Physical Sciences

Altimetry Using GPS-Reflection / Occultation Interferometry

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A Global Positioning System (GPS)-reflection / occultation interferometry was examined as a means of altimetry of water and ice surfaces in polar regions. In GPS-reflection / occultation interferometry, a GPS receiver aboard a satellite in a low orbit around the Earth is used to determine the temporally varying carrier-phase delay between (1) one component of a signal from a GPS transmitter propagating directly through the atmosphere just as the GPS transmitter falls below the horizon and (2) another component of the same signal, propagating along a slightly different path, reflected at glancing incidence upon the water or ice surface.

The integer-cycle phase-difference ambiguity is resolved by noting that both signal components eventually collapse into a single component, representing zero phase difference. From the phase difference and the known positions of the two spacecraft as functions of time, an atmospheric correction obtained as the main data product of the GPS-receiver mission, and basic geometry, the difference in length between the direct and reflection signal paths and the altitude of the effective specular-reflection point can be calculated. This method yields altitude at about 0.7-m precision with horizontal resolution of a few kilometers.

This work was done by Estel Cardellach, Manuel De La Torre, George A. Hajj, and Chi Ao of Caltech for NASA's Jet Propulsion Laboratory. For more information, contact iaoffice@jpl.nasa.gov. NPO-41551

Thermally Driven Josephson Effect

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A concept is proposed of the thermally driven Josephson effect in superfluid helium. Heretofore, the Josephson effect in a superfluid has been recognized as an oscillatory flow that arises in response to a steady pressure difference between two superfluid reservoirs separated by an array of submicron-sized orifices, which act in unison as a single Josephson junction. Analogously, the thermally driven Josephson effect is an oscillatory flow that arises in response to a steady temperature difference.

The thermally driven Josephson effect is partly a consequence of a quantum-mechanical effect known as the fountain effect, in which a temperature difference in a superfluid is accompanied by a pressure difference. The thermally driven Josephson effect may have significance for the development of a high-resolution gyroscope based on the Josephson effect in a superfluid: If the pressure-driven Josephson effect were used, then the fluid on the high-pressure side would become depleted, necessitating periodic interruption of operation to reverse the pressure difference. If the thermally driven Josephson effect were used, there would be no net flow and so the oscillatory flow could be maintained indefinitely by maintaining the required slightly different temperatures on both sides of the junction.

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Perturbation Effects on a Supercritical C_7H_{16} / N_2 Mixing Layer

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A computational-simulation study has been presented of effects of perturbation wavelengths and initial Reynolds numbers on the transition to turbulence of a heptane / nitrogen mixing layer at supercritical pressure. The governing equations for the simulations were the same as those of related prior studies reported in *NASA Tech Briefs*. Two-dimensional (2D) simulations were performed with initially imposed spanwise perturbations whereas three-dimensional (3D) simulations had both streamwise and spanwise initial perturbations.

The 2D simulations were undertaken to ascertain whether perturbations having the shortest unstable wavelength obtained from a linear stability analysis for inviscid flow are unstable in viscous nonlinear flows. The goal of the 3D simulations was to ascertain whether perturbing the mixing layer at different wavelengths affects the transition to turbulence.

It was found that transitions to turbulence can be obtained at different perturbation wavelengths, provided that they are longer than the shortest unstable wavelength as determined by 2D linear stability analysis for the inviscid case and that the initial Reynolds number is proportionally increased as the wavelength is decreased. The transitional states thus obtained display different dynamic and mixture characteristics, departing strongly from the behaviors of perfect gases and ideal mixtures.

This work was done by Nora Okong'o and Josette Bellan of Caltech for NASA's Jet Propulsion Laboratory. For more information, contact iaoffice@jpl.nasa.gov.
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