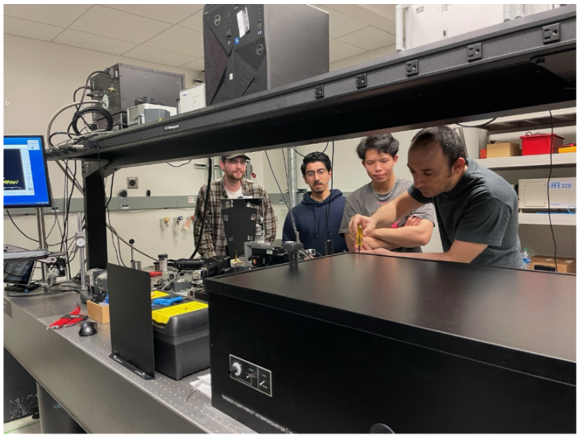
New NSF-funded advanced spectroscope enters operation at UCLA

Brillouin-Mandelstam light scattering spectroscopy profiles fundamental phenomena, with applications in materials science and biomedical research

By Wayne Lewis



At the new Brillouin – Mandelstam Light Scattering Spectroscopy Facility, graduate students Dylan Wright, Erick Guzman and Xuke Fu watch research engineer Fariborz Kargar aligning the optical system.

Investigators at UCLA and beyond can gain access to a new, advanced spectroscopy device supported by the National Science Foundation. The Brillouin – Mandelstam Light Scattering Spectroscopy (BMS) Facility, housed at the California NanoSystems Institute at UCLA, makes it possible to analyze extremely small, atomically thin samples across a wide range of temperatures, from cryogenic to above room temperature.

With an integrated micro-Brillouin – Mandelstam – Raman spectrometer system, scientists and engineers can measure energies of elemental excitations, such as phonons and magnons, in a variety of materials. The data obtained facilitates the synthesis and characterization of new materials, as well as studies in biomedical science. Directed by Alexander Balandin, distinguished professor of materials science and engineering at the UCLA Samueli School of Engineering, the facility provides these capabilities to researchers on campus, from other academic institutions or in private industry.

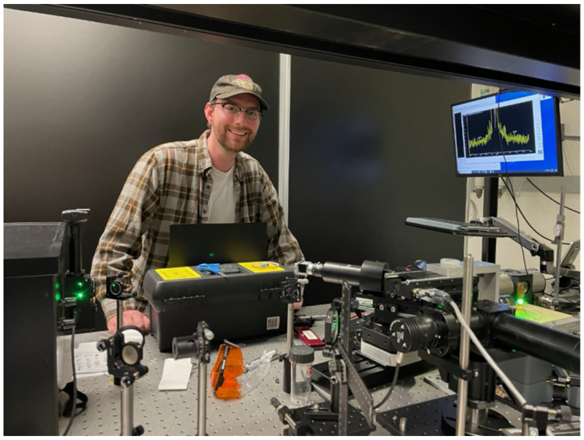
The advanced features of the BMS Facility include a specially designed rotating microscopy stage and imaging system for measurements over a wide range of temperatures (4 K to 700 K).

"The capability of conducting measurements at low temperatures is particularly important for studying quantum, magnetic, spintronic, superconducting and topological materials," Balandin said. "At the same time, Brillouin light scattering spectroscopy is becoming increasingly popular for biological and medical applications."

The new instrument offers a number of new capabilities:

- high spatial resolution for samples with atomic thickness, with lateral dimensions under a micrometer;
- detection of phonon and magnon energies substantially below the current limit of conventional spectrometers;
- a rotating stage with high spatial and temporal resolution allowing for measurements of energy dispersion of the elemental excitations;
- quantitative, label-free capacity to measure the mechanical properties of soft materials including biological cells; and
- analysis with lower-powered lasers amenable to the study of living samples.

In addition to fundamental studies of low-dimensional materials, the instrument can interrogate the strength of magnon-phonon and spin-lattice interactions in magnetic materials. Researchers also gain access to elastic constants, phonon velocities, and Gruneisen parameters in materials, as well as charge density waves in quantum materials. The information about acoustic phonons provided by the instrument can be used to predict the mat erial's heat conduction properties.



Graduate student Dylan Wright performs spectroscopy to study acoustic phonons in ultra-wideband gap semiconductors at the new Brillouin – Mandelstam Light Scattering Spectroscopy Facility.

"In recent years, it became clear that micro-Brillouin spectroscopy is also an emerging tool for mechanobiology," Balandin said. "This type of inelastic light scattering spectroscopy, provided by our instrument, is becoming popular as a nondestructive and contact-free method that allows one to probe the viscoelastic properties of biological samples with diffraction-limited resolution. It can help to determine cells' stiffness, elasticity, and other characteristics important for a range of medical applications."

The construction of the instrument was made possible with National Science Foundation funding via a Major Research Instrumentation Development award. Balandin, the principal investigator, and co-principal investigator Fariborz Kargar of Auburn University proposed the design and oversaw the development conducted with the help of graduate students in the Balandin group.

For more information on the instrument's capabilities and use, please visit the Balandin group contact page or read about the technique details in their recent paper "Advances in Brillouin – Mandelstam light-scattering spectroscopy" published in Nature Photonics.

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