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Exploring space for nuclear fuels

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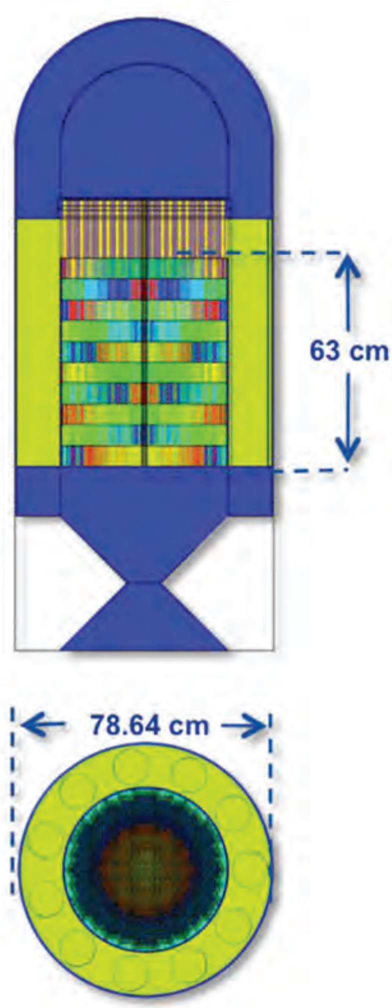
The **Nuclear and Future Flight Propulsion Technical Committee** works to advance the design and implementation of nonchemical, high-energy propulsion systems other than electric thruster systems.

NASA's Glenn Research Center in Ohio this year investigated atmospheric mining of the outer solar system as a first step in interstellar flight. The moons of these planets may be excellent storage and manufacturing facilities for building the elements and making the fuel of a starship. The nuclear fuels would be wrested from the planet's atmosphere and then delivered to a factory for processing. The moons' water ices would also be processed into oxygen and hydrogen for chemical propulsion landers. The landers would rendezvous with and supply fresh hydrogen propellant to the nuclear electric orbital transfer vehicles that deliver the atmospheric gases to the moons. The mass of several transportation systems for mining factories for Uranus and Neptune was estimated. **Miranda** (at Uranus) and **Thalassa** (at Neptune) would be promising small moons for propellant facilities. While the moons closest to the planets were the most attractive in terms of minimizing the transportation system mass, their gravity levels are quite low, which would make many fluid and propellant processes difficult to complete. Additional artificial gravity facilities on the moons would likely be needed for an effective propellant factory system. Even the largest moons of Uranus and Neptune have relatively low gravity levels, and they would also require artificial gravity facilities.

As a continuing line of research, improved reactor designs for power and propulsion are being investigated. While radioisotope power systems have been used for many robotic reconnaissance missions, using nuclear fission for large human and robotic science missions is vitally important. The concern has been raised regarding the importance of highly enriched uranium versus the recent suggestion of only using low-enriched uranium. **Low-enriched uranium** has been an issue in nuclear proliferation discussions; advocates believe the materials would promote the safety of nuclear systems on Earth. In general, the highly enriched uranium systems are very critical for spaceflight reactors to make them lightweight and compact. An option for the **highly enriched uranium reactor design** was released by the Center for Space Nuclear Research in Idaho, Aerojet Rocketdyne and the Ultra Safe Nuclear Corp. in New Mexico. The discussion regarding the two variants is an important ongoing issue in the nuclear technical community and the United Nations.



Center for Space Nuclear Research; Ohio State University; Ultra Safe Nuclear Corp; Aerojet Rocketdyne

▲ **In this conceptual design,** a fission reaction occurs among highly enriched-uranium fuel elements in the center of the cross section. The reaction heats hydrogen, which accelerates out a nozzle to propel the spacecraft. The reactor would be turned on once the spacecraft is beyond Earth's atmosphere.

Many international research groups have made claims regarding unusual physics that may lead to a better understanding and perhaps control of gravity. This year, researchers at the Dresden University of Technology in Germany conducted experiments and investigated numerous claims of gravity modification. After many careful steps in hundreds of experiments, the researchers showed that many effects noted by other research groups were part of extraneous signals or other electric interference. When meticulous steps were taken to electrically isolate the experimental equipment from the extraneous signals, the possibility of gravity modification was discounted and disproven.

In April, a group that includes a noted Russian billionaire and Stephen Hawking announced an ambitious proposal for interstellar flight. In this **StarShot** proposal, powerful gigawatt-class ground-based lasers would accelerate a very tiny spacecraft weighing only a few grams to 10 or 20 percent the speed of light. The spacecraft would be the size of a postage stamp and would have a gossamer light sail attached to intercept the powerful laser's energy. The energy flux on the StarShot would be extremely high; the proposed gigawatt-class laser power level would be equal to that of a space shuttle at liftoff. Although it is an extremely high-risk and challenging venture, StarShot may lead to other technological breakthroughs in communications, materials and propulsion. ★