High Performance Nuclear Thermal Propulsion

The Centrifugal Nuclear Thermal Rocket (CNTR) is a High Performance Nuclear Thermal Propulsion (HPNTP) concept designed to heat propellant directly by the reactor fuel. The primary difference between the CNTR concept and traditional NTP systems is that rather than using traditional solid fuel elements, the CNTR uses liquid fuel with the liquid contained in rotating cylinders by centrifugal force. If the concept can be successfully realized, the CNTR would have a high specific impulse (~1800 s with hydrogen propellant) at high thrust, which may enable (i) viable near-term human Mars exploration by reducing round-trip times to 420 days and (ii) direct injection orbits for scientific missions to the Solar System outer planets and potentially Kuiper Belt objects and comets. The CNTR could also use storable propellants such as ammonia, methane, or propane at an Isp of ~900 s, enabling long-term in-space storage of a dormant system. Significant engineering challenges must be addressed to establish the technical viability of the CNTR. Research is presently underway to determine resolutions for these engineering challenges. In particular, research has begun on the analytical modeling and simulation of the two-phase heat transfer between the liquid metallic uranium fuel and the gaseous propellant. A paper was presented at the 2022 IAC which described these challenges and the study plan to address them. This presentation will describe the analytical and experimental progress to date toward resolving these challenges and establishing the engineering feasibility of the CNTR technology.