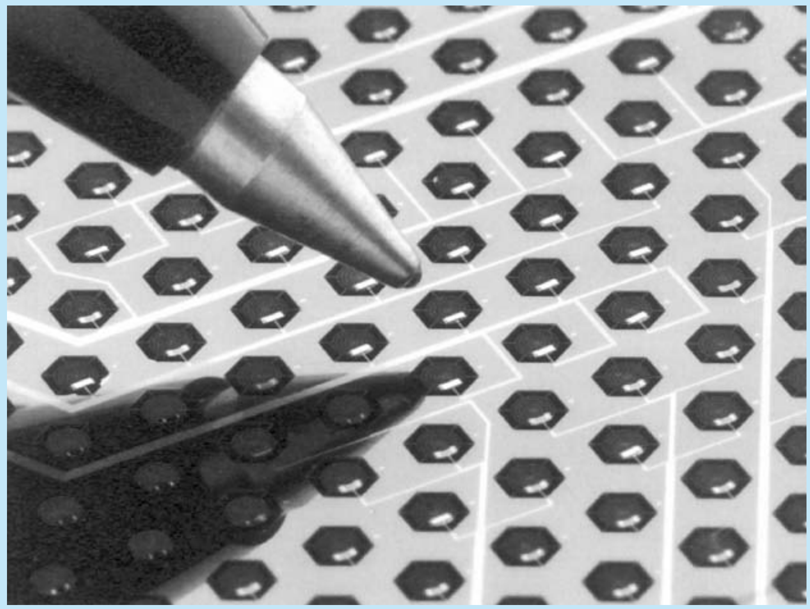
Physical Sciences

Array of Bolometers for Submillimeter-Wavelength Operation

This is a prototype of arrays for astrophysical imaging and photometry.

NASA's Jet Propulsion Laboratory, Pasadena, California

A feed-horn-coupled monolithic array of micromesh bolometers is undergoing development for use in a photometric camera. The array is designed for conducting astrophysical observations in a wavelength band centered at 350 μm. The bolometers are improved versions of previously developed bolometers comprising metalized Si_3N_4 micromesh radiation absorbers coupled with neutron-transmutation-doped Ge thermistors. Incident radiation heats the absorbers above a base temperature, changing the electrical resistance of each thermistor. In the present array of improved bolometers (see figure), the thermistors are attached to the micromesh absorbers by indium bump bonds and are addressed by use of lithographed, vapor-deposited electrical leads. This architecture reduces the heat capacity and minimizes the thermal conductivity to 1/20 and 1/300, respectively, of earlier versions of these detectors, with consequent improvement in sensitivity and speed of response.



This **Array of Micromesh Bolometers** was designed for photometry at a wavelength of 350 μm. Each device includes a 725-μm-diameter micromesh absorber with a grid spacing of 72.5 μm and a grid filling factor of 0.077. A thermistor is located on one side of each absorber and is electrically addressed by two leads deposited on a single 18-μm-wide supporting member. The pixel spacing is 1.75 mm.

The micromesh bolometers, intended to operate under an optical background set by thermal emission from an ambient-temperature space-borne telescope, are designed such that the random arrival of photons ("photon noise") dominates the noise sources arising from the detector and readout electronics. The micromesh is designed to be a highly thermally and optically efficient absorber with a limiting response time of about 100 μs. The absorber and thermistor heat capacity are minimized in order to give rapid speed of response. Due to the minimization of the absorber volume, the dominant source of heat capacity arises from the thermistor.

The array demonstrates a dark noise-equivalent power of $2.9 \cdot 10^{-17}$ W/(Hz)$^{1/2}$ and a mean heat capacity of 1.3 pJ/K at a detector temperature of 0.390 K from a 0.300 K cold plate. The optical efficiency of the bolometer and feedhorn array, measured by comparing the responses to blackbody calibration sources, lies between 0.4 and 0.6. Photon noise dominates over detector noise arising from phonon, Johnson, and amplifier noise, as measured under the design background conditions. The ratio of total noise to photon noise is found to be 1.21 at an absorbed optical power of 2.4 pW. The array shows high stability with excess noise found to be negligible at frequencies as low as 30 mHz.

This work was done by James Bock and Anthony Turner of Caltech for **NASA's Jet Propulsion Laboratory**. *Further information is contained in a TSP (see page 1).*
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Delta-Doped CCDs as Detector Arrays in Mass Spectrometers

Improved performance is obtained with reduced size, mass, and power.

NASA's Jet Propulsion Laboratory, Pasadena, California

In a conventional mass spectrometer, charged particles (ions) are dispersed through a magnetic sector onto an MCP at an output (focal) plane. In the MCP, the impinging charged particles excite electron cascades that afford signal gain. Electrons leaving the MCP can be read out by any of a variety of means; most commonly, they are post-accelerated onto a solid-state detector array, wherein the electron pulses are converted to photons, which, in turn, are converted to measurable electric-current pulses by photodetectors. Each step in the conversion from the impinging charged particles to the output