

Science and Education Portfolio for UAE Long-Duration Astronaut Mission 2023

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Abstract

An Emirati astronaut will undergo a 6 months duration mission to the International Space Station (ISS) as part of the SpaceX Crew-6 mission scheduled to commence from Florida Kennedy Space Center in the first half of 2023. This will be the UAE's second space mission and the first long-duration mission. The first was in 2019 when Hazzaa Al Mansoori conducted an eight-day trip to the orbiting laboratory on a Soyuz rocket.

There are several scientific projects collaborated with different universities and space agencies to ensure that the astronaut candidate participates in conducting scientific experiments in ISS. Experiments will be conducted in both the ISS and on the ground across different fields of research, such as agricultural science, programming, artificial intelligence, human health, water and food resources. Further collaborations are also planned that will provide great opportunities for students to be exposed to practical experiences that is insightful and inspire the next generation of scientists and astronauts. This presentation will focus on sharing the science portfolio for UAE Astronaut part of Crew-6 mission and the initiatives, outreach and educational science events that are going to be launched as part of this mission in 2023.

Acronyms/Abbreviations (Below to be arranged in Alphabetical order)

ISS: International Space Station
MBRSC: Mohammed Bin Rashid Space Centre
UAE AP: UAE Astronaut Program
CSA: Canadian Space Agency
CNES: Centre National d'Études Spatiales
ESA: European Space Agency
ISS: International Space Station
JAXA: Japan Aerospace Exploration Agency
NASA: National Aeronautics and Space Administration
RSLV: Reusable Suborbital Launch Vehicle
STEM: Science, Technology, Engineering and Mathematics

1. Introduction

In April 2017, His Highness Sheikh Mohammed Bin Rashid Al Maktoum, Vice President and Prime Minister of the UAE and Ruler of Dubai, and His Highness Sheikh Mohammed Bin Zayed Al Nahyan, Crown Prince of Abu Dhabi and Deputy Supreme Commander of the UAE Armed Forces, announced the establishment of the UAE National Space Programme and the launch of the UAE Astronaut Programme. The UAE Astronaut Programme (UAE AP) is managed by Mohammed Bin Rashid Space Centre (MBRSC), and is the first integrated programme in the Arab region to prepare national cadres to contribute in scientific exploration space flight missions, and to promote the culture of research, passion for beyond Low Earth Orbit (LEO) exploration, and innovation among UAE's science community.

After the successful completion of the historic mission of Hazza AlMansoori, the first UAE Astronaut, The UAE has secured a six-month mission to the International Space Station for the second UAE astronaut Sultan AlNeyadi through Axiom Space’s SpaceX rocket. The launch for the mission is planned in February 2023, and the astronaut will be part of SpaceX Crew-6 and will take off from the Kennedy Space Centre in Florida. During the mission, the UAE Astronaut Sultan AlNeyadi will conduct numerous in-depth and advanced scientific experiments and outreach, which will be done in a collaboration with NASA, CSA, ESA, JAXA and CNES as well as conducting scientific experiments from UAE local universities.

2. Leveraging Spaceflight to Advance Research on Earth

There will be over 15 scientific experiments that will be conducted during the mission. The studies will address numerous topics across various fields such as:

- Cardiovascular System: the study of the cardiovascular system in microgravity provides new insight on development of counter measures to protect astronaut health, and help improve cardiovascular health on Earth [1].
- Epigenetic: The studies help pinpoint the countermeasures that could be used to make medication [2].
- Fluid science: Analyzing the way fluids react with microgravity helps in the industrial application of fluid science, particularly in the way that fluid would react in spacecraft and machines used in space [3].
- Plant Biology: Examining plants at the molecular level can shed light on potential ways that food can be produced in the ISS as well as having a deeper level of understanding on how plants could adapt to new environments. The practical implementation of this knowledge can result in increased production and productivity in farming and agriculture. [4].
- Material science: The experiments conducted in microgravity environment on material properties can help industrial development on Earth for more durable and more efficient material production. [5].
- Radiation: The major health risk facing astronauts in long-term missions is the high level of radiation exposure. The radiation levels in space are significantly higher than on earth, making it crucial to be understood its impact on the assets in space and the health of those on board the ISS. Predicting and calculating space radiation allows for better of planning future space missions and ensuring the health and safety of the astronauts [6].
- Technical Demonstration: Conducting technical demonstration on the ISS provides valuable information on the applicability of theories and helps in understanding methods to enhance the performance, functionality and longevity of the space platforms [7].
- Protein Crystal Growth: Space-grown protein crystals are often of higher quality The improved quality of these crystals can then be used to study the structure of proteins and their interactions with molecules, which is important for drug design and new findings in Biology.

3. UAE AP Research Grant Program

The UAE AP Research Grant Program provides Research Grants to UAE science community to propose science or technology-driven projects to be conducted on the International Space Station (ISS) in a specific field. The program aims to:

- Further humanity’s knowledge and support future human exploration missions beyond Low Earth Orbit (LEO).
- Develop scientific foundations for the space science and research sector to qualify new generations of scientists.
- Serve strategic goal of the UAE vision of developing new generation of scientists and moving toward knowledge-based economy.
- Encourage students and faculty to pursue space-related research.

The 2020 Call for Scientific Proposal focused on the following fields:

- **Earth and Space Science**

The field of Earth and Space Science research done on the ISS mainly focuses on testing technologies and materials that will be vital for long-duration exploration missions or collecting Earth and space science related data from an altitude of 400 km to provide comprehensive information when compared with data from Earth satellites or ground-based observatories.

- **Human Health**

The field of Human Health research done on the ISS focuses on improving astronaut health and performance, development of countermeasures, as well as development and validation of new technologies to meet the needs of future exploration missions, and to enable safe and productive human space exploration.

As part of the UAE AP’s 2020 call, two research projects under Human Health Sciences track from Mohammed Bin Rashid University of Medicine and Health Sciences were funded. The first project focuses on studying human physiology in microgravity and normal gravity, while the second project investigates dental stem cells in a simulated microgravity environment and compares it to normal gravity.

The funded projects ensure the involvement of UAE national and non-national researchers/students in the projects for building capability and ensuring long-term knowledge transfer to the country, as well as the involvement of an MBRSC Space Science Researcher in one of the project’s research team to enable knowledge transfer to the center.

3. Educational and outreach Plan:

The International Space Station (ISS) is an invaluable platform for educational outreach. The educational and outreach plan for the UAE participation in the Crew-6 mission leverages the International Space Station to increase engagement in Science, Technology, Engineering and Mathematics (STEM) fields in the United Arab Emirates (UAE).



Figure 1: UAE science community meeting in the International Space Life Science open day workshop

The educational plan for the mission aims to contribute to:

- Develop knowledge-based economy in the UAE,
- Promote STEM education in the UAE,
- Advance science literacy nationwide,
- Empower educators to inspire students and actively engage students, educators, the science community and the general public through a variety of outreach and educational efforts.

The plan includes various activities and initiatives including MBRSC Learning Hub, In-Flight STEM Demonstrations, Teacher Development opportunities, a variety of workshops and research opportunities. Moreover, there will be opportunities for university students to participate in competitions that are linked with activities on the ISS.

Some of the initiatives under the educational and outreach plan is listed below:

3.1 Science Community Engagement:

MBRSC Learning Hub:

An educational website that uses space as a pedagogical tool for students and educators. The platform provides accessible space science resources to encourage the young generation to be increasingly involved in STEM education in the United Arab Emirates. The hub aims to inspire the next generation and spark interest in space science. The MBRSC Learning Hub targets a wide range of age groups, from K-12 to university level learners. Additionally, educators will be able to use the resources available to enhance the learning experience in classrooms and provide sources that can be integrated into the curriculum. The Learning Hub will provide detailed information of Sultan AlNeyadi's six-months mission to the ISS, focusing on scientific experiments and other aspects of the mission.

3.2 In-Flight STEM Demonstrations:

In partnership with NASA, Astronaut Sultan will conduct STEM demonstrations, in both Arabic and English, on the space station. The demonstrations are educational videos to demonstrate the unique microgravity environment. The demonstrations are prepared by former educators using NASA approved vocabulary to target a specific age group. The scientific demonstrations Astronaut Sultan AlNeyadi will be illustrating on the ISS are Centripetal Force, Photosynthesis and Chemical and Physical Change. In addition to the educational videos, each demonstration will have a corresponding Classroom Connection Teacher Plan. The selected educational demonstration engages students and educators across multiple grade levels, The Centripetal Force and Photosynthesis demonstrations target grades 9-12. As for the Chemical and Physical Change demonstration, it targets a younger audience, specifically grades 5-8.

3.3 Variety of Workshops:

A variety of hands-on workshops will be developed to engage the youth in space education and advance quality of learning in the UAE. The workshops are designed for both school level and university level students. The interactive

workshops cover a wide range of topics in the field of space life science, including Microorganisms in Space and Effects of spaceflight on Human Health.

3.4 Teacher Development Program

To deliver high-quality education in the UAE, teacher development opportunities will be developed including workshops and online resources. This initiative aims to utilize Astronaut Sultan AlNeyadi's mission to the ISS to equip school instructors with the tools to empower the next generation and increase interest in STEM fields.

3.4 Science Data Accessibility:

With the mission being a 6-month duration, the plan is to involve the science community to be able to utilize the data from the scientific studies as well as to provide opportunities for the local universities and entities to participate. Accessibility to mission data will be available and archived after the mission is completed in a platform hosted by MBRSC. The UAE science community will be introduced to the mission's science program and the involvement opportunities throughout the mission duration and beyond

4. Conclusion

The Crew 6 mission will provide an opportunity for the country to enhance its local knowledge and expertise in space exploration and in science experiments. It is also a very valuable opportunity for the UAE to enhance its integration and cooperation with other space agencies to work together in the future.

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