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HUMAN MARS EXPLORATION MISSION ARCHITECTURE AND THE CORRESPONDING SPACE
TRANSPORTATION SYSTEM

Abstract

With the development of human society and deep space exploration technology, Mars exploration has become more and more attractive. As Mars exploration missions progresses, countries around the world have carried out researches on Mars surface sample return, human Mars exploration and Mars base. The human Mars exploration is of great significance in exploring extraterrestrial life, interplanetary migration, international cooperation and exchange, promoting the development of science and technology, and promoting the progress of human society. It is essential to design the mission architecture firstly for the human Mars exploration. And the human Mars exploration space transportation system is the basis for the implementation of the human Mars exploration mission, and it has an important impact on the risk, complexity, and cost of the whole mission. It is necessary to study the human Mars exploration architecture and the corresponding space transportation system. This paper is some research results from the IAA study group SG3.33 "Space Transportation System of Human Mars Exploration", which firstly summarizes the research progress on human Mars exploration and the corresponding proposed space transportation systems in the world, and analyzes the development trends. The two kinds of space transportation systems are compared between traditional cislunar mission architecture and human Mars mission. Compared with cislunar mission space transportation system, the human Mars mission space transportation system has larger scale and higher complexity. Then, a three-step development roadmap for human Mars exploration is proposed in this paper, including robotic Mars exploration, initial human Mars exploration and routine human Mars exploration. For the initial human Mars exploration, four initial human Mars mission architectures and the corresponding space transportation systems are proposed and analyzed, and they have different crew and cargo transfer modes, transfer orbit types, the propulsion technologies, Earth parking orbits, Earth escape modes, the Mars capture modes, and etc. For instance, the propulsion options includes chemical propulsion, nuclear thermal propulsion and nuclear electric propulsion, and the Earth parking orbits including Low Earth Orbit (LEO), High Earth Orbit (HEO) and etc. These four options are compared from their advantages and disadvantages. The composition and scale of these four space transportation systems are also investigated and given in this paper. In the end the key technologies of space transportation system of human Mars exploration are sorted out and analyzed. The results can be a reference for future further research.