Physical Sciences

Foam Sensor Structures Would Be Self-Deployable and Survive Hard Landings

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A document proposes systems of sensors encased in cold hibernated elastic memory (CHEM) structures for exploring remote planets. The CHEM concept was described in two prior *NASA Tech Briefs* articles, including "Cold Hibernated Elastic Memory (CHEM) Expandable Structures" (NPO-20394), Vol. 23, No. 2 (February 1999), page 56 and "Solar Heating for Deployment of Foam Structures" (NPO-20961), Vol. 25, No. 10 (October 2001), page 36. To recapitulate: Lightweight structures that can be compressed for storage and later expanded, then rigidified for use are made from foams of shape-memory polymers (SMPs). According to the instant proposal, a CHEM sensor structure would be fabricated at full size from SMP foam at a temperature below its glass-transition temperature (T_g). It would then be heated above T_g and compacted to a small volume, then cooled below T_g and kept below T_g during launch, flight, and landing. At landing, the inelastic yielding of the rigid compacted foam would absorb impact energy, thereby enabling the structure to survive the landing. The structure would then be solar heated above T_g, causing it to revert to its original size and shape. Finally, the structure would be rigidified by cooling it below T_g by the cold planetary or space environment. Besides surviving hard landing, this sensor system will provide a soft, stick-at-the-impact-site landing to access scientifically and commercially interesting sites, including difficult and hard-to-reach areas.

*This work was done by Witold Sokolowski and Eric Baumgartner of Caltech for **NASA's Jet Propulsion Laboratory**. Further information is contained in a TSP (see page 1). NPO-30654*

Real-Gas Effects on Binary Mixing Layers

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This paper presents a computational study of real-gas effects on the mean flow and temporal stability of heptane/nitrogen and oxygen/hydrogen mixing layers at supercritical pressures. These layers consist of two counterflowing free streams of different composition, temperature, and density. As in related prior studies reported in *NASA Tech Briefs*, the governing conservation equations were the Navier-Stokes equations of compressible flow plus equations for the conservation of total energy and of chemical-species masses. In these equations, the expressions for heat fluxes and chemical-species mass fluxes were derived from fluctuation-dissipation theory and incorporate Soret and Dufour effects. Similarity equations for the streamwise velocity, temperature, and mass fractions were derived as approximations to the governing equations. Similarity profiles showed important real-gas, non-ideal-mixture effects, particularly for temperature, in departing from the error-function profile, which is the similarity solution for incompressible flow. The temperature behavior was attributed to real-gas thermodynamics and variations in Schmidt and Prandtl numbers. Temporal linear inviscid stability analyses were performed using the similarity and error-function profiles as the mean flow. For the similarity profiles, the growth rates were found to be larger and the wavelengths of highest instability shorter, relative to those of the error-function profiles and to those obtained from incompressible-flow stability analysis. The range of unstable wavelengths was found to be larger for the similarity profiles than for the error-function profiles.

*This work was done by Nora Okong'o and Josette Bellan of Caltech for **NASA's Jet Propulsion Laboratory**. Further information is contained in a TSP (see page 1). NPO-40162*

Earth-Space Link Attenuation Estimation via Ground Radar Kdp

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A method of predicting attenuation on microwave Earth/spacecraft communication links, over wide areas and under various atmospheric conditions, has been developed. In the area around the ground station locations, a nearly horizontally aimed polarimetric S-band ground radar measures the specific differential phase (Kdp) along the Earth-space path. The specific attenuation along a path of interest is then computed by use of a theoretical model of the relationship between the measured S-band specific differential phase and the specific attenuation at the frequency to be used on the communication link. The model includes effects of rain, wet ice, and other forms of precipitation.