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CISLUNAR SPACE, A NECESSARY STEPPING STONE FOR SUCCESSFULLY GOING TO MARS

Abstract

This work will discuss how mission risk could be reduced and a number of possible mission objectives accomplished in cislunar space to improve the probability of keeping astronauts healthy and returning them safely to Earth. NASA's Journey to Mars is a stepwise approach towards landing humans on the Red Planet by the end of the 2030's. The JPL Minimal Mars Study provided an existence proof that, with budgets adjusted for inflation, it could be possible to send humans to Mars affordably by 2039. An important segment of the JPL Minimal Mars Study not previously discussed, were the activities and flights in cislunar space that would test the systems before sending humans to Mars. Cislunar space provides a relatively similar deep space environment from a microgravity, radiation and orbital dynamics perspective, but it is much closer to Earth in the event that something doesn't work as planned. While lunar gravity is about half that of Mars, the systems and techniques required to successfully execute a mission to Mars could be practiced at the Moon. Deep space operations techniques were demonstrated at the Moon during the Apollo Program in the 1970's, however, these capabilities need to be redeveloped and practiced with the modern day systems that would be used to go to Mars.

The approach that we propose to take is that each system used to send humans to Mars would be fully tested before being used on an actual human Mars mission. While each vehicle component and subsystem could be tested on the ground, flight tests in cislunar space would verify how the systems work together in a relatively similar environment including how the astronauts would pilot the various vehicles. Each system would have a number of different flight test objectives. Transportation systems (SLS and Orion) would be checked out to ensure that they achieve the necessary performance to and from the Moon. Habitation systems would be exercised to ensure that critical subsystems (e.g. life support), can operate for the planned mission duration. Terminal propulsive descent, landing, surface operations, and ascent systems could be tested on the Mars lander during a flight to the Lunar surface. With NASA already developing or studying most of the systems that it plans to use to send humans to Mars, the 'Proving Ground' would provide an opportunity to improve the probability of successfully sending humans to Mars and returning them safely.