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Author: Dr. ALESSANDRO ANGELUCCI
United Nations, Italy

Mr. ANDREA ANGELUCCI
Agenzia Spaziale Italiana (ASI), Italy
Dr. Massimo Angelucci
Agenzia Spaziale Italiana (ASI), Italy

SPACE SUSTAINABILITY: GLOBAL INITIATIVES AND FUTURE INNOVATIONS

Abstract

Space sustainability has become a critical goal as space missions expand, with an increasing number of satellites and the potential for colonizing celestial bodies like the Moon and Mars. To ensure the responsible and long-term use of space resources, innovative technologies and global strategies are required. The United Nations is playing a key role in this process, with initiatives that could reshape the future of space activities. 1. Space Debris Management Space debris management is a primary challenge for sustainability. The United Nations, through the "Space Debris Mitigation and Sustainable Orbit Use Program" (SDM-SOUP), has created a platform for space agencies and private companies to share real-time debris data, with the goal of reducing orbital debris. The program includes technologies such as autonomous systems and the use of gravitational tractors developed by CNSA, which could revolutionize debris removal. 2. In-Situ Resource Utilization (ISRU) ISRU is key to long-term missions to the Moon and Mars. The United Nations is working with Russia, India, and Japan to create the "Lunar Mining Agreement", which establishes an international framework for lunar resource extraction, preventing territorial conflicts. This agreement, expected to be ratified by 2026, promotes multinational cooperation in the use of space resources. 3. Renewable Energy in Space The United Nations is supporting the development of solar satellites to provide renewable energy both in space and on Earth. The "Space Solar Power System" project aims to transmit solar energy from space to Earth, contributing to the Sustainable Development Goals (SDGs). Additionally, ISRO is designing solar-powered satellites to support lunar stations, reducing dependency on Earth-based resources. 4. Technologies to Reduce Resource Consumption The United Nations is funding the development of quantum technologies to improve resource management in space, such as quantum communication satellites to secure mission data and prevent cyberattacks. 5. Space Circular Economy The United Nations, in collaboration with SpaceX and Blue Origin, is creating a space recycling center that will allow the recovery and reuse of debris and spent rockets. By 2030, a circular economic model is expected to be in place, reducing the need for new resources and promoting long-term sustainability. Conclusion The United Nations is paving the way for a future where space exploration can proceed without compromising the environment, through innovation and international cooperation. With these projects, space access will be sustainable for future generations.