Chapter

Introductory Chapter: Planetology

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1. Introduction

Over the last 80 years, dreamers, engineers, mission planners, and scientists have sought, defined, and created many methods of exploring the solar system [1]. Robotic missions to nearly every type of solar system object have been conducted. The data from these missions has opened new vistas on the riches of the planets and the asteroids. Water and other materials that can help humans survive in space are near ubiquitous. Human lunar missions have returned hundreds of kilograms of rocky and dusty samples; that regolith has given us hope that humanity will one day colonize the Moon, Mars, and the moons of other planets.

Many space agencies around the world have shared their information and created collaborations for the betterment of all. The agencies of NASA, ESA, and others have begun to discuss and plan a Moon Village; such a village will allow the development of lunar resources and create great wealth for all humanity. India and the United States has created instruments that have verified the presence of lunar polar water ice [2]. China has demonstrated effective communications for lunar far-side rover operations. Thus, many nations are creating new lunar data and capabilities. Pooling all of this knowledge will lead to new breakthrough in understanding the lunar environment.

Interplanetary dreams are part of humanity's future. Extended exploration missions and the initial colonization of the Moon will lead to a better understanding of the limits of the human body. While our minds can create new brilliant ideas and concepts for supporting life, the human body is frail and must be protected from the ravages of microgravity, radiation, and loneliness. Exposure to microgravity weakens the cardiovascular system and human muscles, so artificial gravity may be required for long-duration space flights [3]. Radiation can destroy the human DNA; protective methods of living underground on the Moon and Mars give hope to solving such issues. Once these impediments are better understood, humanity can begin to flourish throughout the planets.

Asteroids, while small in comparison to moons, offer many natural resources. Metals, water, and frozen gases may be mined there. The asteroids occupy many spaces throughout the solar system, so they may be caches for resources almost anywhere we travel. While rich in minerals, near-Earth asteroids also pose a threat to life on Earth. Asteroid defense studies and experiments have paved the way to manipulate these rocky and metallic objects, deflecting them from any potential Earth impacts.

In the outer planets, Jupiter, Saturn, Uranus, and Neptune can provide gases and other materials from which starship construction can begin. Nuclear fuels, such as deuterium and helium 3, can be wrested from the hydrogen and helium atmospheres of these giant planets [4]. Fission and fusion propulsion systems can be fueled from these atmospheric constituents. Past design studies have discussed robotic interstellar missions that begin with such atmospheric mining. It's important to point out that for a large interstellar mission to Alpha Centauri, our nearest stellar neighbor, traveling at one-tenth the speed of light, the total energy required to accomplish that mission will be between 1 and 100 times the total world's energy output. This energy challenge is very readily met by using the resources of the outer planets.

The energy for Earth launch will be a great focus of attention. New concepts in reusability are reducing launch costs. Large-scale projects can be accomplished with hundreds of small components lofted by reusable rockets. Such an assembly process may be beneficial for robotic missions. During a lunar planning study, assembling a large lunar cargo mission of 250 MT would take more than 25 launches of 10 MT payloads to orbit. If the payload flights were once a month, it would require over 2 years to assemble the complete vehicle in low Earth orbit. Given this lengthy assembly process, there are many opportunities for propellant boil-off, missed or failed rendezvous and docking attempts, and other delaying issues. Human space flights may require a faster method. Alternatively, extremely large rocket boosters can lift fully assembled multi-hundred ton interplanetary vehicles into orbit in one piece. The benefits of both ideas will likely be exploited to the fullest.

Humanity must also acknowledge that sustainability is crucial to survival. New techniques in regolith-based construction are under development now. Solar energy focused on sintered regolith can allow building block assembly of small and large structures. Using biomimicry and bio-inspired processes will come to the fore. Humanity's waste products will be reformed into building materials. Many teams around the world are inspired by space flight and are addressing the sustainability issue. Conversion methods for human-made waste products have been envisioned as creating radiation shields, purified water supplies, and rocket propellants. Numerous other applications and product will no doubt be formulated.

Krafft Ehricke, a noted space flight engineer and visionary, maintained that humanity has a destiny in the heavens. Ehricke was the first project manager for the world's first high energy oxygen/hydrogen rocket stage, the Centaur. While leading that project, he also directed a team of engineers and scientists to develop human interplanetary mission concepts. These concepts ranged from human space travel to all of the planets from Mercury to Saturn [5]. While these missions have not yet come to fruition, these ideas have inspired new research in human and robotic space travel. Over many decades, numerous teams have furthered his team's research in interplanetary travel. Robots blaze the trails to planets, reveal incredible secrets, and give us pause to reflect on the wonders of the far reaches of the solar system.

While we strive to understand our solar system, we also have the influences of the rest of the galaxy to explore. Gravity waves, galactic cosmic rays, and the Sun's interactions with the rest of the Milky Way will teach us how the rest of the universe works. Humanity has a boundless imagination and we hope of the fullest understanding of all we see and touch. The measurement of gravity waves from the collision of two black holes many times the mass of our Sun bodes well for new directions in science and technology. Perhaps among the 200 billion other stars in our galaxy, other intelligent life exists, awaiting our emergence from the solar heliopause bubble.

Exploring the solar system is an endless process. There are so many facets to examine, and new theories and models of the natural solar system processes are created every year. Thousands of new research project personnel examine the Apollo lunar samples, the data from our interplanetary robotic emissaries, model the future of humans in space, and create new theories about life in the universe. Perhaps, the hopeful human lunar missions will once again ignite the imagination and allow the first steps to Mars and then to the stars.

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