A standard laser current driver is used to drive a single laser diode. Laser diode current, voltage, power, and wavelength are measured for each laser diode, and a method of selecting the most adequate laser diodes for space deployment is implemented. The method consists of creating histograms of laser threshold currents, powers at a designated current, and wavelengths at designated power. From these histograms, the laser diodes that illustrate a performance that is outside the normal are rejected and the remaining lasers are considered spaceborne candidates.

To perform laser lifetime testing, the facility is equipped with 20 custom laser drivers that were designed and built by California Institute of Technology specifically to drive NuSTAR metrology lasers. The laser drivers can be operated in constant-current mode or alternating-current mode. Situated inside the enclosure, in front of the laser diodes, are 20 power-meter heads to record laser power throughout the duration of lifetime testing.

Prior to connecting a laser diode to the current source for characterization and lifetime testing, a background program is initiated to collect current, voltage, and resistance. This backstage data collection enables the operational test facility to have full laser diode traceablity.

This work was done by Carl C. Liebe, Robert P. Dillon, Ivair Gontijo, Siamak Forouhar, Andrew A. Shapiro, Mark S. Cooper, and Patrick L. Meras of Caltech for NASA's Jet Propulsion Laboratory. For more information, contact iaoffice@jpl.nasa.gov. NPO-47164

Plenoptic Imager for Automated Surface Navigation

John H. Glenn Research Center, Cleveland, Ohio

An electro-optical imaging device is capable of autonomously determining the range to objects in a scene without the use of active emitters or multiple apertures. The novel, automated, low-power imaging system is based on a plenoptic camera design that was constructed as a breadboard system. Nanohmics proved feasibility of the concept by designing an optical system for a prototype plenoptic camera, developing simulated plenoptic images and range-calculation algorithms, constructing a breadboard prototype plenoptic camera, and processing images (including range calculations) from the prototype system.

The breadboard demonstration included an optical subsystem comprised of a main aperture lens, a mechanical structure that holds an array of micro lenses at the focal distance from the main lens, and a structure that mates a CMOS imaging sensor the correct distance from the micro lenses. The demonstrator also featured embedded electronics for camera readout, and a post-processor executing image-processing algorithms to provide ranging information.

This work was done by Byron Zollars, Andrew Milder, and Michael Mayo of Nanohmics, Inc. for Glenn Research Center. Further information is contained in a TSP (see page 1).

Inquiries concerning rights for the commercial use of this invention should be addressed to NASA Glenn Research Center, Innovative Partnerships Office, Attn: Steve Fedor, Mail Stop 4–8, 21000 Brookpark Road, Cleveland, Ohio 44135. Refer to LEW-18525-1.

Maglev Facility for Simulating Variable Gravity

Effects of gravity on thermal fluid systems and small living things can be tested.

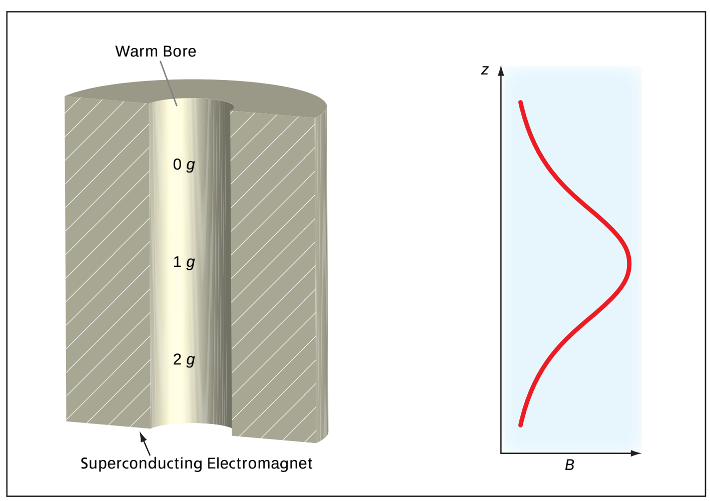
NASA's Jet Propulsion Laboratory, Pasadena, California

An improved magnetic levitation apparatus ("Maglev Facility") has been built for use in experiments in which there are requirements to impose variable gravity (including zero gravity) in order to assess the effects of gravity or the absence thereof on physical and physiological processes. The apparatus is expected to be especially useful for experiments on the effects of gravity on convection, boiling, and heat transfer in fluids and for experiments on mice to gain understanding of bone loss induced in human astronauts by prolonged exposure to reduced gravity in space flight.

The maglev principle employed by the apparatus is well established. The basic equation for equilibrium levitation of a diamagnetic object is

$$|\chi B \nabla_z B / \mu_0| = \rho g,$$

where χ is the magnetic susceptibility of the object, B is the magnitude of the magnetic-flux density, μ_0 is the magnetic permeability of the vacuum, ρ is the mass density of the object, g is the local gravitational acceleration, and $\nabla_z B$ is the vertical gradient of the magnetic field. Diamagnetic cryogenic fluids such as liquid helium have been magnetically levitated for studying their phase transitions and critical



The **Superconducting Electromagnet** generates a static magnetic field with a vertical gradient. For water or other substances of diamagnetism, the gradient magnetic field opposes or aids the gravitational body force by an amount that varies with position along the bore.

behaviors. Biological entities consist mostly of diamagnetic molecules (e.g., water molecules) and thus can be levitated by use of sufficiently strong magnetic fields having sufficiently strong vertical gradients.

The heart of the present maglev apparatus is a vertically oriented superconducting solenoid electromagnet (see figure) that generates a static magnetic field of about 16 T with a vertical gradient sufficient for levitation of water in normal Earth gravity. The electromagnet is enclosed in a Dewar flask having a volume of 100 L that contains liquid helium to maintain superconductivity. The Dewar flask features a 66-mm-diameter warm bore, lying within the bore of the magnet, wherein experiments can be performed at room temperature. The warm bore is accessible from its top and bottom ends. The superconducting electromagnet is run in the persistent mode, in which the supercurrent and the magnetic field can be maintained for weeks with little decay, making this apparatus extremely cost and energy efficient to operate. In addition to water, this apparatus can levitate several common fluids: liquid hydrogen, liquid oxygen, methane, ammonia, sodium, and lithium, all of which are useful, variously, as rocket fuels or as working fluids for heat transfer devices. A drop of water 45 mm in diameter and a small laboratory mouse have been levitated in this apparatus.

This work was done by Yuanming Liu, Donald M. Strayer, and Ulf E. Israelsson of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1).NPO-45886

Hybrid AlGaN-SiC Avalanche Photodiode for Deep-UV Photon Detection

NASA's Goddard Space Flight Center, Greenbelt, Maryland

The proposed device is capable of counting ultraviolet (UV) photons, is compatible for inclusion into space instruments, and has applications as deep-UV detectors for calibration systems, curing systems, and crack detection. The device is based on a Separate Absorption and Charge Multiplication (SACM) structure. It is based on aluminum gallium nitride (AlGaN) absorber on a silicon carbide APD (avalanche photodiode). The AlGaN layer absorbs incident UV photons and injects photogenerated carriers into an underlying SiC APD that is operated in Geiger mode and provides current multiplication via avalanche breakdown.

The solid-state detector is capable of sensing 100-to-365-nanometer wavelength radiation at a flux level as low as 6 photons/pixel/s. Advantages include, visible-light blindness, operation in harsh environments (e.g., high temperatures), deep-UV detection response, high gain, and Geiger mode operation at low voltage. Furthermore, the device can also be designed in array formats, e.g., linear arrays or 2D arrays (micropixels inside a superpixel).

This work was done by Shahid Aslam, Federico A. Herrero, and John Sigwarth of Goddard Space Flight Center and Neil Goldsman and Akin Akturk of The University of Maryland. Further information is contained in a TSP (see page 1). GSC-15604-1

High-Speed Operation of Interband Cascade Lasers

NASA's Jet Propulsion Laboratory, Pasadena, California

Optical sources operating in the atmospheric window of 3–5 µm are of particular interest for the development of free-space optical communication link. It is more advantageous to operate the free-space optical communication link in 3–5-µm atmospheric transmission window than at the telecom wavelength of 1.5 µm due to lower optical scattering, scintillation, and background radiation. However, the realization of optical communications at the longer wavelength has encountered significant difficulties due to lack of adequate optical sources and detectors operating in the desirable wavelength regions.

Interband Cascade (IC) lasers are novel semiconductor lasers that have a great potential for the realization of high-power, room-temperature optical sources in the 3–5-µm wavelength region, yet no experimental work, until this one, was done on high-speed direct modulation of IC lasers. Here, high-speed interband cascade laser, operating at wavelength 3.0 µm, has been developed and the first direct measurement of the laser modulation bandwidth has been performed using a unique, high-speed quantum well infrared photodetector (QWIP). The developed laser has modulation bandwidth exceeding 3 GHz. This constitutes a significant increase of the IC laser modulation bandwidth over currently existing devices. This result has demonstrated suitability of IC lasers as a mid-IR light source for multi-GHz free-space optical communications links.

This work was done by Alexander Soibel, Cory J. Hill, Sam A. Keo, Malcom W. Wright, and William H. Farr of Caltech; Rui Q. Yang of the University of Oklahoma; and H.C. Liu of the Institute for Microstructural Science for NASA's Jet Propulsion Laboratory. For more information, contact iaoffice@jpl.nasa.gov. NPO-46738