Powerful NIST detectors on Hawaiian telescope to probe origins of stars, planets and galaxies

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The world's largest submillimeter camera—based on superconducting technology designed by the National Institute of Standards and Technology (NIST)—is now ready to scan the universe, including faint and faraway parts never seen before.

Mounted on the James Clerk Maxwell Telescope on Mauna Kea in Hawaii, the NIST technology will help accelerate studies of the origins of stars, planets and galaxies.

The new 4.5-ton SCUBA-2 camera, which contains more than 10,000 of NIST's superconducting sensors, is far more sensitive than its predecessor SCUBA (the highly productive Submillimeter Common-Use Bolometer Array), and will enable astronomers to map the sky hundreds of times faster and with a much larger field of view. SCUBA-2 will produce better images and sky maps, image new targets, and support deeper and broader surveys.

The product of an international research collaboration, SCUBA-2 will image objects ranging from comets in the Earth's solar system to galaxies at the far ends of the universe. The camera is sensitive to objects associated with very cold gas and dust clouds, which absorb visible light (and therefore look black to optical telescopes) but emit the barest whiffs of submillimeter radiation—at wavelengths below 1 millimeter, between the microwave and infrared bands. Submillimeter

light oscillates at terahertz frequencies, hundreds of times faster than cell phones.

“The submillimeter is the last frontier in astronomical imaging,” says NIST physicist Gene Hilton, who developed the fabrication method for the NIST instrument. “It’s been very difficult to develop cameras that work at this wavelength, so the submillimeter is largely unexplored. We’re excited to see what SCUBA-2 will reveal.”

SCUBA-2 complements other observatories. For instance, its ability to quickly carry out large-scale surveys could identify targets for high-resolution studies by the Atacama Large Millimetre/submillimetre Array (Alma), an array of radiotelescope dishes recently unveiled in Chile.

The NIST sensors precisely measure submillimeter radiated power using a superconducting metal, molybdenum-copper, that changes resistance in response to heat from radiation. Each tiny but powerful sensor functions as a single pixel in the camera. In sheer numbers of pixels, the NIST instrument is the largest superconducting camera ever made, although its physical size is only about 30 square inches divided into two areas targeting different wavelengths. SCUBA-2 can detect two colors of submillimeter light (at 450 and 850 micrometers).

The NIST sensor arrays are packaged with superconducting amplifiers to boost signal strength. The sensors and amplifiers are cooled to cryogenic temperatures near absolute zero. NIST physicist Kent Irwin, who invented the sensor technology, worked with Hilton and other NIST researchers to develop a way of linking the amplifiers to make large-scale sensor arrays practical, greatly reducing the number of wires between the cryogenic instruments and the room-temperature electronics used to compile the data.

SCUBA-2 is a collaboration of the UK Astronomy Technology Centre in

Edinburgh, Scotland; NIST; four British and Canadian universities; and the Joint Astronomy Centre in Hawaii, which operates the telescope.

More information: For more, see www.stfc.ac.uk/pmc/news.aspx