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CHINESE DEVELOPMENT OF NUCLEAR THERMAL PROPULSION FOR MANNED SPACE
EXPLORATION

Abstract

Nuclear power is the most powerful form of energy that humans have so far been able to exploit. The nuclear energy of 1 kg of uranium 235 is equal to the chemical energy of 2,500 tons of high-quality coal. Moreover, more than 90% of nuclear energy can be transformed to heat. Nuclear thermal propulsion (NTP) technology is the best choice for future deep-space exploration - better than chemical or electrical propulsion - because it offers thrust of more than 10 tons and specific impulse of nearly 1,000 seconds. With current technology, a manned mission to Mars should use spacecrafts with an initial mass in Earth orbit of no more than 900 tons. The trip time - out and back, but excluding exploration time - should be less than 500 days. To achieve that, the greatest challenges are in developing a heavy launch vehicle and an NTP system. In recent years, the main spacefaring countries have all proposed NTP research projects. China began research and development of NTP in 2012. This article will discuss principle conclusions of that research - for example, in the key technologies of reactor materials and engine cooling. Preliminary results indicate that for a prototype Chinese NTP engine would have a thrust of about 15 tons, specific impulse of more than 900 seconds, and a thrust-to-weight ratio of about 3. Encouragingly, we have found that a high-thrust NTP engine could be built in the foreseeable future with international cooperation and that with such an engine we can indeed build a spacecraft for long-distance human space exploration - for example, to Mars.