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NEW ROUTES TO ADVANCE KNOWLEDGE IN MICROGRAVITY RESEARCH: THE ASI RESEARCH PORTFOLIO FOR AX-3

Abstract

In January 2024, ASI participated to Ax-3, Axiom Space's third commercial spaceflight mission on the ISS, leveraging the participation of Italian Air Force Col. Walter Villadei as Ax-3 Pilot. We performed several outreach initiatives and conducted a research portfolio of experiments to advance our knowledge on the physiological effects of spaceflight on humans and their mitigation strategies, with strong potential to translate benefits to Earth. 1. Beta-Amyloid Aggregation and Prometeo II: advancing our understanding of age-related diseases and potential therapies. These experiments aim to investigate the effect of spaceflight on neurodegeneration and explore countermeasures for future missions as well as therapies for neurodegenerative diseases on Earth. Beta-Amyloid Aggregation investigates how microgravity affects the aggregation of amyloid beta (AB) proteins, which are implicated in Alzheimer's disease. Prometeo II explores how specific antioxidant nanoparticles can counteract the oxidative stress induced by the space environment on neuronal cells, with potential relevance also to Parkinson's disease treatment. ESA provided Kubik utilization services for Prometeo II. 2. LIDAL: characterizing the radiation environment to enable health risk assessment. LIDAL is an advanced detector system that continuously measures the harmful cosmic radiation since January 2020. It is conceived to provide for the first time all the parameters needed for a real-time radiation risk-meter on the ISS, that would also inform the crew about risks from radiation and space weather events. 3. EMSi: monitoring mobility function to inform real-time countermeasures to muscle loss. EMSi is an intra-vehicular suit measuring muscle activity during astronauts' daily activities while applying compression to counteract shifts in body fluid distribution. It will be upgraded with electrostimulation properties to prevent microgravity-induced muscle loss. EMSi can improve astronaut health during future space missions, besides supporting muscle rehabilitation therapy or muscle strengthening on Earth. 4. AstRNAuts and NUT: investigating new molecular signatures of the space environment effect on human organisms. These experiments analyse astronauts' biological samples collected at different times before and after the Ax-3 mission. AstRNAuts aims to characterize distinctive molecular signatures of circulating biomarkers that are altered upon space environment exposure. By comparing astronauts and submariners, NUT aims to distinguish the alterations induced by microgravity and cosmic rays, stressors peculiar to the space environment, from those induced by isolation and confinement, common to the ISS and submarines. Together, the results may contribute to improving astronauts' health status monitoring and to develop point-of-care devices for diagnosis and prognosis of diseases on Earth.