egyptian destination to enrich its tourist offer both nationally and internationally. Further, there is a gap in the literature about astronomy tourism and its potentials in Egypt; the current practices and the ongoing construction of astronomy tourism in Egypt; the categories of astronomy tourism that mostly exist in Egypt; and the current situation and prospects for the future development of this new trend in Egypt. This research is written with the intention to bridge these gaps, hence, it highlights the potential of astronomy tourism in Egypt and suggest ways to introduce and develop this new trend in Egypt. There are two principal ways of trying to understand the new trend in tourism. The first one is to analyze current practices and the ongoing construction of this new trend in a destination. The second one is to look at historical processes of destination making and comparable tourist practices in the past (Steinbrink, et al., 2012). Thus**, the main objectives of this study are to:**

- Insight the history of astronomy in Egypt and explore the current practices and the ongoing construction of astronomy tourism in Egypt.

- Figure out the potential of astronomy tourism in Egypt.
- Identify the astronomy tourists and which kind of astronomy tourism they prefer.
- Detect the categories of astronomy tourism that mostly exist in Egypt.
- Explore the group culture of astronomy tourists, their behaviors and individual travel experience.
- Present the current situation and prospects for the future development of this new trend in Egypt.

The study also aims at testing the following hypothesis:

H1: Intellectual factors motivation has significant positive effect on the tourists' attitude toward astronomy tourism in Egypt.

H2: Stimulus avoidance motivation has significant positive effect on the tourists' attitude toward astronomy tourism in Egypt.

H3: Competence mastery motivation has significant positive effect on the tourists' attitude toward astronomy tourism in Egypt.

H4: Social motivation has significant positive effect on the tourists' attitude toward astronomy tourism in Egypt.

Literature Review

Astronomy Tourism

Astronomy tourism is considered to be special interest tourism (Soleimani, et al., 2019). It is defined as "... tourism using the natural resource of unpolluted night skies and appropriate scientific knowledge for astronomical, cultural and environmental activities" (Fayos, et al., 2014:664). It focuses visitor interests on the observation and appreciation of naturally occurring celestial phenomena (Weaver, 2011) as a unique form of ecotourism (Najafabadi, 2012). It offers a noble way to draw tourists closer to nature (Fayos, et al. 2014). Its greatest assets never need maintenance or development; are always available, unique in its features, and continuously considered one of the highest sustainable fascinations (Najafabadi, 2012).

Astronomy tourism represents a segment of sustainable tourism where a dark night sky is the underlying resource (Collins and Poe, 2013). Location is a key to looking deeper into space by means of a clear dark night sky free from artificial light (Najafabadi, 2012). Considering that half of the world's population can no longer see the stars due to overcast light pollution, desolate places with their apparent emptiness have now become noteworthy attractions (Ingle, 2010). African skies remain the most accessible and biggest astronomy laboratories as the continent is situated under the clearest and darkest night sky (Govender, 2011). Two bodies accredit astronomy tourism destinations: Starlight Foundation (Starlight Foundation, n. d.) and International Dark Sky Association (Darksky, n. d.).

Astronomy is a science that studies the position, movement, structure, origin and development of celestial bodies and the system of which it formed. According to this definition,

the term astronomy tourism refers only to observational astronomy, and includes observation of celestial bodies and phenomena in tourist tours (with the main purpose, or by the way), for pleasure/fun, and, inseparably, astronomical observatories (Robson and Christensen, 2005; Weaver, 2011) and astronomical instruments, contemporary and from the past (including Archaeoastronomical Observatory). Unlike space tourism astronomy tourism nor exclusive nor adventurous/extreme form of tourism, it is open to all tourists, not a risk to health and life-threatening.
Astronomy tourism opens new opportunities for bridging science and tourism, motivating alliances for starry nights, science, culture, and nature. It entails observatories, stargazing places and dates, heritage sites related to astronomy, and natural dark sky areas of outstanding beauty (Malville, 2008). Key terms in astronomy tourism are the observations and observatories, or just looking for the word observatory means observation posts. Astronomy tourism is oriented towards the celestial sphere and extraterrestrial space, but without departing from the Earth's surface: astro-tourists are not astronauts (Macionis, 2004). Astro-tourist is perceived as a person who value uniqueness of such phenomena, as they bring him/her satisfaction, a sense of freedom and calm (Matos, 2017). In this context, (Macionis, 2004) divided astro-tourists into three categories:

- Specific Astro-tourist, who actively researches for places where astronomical events will happen and the various locations either for work or for leisure.

- Casual Astro-tourist, who does not specifically looks for the astro-event location, but participates in any activity related to it while at the destination.

- Serendipitous Astro-tourist, who just happens to be at the destination or location where an astro-event occurred.

Astronomy tourism experiences belong to one of the categories mentioned in (Table 1). The mentioned list is far from being exhaustive or definitive (as new experiences can be invented every day). It should also be noted that astronomy tourism products offered to the public can combine a number of different experiences apart from those already described (e.g. they can be combined with non-astro-touristic experiences such as trekking, gastronomy, etc.).

Table (1) Astronomy tourism Categories

Sky observations in observatories	They take place in enclosures that are built and/ or modified for astronomical observations and tourist services. They usually involve the use of telescopes.
Excursions with outdoor observations	These require moving to dark sites (by car, on horseback, on foot, etc.), to observe the sky, whether with the naked eye or through the use of binoculars and/or telescopes.
Tours of scientific facilities	They refer to visits to scientific observatories, those with advanced technologies as well as those that are more historical in character. They usually cover the use of telescopes and spaces where astronomers work.
Lodging and astronomical observations	This refers to hotel services that include activities and possibly decorations related to astronomy.
Solar observations	Carried out during the day, they involve observing the Sun using solar telescopes or specially adapted telescopes (i.e. with special filters).
Astrophotography	This includes everything from renting specially equipped telescopes to beginner and advanced level workshops on photographing celestial bodies.

Lectures and courses	Presentations on astronomical topics, conducted by guides, astronomers or other experts, together with astronomical observations.
Astronomical exhibition tours	Visits to museum exhibitions or outdoor displays (astronomical parks) centered on the theme of the cosmos and/or the ways of studying it.
Audiovisual presentations	These consist of shows projected on planetariums – fixed or portable – and videos and digital presentations made by guides or individuals with knowledge of astronomy.
Archaeoastronomy sites	They refer to visiting sites where cultural heritage is associated with astronomy. These are locations and destinations that possess heritage manifestations that are connected to the astronomy of the past men.

(Source: Modified from a design Manual of Astrotourism Experiences, n.d)

Other Astronomy tourism activities include space journeys in the form of flights to the stratosphere (Wilson, 2019) or space itself (Cohen and Spector, 2019), also visits to space rocket launch sites, self-discovery in the form of visits to scientific astro-exhibitions, observatories, planetariums, expert lectures on astronomy and cosmology, and meeting astronauts. Virtual reality also belongs to astronomy

tourism, adequately substituting real travels into the stratosphere and beyond, thanks to its trusted simulation of space and spaceflight (Toivonen, 2021).

Consequently, astronomy tourism consists of two basic parts, space tourism and terrestrial astronomy tourism (Van Wyk-Jacobs, 2018 and Matos, 2017). The focus of this study is the terrestrial astronomy tourism that includes in general the following main elements:

- Comets, Planets and Stargazing: These activities can happen anywhere, although the best locations to admire such phenomena are those where the light pollution is not excessive. Gazing at the sky and track these objects can be done with or without equipment (e.g. telescopes, binoculars), and by oneself or in groups (Berendsen, 2005).

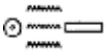
- Eclipses: They are astronomical events that occur when an astronomical object is temporarily obscured – partially or completely – either by the passing shadow of another body (e.g. Lunar eclipse) or by having another body passing between it and the observer (e.g. Solar eclipse, Venus and Mercury Transits) (Brezina, 2019).

- The Auroras: The auroras is described as an astronomical "colour" (e.g., green, red) phenomenon that occurs when high energetic particles penetrate the upper atmosphere (hundred kilometers above the Earth's surface) and collide with nitrogen and oxygen atoms and molecules (Mackowiak, 2013).

- Ancient Astronomical Observatories and Sacred Sites: Ancient civilizations were significantly associated with the observation and interpretation of the universe and left many structures used in all probability for astronomical observations, or at least related to astronomical knowledge. Archaeoastronomy sites are where cultural heritage sites associated with astronomy that also motivates travelers (Marin, 2009).

The current study explores the terrestrial astronomy tourism in Egypt that includes the ancient Egyptian Observatories and Archaeoastronomy sites, besides the various astronomical phenomena that have the potential to attract the attention of common tourism participants, such as, Comets, Planets and Stargazing, and eclipses (Kunjaya, et al, 2019, Najafabadi, 2012).

Astronomy in Ancient Egypt

The ancient Egyptians were interested in astronomy, mainly for practical and religious purposes. Based on astronomical observation, they invented the first calendar developed in Egypt "the lunar calendar" and determined the hours of night, the festive dates, the annual flooding of the Nile, and thus the planting times and the three seasons of the year (inundation *ꜣḫt*  , planting *prt*  , and harvest *šmw*  . They also established a 24-hour day of fixed length (أيمن و رؤوف، 2012).

The ancient Egyptian astronomers were the Hour Watching Priests, the "Keepers of Time", who were responsible for watching and observing the nightly movement of the stars,

the order of the fixed stars, the movements of the moon and the planets, the rising of the sun and the moon, as well as their setting times, and the orbits of the various celestial bodies. These learned individuals were thereafter ready to tell this information in counsel and to provide details about the changes occurs in the sky in any specific time. They used instruments or indicators (the sundial, water clocks or clepsydras, and the merkhet) for observing the circumpolar stars that was required for both time measurement and the proper orientation of important building projects like pyramids and temples (Deyoung, 2000). The Egyptian astronomers observed from the terraces of the temples and palaces. From that height they looked for horizons free from obstacles. The following subtitles introduce the important observatories and Archaeoastronomy sites that were known in ancient Egypt.

Ancient Egyptian Observatories

Nabta Playa (Fig. 1) is considered to be the earliest known prehistoric astronomical site built in Africa about 100 km west of Abu Simbel in southern Egypt and possibly the oldest astronomical observatory on the earth. It is a 7,000 years old stone circle that was aligned with the sun and stars to mark the arrival of the annual monsoon season and the summer solstice. (Holbrook, Medupe, and Urama, 2008)

Fig. (1) The astronomical site of Nabta Playa
(Source: Ancient Astronomy of the Nabta Playa Nubian Stone Circle, 2020)

The Great Pyramid at Giza plateau appears as the largest and in its entirety most perfect observatory that was possible before the invention of the telescope. One can imagine that the construction, which tapered towards the top, offered excellent astronomical possibilities as long as the cover plates were not in place and the gallery was open at the top. It is ideal to observe the starry sky. This gave an excellent opportunity to recognize the course of the stars and the slightest change. (Baumgartl, 1995)

Another observatory known from ancient Egypt is the one of Ausim/Letopolis. It is believed that in Letopolis there was an astronomical observatory because of the existence of a guard tower, and according to Strabo, this guard tower was used as astronomical observatory. This tower was established on the top of a high hill away from the danger of the Nile flood. The directions the northern side of Khufu pyramid was centered and oriented toward the city of Letopolis (Waziry, 2021).

Heliopolis is regarded as one of Egypt's most important cultural centers in both astronomy and engineering. As a

result, it most likely had a significant role in observing, monitoring, and analyzing the stars. Thus, it is assumed that it has an astronomical observatory for observing the stars (Waziry, 2021). Heliopolis is also thought to have gotten its name from one of the astronomical observation towers (Grimal, 1994; Aldred 1965). Furthermore, the ancient Egyptians' astronomical orientation was founded on careful observation, testing, and analysis, making it extremely exact. In ancient Egypt, the technique of observation was crucial, especially for determining the precise date of religious feasts and burial procedures (Wells, 1992).

The Djhuty Hill area, which is located in the west of Thebes and known as the Hill of Thoth was regarded as one of the most significant archaeological sites, not only in terms of archaeology but also in terms of astronomy and celestial spheres (Waziry, 2021). It was also linked to the god Thoth, who was the creator of the Epagomenal Days in ancient Egypt and the god of writing and astronomy (Spalinger, 1995). As a result, this area is believed to possess an observatory which was one of the most prominent observatories of the time and in the archaeological area (Waziry, 2021).

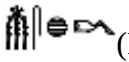
Ancient Egyptian Archaeoastronomy Sites

The term “Archaeoastronomy” denotes the combination of two disciplines: “Archeology” and "Astronomy". More precisely, Archaeoastronomy is defined as the study of the astronomical orientation and content of any archaeological remains including monuments, drawings, bas-reliefs, and texts (Gadré, 2011b). The Archaeoastronomy locations and destinations are possess heritage manifestations that are connected to the astronomy of the ancient people, e.g. in Egypt, sun alignment in Abu Simble Temple (Magli, 2020).

The Egyptian Archaeoastronomy reflects the vision of the ancient Egyptians concerning the world and beyond that was expressed in their monuments and artifacts by writing texts referring to the surrounding nature, attributing a particular astronomical orientation to the monument, and decorating the ceilings and walls of temples, tombs, and sarcophagi with astronomical scenes (Gadré, 2011a).

Astronomical Orientations in Ancient Egyptian monuments

Almost every historical monument has a particular astronomical orientation sometimes solar, often stellar. Its main object is to meet certain worship or cultural imperatives (Gadré, 2011c). The temples of the Delta and Nile Valley were orientated according to the Nile and astronomical measures. There were only three main kinds of astronomical orientation that were present in most of the Egyptian temples (Belmonte, Shaltout, and Fekri, 2008);

- The cardinal or meridian orientation following the movement of a group of stars Ursa Major (Big Bear) called in ancient Egypt *Msḫtyw*  (Faulkner, 1991), such as the temple of goddess Hathor at Dandara the main building is orientated close to north and possibly to the rising of Meskhetiu (Fig. 2.a). (Belmonte, 2009)

- The stellar orientation following the movement of the two brightest stars of Sirius (Sopdet) and Canopus, such as the small temple of goddess Isis to the rear of the Hathor temple at Dandara was aligned to the rising of Sirius at the time of its foundation and the Middle

Kingdom temple of Qasr al-Sagha (Fig. 2.b) located in the former northern shore of Lake Moeris and now ten kilometers inland inside the desert was orientated to Canopus at the moment of its construction. (Furlong, 2007)

- The solar orientation that was principally linked to important time marks of the annual cycle and specific dates in the civil calendar such as Wepet Renpet (New Year's Eve) or the eves of the other two seasons of the calendar, Shemu and Peret. (Belmonte, 2009)

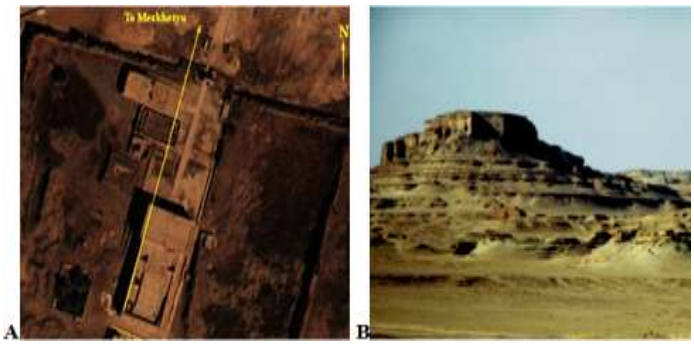


Fig. (2) a. the temple of goddess Hathor at Dendara, b. the temple of Qasr al-Sagha (Source: Belmonte, 2009, 80, 81, Figs. 6, 7)

Both solar and stellar orientations were most probably already in operation during the Neolithic Period in Nabta Playa (Fig. 1) (Holbrook, Medupe, and Urama, 2008). In general, the temples of solar deities have solar orientations, while those belonging to goddesses were mainly orientated to the brightest stars in the ancient Egyptian sky "Sirius". (Belmonte, Shaltout, and Fekri, 2008)

The Cardinal Orientation in the Pyramids at Giza Plateau

Concerning the astronomical aspects of the pyramids at Giza plateau; its sides were aligned to the four cardinal points north-south and east-west. Determining the cardinal points is astronomy in itself. You have to orientate yourself if you want to explore the course of the stars. The area of 50,000 square meters of the Great Pyramid is just as precise - to the nearest centimeter. This is also a prerequisite for observing the sky. The prerequisites for astronomy are thus confirmed (Baumgartl, 1995). A further adjustment was made by aligning the descending corridor, which exists in all pyramids, with the Pole Star (Magli and Belmonte, 2009). The Giza pyramids had been positioned in a manner that, from each pyramid, it was always possible to observe the points of the horizon where the sun was rising and setting on each day of the year (Sparavigna, 2016).

The Solar Orientation or Solstice Alignment

The solstice alignment is defined as the time or date (twice each year; midsummer and midwinter sunrises and sunsets) at which the sun reaches its maximum or minimum declination, marked by the longest and shortest days. A series of temples were orientated to sunrise at the winter solstice (Belmonte, 2009). Among the ancient Egyptian temples that were aligned to the midwinter sunrise are; the central meridian line of the temple of Amun-Ra at Karnak Complex (Fig.3.a), the mortuary temple of Amenhotp I at Deir El Madina, the mortuary temple of Amenhotep III at El Qurna (from this great temple remains two famous statues of the king, known as the Colossi of Memnon that stand as gigantic guards, overlooking the morning sun in

the midwinter, at its eastern end), the mortuary temple of Queen Hatshepsut at El Deir El Bahari that was placed alongside the other prominent worldwide monuments, which witnessed the same phenomenon, like the Stonehenge in England, the Maes Howe in Scotland, and the Great Burial Mound of Newgrange in Irland (Furlong, 2010), and the temple of god Sobek-Ra in Qsar Qarun at El-Fayum Oasis (Fig.3.b). (Belmonte, 2009)

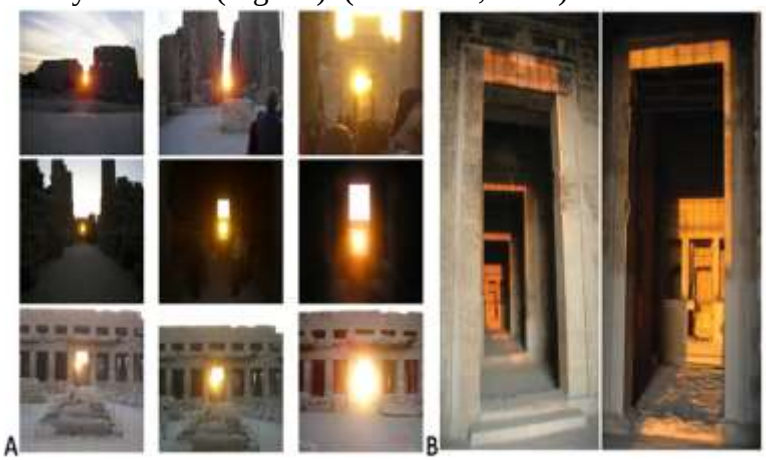


Fig. (3) a. The midwinter sunrise at the temple of Amun-Ra at Karnak Complex (Source: Furlong, 2014); **b.** Sunrise at the winter solstice at the inner sanctuary of the temple of god Sobek-Ra in Qsar Qarun at El-Fayum Oasis (Source: Belmonte, 2009, 79, Fig. 4)

The widely known solar alignment, which attracts many hundreds of visitors every year, is found in the temple of Abu Simbel (Fig. 4) built by king Ramses II as his cult temple. Despite being rescued in 1972 from the rising waters behind the Aswan dam, the solar illumination of the inner sanctuary of the temple can still be seen today about 22nd of February and October each year. (Furlong, 2007)

Thousands of tourists from around the world (approximately 6000 Egyptian and foreign visitors) witness the phenomenal solar alignment on king Ramses II's face in Abu Simbel, a wonderful festival on a special day in history 22.2.2022. (Ministry of Tourism and Antiquities, 2022)

Fig. (4) Solar alignment on the temple of Abu Simbel (Source: Ministry of Tourism and Antiquities, 2022)

The Lunar Orientation

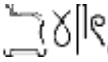
In addition to the previously mentioned main orientations there is the lunar orientation that appeared in; the temple of king Seti I at El Qurna that points towards one of the Moonrise azimuths, the temple of god Ptah at Karnak complex that is aligned to a significant lunar position known as the southernmost major Moon standstill, and the temple of god Khnum at Esna that could align to the Northernmost Maximum Moonrise, depending on the eastern horizon view (Furlong, 2007). The first clear lunar orientation discovered in Egypt is found in the temple of god Thoth (the lunar god) at Sheikh 'Abada in Minia governorate (Fig.5) due to its location at the latitude where the moon marked by the alignment also crosses the zenith of the site (Belmonte, Fekri, Abdel-Hadi, Shaltout, and Gonzalez-Garcia, 2010).

Fig. (5) The temple of god Thoth at Sheikh Abada in Minia governorate

(Source: Belmonte, Fekri, Abdel-Hadi, Shaltout, and Gonzalez-Garcia, 2010, 6, Fig.4)

Textual Sources for the assignment of a particular astronomical orientation to the Egyptian monuments

A fragment of the Palermo Stone dating from the Old Kingdom mentioned the ceremony of stretching the cord

(*pḏ-šs*  (Faulkner, 1991)) for the orientation and foundation of sacred buildings. The invention of this ceremony was attributed to Imhotep, the architect of the 3rd Dynasty king Djoser's Step pyramid at Saqqara which could have been a place of orientation as Sokar was the god of orientation in ancient Egypt (Baumgartl, 1995). A fragment of a bas-relief found in the 5th Dynasty solar temple of king Niuserre represents the main theme of the ceremony. The king and a priestess incarnating goddess Seshat (the goddess of measurement in ancient Egypt) are shown each holding a mallet and a stake to which the calibrated cord is attached (Gadré, 2011b).

Various bas-reliefs dating from the New Kingdom and the Ptolemaic Period show the king and goddess Seshat preceding, within the framework of the ceremony of stretching the cord for the orientation of sacred buildings, following the movement of Meskhetiu the Big Bear (Fig.6). On one of the walls of the temple of god Horus at Edfu, the king says "*I grabbed the stakes at the same time as the handle of the mallet. I take the measuring rope with Seshat. I examine the constant movement of the stars. My gaze is on the constellation Bull's Thigh. I measure the passing time, especially the clock, and I establish the angles of the temple*". On one of the walls of the temple of goddess Hathor at Dandara, the king declares "*Observing the course of the stars rising in the sky, recognizing the constellation of the Bull's Thigh, I establish the angles of the temple of His Majesty*" (Gadré, 2011b).

It is most likely that the solar equinox was the day chosen for the ceremony of stretching the cord. During the equinox, the gnomon (the projecting piece on a sundial that

shows the time by the position of its shadow) shadow would immediately indicate the E-W cardinal points. Therefore, it is reasonable to choose solar geometry, at the equinox, to determine the primary direction of the pyramid complex. Sundials based on the equinox sun-shadow were known since the Pre-historic times and were commonly used during the 3rd century B.C. (Kittler and Darula, 2008).

Fig. (6) On one of the walls of her chapel at Karnak, Queen Hatshepsut along with goddess Seshat stretching the cord (Source: Gadré, 2011b, 6, Fig. 4)

The stars chosen to orient the Egyptian monuments, pyramids and temples, appear among the list of candidate stars for the Egyptian decans (patterns or groups of stars that were separated by ten nights and were used for telling time at night (DeYoung, 2000), for example the decans in the pyramid of king Unas at Saqqara (2012 ،أيمن و رؤوف). It was believed that the location of a building (east or west of the Nile) is not systematically linked to the source of its orientation (setting or rising azimuth of a star), while the purpose of a building (its funerary or religious character) is

closely linked to the source of its orientation (azimuth of setting or rising of a star) (Gadré, 2011b).

The Astronomical Scenes

The astronomical scenes adorn the ceilings and walls of temples and tombs as well as the interior of the lid of sarcophagi dating from the dynastic period till the Graeco-Roman period. About one hundred water clocks, stellar clocks, and astronomical ceilings were inscribed with astronomical texts giving the ancient Egyptian names of 90 decanal stars in the order of their successive heliacal risings, nocturnal risings or transits (Gadré, 2011c).

The ancient Egyptians depicted the stellar clocks on the inner lids of their sarcophagi. About 19 sarcophagi with the representation of the stellar clock on the inner lid were discovered in the necropolises of Upper and Middle Egypt (Thebes, Gebelein, Aswan, Abydos, and Asyut). The stellar clock was also painted on the 19th Dynasty Osirion of king Seti I at Abydos. The work of such a clock depended on the sequent appearance of the stars in the east between the end of the astronomical twilight and the beginning of dawn throughout the ancient Egyptian year (Gadré and Roques, 2009).

The ancient Egyptians managed to make an accurate correct star map that appears clearly in the New Kingdom astronomical ceilings of tombs and temples containing decorative motifs designed to provide a symbolic and schematic summary of the astronomical knowledge of the Egyptians (DeYoung, 2000). They denote the ancient Egyptian methods of finding extending direction. They show symbolic representations for the deities of the days of the lunar month, the decanal stars and constellations, mainly the constellation *Msḫtyw* that is usually depicted as a bull or bull's foreleg being guarded by goddess Isis in the image of a great hippopotamus (*rrt wrt*) (Wilkinson, 1991).

The oldest, best known and preserved astronomical ceiling and star map is found in the 18th Dynasty tomb of Senmut TT 353 (Fig.7) (Novakovic, 2008). Other interesting examples of such ceilings are found in; Hall K in the 19th Dynasty tomb of king Seti I KV 17; the tomb of Merenptah (KV 8); the tomb of Tawosret (KV 14); the tomb of Ramesses IV (KV 2); the tomb of Ramesses VI (KV 9); the tomb of Ramesses VII (KV 1); the tomb of Ramesses IX (KV 6); the second hypostyle hall of the Ramesseum (the funerary temple of king Ramesses II) (Kondo, 2016); the 26th Dynasty tombs of Pademenope TT 33 and Montuemhat at El Assasif (DeYoung, 2000); and the sanctuary of the Roman temple of Amun at Deir el Haggar in Dakhla Oasis (Lull and Belmonte, 2009).

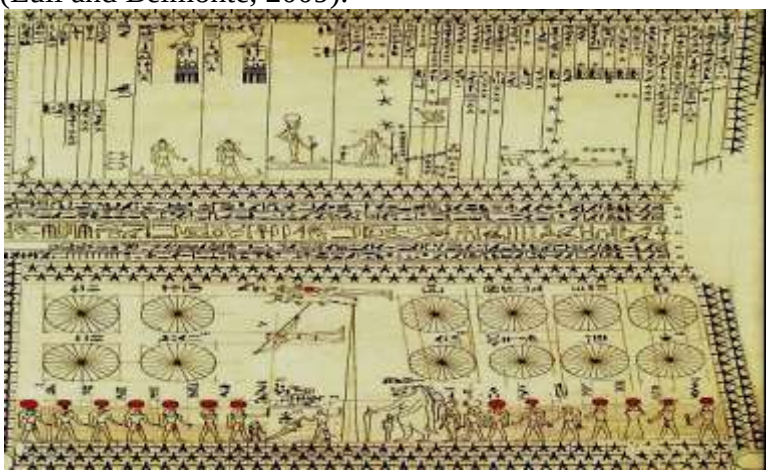


Fig. (7) The oldest astronomical ceiling and star map in the tomb of Senmut TT 353 (Source: Wilkinson, 1083, 31, Fig. 27)

Besides the New Kingdom star maps, the ancient Egyptians depicted the detailed star charts that show the locations and

positions of some stars and cosmic celestial bodies. Its practical purpose was to determine and measure time, and observe the different cosmic phenomena (أيمن و رؤوف، 2012), for example the star charts in the corridor of the tomb of king Ramesses IX KV 6 (Fig. 8). (Lull and Belmonte, 2009)

Fig. (8) A section of the star charts in the tomb of Ramesses IX KV 6

(Source: Lull and Belmonte, 2009, 168, Fig. 6.6)

The illustration of the Zodiac was available represented on the Graeco-Roman sarcophagi and ceilings of tombs and temples (أيمن و رؤوف، 2012), such as the tomb of Petosiris in Dakhla Oasis (Fig.9.a, Priskin, 2017) and the temples of Esna, Edfu, Kom Ombo, Philae, and the famous Dandara Zodiac of the temple of goddess Hathor that is now preserved in the Louvre museum in Paris, while a plaster copy is on site today (Furlong, 2007). Dandara Zodiac (Fig.9.b) is considered to be the only celestial diagram with a circular form known in Egypt. It shows representations of constellations, 5 planets and 36 decanal stars accompanied by their ancient Egyptian names, and the four goddesses of the four cardinal points, together with four pairs of falcon-headed divinities supporting the sky. (Lull and Belmonte, 2009)

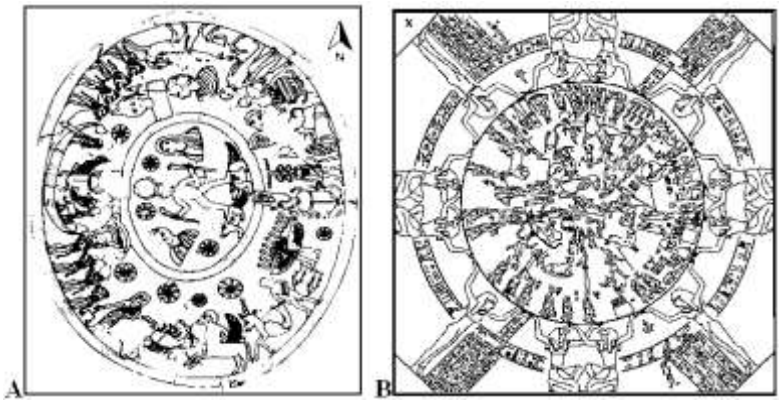


Fig. (9) a. Inner frame of the Zodiac of Petosiris; b. The first drawing of the original masterpiece of Dandara Zodiac (Source: Priskin, 2017, 17, Fig.2; Lull and Belmonte, 2009, 179, Fig. 6.16)

The ancient Egyptians managed to observe certain planets. Their knowledge of planetary astronomy included the observation of about five planets that were depicted in Dandara Zodiac, the retrograde motion of Mars, and the revolution of Mercury and Venus around the Sun (Deyoung, 2000). They called Venus "the morning star or the evening star", and described Jupiter as "The Shining", Saturn as "Horus the Bull", and Mars as "Horus the Red" (أيمن و رؤوف، 2012). It was also possible to understand the heliocentric structure of our solar system from the careful observation of the planetary orbits and their relationships to each other (Baumgartl, 1995).

Astronomy in Egypt in the present Time

Egypt is witnessing a wave of interest in astronomy among young people today, which calls for organizing many tours for astronomical observation, which often target the Sinai, especially the Fjord Bay, Jebel Musa and Saint Catherine, Al-Kottamia Astronomical Observatory on the Suez Desert Road, and Wadi El-Hittan, Wadi El Rayan and Jabal Al Mudawara in Fayoum, as well as Siwa Oasis, and the White Desert.

Astronomers in Egypt observe many objects and phenomena, the most famous of which are the moon , planets , stars , comets , meteor showers, and many distant sky objects such as star clusters, galaxies and nebulae (Fig.10). There is also the phenomenon of conjugation, which is a very popular astronomical phenomenon in Egypt. It occurs when two celestial bodies meet at a close distance in the sky. It can be seen with the naked eye from anywhere. The phenomenon of the "super moon" or the giant moon is considered the most famous astronomical phenomenon that the public has followed in the last two years. It occurs when the moon is at its closest point to the Earth. It appears larger and brighter. In addition to the blood moon, in which a total or partial lunar eclipse occurs, where the moon's light is blocked from the Earth, except some red rays that pass from the atmosphere and give the moon a red color (Ruggles, 2005).

Egypt is astronomically advanced, agencies such as "NASA", "European Space" and "National Geographic" published Photos of some phenomena from observatories in Egypt. Moreover, El Heiz Observatory in the Bahariyya Oasis is going to be accredited by the International Dark-sky Association (Interview with the head of ASMM, 2022).

Potentials of Astronomy Tourism in Egypt

First, The Best places for Astronomical Observation in Egypt

Here is an overview of the famous astronomical observation sites in Egypt. Pyramids of Giza, watching the Milky Way light up the sky over ancient Egypt seems too good to be true, but luckily, it is a reality. While tourists rush to view the Great Pyramids of Giza and the Sphinx in the early morning, opt for doing the same, but at night tourists will not only get to stargaze into the dark sky (Fig.11), but also they will get to see the pyramids uniquely while escaping the crowds. In addition, the sound and light show that brings the great pyramids to life while the Sphinx narrates ancient history (The best places for stargazing in Egypt, 2021).

Al-Fayoum Desert, located just an hour and a half away from Cairo via car, stargazing has never been this easy and accessible in the Egyptian desert. While every oasis is hours away from Cairo, Al-Fayoum is as close as tourists can get to the breathtaking Egyptian oasis. Most activities in Al-Fayoum are spent outdoors like sand boarding, horseback riding, exploring ancient monuments and more. The most prominent, of course, is night dreaming into Fayoum's constellations over its marvelous Magic Lake in the middle of the desert (Ramzy, 2013).

Siwa Oasis, right in the heart of the Western Desert lies an Egyptian oasis like no other, far away from the city's hustle and bustle. It is a distinctive cultural location as tribes who speak Siwi still live here and retain their language. There are several ways to enjoy Siwa; either through skin treatment to its hot springs, cycling in the city, climbing mountains, camping in the desert or staring at the stars at

night as they light up the city's famous palm trees and surreal salt lake (Amara, 2010).

The White Desert, is located in Egypt , 45 kilometers (30 miles) north of the Farafra Oasis in the New Valley Governorate, about 500 kilometers from Cairo. It was declared a nature reserve in 2002 (National Parks, n. d.). It is called the White Desert because it has a white color that covers most of its territory, with a total area of 3010 square kilometers, and also possesses a huge chalk rock (Fig. 12). The desert contains many formations that were created as a result of an accidental sandstorm in the region (Barich, et al., 2014).

Saint Catherine is considered to be one of the highest mountains in Sinai, with a height of 2.629m above sea level. Snow falls on the mountain in the winter like the rest of the mountains of the South region Sinai. It can take hours to climb Mount Catherine and reach its summit. However, after reaching the top of the mountain, one can see one of nature's most amazing views. There is also Jabal Musa, which is the easiest to climb. Most visitors enjoy watching the sunrise from above. However, it is possible to choose a completely different experience and see the dark sky as they have never seen it before (Shams, 2011).

Sharm El-Sheikh, located on the southeast coast of Sinai Peninsula, is Egypt's most visited resort town for its crystal blue beaches, colorful coral reefs and amazing diving locations. It is true that Sharm El-Sheikh's Red Sea has a unique world under the sea that will leave anyone speechless. However, it also has an astonishing world above the water when looking at its sky. Dive into its dark sky with your significant other and experience a romantic

night filled with stars lighting up the coral coast (Magi and Fabbri, 2005).

Nuweiba, just two hours away from Sharm El-Sheikh, tourists can enjoy a different kind of a stargazing experience in the eastern part of the Sinai Peninsula. The area is famous for its environmentally friendly lodges, where most rooms are made of bamboo huts serving the boho spirit of the area. It is a place where tourists can enjoy nature, peace and tranquility, as well as the beach and its white sand. Get lost staring into the beautiful sky overlooking the beach and mountains and disconnect from reality (Basha, 2017).

Fig. (10) Orion Nebula-Valley of Whales El-Fayoum; **Fig. (11)** Stargazing in Giza Plateau; **Fig. (12)** The Milky Way in the White Desert

(Source: Orion nebula from the Valley of whales in Egypt, 2021; the best places to stargazing in Egypt, 2021; and Shohayeb, 2018).

Second, Specialized Authorities in Astronomical Observation in Egypt

Egypt has many bodies involved in astronomy; the following lines declare the most important and well known ones.

National Research Institute of Astronomy and Geophysics (NRIAG): It has a very long history of astronomical and Geophysical observation since it was established on the year 1839 as a Royal observatory at Bollaq, then moved to Abbasia in the year 1868 before it was moved to the current location at Helwan in 1903, making it the oldest research institute in North Africa and be one of world heritage sites in Science and technology (UNESCO, 2010). Being dedicated to exploring the Earth and universe, NRIAG is focusing on providing the needs of the researchers of, up to date, precise technologies to meet the modern scientific challenges in the fields of specialization. The research facilities of NRIAG are spread all over Egypt, powered by more than 300 researchers in five scientific divisions covering every task of astronomy and geophysics. Moreover, NRIAG managed to build a worldwide cooperation network with distinguished international institutions and universities. Numerous projects and studies were completed in collaboration with national and international academic partners that qualify the staff of NRIAG for the highest level of applications (NRIAG, n. d).

The Astronomical Society of Mostafa Mahmoud (ASMM): It is an Egyptian private scientific organization dedicated to astronomy and space sciences. It was founded by the famous Egyptian polymath Dr. Mostafa Mahmoud in 1981. It is one of the subsidiary associations of the Mosque Charitable Foundation in Mostafa Mahmoud Mosque to help, support and educate astronomy lovers and amateurs inside and outside Egypt. ASMM is the first and the oldest Egyptian private society for astronomy and space sciences

in Egypt (The Astronomical Society of Mahmoud Mosque, n. d).

The Egyptian Society for Astronomy (ESA): It is a non-profit organization declared and registered under the Ministry of Social Solidarity of Egypt in 2015, aiming at raising scientific public awareness in astronomy and space. (Egyptian Society for Astronomy, 2020).

Al-Kottamia Astronomical Observatory (KAO): one of the most important observatories in Egypt is Al-Kottamia astronomical observatory (see Fig. 13). It is the largest telescope in the Arab world, the Middle East and North Africa. The National Research Institute of Astronomy and Geophysics (NRIAG) of Egypt operates the Al-Kottamia Observatory through its Astronomy Department. A large number of scientists and researchers in the field of physics and astronomy use this telescope. It is unique in terms of its location. This telescope is located approximately at 80 km from the center of the capital "Cairo" in the direction of the Suez city (Ain El Sokhna Road) over a mount rises 450 meters above sea level. Al-Kottamia Telescope is the Northern eye of Astronomy in Africa. Given the unique location of Egypt, there are around 250 net clear nights throughout the year. It is reflected in the accuracy of the Observations and purity of images taken from Kottamia, which made it one of the famous Telescopes in the world at that time (Al-Kottamia Astronomical Observatory, n. d.).

Fig. (13) The KAO Dome and 74 Telescope
(Source: Azzam, et al., 2008, 272, 274, Figs. 1, 2)

The Egyptian Space Agency (EGSA): It is a Governmental Organization established in August 2019, aiming at acquiring Space Technology and Satellite Launching capabilities towards the accomplishment of The National Sustainable Development Strategy "Egypt-SDS 2030" objectives (Egyptian space agency,

Third, Astronomy Education in Egypt

No doubt, Cairo University has been the pioneer in the development of science and the building of the knowledge economy. Since the opening of the Faculty of Science, it has been the first to establish a department of astronomy, space and meteorology, the oldest in Egypt, the Arab world and the African continent, and remained the only one for many years. To complete this pioneering role, the University worked hard to establish the aerospace engineering program at the Faculty of Engineering (Aerospace Engineering Department, n. d). After establishing the Egyptian Space Agency, and in light of the efforts exerted by the University Agency for Community and Environment Affairs to contribute to the development of a national plan to promote the human element in the field of astronomy and space science, it has established the

Center for Studies and Consultations of Space Science to achieve the aspirations of the State in the promising fields of space (Cairo University, n.d).

Recently, the Faculty of Navigation Sciences and Space Technology (NSST) in Beni-suef University was established on 2018. It is the first Egyptian and Arab faculty specialized in the field of space navigation and the applications and uses of space technology. It aims at graduating scientific cadres capable of working in the Arab, African and international space systems. It aims to transfer space technology to students, graduates and researchers in this field (The Faculty of Navigation Sciences and Space Technology, n. d.).

Finally, Egypt started its project by developing designs for an integrated city for space tourism and astronomy (Tutera City) (Fig. 14) to be Egypt's fourth Pyramid, which will include the largest center for research and studies of space sciences and astronomy in the world (TUTERA Pyramid, 2021).

Planetariums in Egypt

Planetarium is a theater built for presenting shows about astronomy and the night sky. Scenes of the stars, planets and other celestial objects are projected on the dome-shaped screen of a planetarium to simulate the motions of space (Robson and Christensen, 2005). There are many permanent planetariums in Egypt that have public astronomy and space viewing programs (Planetarium, n. d.); table (2) declares some of them.

Table (2) Planetariums in Egypt

Planetarium	Description
The Planetarium Science Center (PSC) (Fig.15) Bibliotheca Alexandrina, El Shatby Alexandria	Opened in 2002, Dome 14 m, 120 Seats, Digital system RSA-Cosmos Sky Explorer 4.
New Science Park The 6th Of October City, Cairo	Opened in 2011, Dome of 18.0m, 120 seats, Digital system Sky-Skan Definiti.
Arabic Academy for science and maritime Transport AASMT	Opened in 2012, Dome of 12.0m, 67 seats Digital system Evans_and_Sutherland Digistar 4.
Suez Discovery & Science Center Suez	Opened in 2012, Dome of 10.0m, 70 seats Digital system Evans_and_Sutherland Digistar 4.

(Source: Modified from Worldwide planetariums database, 2021)

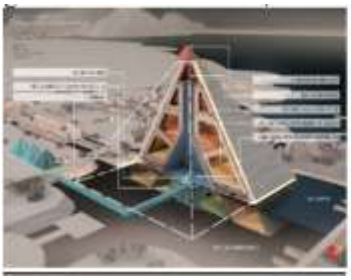


Fig. (14) Tutera City

Fig. (15) The Planetarium Science Center

(Source: TUTERA Pyramid, 2021; and Planetarium Science Center, n. d.)

Fourth, Astronomy Awareness in Egypt

Regarding awareness, there are many initiatives aim at spreading the awareness about astronomy in Egypt. Some of them are mentioned as follows:

- **The Astronomy Club, at the American University in Cairo (AUC)**, aims to spread awareness about Astronomy and Science in the community (Astronomy club, n. d.).

- **Space Knowledge initiative**, is one of the scientific initiatives specialized in the field of astronomy and space technology through social media platforms since 2011. It provides lectures, workshops and evenings for astronomical observations. Moreover, it assists those who have passion with astronomy and put them on the right path, in addition, it publishes all that is new about celestial events and methods of observing the sky (Space Knowledge, n. d.).

- **Spaceak**, is a free educational grant supported by the Egyptian Space Agency - Ministry of Youth and Sports - Faculty of Science, Al-Azhar University, to prepare a generation capable of space exploration (Speaceak, n. d.).

- **Astronomy Club Sohag University**, it is the first student activity in Sohag interested in astronomy and space science. Their goal is to discover the universe and the unknown phenomena, create a generation understanding astronomy, and get rid of astrology, myths and wrong beliefs (Astronomy Club – Sohag, n. d.).

- **Astro-Trips Egypt**, it is a leading travel and astronomy trips company started in 2014. It offers trips with guided astronomers wildlife safaris expedition cruises, active adventures, family trips, photography workshops, and more (Astrotrips, n .d).

Motivations to Astronomy Tourism

Motivation is a psychological concept that refers to the driving force within the individual impelling him/her to action (Mayo and Jarvic, 1981; Schiffman and Kanuk, 2003); it is the stimulus that any given or pursued situation gives to an individual that, due to its expected desirable or undesirable incentives, will act accordingly to pursue or avoid them, i.e. "a person chooses a certain behavior for its expected results" (Hsu, Cai, and Li, 2010). This means that people act or engage in certain activities in order to be satisfied or pleased afterwards.

An individual is more likely to continue to participate in leisure activities by having had positive and satisfying leisure experiences (Beggs and Elkins, 2010). Therefore, it is important to understand what motivated tourists to engage in astro-activities, and what are the positive factors that contributed to their experience. In order to assess what are the main motives, or factors, that draw tourists into this niche, the Leisure Motivation Scale (LMS) theory, developed by Beard and Ragheb in 1980 and derived from Maslow's Hierarchy of Needs (Griffiths, 2012) is used in this study. The chosen motivational theory will try to identify the dimensions that motivate tourists the most to engage in astrotourism.

Leisure Motivation Scale

The Leisure Motivated Scale (LMS) measures an individual's motivation to participate in leisure activities (Wang, 2008), in this study, it will be used in the context of terrestrial astrotourism. Beard and Ragheb (1983) identified 48 motivators and divided them into five main dimensions: intellectual, social, competence-mastery, stimulus avoidance and physical skills. (1) The intellectual dimension refers to mental stimulations, being motivated because of a need for learning or discovery, e.g. cognitive learning to learn about things around oneself, or the opportunity to use one's imagination to explore new ideas, discover new things, to discover new things and learn about him/his self (Beggs and Elkins, 2010). (2) The competence/mastery explains motivation in terms of the desire for mastery, competition and challenge; it can be translated into the desire for mastery, competition and challenge. It covers everything from improving and challenge skills, to a feeling of belonging and gain other's

respect (Griffiths, 2012). (3) The stimulus avoidance dimension refers to escape and restoration the individual seeks in his/her leisure activities, mainly to seek solitude or to unwind and relax (Beggs and Elkins, 2010). (4) The social dimension refers to the need for friendship or interpersonal relationships; the need the individual has for friendship and interpersonal relationships. It covers everything from building new friendships, interacting with others to develop and consolidate friendships (Griffiths, 2012). (5) The physical skills dimension refers pursue the physical fitness, weight control, and well-being (Beggs and Elkins, 2010; Griffiths, 2012). The physical skills dimension is not portrayed in this study, as it is not considered relevant concerning this them, it refers to the motivation of pursuing physical fitness, weight control, and well-being. It is not common, that tourists maybe engage in physical activities when they witness an astronomic event and/or participated in any astronomy activity (Matos, 2017).

Methodology

This study is exploratory. Exploratory research is a methodological approach that investigates research questions that have not previously been studied in depth. Exploratory research is often qualitative in nature. However, a study with a large sample conducted in an exploratory manner can be quantitative as well (George, 2021). The current research based on the mixed method approach, in the one hand, semi-structured interviews were conducted with the managers of tour operators in Egypt who engage such astronomical activities/events within their programs. Further, an interview was conducted with the manager of Al-Kottamia Observatory, besides; interviews were conducted with the heads of astronomical societies in Egypt. On the other hand, a questionnaire was conducted to explore why tourists engage in astrotourism, their attitude towards such kind of tourism, and what motivates them to travel to see such exquisite phenomena. An online questionnaire link was posted on social media platforms, and other paper-based questionnaires were distributed to Egyptian tourists and foreign tourists in Luxor, Cairo and Hurghada. The questionnaire includes three main parts: (1) general information; (2) attitudes toward such kind of tourism, and (3) Motivations. Each item in section two and three was evaluated using a five-point Likert scale where 1="strongly disagree" and 5="strongly agree". The statements in the questionnaire were adopted and modified from (Matos, 2017).The internal consistency of the questionnaire was established using Cronbach's Alpha method (Table 3) illustrates that the alpha correlation coefficient of the questionnaire ranges from (0.702 to

0.943). Therefore, all coefficients are significant, which indicates that the questionnaire is quite reliable.

Table (3) Reliability (Cronbach's alpha) of Each Scale

Scale	N. of Items	Cronbach's Alpha
Astronomy tourism Attitudes in Egypt (AAE)	5	0.702
Intellectual Factors Motivations (IFM)	7	0.918
Stimulus Avoidance Motivations (SAM)	6	0.926
Competency Mastery Motivations (CMM)	5	0.920
Social Motivations (SM)	6	0.943

Sampling and Data Collection

Regarding the interview's sample, according to Bryman (2012) and Maxwell (2009), purposeful sampling is highly recommended in qualitative studies. It is "a strategy in which particular settings, persons, or events are deliberately selected for the important information they can provide that cannot be gotten as well from other choices" (Maxwell, 2009, 239). The current study collected data by conducting 18 in-depth interviews via phone calls, from January to March 2022, interviews with the tour operators' managers in Hurghada (5) Cairo (5), Almansoura (2) AlFayoum (3) and admins of online travel groups (3), in addition, interviews with the managers of the observatories and astronomical societies in Egypt were conducted. The researchers recorded the interviews after verbal agreement from the respondents. The duration of calls ranged between 15:00 minutes and 25:00 minutes. The researchers conducted semi-structured interviews to explore the current practices and the ongoing construction of Astronomy tourism in Egypt.

Regarding the questionnaire, the question of sample size in this research is a complex one due to the absence of recent

data about the number of foreign tourists because of the Covid-19 pandemic; in addition, there was no available data about the number of domestic tourists in Egypt. One of the rules of thumb that can be helpful is to note that there is a positive relationship between the number of items (questions in a questionnaire) and sample size. The sample should allow for a ratio of at least 1:4 or 1:5 – that is, four or five respondents per question (Hinkin et al., 1997). Ryan (1995), though, argues for a more demanding ratio of at least ten respondents per item. A simple application of the "10-times rule" (Hair et al., 2011) is used to determine the sample size for this research, "10 times the maximum number of inner or outer links pointing at any latent variable". It is a method of more favorite to more researchers. This research employed (29) items from previous studies to measure the motivational factors of tourists regarding astronomy tourism. Therefore, to determine the appropriate sample size, if the questionnaire has (29) questions, the sample should be at least (290) respondents. Noteworthy, despite the determined number of sample is (290), the researches succeeded to gather (195) foreign tourists' valid forms, and (285) Egyptians' valid forms. Hence, total number of (480) valid forms were collected from January to March 2022 with the help of the tour operators and Admins of online travel groups, who organize or engage astronomical events in their programs, and also tour guides especially on 22nd February during the solar Alignment on Abu simple Temple event. The sample includes both foreign and Egyptian tourists to explore astronomy tourism position in Egypt nationally and internationally.

Measurement items

The questionnaire includes three main parts explained as follows: first, the questionnaire asked about some demographic information of the respondents, their contact with the astronomy tourism, their practiced astronomy activities/ events, and the frequency of attending such events in Egypt. Regarding the second and third part of the questionnaire, the evaluation of all items was anchored on a five-point Likert scale. The study employed (5) items developed by the researchers to measure the tourists' attitude towards astrotourism in Egypt, however, (24) items were adopted and modified from previous studies to measure the motivations of tourists to engage in the astrotourism activity and events. Following Matos (2017), the (LMS) is applied in this study, more specifically, to terrestrial astrotourism, in order to make an assessment of the most influential factors that drive tourists to those activities/events. A list of the motivational dimensions is shown in Appendix (b, c, d, e, and f).

Data analysis

Regarding the interviews, after collecting all the opinions and interviews' comments, the qualitative data from the interviews was analyzed through qualitative analysis. Qualitative analysis means analyzing the interview to identify the main themes that emerge from the answers of the respondents (Harding, 2018). The study identifies and analyzes the responses of the interviewees, and summarizes the data to conclude findings, and achieve the objectives of the study. However, the collected data from the questionnaire was analyzed using the aid of a Social Science Statistical Package (SPSS) version 22. This study selected SPSS, which has descriptive statistics such as

frequencies and percentages, mean and standard deviation to avail demographic characteristics of the respondents. In addition, the independent sample t-test was used to test the differences in travel motivation among foreign and Egyptian tourists and simple linear regression was used to measure the effect of the four motivations on tourists' attitude towards the astronomy tourism in Egypt.

Results

First: Qualitative Data Results

- **Interviews with the managers of tour operators and the admins of online travel groups who engage astronomical activities and events in their programs:**

The researchers conducted 18 interviews and then reached saturation. The researches codes the interviewees of each group in the same category, as they respondents are the same. Managers of tour operators in Hurghada and the Red Sea (I1), managers of tour operators in Cairo (I2), managers of tour operators El Mansoura (I3), managers of tour operators El Fayoum (I4), and admins of online travel groups (I5)

Organizing astronomical activities and events in Egypt

All the respondents (I1 to I5) declared that usually they organize these activities as a part of the adventure and safari tours. The safari program starts at the afternoon and after dinner, the safari program ends with observing the stars in the sky with the help of a specialized tour guide who talks about astronomy and stars and explains the different constellations in the sky using the telescope. Besides, the tours of stargazing are organized according to the seasons, because watching the stars in general has specific timings, for example in Wadi Al-Hitan in El Fayoum Governorate: on lunar days, it is difficult to stargaze, because the moon obscures the stars and reduces the visibility of meteors due to its light, unless the purpose of the tour is to observe the moon itself, on the days of rising of the arm of the galaxy from the end of April to the beginning of September, and in the days of meteor showers (such as the Geminids, Orionids, and Leonids) that have

certain times and specific dates known to those who are interested.

Availability of organizing the astronomical activities separately without engaging them in the safari program

All the respondents (I1 to I5) agreed that astronomical activities could be organized either as an individual program or within the safari program. It is included in the optional tour programs, which the company organizes. The safari tours contain such optional programs, including stargazing activity that is an optional individual program that is not included in the main program of the tour, however, it is purchased. The activity could be an individual program in case of special astronomical events such as the appearance of meteors in the sky.

Who is most interested in astronomical activities

(I1) illustrated that they do not deal with the Egyptian tourists, yet, the activity is in great interest and demand from the foreign tourists, especially the British tourists. However, (I2, I3, I4, I5) mentioned that there is a great demand from the Egyptian tourists to practice these activities, especially when there are special events such as observing the meteors in the sky.

Sites of organizing astronomical activities

Half of (I1) explained that there is a place in the desert called the safari area, where every tour operator or every supplier has a specific place to start their program, each tour operator deals with a certain supplier. Although, the sites for each supplier within the safari area are next to each other, there are slight distances between them. Further, the other half declared that there are many sites to camp for a

desert safari however, the timing is very crucial. Every site has its timings for camping on it for astronomical observation, i.e. observing in a site in the presence of clouds is not useful because it is one of the challenges that face the astronomical observation. Another challenge could be a dust storm. Moreover, camping in Wadi El-Rayan in March is not useful because it is the season of scorpions. Consequently, it is necessary to examine the site first and make sure that it is free of any nature's challenges. Furthermore, (I2, I3, I4, I5) confirmed that the two nature reserves; the White Desert and Wadi Al-Hitan are the most popular sites where they organize astronomical observation activities. Being close to Cairo (about 3 hours away), far from the pollution and noise of the city, and their sky is clear at night where galaxies and stars are quite visible, make them the most ideal sites for astronomical observation, stargazing and enjoying the nature.

Sites' Set-up

On the one hand, (I1, I2, I3, I4) agreed that the requirements to set up a site for astronomical observation are very simple, it just needs carpets to install the telescope on it in a certain way to determine the most appropriate angle for seeing the moon and observing the stars, besides, the Bedouins prepare a simple tent in a very primitive way to rest and have tea. On the other hand, (I5) mentioned that set-up and facilities vary from one camp to another, yet, simple tents, cafeterias, and bathrooms are mostly provided. On the contrary, some of the respondents argued that setting-up of some sites is not easy, as permissions such as the overnight permissions and the borders' crossing permissions are needed. Consequently, every site has its camping situation, so a regulation guide is required.

Ways of observing the sky (with the naked eye or with a telescope)

(I1 to I5) revealed that the way of observing the sky depends on the site, time, and phenomenon, i.e., in Wadi Al-Hitan, when observing the arm of the galaxy, tourists can see it with the naked eye, however, sometimes stars cannot be seen with their naked eye, in this case a telescope is appropriately needed. Furthermore, some of the respondents declared that the observation of the sky with the naked eye is to identify the north direction, star constellations, and deep space objects, however, the telescope is used to observe Planets, Orion nebula, and Andromeda galaxy. Additionally, all the respondents agreed that there is always an astronomical guide responsible for explaining what is seen in the night sky and the best way to observe it.

Tourism satisfaction and desire to participate in astronomical observation activities and events

All the respondents (I1 to I5) agreed that tourists who intended to buy this activity as an individual program were totally satisfied, additionally; they have a passion for practicing such activities. For example, the sky in Wadi Al-Hitan in particular, is quite dazzling for tourists, where they gazed at thousands of stars with their naked eyes and they were very happy to be able to take photos of the stars and galaxies. Moreover, interested tourists are also fascinated by the timely detailed telescope images of stereoscopic 3D vision and thus they could easily take photos with their mobile phones through the telescope lens.

Future prospects for developing astronomy tourism in Egypt

All the respondents (I1 to I5) declared that they are already organizing two types of programs concerning the astronomical activities and events; first, a program in which they engage such activities and events within the safari program, where tourists are using the telescope to observe the stars and the moon at the end of this program. Second, a specialized program that is only limited to a full tour to observe astronomical events.

- **Interview with the manager of Al Kottamia Astronomical Observatory (I6):**

Categories of visitors and times of visit

(I6) illustrated that visitors to the observatory are divided into two categories; normal visitors and researchers, each of them has different times for their visit. For example, researchers have specific dates for researching and studying the astronomical observations, which are on non-lunar nights, such as the beginning, middle or end of the Arabic month, because researchers need a dark sky or a dark night to investigate the phenomena. Besides, professional astro-tourists are also permitted to attend with researchers on their visiting dates on non-lunar nights. However, lunar nights or semi-lunar nights are especially for visitors to observe the moon and planets with the telescope. Moreover, he declared that the visitors are Egyptians and foreign tourists from different nationalities, mainly French, German, Japanese, Americans and England.

Frequency and number of visitors

(I6) declared that, usually the average number of visitors is 60 in the normal times, however in the time of certain rare phenomena or events the number varies between 300-500 individuals and sometimes more.

Presence of astronomical specialist

(I6) confirmed that, there is always an astronomical specialist who shows the visitors how to use star-charts, and adjust the telescope for a better view.

Cooperation with tour operators and the astronomy parties in Egypt

(I6) illustrated that there is no cooperation with the tour operators in Egypt, however there is a link with the astronomy parties in Egypt such as the Egyptian Society for Astronomy (ESA) and the Astronomical Society of Mustafa Mahmoud (ASMM), as these associations organize visits to the observatory. Moreover, there are also online groups such as Astrotrips and GeoAstro. They are individual groups who work on a personal project to gather people through social media networks such as Facebook and sometimes they organize with the observatory to arrange visits.

- **Interviews with the head of the Egyptian Society for Astronomy (ESA) (I7) and the head of the Astronomical Society of Mustafa Mahmoud (ASMM) (I8)**

Main activities of the societies

The interviewees (I7, I8) declared that their societies' activities include public seminars to raise awareness of astronomy, workshops and astronomical evenings for

astronomical observation with telescopes in public libraries and cultural centers, and tours to areas far from pollution such as nature reserves, the desert, and Al-Kottamia Astronomical Observatory to observe more and raise the audience's knowledge. Additionally, they mentioned that the societies are not a place for visits or scientific research, yet, they organize their activities in cultural centers and public libraries that can accommodate a large number of audiences.

Frequency and turnout of audience

Both interviewees (I7, I8) revealed that, regarding the periodic activities such as seminars and lectures, the number of attendees is 20 to 40 individuals. However, In the case of observing astronomical events, the average number of audience is 150, besides when the event is special the number might reach 500. It is noteworthy that the majority of the audiences are students and youth categories (15:25 years old). Generally, the numbers of the audience vary according to the event and its time.

Nationality of audience

(I7, I8) agreed that the majority of their audiences are Egyptians, perhaps because the societies' activities are announced in Arabic only. Foreigners attend some minor events, but in a small percentage compared with the Egyptians, usually they are the foreigners residing in Egypt for a long period, thus they can attend the activities of the society. They declared further that the society is not a tourist company directed to foreigners, but those who are interested in astronomy in Egypt attend and follow their activities.

Coordination and cooperation with the NRIAG or any other parties concerned with astronomy in Egypt

The interviewees (I7, I8) confirmed the presence of cooperation between them and the NRIAG as they always arrange visits to Al-Kottamia observatory.

Resources of astronomy tourism in Egypt

The most important characteristic of astronomy tourism in Egypt are the archaeoastronomy found in the ancient Egyptian monuments like the astronomical ceilings of the temples, the solar alignment in the temples such as the Abu Simbel temple, as well as the Nabta Playa, which is the oldest astronomical monument in the world, located near the Egyptian borders, and there is a model for it in the Nubian Museum at Aswan. They added that, Egypt is well known for its clear and cloudless sky rather than other European and North Asian countries. Therefore, Egypt's sky is very distinct due to the presence of many sites far from the light pollution of the large cities such as Cairo and this is considered a strong motivation for those who wish to observe an astronomical event in Egypt. From the interviewees' point of view, these resources are sufficient to attract foreign tourists who are interested in astronomy to Egypt, and are enough to put Egypt on the map of astronomy tourism countries worldwide.

Efforts of various authorities to develop astronomy tourism in Egypt

Both interviewees (I7, I8) agreed that there are no efforts from any academic or governmental authorities. The only submitted efforts are from them as civil societies, and some other important private parties concerned with astronomy represented on youth online initiatives on the social media (such as: space knowledge Initiative, Tonight Initiative).

These trends existed online aim at gathering people who are interested in astronomy, and sometimes they coordinate with the societies to assign a specialist to discuss and explain in some events. Other than that, the efforts are very small and almost non-exist.

The Extent of awareness about astronomy tourism among Egyptians

The interviews (I7,I8) confirmed that, the percentage of the Egyptian's awareness about astronomy tourism does not exceed (10%: 15%) of the Egyptian community.

The most famous astronomical events in Egypt

Both interviewees (I7,I8) declared that the lunar and solar eclipses phenomena are the phenomena that concern the public. The most famous of which is the full solar eclipse that occurred in Egypt in 2006, which was attended by more than 500 scientists worldwide. It was a major event attended by the President at this time in Matrouh Governorate. He stated further that this phenomenon will be repeated in 2027 and will be in Luxor. Consequently, it is important to prepare for this event early so that it becomes a global event. Moreover, Scenes of heavy meteors in the sky, which occur on certain days and are observed with the naked eye, are a motive for practicing very enjoyable activities in the desert. Furthermore, there are some events that concern scientists only, such as the transit of a planet like Mercury and Venus in front of the sun, where they appear as a spot on the sun that is seen through a telescope. (I8) mentioned that photos of some phenomena from observatories in Egypt were published on "NASA", "European Space" and "National Geographic".

The future of astronomy tourism in Egypt; Opportunities and challenges

(I7, I8) summarized the opportunities for astronomy tourism in Egypt in the appropriate atmosphere, which is very suitable for the astronomical observation (the clearness of the sky on most of the year nights and the presence of many sites far from light pollution). They added that these opportunities when added to the diversity of the tourist product and activities in the tourist program in Egypt will lead to more attractions for tourists. However, the main challenges that could face astronomy tourism in Egypt are: the high cost of establishing observatories; the lack of astronomical awareness; the banning the entry of telescopes inside the country by the security authorities; and the lack of safety in some places far from light pollution.

Second: Quantitative Data Results

Table (4) Descriptive Statistics of the Respondents' Demographic Variables

Variables		FT (N = 212, 42.7%)	ET (N =285, 57.3%)	Total (N = 497, 100%)
Sex	Male	112 (52.8%)	126 (44.2%)	238 (47.9%)
	Female	100 (47.2%)	159 (55.8%)	259 (52.1%)
Age	Less than 20 years	3 (1.4%)	12 (4.2%)	15 (3%)
	21-30 years	57 (26.9%)	66 (23.2%)	123 (24.7%)
	31-40 years	73 (34.4%)	99 (34.7%)	172 (34.6%)
	41-50 years	30 (14.2%)	60 (21.1%)	90 (18.1%)
	51-60 years	24 (11.3%)	21 (7.4%)	45 (9.1%)
	More than 60 years	25 (11.8%)	27 (9.6%)	52 (10.5%)

As declared earlier the sample includes two groups {foreign tourists (FTs) and Egyptian tourists (ETs)}. The demographic variables of the respondents are explained as

follows (see Table 4). Basically, the FTs group represents (42.7%) of the sample, while the ETs group represents (57.3%). First, the majority of the FTs group is males (52.8%), however, the majority of ETs are females (55.8%). Further, the majority in the sample in general are females (52.1). Second, most FTs and ETs in the sample are 31-40 years old (34. 4, 34.7% respectively), followed by the age category 21-30 (26.9%, 23.2% respectively). Overall, approximately two-thirds of the sample (59.3%) is youth whose ages are ranging between 21 and 40 years.

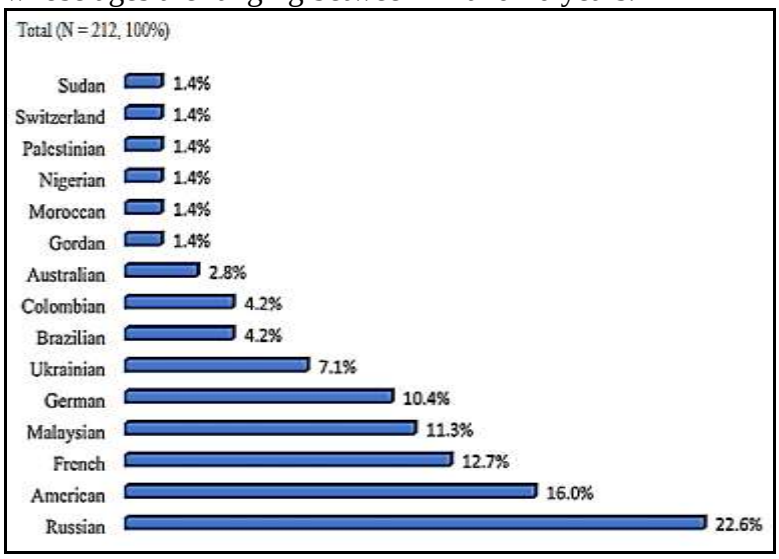


Fig. (16) Descriptive Statistics of the Foreign Tourists' Nationalities

Fig (16) declares the descriptive statistics of the FTs nationalities, as noticed the majority of FTs are Russian and American (22.6%, 16% respectively), followed by French, Malaysian and German (12.7%, 11, 3%, 10.4% respectively).

Table (5) Frequency of Astronomy Tourism Contact

Sample	Frequently	Usually	Sometimes	Rarely	Never	Mean	SD
FTs (N= 212)	9(4.2%)	9(4.2%)	24(11.3%)	30(14.2%)	140(66%)	1.67	1.104
ETs (N= 285)	3(1.1%)	15(5.3%)	36(12.6%)	36(12.6%)	195(68.4%)	1.58	0.970

In the comparison between FTs and ETs in the frequency of having contact with astronomy tourism, the results (see table 5) are almost the same for both FTs and ETs. Thus, the majority of FTs and ETs (66%, 68.4% respectively) never had contact with astronomy tourism before. However, (25.5%, 25.2%) of FTs and ETs sometimes and rarely have contact with astronomy tourism. Further, (8.4%, 6.4% respectively) of FTs and ETs frequently and usually have contact with astronomy tourism.

Table (6) Category of Practiced Astronomy Tourism

Category	FTs (N = 212, 42.7%)	ETs (N =285, 57.3%)	Total (N = 497, 100%)
Star/Planet/Comet/Aurorae gazing, Eclipse watching, etc.	119 (56.1%)	90 (31.6%)	209 (42.1%)
Observatory, Park or Reserve, Space Centre, or other facilities.	67 (31.6%)	27 (9.5%)	94 (18.9%)
Watching archaeological astronomical phenomena and scenes on ancient monuments.	42 (19.8%)	45 (15.8%)	87 (17.5%)
Space Movie location or other popular culture related to Astronomy tourism.	30 (14.2%)	48 (16.8%)	78 (15.7%)
Space Simulations or Virtual Gaming activities.	39 (18.4%)	12 (4.2%)	51 (10.3%)
Space Tourism.	9 (4.2%)	9 (3.2%)	18 (3.6%)
None	42 (19.8%)	135 (47.4%)	177 (35.6%)
Other*	9 (4.2%)	6 (2.1%)	15 (3%)

*Other (FTs' activities (Cycling = 3 (1.4%), Human Design = 3 (1.4%), Astrology Cart = 3 (1.4%)/ ETs' activities (Reading and language learning = 3 (1.1%), Look up and watch the sky = 3 (1.1%)).

According to FTs' and ETs' experience with astronomy tourism (see table 6), the majority of FTs and ETs (56.1%, 31.6% respectively) insisted that Star/Planet/Comet/Aurorae gazing, Eclipse watching, etc. is the most practiced category. Overall, it represents (42.1%) of the sample. Followed by (18.9%) visiting observatories, parks or reserves, and space centers, while watching archaeological astronomical phenomena and scenes on ancient monuments comes in the third rank (17.5%).

Table (7) Frequency of Attending Unique Astronomical Events in Egypt

Sample	Frequently	Usually	Sometimes	Rarely	Never	Mean	SD
FTs (N= 212)	1(0.5%)	13(6.1%)	43(20.3%)	35(16.5%)	120(56.6%)	1.77	1.005
ETs (N= 285)	8(2.8%)	11(3.9%)	51(17.9%)	37(13%)	178(62.5%)	1.72	1.065

Regarding the frequency of attending unique astronomical events in Egypt (see table 7), more than half of the FTs (56, 6%) have never attended any astronomical events/ activities in Egypt before; noteworthy that it was their first time to attend such astronomical events in Egypt. Further, approximately two-thirds (62.5%) of ETs never attends any astronomical events/ activities in Egypt as well. Yet, only (26.4%) of the FTs' group and (21.8%) of the ETs' group usually and sometimes attend astronomical events/ activities in Egypt.

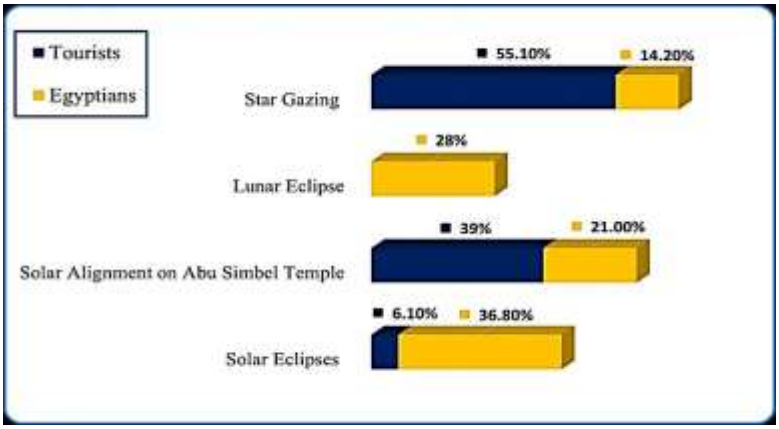


Fig. (17) Astronomy Tourism Activities and Events attended in Egypt

The results also declared the activities and events that both FTs and ETs attend in Egypt (see Fig. 17). According to FTs, the most attended astronomical events in Egypt are star gazing (55.1%), and watching the sun alignment on Abu Simble temple (39%). However, according to ETs, the most attended astronomical events in Egypt are observing the solar eclipses (36.8%), followed by observing the lunar eclipses (28%) and watching the sun alignment on Abu Simble temple (21%) and finally stargazing (14.2%).

Table (8) Attitudes towards Astronomy Tourism in Egypt (AAE)

AAE		Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Mean	SD
AAE 1	FTs	12(5.7%)	49(23.1%)	36(17%)	60(28.3)	55(25.9)	2.54	1.256
	ETs	42(14.7%)	30(10.5%)	42(14.7)	87(30.5)	84(29.5)	2.51	1.393
AAE 2	FTs	30(14.2%)	100(47.2%)	54(25.5)	25(11.8)	3(1.4%)	3.61	0.920
	ETs	150(52.6%)	78(27.4%)	36(12.6)	9(3.2%)	12(4.2%)	4.21	1.057
AAE 3	FTs	33(15.6%)	131(61.8%)	39(18.4)	6(2.8%)	3(1.4%)	3.87	0.753
	ETs	129(45.3%)	90(31.6%)	30(10.5)	27(9.5%)	9(3.2%)	4.06	1.105
AAE 4	FTs	49(23.1%)	99(46.7%)	50(23.6)	11(5.2%)	3(1.4%)	3.85	0.885
	ETs	147(51.6%)	78(27.4%)	30(10.5)	15(5.3%)	15(5.3%)	4.15	1.135
AAE 5	FTs	52(24.5%)	90(42.5%)	58(27.4)	8(3.8%)	4(1.9%)	3.84	0.904
	ETs	141(49.5%)	78(27.4%)	48(16.8)	9(3.2%)	9(3.2%)	4.17	1.024

The results further explored the tourists' attitudes toward astronomy tourism in Egypt (see table 8). First, almost half of the FTs (54.2%) and two-thirds of the ETs (60%) strongly disagreed and disagreed that they have a good idea about the astronomy activities/ events that exist in Egypt. Second, (61.4%) of the FTs and (80%) of the ETs strongly agreed and agreed that they would like to discover such phenomena in Egypt. Third, the majority of both FTs and ETs (77.4%, 76.9% respectively) strongly agreed and agreed that they would like to participate in astronomical observations in Egypt. Thus, astronomical observation events should be held widely to attract large number of audience. Fourth, a large number of FTs 148 (69.8%) and the majority of ETs 225 (78.4%) strongly agreed and agreed that they would like to watch certain archaeoastronomical phenomena in historical sites in Egypt, such as watching the Abu Simbel Solar Alignment. Fifth,

(67%) of FTs and (76.9%) of ETs strongly agreed and agreed that they would like to add astronomy activities and events to their Programs in Egypt.

Table (9) Distribution of respondents' (Foreign tourists and Egyptian tourists) Responses on Intellectual Factors Motivations (IFM)

Motivations		Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Mean	SD
IFM 1	FTs	62(29.2%)	106(50%)	33(15.6%)	5(2.4%)	6(2.8%)	4.00	0.895
	ETs	69(24.2%)	174(61.1%)	30(10.5%)	3(1.1%)	9(3.2%)	4.02	0.822
IFM 2	FTs	61(28.8%)	108(50.9%)	30(14.2%)	7(3.3%)	6(2.8%)	4.00	0.905
	ETs	51(17.9%)	114(40%)	63(22.1%)	36(12.6%)	21(7.4%)	3.48	1.143
IFM 3	FTs	82(38.7%)	86(40.6%)	34(16%)	4(1.9%)	6(2.8%)	4.10	0.933
	ETs	81(28.4)	162(56.8)	30(10.5%)	3(1.1%)	9(3.2%)	4.06	0.845
IFM 4	FTs	89(42%)	100(47.2)	12(5.7%)	6(2.8%)	5(2.4%)	4.24	0.866
	ETs	81(28.4)	147(51.6)	48(16.8%)	0(0%)	9(3.2%)	4.02	0.860
IFM 5	FTs	81(38.2)	92(43.4%)	25(11.8%)	8(3.8%)	6(2.8%)	4.10	0.948
	ETs	90(31.6%)	153(53.7%)	30(10.5%)	3(1.1%)	9(3.2%)	4.09	0.861
IFM 6	FTs	59(27.8%)	82(38.7%)	48(22.6%)	12(5.7%)	11(5.2%)	3.78	1.075
	ETs	66(23.2%)	72(25.3%)	105(36.8%)	18(6.3%)	24(8.4%)	3.48	1.162
IFM 7	FTs	50(23.6%)	83(39.2%)	54(25.5%)	16(7.5%)	9(4.2%)	3.70	1.045
	ETs	69(24.2%)	105(36.8%)	66(23.2%)	27(9.5%)	18(6.3%)	3.63	1.136

With regard to intellectual factors motivations, the results shown in table (9) revealed that, the most frequent factors for both FTs and ETs which make them feel motivated to participate in astronomy tourism activities and events are, expanding their knowledge (4.24, 4.09) and discovering new things (4.10, 4.09).

Table (10) Distribution of respondents' (Foreign tourists and Egyptian tourists) responses on Stimulus Avoidance Motivations (SAM)

Motivations		Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Mean	SD
SAM1	FTs	41(19.3%)	81(38.2%)	59(27.8%)	20(9.4%)	11(5.2%)	3.57	1.066
	ETs	69(24.2%)	102(35.8%)	78(27.4%)	12(4.2%)	24(8.4%)	3.63	1.145
SAM2	FTs	49(23.1%)	111(52.4%)	31(14.6%)	10(4.7%)	11(5.2%)	3.83	1.005
	ETs	63(22.1%)	117(41.1%)	72(25.3%)	12(4.2%)	21(7.4%)	3.66	1.094
SAM3	FTs	54(25.5%)	109(51.4%)	33(15.6%)	6(2.8%)	10(4.7%)	3.90	0.971
	ETs	69(24.2%)	111(38.9%)	78(27.4%)	12(4.2%)	15(5.3%)	3.73	1.042
SAM4	FTs	49(23.1%)	79(37.3%)	62(29.2%)	10(4.7%)	12(5.7%)	3.67	1.059
	ETs	66(23.2%)	144(50.5%)	48(16.8%)	15(5.3%)	12(4.2%)	3.83	0.982
SAM5	FTs	49(23.1%)	64(30.2%)	66(31.1%)	20(9.4%)	13(6.1%)	3.55	1.128
	ETs	69(24.2%)	138(48.4%)	54(18.9%)	12(4.2%)	12(4.2%)	3.84	0.978
SAM6	FTs	42(19.8%)	69(32.5%)	64(30.2%)	23(10.8%)	14(6.6%)	3.48	1.125
	ETs	81(28.4%)	144(50.5%)	39(13.7%)	12(4.2%)	9(3.2%)	3.97	0.936

Regarding the stimulus avoidance motivations**,** the results (see table10) confirmed that, to relax mentally (3.90), to relax physically (3.83), and to avoid the hustle and bustle of daily activities (3.67) are the most frequent factors that drive FTs to engage in astronomy tourism activities and events. However, the most relevant factors according to ETs are, to unstructure their time (3.97), to relieve stress and tension (3.84), and to avoid the hustle and bustle of daily activities (3.83).

Table (11) Distribution of respondents' (Foreign tourists and Egyptian tourists) responses on Competency Mastery Motivations (CMM)

Motivations		Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Mean	SD
CMM1	FTs	33(15.6%)	78(36.8%)	64(30.2%)	22(10.4%)	15(7.1%)	3.43	1.093
	ETs	48(16.8%)	105(36.8%)	96(33.7%)	18(6.3%)	18(6.3%)	3.52	1.047
CMM2	FTs	33(15.6%)	88(41.5%)	55(25.9%)	21(9.9%)	15(7.1%)	3.49	1.091
	ETs	39(13.7%)	66(23.2%)	81(28.4%)	60(21.1%)	39(13.7%)	3.02	1.242
CMM3	FTs	44(20.8%)	90(42.5%)	51(24.1%)	18(8.5%)	9(4.2%)	3.67	1.032
	ETs	57(20%)	105(36.8%)	84(29.5%)	21(7.4%)	18(6.3%)	3.57	1.084
CMM4	FTs	46(21.7%)	96(45.3%)	37(17.5%)	21(9.9%)	12(5.7%)	3.67	1.094
	ETs	45(15.8%)	120(42.1%)	72(25.3%)	30(10.5%)	18(6.3%)	3.51	1.077
CMM5	FTs	49(23.1%)	94(44.3%)	43(20.3%)	15(7.1%)	11(5.2%)	3.73	1.057
	ETs	42(14.7%)	135(47.4%)	60(21.1%)	33(11.6%)	15(5.3%)	3.55	1.046

With regard to competency mastery motivations, the results (see table 11) illustrated that, to be active (3.75), challenge and improve their abilities (3.67), and improve their skill and their ability in doing it (3.67) are the most relevant factors according to the FTs' group. Further, according to the ETs' group, the most relevant factors are, to challenge and improve their abilities (3.57), to be active (3.55), and to gain a feeling of belonging (3.52).

Table (12) Distribution of respondents' (Foreign tourists and Egyptian tourists) responses on Social Motivations (SM)

Motivations		Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Mean	SD
SM1	FTs	38(17.9)	83(39.2%)	61(28.8%)	18(8.5%)	12(5.7%)	3.55	1.059
	ETs	36(12.6%)	138(48.4%)	66(23.2%)	24(8.4%)	21(7.4%)	3.51	1.057
SM2	FTs	40(18.9%)	76(35.8%)	59(27.8%)	25(11.8%)	12(5.7%)	3.50	1.099
	ETs	48(16.8%)	126(44.2%)	66(23.2%)	27(9.5%)	18(6.3%)	3.56	1.075
SM3	FTs	50(23.6%)	70(33%)	50(23.6%)	27(12.7%)	15(7.1%)	3.53	1.186
	ETs	42(14.7%)	114(40%)	84(29.5%)	27(9.5%)	18(6.3%)	3.47	1.057
SM4	FTs	48(22.6%)	81(38.2%)	42(19.8%)	27(12.7%)	14(6.6%)	3.58	1.164
	ETs	42(14.7%)	144(50.5%)	60(21.1%)	21(7.4%)	18(6.3%)	3.60	1.032
SM5	FTs	41(19.3%)	83(39.2%)	45(21.2%)	28(13.2%)	15(7.1%)	3.50	1.154
	ETs	42(14.7%)	120(42.1%)	81(28.4%)	21(7.4%)	21(7.4%)	3.49	1.067
SM6	FTs	51(24.1%)	74(34.9%)	43(20.3%)	30(14.2%)	14(6.6%)	3.56	1.189
	ETs	39(13.7%)	144(50.5%)	69(24.2%)	15(5.3%)	18(6.3%)	3.60	1.001

In the context of social motivations, the findings (see table 12) indicated that, the most relevant factors according to the FTs' group are, to meet new and different people (4.58), to be socially competent and skillful (3.56), and to build friendships with others (3.55). Further, according to the ETs' group, to meet new and different people (3.60), to be socially competent and skillful (3.60), and to interact with others (3.56) are the factors that drive them to engage in astronomy activities and events.

Table (13) Differences in (AAE, IFM, SAM, CMM, and SM) between Foreign Tourists and Egyptian Tourists

Variables	Sample	Mean	SD	T value	p
AAE	FTs	19.18	4.095	3.483	0.001*
	ETs	18.00	3.223		
IFM	FTs	26.96	5.478	-1.110	0.267
	ETs	27.52	5.712		
SAM	FTs	22.84	5.383	1.628	0.104
	ETs	22.05	5.375		
CMM	FTs	17.21	4.779	-1.222	0.222
	ETs	17.74	4.754		
SM	FTs	21.32	5.658	0.289	0.773
	ETs	21.16	5.842		

(*) Statistically significant results at (0.05)

As declared in Table (13), the t-test results indicated that there is a significant difference between FTs and ETs in their attitude towards astronomy tourism in Egypt (T value= 3.483; p= 0.001). Yet, there is no significant difference between FTs and ETs in their motivations (IFM, SAM, CMM, SM) to be engaged in astronomy tourism activities and events (p>0.5).

Table (14) Simple Linear Regression Analysis

	Attitude (AAE)		
	R square	F	Sig.
Intellectual Factors Motivations (IFM)	.241	158.167	.000
Stimulus Avoidance Motivations (SAM)	.173	104.495	.000
Competency Mastery Motivations (CMM)	.066	35.772	.000
Social Motivations (SM)	.103	57.837	.000

To test the proposed hypotheses, the study performed simple linear regression analysis of the four motivational factors on the tourists' attitude towards astronomy tourism in Egypt. Results in table (14) show that the four motivations have significant positive effect on the tourists' attitude towards astronomy tourism in Egypt. Intellectual factors motivation affects the tourists' attitude toward astronomy tourism in Egypt with (24.1%), followed by stimulus avoidance motivations with (17.3%), then social motivations with (10.3%), and finally the competency mastery motivations with (6.6%). Moreover, the results indicate that the intellectual factors motivations have the highest effect followed by the stimulus avoidance motivations, social motivations and competency mastery motivations. Based on the previous results the four hypothesis of the study are supported.

Discussion

The study aims at giving insight into terrestrial astronomy tourism in Egypt; exploring it's current practices and the ongoing construction; explore the group culture of astronomy tourists, their behaviors and individual travel experience; which kind of terrestrial astronomy tourism do they prefer; and the current situation and the prospects for the future development of this new trend in Egypt**.**

The findings revealed that astronomical observation are usually engaged with the safari programs, however, sometimes it could be organized in a specialized program that is only limited to a full tour to observe astronomical events. Further, tourists who were engaged in such activities and events were very satisfied.

According to the most preferred and frequently practiced astronomy tourism category in Egypt, the results illustrated that according to FTs, the most attended astronomical events in Egypt are stargazing and watching the sun alignment on Abu Simble temple. However, according to ETs, they attend lots of astronomical events in Egypt such as observing the solar and lunar eclipses, stargazing and watching the sun alignment on Abu Simble temple. The difference between FTs and ETs might be due to the preference and availability of each event to the tourists, i.e., regarding the FTs, according to the stargazing; it is usually a part of the safari programs which they prefer to participate in. Further, there are lots of tourists who come specially to watch such phenomena on Abu Simble Temple. Regarding the ETs, it is easy to frequently drive to the desert where there is no light pollution to watch Solar and lunar eclipses rather than travelling to Luxor to watch the

sun alignment on Abu Simble Temple, unless they are living near to Luxor.

Noteworthy that, Wadi Al-Hitan, the White desert and desert in Sharm ElSheikh are the most popular and best places for astronomical observations in Egypt which could be seen either with naked eyes or with the telescopes, depending on the site, time, and phenomenon, such as Orion nebula, and Andromeda galaxy, meteor showers (the Geminids, Orionids, and Leonids), solar and lunar eclipses. Moreover, Al-Kottamia observatory plays an important role for both tourists and researchers with regard to astronomy and astronomical observations.

Regarding the astronomical awareness, the findings revealed the lack of awareness about astronomy tourism in Egypt, consequently, raising the awareness about the astronomical activities and events in Egypt is necessary. Astronomy societies and initiatives in Egypt are doing great efforts in this discipline, yet, stakeholders in Egypt should pay more attention to highlight such astronomical activities and events nationally and internationally.

With regard to the attitudes towards astronomy tourism in Egypt, the majority of FTs and ETs strongly agreed and agreed that they would like to discover the astronomical phenomena in Egypt. Therefore, such phenomena should gain more promotional and advertising campaigns at appropriate time before its occurrence. Besides, they also agreed to add astronomy activities and events to their Programs in Egypt, thus, tour operators in Egypt should pay more attention to engage such astronomical activities and events in their national and international tourists' programs. Generally, it could be said that attitudes towards astronomy tourism in Egypt is high, as tourists show their willingness

to explore, participate and practice different astronomical activities and events in Egypt, which in turn will enhance the development and promotion of this niche in Egypt in the future.

Furthermore, t-test results indicated that there is a significant difference between FTs and ETs in their attitude towards astronomy tourism in Egypt where FTs are more interested to participate and explore more astronomical activities and events in Egypt than ETs. It is noteworthy that according to the responses of FTs group in this study, they need to explore more about astronomy tourism in Egypt as they only participated in limited categories of astronomy tourism activities before (Stargazing and Solar alignment in Abu Simble temple). However, according to ETs group, In spite of the low frequency in practicing astronomical events, the practiced ones were different and varied (star, comets, planets gazing, solar and lunar eclipses, Solar alignment in Abu Simble temple). Yet, there is no significant difference between FTs and ETs in their motivations (IFM, SAM, CMM, SM) to be engaged in astronomy tourism activities and events.

In terms of the factors that motivate tourists to participate and practice different astronomical activities and events, the results illustrate that intellectual factors motivations have the highest effect on the tourists' attitude towards astronomy tourism in Egypt. Accordingly, tour operators and stakeholders in Egypt should take care within their advertising and promotional campaigns to target the four motivational factors in order to encourage tourists to engage in astronomical activities and events in Egypt. The results of the current study in this point is compared with the results of Matos' study (Matos, 2017) who applied the

(LMS) to assess the most influential factors that draw tourists to astronomy activities and events. Although the results of the current study in this point agrees with the results of Matos' quantitative method (survey) in his study, it contradicts the results of his qualitative method (interviews) in the same study, where his interviewees are highly motivated by the social factors. The difference in the results could be explained due to the difference between the two methods (quantitative and qualitative) used in each study, and the difference between people in their motivations and satisfaction with different things.

In the context of astronomy tourist potentials in Egypt, the results confirmed that Egypt has lots of resources (historical, natural, manpower, institutes, observatories and planetariums) that qualify it to be added to the map of astronomy tourism countries worldwide. However, the most prominent challenges facing astronomy tourism in Egypt are: the high cost of establishing observatories; the lack of astronomical awareness; banning the entry of telescopes inside the country by the security authorities; and the lack of safety in some places far from light pollution.

Furthermore, terrestrial astronomy tourism is noted to be a low-cost tourism, which enhances the idea of developing it on a large scale. Nevertheless, it releases high income to the countries as the astronomical tourist spends a lot, which is approximately 10 to 15 times the normal tourist, and after the Covid-19 pandemic, destinations will try to invite those interested in astronomical tourism worldwide. Although, astronomy tourism sometimes needs a set of giant telescopes, it costs less if compared with the expenses of building hotels and resorts.

Conclusion

Astronomy tourism as a new trend is already alive in Egypt, it just needs more attention from the tour operators and the Ministry of Tourism and Antiquities in Egypt to carry out professional advertising and promotional campaigns, and start putting Egypt on the map of astronomical tourism. It will resonate globally to discover another side of Egypt that is fertile with many attractions. Egypt has infinite potentials to develop Astronomy tourism; Egypt owns sufficient natural and human resources with an interesting history. Based on that, it can offer to astro-tourists original programs whose carrier should be astronomical societies in collaboration with the astronomical observatories and tour operators in Egypt. Programs involving astronomical resources coupled with interesting histories, and other attractions can involve an active astro-tourist. In other words, targeting the sky features of a destination combined with the earth facilities to attract tourists is one of the new opportunities to deliver unique tourism products.

Recommendations

Management of the current facilities and innovation of new ones is crucial to the development of astronomy tourism in Egypt, because it is expected from the destination managers to promote their facilities and design them with the tourist offer to Astro-tourists who are travelling to satisfy their need for knowledge and experiences related to astronomy.

Recommendation to Tour Operators

- Publish a booklet about Egypt in order to make the astronomical sites widely known to the public and help attract tourists.

- Launch wide promotional and advertising campaigns for astronomy tourism in Egypt, highlighting its sites, activities and events that could be held.

- Create dedicated websites to serve as working environments between tour operators and astronomical sites for developing and providing useful information about astronomy tours and packages.

- Conduct astronomy activities in some hotels in Egypt similar to hotels in Finland, Switzerland, Virginia, and Namibia. During the nighttime, the hotel guests will see how to use star-charts and almanacs to observe the stars and constellations. Moreover, they can see the amazing celestial objects using telescopes or naked eyes.

- Promote the idea of a one-day or multi-days observation trip to observe the starry sky with the naked eye or with a telescope.

- Special events to observe the lunar eclipses, meteor showers, lunar occultation of planets, comets, etc., should be held widely to attract a large number of audiences.

- Design an appropriate individual astro-tourist program that should include visits to temples in which all kinds of alignments take place; i.e. temples that contain astronomical scenes (such as Dandara, Esna, Philae, Kom Ombo); tombs that contain astronomical scenes, either private or royal tombs; museums that contain time-measuring tools in ancient Egypt (such as the Egyptian Museum at Cairo, the Nubia Museum in Aswan, and the Luxor Museum), as well as the coffins with astronomical scenes; star observing sites in the Egyptian desert.

Recommendation to Astronomical Societies and Stakeholders

- Increase the awareness about astronomy tourism in Egypt. Members of the astronomical societies with the collaboration of the astronomical communities in Egypt can invite community's schools, colleges, residential areas, and public places to give talks, conduct solar observation sessions, stargazing sessions and planetarium shows.

- Encourage, support the astronomy initiatives, and make cooperation between them and the astronomy societies in Egypt.

- Coordinating a cooperation protocol between the Syndicate of Tourist Guides and the National Research Institute of Astronomy and Geophysics to organize training courses for tour guides to raise their awareness of about astronomy tourism and astronomy, as well as to enhance their ability in explaining the astronomical scenes on the wall and ceilings of the Egyptian tombs, temples, and sarcophagi, the archaeoastronomical phenomena, and other different aspects of astronomy. Besides their knowledge about the Egyptian astronomical monuments, they should be trained to know more about the principles of sky observation to enhance their profession. For example, they must get to know that Abu Simbel temple area is far from light pollution and therefore, it is a special place to observe the stars very clearly. Astronomically well-trained tour guide can add more advantages to the tourist program by specifying a place where the astronomical monument and the appropriate atmosphere for observing meet.

- Create Astronomy Mobile Application for Egypt, which will help tourists to better prepare for the weather, and find out when key astronomical events are taking place.

- Pay more attention to the astronomy sites and the surrounded environment, as astronomy tourism is considered one of the tourism patterns that preserve the environment and enhance the concept of sustainable tourism.
- Providing the astronomical sites' designated for observing the stars and the night sky with tents like space capsules, and making the ceiling transparent, from which you audience see the sky and the stars, such as the area of Wadi Ram in Jordan.
- Try to fulfill the requirements of Foundation Stars and IDA in the astronomical sites in Egypt in order to be accredited by these organizations, which in turn will help to put Egypt on the global astronomy tourism map.
- Build new observatories in certain sites in Egypt.
- Reopen the closed planetariums in Cairo.

Research Limitations and Further Studies

One of the Limitations of this research is the lack of specialized references in astronomy tourism in Egypt; therefore, some data were gathered through documented websites, social media platforms, interviews and the questionnaire. This research illustrates the first steps of a research work within a new niche of tourism in Egypt. Despite little theoretical background within astrotourism, this research hopes to make way for further research and future development of the niche. Further studies can design and assess a proposal of a specialized tourist program, whose dominant feature is the astronomical activities and events in Egypt. Other studies can evaluate the readiness of certain astronomical observation sites in Egypt and the potentials of their development.

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Appendixes

Appendix A

FTs Foreign Tourists
ETs Egyptian Tourists

Appendix B

AAE1 I have good idea about the astronomy activities/ events that exist in Egypt.
AAE2 I would like to discover such phenomena in Egypt.
AAE3 I would like to participate in astronomical observations in Egypt.
AAE4 I would like to watch certain archaeoastronomical phenomena in historical sites in Egypt, such as watching the Abu Simbel Solar Alignment.
AAE5 I would like to add these activities related to the astronomy phenomena to my Program in Egypt.

Appendix C

IFM1 To learn about things around me.
IFM2 To satisfy my curiosity.
IFM3 To explore new ideas.
IFM4 To expand my knowledge.
IFM5 To discover new things.
IFM6 To be creative.
IFM7 To use my imagination.

Appendix D

SAM1 Because I sometimes like to be alone.
SAM2 To relax physically.
SAM3 To relax mentally.
SAM4 To avoid the hustle and bustle of daily activities.
SAM5 To relieve stress and tension.
SAM6 To unstructured my time.

Appendix E

CMM1 To gain a feeling of belonging.
CMM2 To gain other's respect.
CMM3 To challenge and improve my abilities.
CMM4 To improve my skill and my ability in doing it.
CMM5 To be active.

Appendix F

SM1 To build friendships with others.
SM2 To interact with others.
SM3 To develop close friendships.
SM4 To meet new and different people.
SM5 To reveal my thoughts, feelings, or physical skills to others.
SM6 To be socially competent and skillful.

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