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40-kW Solar Electric Propulsion Stage for Enhanced Robotic and Human Space Exploration

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Numerous studies have suggested that existing solar electric propulsion (SEP) technology can significantly enhance scientific exploration of the solar system, and that advanced SEP systems would be beneficial to transport the massive cargo vehicles associated with human space missions. The development of a SEP stage that bridges the gap between existing SEP systems (the Dawn spacecraft has 10 kW arrays and commercial satellites operate up to 24 kW systems) and advanced levels for human elements (100-kW class systems provide deep space capability) therefore appears to be a mutually beneficial investment for both science and human exploration endeavors. We propose that a 40-kW system would define a "sweet spot" relative to extensibility, capability, and risk reduction for deep-space applications. SEP benefits for interplanetary science missions include: smaller less expensive launch vehicles, more flexible launch opportunities, reduced number of mission critical events, increased mission capability (e.g. multiple small body rendezvous like Dawn), resilience to mass growth, and shorter trip times to high delta-V destinations. Notable benefits for human space exploration are: significantly reduced launch mass to low Earth orbit, less sensitivity to mass growth of elements, More capability / cargo to and from the destination, additional mission flexibility and robustness, more graceful failure modes, and facilitation of payload reuse. We examine these benefits of SEP for robotic missions to Phobos/Deimos, a Trojan asteroid rendezvous, Europa observation, Saturn probes, and a Uranus orbiter, and apply the same SEP technology for ISS-reboost, Earth-Moon L2 station development, and a one-year round-trip human asteroid mission.

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