South Pole telescope detector aids study of the universe

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Center for Nanoscale Materials (CNM) users from Argonne's High Energy Physics and Materials Science divisions helped design and operate part of the South Pole Telescope, a project that aims a large telescope at the night sky to track radiation from the period just after the universe was born. Developing and designing the detectors for the camera required expertise from several Argonne facilities and research divisions, including the expertise and capabilities in CNM's Nanofabrication & Devices Group.

In the wake of the Big Bang, all matter was hot, dense particles and light. As the universe aged, it began to spread and cool, and the intense light from that period traveled across space. The light is still traveling and has a very distinct radiation signature called the cosmic microwave background. Mapping the cosmic microwave background can reveal information about dark matter and dark energy, which are thought to make up 95% of the universe. Dark energy affects the way galaxy clusters form. By comparing the distribution of distant galaxy clusters with the distribution observed nearby, scientists can decode the role dark energy plays in the universe.

The majority of cosmic microwave background radiation has wavelengths of 1-2 mm. These photons are absorbed by water, so a dry, flat and preferably cold space is needed to capture them. The South Pole is one of only two ideal locations on Earth. The South Pole telescope is more than 30 feet across, and Argonne scientists helped build its camera. Detectors for the camera were developed and designed with expertise from several Argonne facilities and research divisions.

At the core of the detector technology is a thin—at the nanoscale—superconducting film comprised of Mo/Au bilayer-based heterostructures modified with superconducting (niobium) and normal (gold) metal stripes. Superconductors can carry an electrical charge perfectly and are highly sensitive to changes in temperature. When thermal radiation from the cosmic microwave background hits the camera, it heats the material slightly, changing the conductivity of the film. The energy coming from that particular part of the sky is then recorded.

More information: D. Hanson et al., "Detection of B-Mode

Polarization in the Cosmic Microwave Background with Data from the South Pole Telescope," Phys. Rev. Lett., 111, 141301 (2013)

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