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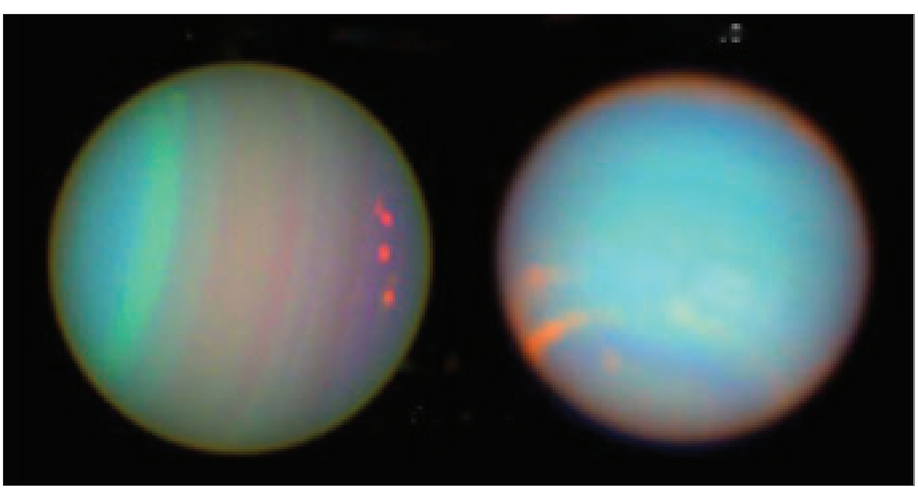
Nuclear and future flight propulsion

Atmospheric mining of the outer planets can be a powerful tool in extracting fuels to allow fast human and robotic exploration of the solar system. Preliminary designs of aerospacecraft with gas core engines for mining the outer planets were developed at NASA Glenn. The analyses showed that such engines can reduce the mass of atmospheric mining vehicles very significantly, enabling a reduction of 72-80% over NTP (nuclear thermal propulsion) solid core powered mining vehicles.

Although this reduction in the mass of the overall mining system is important, a fissioning plasma gas core rocket is much more complex than the more traditional solid core NTP engines. Flight rates necessary for fueling an interstellar-class vehicle with a 50,000-metric-ton propellant load have been estimated. While up to 20 mining flights a day would be needed to meet a 20-year assembly time, a more moderate number of daily flights would be required if the assembly time were relaxed to 50 years.



Uranus and Neptune may provide vast quantities of accessible fuels.

If the assembly time is extended to 100 years, the number of flights is reduced to three per day for the 0.5-metric-ton payload (per mining flight) case, and less than one per day with the 2-metric-ton payload case. The assembly time of 100 years may be impractical, but it does reduce the flight times to only one to three per day.

Based on these analyses, there are likely several possible future avenues for effectively using the gases of the outer planets to fuel exciting exploration missions. Uranus and Neptune offer vast reservoirs of fuels that are more readily accessible than those of Jupiter and Saturn and, with the advent of nuclear fusion propulsion, may offer us the best option for the first practical interstellar flight.

A novel model for air transport has been proposed in a study at Cranfield University and analyzed for feasibility. Out of many future alternative sources of power and propulsion, nuclear propulsion seems to be one of the practical future methods for travel. According to the proposed concept, all the chemically propelled aircraft traveling on a particular sector could be optimized only for takeoff and climb, which would result in increased efficiency.

After reaching a designated height, these optimized aircraft would be carried from one location to another by a nuclear-powered aircraft. At the destination, chemically propelled aircraft could land using their own onboard engines. Optimizing a chemical aircraft for takeoff and climb and then shutting off the engine for cruise results in less fuel consumption, lower takeoff weight, and reduced emissions.

Historically, researchers concluded that the operating cost of nuclear-powered aircraft could be substantially reduced by increasing the gross weight—increased aircraft size will make it more feasible to convert the present fleet of aircraft to the proposed nuclear-powered air transport cycle.

A large number of aircraft accidents happen during either landing or takeoff, or because of human error. Nuclear-powered flight, which will have no takeoff or landing and no human pilots, will substantially lower the possibility of an accident. The decreasing availability of fossil fuels for air transportation also would be less of a problem with the proposed nuclear-powered air transport model, which would save substantial amounts of fuel: Reduction in the NO_x (oxides of nitrogen) emissions is 33% for short-range aircraft of 1,000-km range; for the 10,000-km range case, this reduction is up to 80%.

More information is available at the SBIR (Small Business Innovation Research) fuels and space propellants Web site, www.grc.nasa.gov/WWW/Fuels-And-Space-Propellants/foctopsb.htm.

by **Bryan Palaszewski**