



Physical Sciences at ORNL

Oak Ridge National Laboratory's (ORNL's) Physical Sciences Directorate (PSD) has a mission to deliver scientific discoveries and technical breakthroughs needed to realize solutions in energy and national security and provide economic benefit to the nation. Our portfolio includes materials, chemistry, nanoscience, and nuclear and particle physics, and spans the research spectrum from fundamental science to technology attaining high readiness levels. Our research provides cross-cutting foundational knowledge to enable missions across ORNL directorates. Our expertise aligns with the Laboratory's scientific activities and initiatives, particularly in the areas of computational and data sciences, and we are committed to leading the world in neutron scattering research for materials and chemical sciences.

From Innovation to Impact

PSD has primary responsibility for accelerating the discovery, design, and application of new materials and chemical processes for energy. Our research spans disciplines representing ORNL's strengths.

- **Innovative materials and chemistries**—We couple basic and applied research with state-of-the-art synthesis, characterization, and computation to deliver a wide range of materials designed with tailored properties. Core expertise includes novel structural materials, chemical and isotope separations, energy production and storage, and materials for extreme environments.
- **World-leading tools for science**—We use and develop advanced characterization techniques that deliver highly innovative materials and chemical science solutions for real-world applications and advance nuclear analytical capabilities to support national strategic goals.
- **Knowledge at the quantum level**—We harness quantum mechanics to understand nuclear, chemical, and material properties that govern quantum materials and to develop quantum devices and sensors with exquisite performances and sensitivities.
- **Advancing theory**—We use theory, modeling, and simulation to enable the design of new materials with superior properties to address the world's energy and national security needs, provide insights into chemical properties of matter, and enable descriptions of nuclei and stellar nucleosynthesis.
- **Fundamental to applied physics**—We search for extremely rare decays and minute physical effects to advance our fundamental understanding of nature and help solve the puzzle of why the universe has more matter than antimatter. We also study the behavior of nuclei under extreme conditions and develop nuclear physics-based detectors and techniques that enable high-resolution nondestructive imaging. Additionally, we develop data science methods founded in first-principles physics to advance state-of-the-art capabilities in the field.



“We solve fundamental science challenges and advance technological solutions to enable a resilient and secure energy future.”

Cynthia Jenks, Associate Laboratory Director
Physical Sciences Directorate



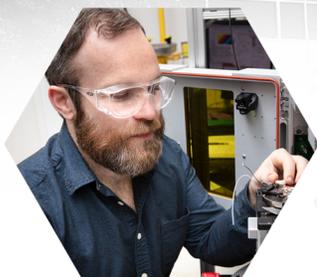
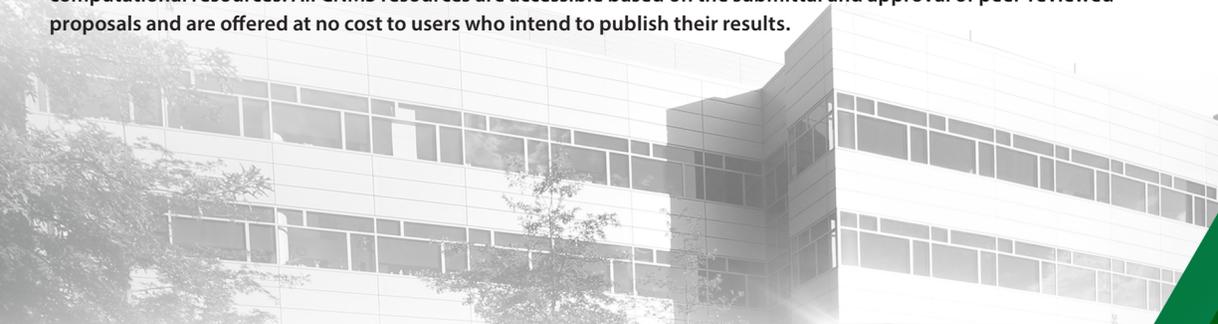
Programmatic and Technical Leadership

PSD provides leadership at ORNL for the US Department of Energy's (DOE's) Basic Energy Sciences program, including research for the Materials Sciences and Engineering Division; the Chemical Sciences, Geosciences, and Biosciences Division; and the Scientific User Facilities Division. PSD also provides leadership of ORNL programs supported by the DOE Offices of Nuclear Physics and High Energy Physics. PSD is home to the Center for Nanophase Materials Sciences (CNMS), one of five DOE-BES Nanoscale Science Research Centers.



Parans Paranthaman, a researcher in the Chemical Sciences Division, coordinated research efforts to study the filter efficiency of N95 material, outlining the science behind ORNL's successful production of the material in response to the COVID-19 pandemic.

CNMS provides a national and international user community access to expertise and instrumentation for a broad range of nanoscience research including nanomaterials synthesis; nanofabrication; imaging, microscopy, and characterization; and theory, modeling, and simulation. CNMS also acts as gateway for the nanoscience community to benefit from ORNL's neutron scattering facilities (Spallation Neutron Source and High Flux Isotope Reactor) and computational resources. All CNMS resources are accessible based on the submittal and approval of peer-reviewed proposals and are offered at no cost to users who intend to publish their results.



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