



### **Radio Heating of Lunar Soil To Release Gases**

A report proposes the development of a system to collect volatile elements and compounds from Lunar soil for use in supporting habitation and processing into rocket fuel. Prior exploratory missions revealed that H<sub>2</sub>, He, and N<sub>2</sub> are present in Lunar soil and there are some indications that water ice may also be present. The proposed system would include a shroud that would be placed on the Lunar surface. Inside the shroud would be a radio antenna aimed downward. The antenna would be excited at a suitably high power and at a frequency chosen to optimize the depth of penetration of radio waves into the soil. The radio waves would heat the soil, thereby releasing volatiles bound to soil particles. The escaping volatiles would be retained by the shroud and collected by condensation in a radiatively cooled vessel connected to the shroud. It has been estimated that through radio-frequency heating at a power of 10 kW for one day, it should be possible to increase the temperature of a soil volume of about 1 m<sup>3</sup> by about 200 °C—an amount that should suffice for harvesting a significant quantity of volatile material.

*This work was done by Talso Chui and Konstantin Penanen of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1). NPO-43313*

### **Using Electrostriction To Manipulate Ullage in Microgravity**

A report proposes to use electrostriction to manipulate the ullage in a tank containing a dielectric liquid in a microgravitational environment. In the original intended application, the liquid would be a spacecraft propellant and the goal would be to force the ullage (comprising bubbles of noncondensable gas) to coalesce at one end of the tank, to enable use of one of the established means of (1) measuring the position of the gas/liquid interface and (2) inferring the quantity of liquid from the measurement. Electrically insulated wires would be installed in the tank, shaped and positioned so that application of a suitably high potential (e.g., 1 kV) between adjacent wires in successive pairs would give rise to a sufficient electric field gradient along

the tank. The resulting electrostriction in the liquid would give rise to a pressure gradient that would force the ullage toward the low-electric-field-magnitude end of the tank. The feasibility of this proposal was demonstrated in an experiment in a tank containing liquid helium aboard an airplane flying a low-gravity arc. The ullage-segregating electrostrictive effect is expected to be considerably greater in other liquids.

*This work was done by Talso Chui and Donald Strayer of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1). NPO-43041*

### **Equations for Scoring Rules When Data Are Missing**

A document presents equations for scoring rules in a diagnostic and/or prognostic artificial-intelligence software system of the rule-based inference-engine type. The equations define a set of metrics that characterize the evaluation of a rule when data required for the antecedence clause(s) of the rule are missing. The metrics include a primary measure denoted the rule completeness metric (RCM) plus a number of subsidiary measures that contribute to the RCM. The RCM is derived from an analysis of a rule with respect to its truth and a measure of the completeness of its input data. The derivation is such that the truth value of an antecedent is independent of the measure of its completeness. The RCM can be used to compare the degree of completeness of two or more rules with respect to a given set of data. Hence, the RCM can be used as a guide to choosing among rules during the rule-selection phase of operation of the artificial-intelligence system.

*This work was done by Mark James of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1).*

*The software used in this innovation is available for commercial licensing. Please contact Karina Edmonds of the California Institute of Technology at (818) 393-2827. Refer to NPO-42717.*

### **Insulating Material for Next-Generation Spacecraft**

A report discusses the development of a flexible thermal-insulation material for cryogenic tanks in next-generation space-

craft. This material is denoted Advanced Reusable All-temperature Multimode Insulation System (ARAMIS). The report begins by describing the need for ARAMIS and the technological challenges of developing a single material that is useable throughout the temperature range from storage of liquid hydrogen (20 K) to atmospheric-reentry heating (>2,000 K), has the requisite low thermal conductivity, resists condensation of moisture without need for a gas purge, and withstands reentry heating for a 400-mission lifetime. The report then discusses laboratory apparatuses for testing materials that have been and will be considered as candidates for the development of ARAMIS.

*This work was done by Susan White, Sylvia Johnson, Louis Salerno, Peter Kittel, and Pat Roach of Ames Research Center and Ben Helvensteijn and Ali Kashani of Atlas Scientific. Further information is contained in a TSP (see page 1).*

*Inquiries concerning rights for the commercial use of this invention should be addressed to the Ames Technology Partnerships Division at (650) 604-2954. Refer to ARC-14727-1.*

### **Pseudorandom Switching for Adding Radar to the AFF Sensor**

A document describes the proposed addition of a radar function to the Autonomous Formation Flying Sensor, making possible coarse relative-position control to prevent collisions in the event of failure of one of the spacecraft. According to the proposal, in addition to tracking GPS-like one-way ranging signals transmitted by the other normally functioning spacecraft, each spacecraft could simultaneously track the reflection of its own ranging signal from a disabled, non-transmitting spacecraft. From the round-trip travel time, the approximate distance to the disabled spacecraft could be estimated. To prevent jamming of the receiver by the transmitter on the same spacecraft, the receiver would be switched off during transmission.

*This work was done by Jeffrey Tien, George Purcell, and Lawrence Young of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1). NPO-40417*