Sharjah Investment in the UAE Space Sector

Ilias M. Fernini
Applied Physics and Astronomy Department, University of Sharjah, POB 27272, Sharjah, United Arab Emirates

ifar@sharjah.ac.ae

Abstract. With the newly opened “Sharjah Center for Astronomy and Space Sciences,” the United Arab Emirates has entered a new age in space sciences exploration and research. The center has a state of the art digital planetarium, an astronomical observatory, and several research laboratories, i.e., “GIS and Remote Sensing Center,” “CubeSat Laboratory,” “Ionospheric Laboratory,” “Radio Astronomy Laboratory,” and a “Meteorite Center.” This paper will highlight the center and discusses its objectives in terms of public outreach and the advance of space sciences in the UAE.

1. Introduction
By announcing the institution of a space agency in 2014, the United Arab Emirates has entered a new age of excellence and uniqueness in the Arab world: the space exploration race. Its 2020 unmanned mission to Mars, the Emirates Mars Hope Mission, has opened the door and given a chance to hundreds of young Emiratis to excel in the field of space engineering as well as space sciences. To ensure that the UAE new space program is not just an advertisement program, the UAE Space Agency has set four main objectives: (1) to organize and develop the UAE space sector; (2) to promote and support the efforts of scientific research and innovation; (3) to attract and prepare national cadres to become pioneers in the field of space science; and (4) to focus on ensuring that all the Agency’s services are in accordance with worldwide quality, efficiency and transparency standards. These objectives are helping both the educational and the industrial sector in the UAE to set their priorities to be an integral part of the space program and to fulfill the UAE Space Agency goals.

The United Arab Emirates is home to tens of government and private universities as well as several research centers that form the educational core. The Emirate of Sharjah is one of the seven Emirates of the UAE and Sharjah city is known as the cultural capital of the UAE. Besides its various cultural centers, the University of Sharjah (UoS) and the Sharjah Center for Astronomy and Space Sciences (SCASS) represent the main centers of education in Sharjah. UoS is one the largest university in the UAE with more than 16,000 students spread all over its many branches across the Emirate. Hundreds of degrees in various fields are offered, and both astronomy and space sciences represent an integral part of the university program. A Bachelor degree in Applied Physics and Astronomy is offered, and an MSc program in Astronomy and Space Sciences is under process as a unique program of its kind in the UAE.

The Sharjah Center for Astronomy and Space Sciences (SCASS) is one of the main research centers established to reinforce the university new space sciences program. Established in 2015, its
vision is to be a national center working in the areas of astronomy and space sciences. Figure 1 shows the overall structure of the center. One of its main aims is to develop and promote education about these fields in the Arab World in general, and the UAE in particular. It is striving to be a center dedicated to education, science, research, Islamic heritage, and open to educators, school students, university students, researchers and families of all ages. The center holds tens of workshops for students as well as for professionals at all levels the whole year long. It had the privilege to receive the visit of many dignitaries, presidents, ambassadors, famous scientists, astronauts and paramount space agencies directors.

Figure 1. A general organigram of the Sharjah Center for Astronomy and Space Sciences showing its overall structure.

Figure 2. (Left) A Google aerial view of the Sharjah Center for Astronomy and Space Sciences; (Right) The main building hosting the planetarium (golden dome), the space exhibitions, and the
research laboratories. The whole center resembles a small-scale solar system with the Sun represented by the golden dome, and the planets making a nice cosmic garden around.

The center has many attractions, most important of which are the planetarium theater, the different exhibitions halls (Astronomy Exhibition, Space Exhibition, Exhibition of the Universe in the Holy Qur'an), the astronomical observatory, the Cosmic Garden, and five research laboratories (Figures (2-5)).

Figure 3. A scale model of Saturn (largest scale in the world) and the Lunar Module are part of the Cosmic Garden.

2. The Sharjah Planetarium and Space Exhibitions
The planetarium serves as an educational outreach tool to bring the universe closer to the public and to build in the young generation a sense of wonder and love of knowledge. More than two hundred space enthusiasts can comfortably sit under the planetarium dome of more than eighteen meters in diameter. The planetarium is equipped with a set of high-precision digital projectors in addition to a very advanced MegaStar projector that can display nearly 10 million celestial bodies. Other classical projectors add to the show the motion of the planets as they sway gracefully around the Sun in a wonderful astronomical rhythm. A very advanced Uniview software gives the final touch to living a space adventure which is unlike any other adventure anyone has experienced before. From the planetarium seat, the journey begins, and the cosmos becomes a matter of imagination and wonder. All of the thousands of stars, galaxies, and clusters of galaxies are just a couple of steps ahead before reaching the ultimately visible edge of the Universe. It is a journey in space, unlike any other journey. It is a journey to open the minds and to let anyone wonder about the overall order of space and to seek more and more. The several space science experiments that fill the exhibition halls add more to this adventure and journey.
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Figure 4. The interior of the Sharjah Planetarium with a maximum seating capacity of 200 visitors.

Figure 5. More than 30 scientific experiments make the space exhibition halls the largest in the world.

3. The Sharjah Observatory
The SCASS observatory (Figure 6) is primarily used for teaching observational astronomy, public education in astronomy, and modest students research projects. It is equipped with three telescopes: (1) 17” (450 mm) / f6.8 Corrected Dall-Kirkham reflector which is suitable for deep sky observation and astrography; (2) 180 mm / f7 triplet fluorite apochromatic refractor which is mainly used for planetary observation and white light solar observation; and a 105 mm / f5.2 triplet ED apochromatic refractor, primarily used for Hα solar observations. These three primary instruments are mounted on a German Equatorial Mount. The whole telescopic system resides inside an observatory dome with dust proof sealing. Other instruments are also connected to the system like the SBIG STX16803 CCD camera and an Echelle Compact Spectrograph (BACHES).
Figure 6. (Left) The building hosting the astronomical observatory; (Right) The three main telescopes of the observatory: 45 cm (deep sky objects), 18 cm (Moon and planetary observations), and 10 cm for solar observations.

The observatory system is unique in the quality of the lenses used and the high-quality of the mirrors. It is connected to an electronic control network that posts the acquired data on the Internet to enable users to use the telescope from anywhere in the world. Academically, the observatory plays a significant role in teaching astronomy and astrophysics to the University of Sharjah students who are rapidly increasing in numbers every semester. UoS students carry several ongoing projects at the Applied Physics and Astronomy Department. From observing binary stars systems to using sunspots to determine the Sun’s rotation, students will have to spend several nights at the observatory to take their data and then must write a small research paper presenting their findings.

Enthusiasts and the general public also have a share in the sky as there are two specific open houses every month designated for public viewing. Famous astronomical events such as lunar and solar eclipses are broadcast to the whole University community as well as to the public through different social media.

The observatory also serves the religious community regarding observing the crescent Moon to set the start of the Islamic months. Telescopic Observations are conducted every month, following the new Moon, to spot the tiny crescent to mark the beginning of a new month. This is especially important for the start of Ramadhan (9th month) and Dhu’l Hijjah (12th month), for fasting and pilgrimage, respectively.

4. The Research Laboratories

Research is a critical component of the Sharjah Center for Astronomy and Space Sciences. With the help of the University of Sharjah scientific community, the center is running five main research laboratories, namely: (1) "GIS and Remote Sensing Center"; (2) "Meteorite Center"; (3) "Radio Astronomy Laboratory"; (4) "Ionospheric Laboratory"; and (5) "CubeSat Laboratory." These laboratories are mainly research centers with researchers and university students working on various projects. Table 1 reports the different research themes as well as the different funding agencies that support SCASS, namely, the UAE Space Agency, Mohamed Bin Rashed Space Center, and the University of Sharjah.

There are plans to build a CubeSat to perform space sciences experiments within our atmosphere. A CubeSat is a 10 x 10 x 10 centimeters satellite that can be sent into space at a much lower cost than
a large satellite. The College of Engineering and the College of Sciences at the University of Sharjah are the two colleges mainly involved in this exciting project.

| No. | Research Field                  | Number Faculty | Number Students | Duration (years) | Amount (US$) | Funding Agency                     |
|-----|---------------------------------|----------------|-----------------|------------------|--------------|-----------------------------------|
| 1   | Ionospheric                    | 5              | 12              | 2                | 730,000      | UAE Space Agency                  |
| 2   | UAE Meteor Monitoring           | 7              | 10              | 3                | 432,000      | UAE Space Agency                  |
| 3   | GIS and Remote Sensing          | 4              | 6               | 3                | 200,000      | University of Sharjah             |
| 4   | Martian Atmosphere             | 1              | 4               | 1.5              | 126,000      | Mohamed Bin Rashed Space Center   |
| 5   | Decametric Radio Telescope      | 4              | 4               | 2                | 118,000      | UAE Space Agency                  |
| 6   | AGN/Quasars/ Radio Galaxies     | 1              | 2               | 1.5              | 11,000       | University of Sharjah             |
| 7   | CubeSat                        | 9              | 45              | 3                | 2,500,000    | University of Sharjah             |

There is also a plan to contribute on a large scale to the UAE Space Agency program by building a (30-70) meters radio dish to conduct research in radio astronomy and for the dish to serve in the Deep-Space-Network to communicate with the Emirates Mars Mission probe 'Hope.' Radio astronomy is important in the study of the Universe, especially in studying those objects that emit most of their light in radio. The dish will be linked to the worldwide VLBI network for higher resolution observations.

The “Geographical Information System and Remote Sensing Center” is to be a major center for local/regional planning. The information obtained can be used to determine the land capability for rural planning by mapping information about soils, agriculture, industry, recreation, and future city land developments. The GIS and RS center will help local/regional UAE authorities to make decisions based upon geographical information.

The main aim of the “Meteorite Center” is to perform research on meteorites collected mainly in the Arabian Peninsula, as well as other samples collected in the African sub-Sahara. The center will bring some multi-disciplinary UoS researchers and students to study these meteorites using a variety of instruments like X-Ray Fluorescence, X-Ray Diffraction, Scanning Electron Microscopy, Electron Spin Resonance, Mossbauer Spectroscopy, Nuclear magnetic resonance and optical microscopy.

SCASS is also establishing an "Ionospheric Research Laboratory" to study the effect of the Sun's solar wind on Earth's atmosphere as part of space weather monitoring of the Sun. Given the long-term UAE goal of achieving excellence in space technology, it would be crucial that some ionospheric monitoring stations including very low frequency, high frequency (ionosonde) and ultra-high frequency (GNSS receivers) be established all over UAE. These ionospheric stations may prove to be the cornerstones in developing UAE future space missions such as a regional navigation satellite system. The ionospheric laboratory at SCASS will pave the way for this new era of research in this region. The state-of-the-art ionospheric laboratory will permit the installation of ionospheric monitoring radio systems in all frequency ranges including VLF, HF, and UHF.

5. Conclusion
The University of Sharjah with all of its astronomy and space sciences research program along with the Sharjah Center for Astronomy and Space Sciences are two institutions that are to play a major role in fulfilling the main objectives of the UAE Space Agency. In light of the vision of His Highness Dr. Sheikh Sultan Bin Mohammed Al Qasimi, Supreme Council Member, Ruler of Sharjah and President of the University of Sharjah, both UoS and SCASS are moving forward in the pursuit of introducing space technologies to the UAE in general, and to Sharjah, in particular. With the guidance of HE Prof. Hamid Al Naimiy, Chancellor of the University of Sharjah and Director of the Sharjah Center for Astronomy and Space Sciences, both institutions are also moving forward to achieve the highest national, and international recognition for their role in introducing space sciences as a major field of research in the UAE. The United Arab Emirates as a whole and Sharjah, in particular, are setting the steps to build a bright future for generations to come in space-related programs that many countries worldwide would strive to imitate.