RESEARCH OVERVIEW
'Galactic 07' Mission

- *'Galactic 07'* is Virgin Galactic's seventh spaceflight carrying microgravity research and third since it entered commercial operations last year.
- The suborbital spaceflight will include one Turkish Space Agency (TUA) astronaut and Axiom Mission 3 (Ax-3) Backup Mission Specialist, Tuva Atasever, who is flying with three wearable payloads. In addition, Purdue University and the University of California, Berkeley will have two rack-mounted autonomous payloads onboard through support from NASA's Flight Opportunities program.
- In addition to Tuva's wearable payloads, he will also participate in four human physiology research investigations carried out by Turkish researchers.
- Tuva's experiments will further demonstrate the value of suborbital missions as a training platform and research testbed for orbital missions.
- Purdue University's experiment is designed to study propellant slosh for spacecraft propulsion applications.
- UC Berkeley's payload will 3D print and post-process parts manufactured while in microgravity.
- The flexible nature of Virgin Galactic's commercial business model and spaceship design enables it to fly U.S. and international partners alongside industry customers and academia.

RESEARCHER

TUVA ATASEVER
ASTRONAUT 027

TUVA ATASEVER is an aerospace and technology professional, who was competitively selected to be one of the first two Turkish astronauts as a part of TUA's first-ever astronaut selection campaign. After completing his master's degree in photonics at the University of California, Irvine, Tuva founded two virtual reality startups, Blue Dot VR and HyperSight, Inc. He then worked for ROKETSAN, Inc., a leading Turkish aerospace company, as an avionics systems engineer on the Micro Satellite Launch Vehicle (MSLV), Türkiye's first orbital launch vehicle. He also served as the payload integration manager for ROKETSAN's Space Sounding Rocket (SSR), Türkiye's first domestic launch vehicle. After more than a year of astronaut training with Axiom Space, Tuva was honored to serve as the Ax-3 Backup Mission Specialist for the historic all-European commercial astronaut mission to the International Space Station (ISS).

EXPERIMENT DETAILS

AXIOM SPACE
Tuva's flight is contracted through Axiom Space, the Houston-based company building the world's first commercial space station. Tuva will fly three human-tended experiments from Türkiye and the U.S. and participate in four Turkish physiological research investigations. Three of the Turkish physiological research investigations were also conducted as part of the Ax-3 mission.

TUA's experiments include:

- Testing a smart and active personal dosimeter developed by two Turkish universities and adapted for spaceflight.
- Studying multiple aspects of human performance and physiology during all phases of suborbital spaceflight using a physiological monitoring system.
- Examining the ability to administer accurate doses from insulin pens in microgravity.
- Investigating the effects of suborbital spaceflight in gene expressions and their impact on the immune system response against cancer.
- Identifying the metabolic and transcriptomic changes that occur as a result of a suborbital spaceflight.
- Analyzing the effect of microgravity and radiation exposure on the concentration of myeloid derived suppressor cells within peripheral blood.
- Isolating and analyzing extracellular vesicles after suborbital spaceflight to further investigate the potential of exosome therapies for future astronauts.

Middle East Technical University The Research and Application Center for Space and Accelerator Technologies (METU IVMER) – IvmeRad

Principal Investigator: Prof. Dr. M. Bilge Demirköz, Middle East Technical University and Asst. Prof. Dr. Selcen Uzun Duran, Karadeniz Technical University

About: "IvmeRad" is a wearable, smart, and active personal ionizing radiation dosimeter adapted to spaceflight for this mission. IvmeRad was designed with support from The Scientific and Technological Research Council of Türkiye (TÜBİTAK) for use for use at hospitals and radiological centers, where patients are actively threated by radiopharmaceuticals. Radiopharmaceuticals are agents used to diagnose various medical problems or treat certain diseases, such as cancer. IvmeRad applies Internet of Things (IoT) technologies to dosimetry to create an affordable, lightweight, and easy to use device that actively tracks exposure and identifies potential hazards faster than traditional methods.[1] IvmeRad will fly in a custom-built pocket of Tuva's TUA flight suit. IvmeRad is designed and produced by METU IVMER, supported by Karadeniz Technical University, and tests and logistics are supported by TÜBİTAK UZAY.

Center for Space Medicine Research (CSMR) in the Department of Psychiatry at Massachusetts General Hospital and Harvard Medical School—in collaboration with Louisiana State University (LSU), Massachusetts Institute of Technology (MIT) Media Lab, Northeastern University, and the Health Sciences University (Türkiye)—BEACON-R (Behavioral, Affective, Cognitive and Neurophysiological Responses to Spaceflight)

Principal Investigator: Dr. Vladimir Ivkovic and Ms. JoAnna Pollonais

About: Part of BEACON-R will see Tuva wear NINscan during the Galactic 07 mission. This will be the first spaceflight for NINscan: A custom developed brain and physiological monitoring system originally developed for NASA and used in extreme environments, including parabolic flight. NINscan headgear secures brain activity-monitoring sensors to Tuva's head and has electrode pads and leads for monitoring heart activity, allowing researchers to complete the first-ever continuous monitoring of blood and cerebrospinal fluid flow in all phases of spaceflight. This 'first' is essential for understanding the mechanics behind spaceflight associated neuro-ocular syndrome (SANS)—a major biomedical risk to astronauts involving changes in brain pressure and vision—and studying emotional and physiological responses associated with the 'Overview Effect', as well as spaceflight-induced changes in stress and immune function that will be assessed via blood and salivary biomarkers. Collaborators Dr. Gary Strangman, Dr. Aleksandra Stankovic, and Dr. Quan Zhang from CSMR/MGH/HMS, Dr. Guillaume Spielmann and Ms. Heather Quiriarte at LSU, Dr. Nataliya Kosmyna from the MIT Media Lab, Lab, Dr. Lisa Feldman Barrett, Dr. Karen Quigley and Dr. Jordan Theriault at Northeastern University, and Dr. Nazim Ata from the Health Sciences University of Türkiye will support BEACON-R to provide insight on mitigating spaceflight biomedical risks and managing neurological and psychiatric disorders in clinical practice on Earth.

Axiom Space and TUA – Suborbital Testing of Insulin Pens

Principal Investigators: Dr. John Marshall and Mr. Alex Rubin

About: This experiment serves as a stepping stone to support astronauts with insulin-dependent diabetes and demonstrates a capability necessary for maintenance therapy and hyperglycemic states in insulin-dependent people with diabetes. This human-tended experiment includes two commercially available insulin pens, which will each be secured in a custom 3D-printed container during flight. During the flight, Tuva will retain the insulin pens in his flight suit, dial an insulin dose, and dispense insulin from each pen into a collection container to study the accuracy of dose dispensation in microgravity. Commercial spaceflight and the research flown on these missions are opening space to people with diabetes and those who previously have not been eligible to fly to space.

Bilkent University National Nanotechnology Research Center (UNAM) – YUVA

Principal Investigator: Dr. Fatih İnci

About: Extracellular vesicles (EVs) are "lipid shuttles" secreted from parental cells and contain a diverse array of biomolecules. As part of the YUVA experiment, researchers will collect blood and urine specimens from TUA's astronaut pre- and post-flight to isolate circulating EVs with their state-of-the-art microfluidic chip. This chip is able to isolate EVs from low-volume of samples by minimum instrumentation. Downstream proteomic and transcriptomic analyses will scrutinize the isolated EVs, detecting variations in expression levels to unveil microgravity-induced alterations in EV-based communication. As the next step of the investigation, researchers aim to apply space-travel-induced EVs to healthy human cells to show cellular adaptation occurring during space travel could be transferred to the healthy cells, and potentially in the future, could be employed to prepare astronauts for space missions long before reaching space conditions.

Üsküdar University – MESSAGE

Principal Investigator: Dr. Cihan Taştan

About: In this human physiology experiment, researchers aim to analyze the whole transcriptome profile of a blood sample collected from TUA's astronaut before and after the suborbital spaceflight. This will allow them to determine the genes effected by microgravity whose expression is either up-regulated or down-regulated. After discovering these genes, the research team aims to determine microgravity effect of these gene expressions in in immune system cells in terms of anti-cancer activity.

Ankara University – METABOLOM

Principal Investigator: Prof. Dr. Emel Emregül

About: The main purpose of this study is to better understand the molecular mechanisms that occur in the human body as a result of a suborbital spaceflight through metabolomic analysis of biological samples collected from TUA's astronaut and data received from the blood plasma transcriptome. The investigators will look at the physiological and biochemical changes in gene expression and metabolism of the astronaut under the influence of space environment conditions, namely the exposure to hyper gravity, microgravity, and increased radiation. Furthermore, this study will provide important data for future research on topics such as gravitational physiology, aviation, and space medicine, as well as to contribute to the creation of new therapies and preventive measures for diseases that exist on Earth.

Hacettepe University – MIYELOID

Principal Investigator: Prof. Dr. Güneş Esendağlı

About: Myeloid-Derived Suppressor Cells (MDSCs) are formed when the bone marrow allows the immature cells needed after chronic inflammation and/or acute inflammation to enter circulation and these cells gain immune suppression ability. Within the scope of this investigation, the distribution and concentration of sub-populations of MDSCs within peripheral blood will be determined using the pre-flight and post-flight blood samples taken from TUA's astronaut and the effect of radiation exposure due to the suborbital spaceflight will be analyzed. For the first time, myeloid-derived suppressor cells in peripheral blood samples of a suborbital spaceflight participant after radiation exposure will be analyzed. By understanding the characteristics and function of MDSCs after a spaceflight, investigators are hoping to develop therapeutic interventions for both terrestrial and space applications.[1]

NASA FLIGHT OPPORTUNITIES

NASA has been flying experiments with Virgin Galactic since our first spaceflight in 2018. Virgin Galactic was recently selected as a contracted Flight Provider by Flight Opportunities for the next five years. NASA's Flight Opportunities program is providing support for two autonomous, rack-mounted payloads on Galactic 07.

NASA-funded experiments include:

- Investigating how liquid moves in spacecraft propellant tanks after executing maneuvers.
- Testing new 3D printing techniques that could significantly reduce printing time.

Purdue University School of Aeronautics and Astronautics – Rotational Slosh

Principal Investigator: Dr. Steven Collicott

About: When spacecraft are accelerating in space, such as during a pointing maneuver, re-orientation burns for docking, or to transfer to a new trajectory, it sets the liquid in propellant tanks in motion. After the thruster firing ends, the liquid motion slows down in the zero-gravity environment. This experiment will study the rate of damping of liquid motion after a rotational maneuver. The results will use this additional understanding of low-g propellant slosh to improve spacecraft pointing and mission operations. With the ongoing small satellite revolution, this experiment can use actual propulsion tank sizes for small satellites, rather than sub-scale mock-ups of tanks for larger satellites. The research can be furthered by studying how green propellants movements may differ from traditional propellants, like hydrazine, in zero-g.

University of California, Berkeley – Space Computed Axial Lithography (SpaceCAL)

Principal Investigators: Hayden Taylor, Taylor Waddell

About: Computed axial lithography (CAL) is a new type of additive manufacturing. Unlike conventional 3D printing where objects are formed layer by layer, CAL forms objects all at once by rotating a vial of photopolymer while exposing it to a complex set of projected images, very similar to a CT scan. Since parts are formed all at once, they typically form in minutes or less, much faster than other printing processes. This process can enable printing into high-viscosity fluids or even solids as well as around preexisting solid objects. The SpaceCAL payload has conducted two parabolic flights and Galactic 07 will be its first spaceflight. Given the sensitive light needed to image and cure the 3D printed objects, Virgin Galactic will be building a dark room in its hangar for the team to conduct its pre- and post-flight work.

[1]*Dosimeters flown on VSS Unity during its flight test program determined that passengers do not experience radiation levels high enough for exposure risk.*