- In fabricating the resonator, one strives to obtain

$$r = R[1-(n_d/n_p)^2],$$

where r is the vertical radius of curvature at the contact spot as defined in the figure; R is the horizontal radius of curvature, also as defined in the figure; n_d is the effective index of refraction of the desired mode in the resonator; and n_p is the index of refraction of the prism.
- The reason for this choice of r and R is that it ensures aperture matching with a Gaussian beam cross section at the contact spot.
- The numerical aperture (NA) of the collimated beam must be chosen to have the following value:

$$NA = \sin(\lambda/h),$$

where λ is the vacuum wavelength of the light that one seeks to couple into and out of the resonator, and h is a magnitude of the evanescent electromagnetic field of the resonator, given by

$$h \approx \lambda/[2\pi(n_d^2-n_p^2)^{1/2}].$$

- In practice, the fabrication process does not yield precisely the desired radius r: instead, it yields a slightly different value, r'. Therefore, after fabrication, in order to ensure phase matching, one must select a new desired mode for which the effective index of refraction is given by

$$n_d = n_p(1-r'/R)^{1/2}.$$

- Intermodal coupling is suppressed by use of what, at the time of writing this article, was reported to be a "single mode technique" but not otherwise described. The technique was reported to be described in "Morphology-dependent photonic circuit elements," *Optics Letters* Vol. 31, Issue 9, page 1313.

This work was done by Andrey Matsko, Lute Maleki, Vladimir Iltchenko, and Anatoliy Savchenkov of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1).

This invention is owned by NASA, and a patent application has been filed. Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to the Patent Counsel, NASA Management Office–JPL. Refer to NPO-45462.

Microwave Temperature Profiler Mounted in a Standard Airborne Research Canister

NASA's Jet Propulsion Laboratory, Pasadena, California

Many atmospheric research aircraft use a standard canister design to mount instruments, as this significantly facilitates their electrical and mechanical integration and thereby reduces cost. Based on more than 30 years of airborne science experience with the Microwave Temperature Profiler (MTP), the MTP has been repackaged with state-of-the-art electronics and other design improvements to fly in one of these standard canisters.

All of the controlling electronics are integrated on a single 4×5-in. (≈10×13-cm) multi-layer PCB (printed circuit board) with surface-mount hardware. Improved circuit design, including a self-calibrating RTD (resistive temperature detector) multiplexer, was implemented in order to reduce the size and mass of the electronics while providing increased capability. A new microcontroller-based temperature controller board was designed, providing better control with fewer components. Five such boards are used to provide local control of the temperature in various areas of the instrument, improving radiometric performance. The new stepper motor has an embedded controller eliminating the need for a separate controller board.

The reference target is heated to avoid possible emissivity (and hence calibration) changes due to moisture contamination in humid environments, as well as avoiding issues with ambient targets during ascent and descent. The radiometer is a double-sideband heterodyne receiver tuned sequentially to individual oxygen emission lines near 60 GHz, with the line selection and intermediate frequency bandwidths chosen to accommodate the altitude range of the aircraft and mission.

This work was done by Michael J. Mahoney and Richard F. Denning of Caltech and Jack Fox of NCAR for NASA's Jet Propulsion Laboratory. For more information, contact iaoffice@jpl.nasa.gov. NPO-46737

Alternative Determination of Density of the Titan Atmosphere

NASA's Jet Propulsion Laboratory, Pasadena, California

An alternative has been developed to direct measurement for determining the density of the atmosphere of the Saturn moon Titan as a function of altitude. The basic idea is to deduce the density versus altitude from telemetric data indicative of the effects of aerodynamic torques on the attitude of the Cassini Saturn orbiter spacecraft as it flies past Titan at various altitudes. The Cassini onboard attitude-control software includes a component that can estimate three external per-axis torques exerted on the spacecraft. These estimates are available via telemetry.

The atmospheric torque vector is the product of (1) a drag coefficient (which is known from ground-based experiment and analysis), (2) the Titan atmospheric density that one seeks to determine, (3) the square of the Titan-relative spacecraft speed (which is known from navigation monitoring), and (4) the projected area of the spacecraft and the offset distance between the center of pressure and center of mass, both of which are known functions of the attitude of the spacecraft relative to the known velocity through the atmosphere. Hence, the atmospheric density is the only unknown and can be determined from the other quantities, which are known.

This work was done by Allan Lee, Jay Brown, Antonette Feldman, Scott Peer, and Eric Wang of Caltech for NASA's Jet Propulsion Laboratory.

Further information is contained in a TSP (see page 1). NPO-44606