Innovative Plasma Technology Could Propel Future Deep-Space Missions

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A team of engineers and scientists led by NASA have begun investigating the physics and performance of magnetic nozzles -- innovative devices that could support development of plasma-based propulsion systems.
Such systems could dramatically reduce travel times to Earth's neighboring planets and extend the capabilities of future space exploration missions.

The project, initiated in April, is led by the University of Texas at Austin and includes support by the Propulsion Research Center, a key research organization at NASA's Marshall Space Flight Center in Huntsville, Ala. The Propulsion Research Center leads scientific study of advanced propulsion systems in NASA's state-of-the-art Propulsion Research Laboratory at Marshall. The Advanced Space Propulsion Laboratory at NASA's Johnson Space Center in Houston and the University of Alabama in Huntsville also are part of the research team.

The joint effort was selected from the competitive Broad Agency Announcement No. 2203-3659, issued in July 2004 by the Exploration Systems Mission Directorate at NASA Headquarters in Washington.

"The technology we're pursuing could play an important role in NASA's exploration of the Moon, Mars and the rest of the Solar System," said Dr. Greg Chavers, a plasma physicist at Marshall and co-investigator for the new project. "Magnetic nozzles enable a new type of plasma-based propulsion system that could significantly reduce travel times to different planetary destinations, providing a new means of exploring space."

Plasma is a highly conductive medium formed when a gas is heated and ionized -- the process in which the gas's neutral atoms shed electrons and acquire a positive charge. When properly channeled through a magnetic nozzle, plasma can be accelerated to velocities dramatically faster than those of conventional chemical propulsion systems.

The new research project has two objectives: development of an innovative magnetic nozzle design capable of directing the flow of plasma, and determining how to efficiently eject the plasma from the nozzle to produce the greatest propulsive thrust.

Magnetic nozzle development is critical, Chavers said. Propellant in a plasma state can be accelerated with the use of electromagnetic energy sources to increase the propulsion system's specific impulse -- the equivalent of a car's gas mileage. Such a nozzle, magnetically insulated against the superheated plasma flow, would enable plasma acceleration at temperatures far beyond those conventional materials can endure.

The second challenge is rooted in the physics of magnetized plasma flow. A plasma propulsion system requires magnetic coils to generate and channel the plasma. These coils produce closed magnetic "field lines" -- circular loops of magnetic energy that form around the power source, preventing the plasma from detaching and leaving the spacecraft.

The research consortium seeks to test mechanisms that allow the plasma stream -- already properly shaped by the magnetic nozzle -- to break away from the spacecraft, generating maximum thrust by dispersing the plasma at exactly the right moment following expulsion from the rear of the spacecraft.

Eventually, NASA hopes to adapt this research to develop a new class of rockets incorporating magnetic nozzles and plasma propulsion systems.

Source: NASA