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HUMAN EXPLORATION OF THE SOLAR SYSTEM SYMPOSIUM (A5)
Human Mars Exploration (2)

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MARS ENVELOPE SIMULATION IN A HIGH-PERFORMANCE HUMAN CENTRIFUGE

Abstract

This paper represents an effort to enhance and contribute to the human exploration of Mars by simulating phases of the Earth-Mars-Earth flight envelope in a high performance human centrifuge. Humans are the most valuable part of the Mars mission. The crew will encounter the Space, and has to remain productive during the whole mission. The crushing sensation experienced at high-G levels during take-off, zero and microgravity, can cause many psycho-physiological problems to astronauts. The human body undergoes major changes in Space, especially when returning from weightlessness and readapting to gravity. The centrifuge discussed in this paper, is in essence a robotic manipulator with three degrees of freedom of motion. It is capable of achieving extreme G-loads in short time intervals. In order to achieve an extreme gradient, the main drive of the centrifuge has to work with an overload in short time. This allows an authentic G-simulation. The centrifuge has an onset rate of 9G/s. It consists of three independent controllable axes (angles): the roll, pitch and the yaw axis. The flight envelope for the possible manned Mars mission is examined and simulated in terms of G in this paper. In order to get better acquainted with the conditions astronauts will be exposed in flight, and to improve astronaut training for the Mars mission, in this paper are also given some training profile suggestions. A special emphasis is placed on the Earth launch phase, as well as on the Earth entry and landing phase. The experience of launch, ascent, re-entry, and Mars landing is simulated in terms of G. Astronauts experience a load of about 3G during take-off. Re-entry can be especially dangerous with much higher accelerations, beside the fact that astronauts wear anti-G suits. Simulating the Earth-Mars-Earth envelope accurately, requires a proper adjustment of the three rotational angles, which is also given in this study. The longitudinal G-load is most important for training, given that it has the highest value in real flight. Angle adjustments are made in order to minimize side-load and transverse load, although the centrifuge may provide all three loads. The Earth-Mars-Earth envelope consists of many critical phases. Envelope simulations in a centrifuge are valuable, especially for astronauts. Flight simulation is an essential component of aircrew training, providing a safe and reliable training environment. This result will hopefully help to move faster towards the dream called "Humans on Mars". **Keywords**: *Mars, Simulation, G, envelope*