

New X-ray Light Sources, Innovative Pressure Platforms, and Advances in AI: Opportunities for High-Pressure Research

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Abstract

Large Large-scale X-ray light sources have long been integral to high-pressure research, and major upgrades and new facilities are currently being developed and commissioned around the world. Over the last four years, the Advanced Photon Source (APS) has undergone a transformative upgrade, delivering a state-of-the-art storage ring with significantly increased brightness and improved beam coherence. Concurrently, the High Pressure Collaborative Access Team (HPCAT), a dedicated high-pressure research facility at APS, has implemented substantial upgrades and introduced new experimental capabilities.

HPCAT has also developed and deployed a range of advanced pressure platforms that expand accessible pressure-temperature conditions, enable a broader range of compression rates, and provide opportunities for complex loading paths that can be coupled with cutting-edge X-ray characterization techniques. At the same time, the rapid emergence of artificial intelligence is beginning to transform many aspects of scientific research, from experiment design and autonomous data collection to analysis, interpretation, and discovery.

This presentation will provide an overview of recent developments at APS and HPCAT, highlight selected scientific achievements enabled by these new capabilities, and discuss emerging opportunities and strategic directions for the high-pressure research (at HPCAT and across the broader community) in the coming decade.