CSU PHYSICS COLLOQUIUM

"Exploring the most Extreme Conditions of Matter with ultra-bright X-rays"

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Abstract

Normally, what surrounds us are gases, liquids, or solids. But elsewhere in the universe, 99% of the observable nature exists under extreme conditions that lead to exotic states of matter and the formation of plasmas. Specifically, near the center of Jupiter, hydrogen becomes liquid or even solid - a process important to understand the evolution of our solar system. In the center of the sun, hydrogen is a plasma that burns itself up by nuclear fusion - a process humans want to harness for clean energy production on earth. In the mantle of Neptune, hydrogen and carbon cannot mix and are postulated to form giant diamonds – a process that can explain Neptune's excess heat generation. On the other hand, very hot plasmas are postulated to eject particles that we can observe as cosmic rays and that are a million times more energetic than produced by mankind's largest machines. At SLAC, we are now studying these extreme states of matter in the laboratory. We apply enormous pressures to earthbound samples and use our X-ray laser, the Linac Coherent Light Source (LCLS), to take split-second photographs of the states that result. This lecture will describe these experiments. The information we are gathering provides fundamental insights into the physical properties of matter in extreme conditions whose understanding is important for modeling astrophysical processes and for the pursuit of controlled fusion. To further advance this field, new high intensity petawatt lasers are urgently needed to produce high-energy ion and neutron beams for experiments in combination with LCLS. This new facility upgrade has been proposed and has recently been reviewed and endorsed by the US user community.

Biography

Siegfried Glenzer is professor in the photon science faculty and the director of the high energy density science division at SLAC National Accelerator Laboratory. He joined SLAC as a distinguished scientist in 2013 to build a new program exploring matter in extreme conditions using high-power lasers and the Linac Coherent Light Source, SLAC's X-ray laser.

Glenzer performed his undergraduate and graduate studies at the Ruhr University in Bochum, Germany, where he received his PhD in 1994. He then went to Lawrence Livermore National Laboratory as a postdoctoral fellow and, in time, became the laboratory's group leader for plasma physics. At Livermore, he led the first inertial confinement fusion experiments on the National Ignition Facility. He has been a visiting lecturer at the University of California, Berkeley, and an Alexander von Humboldt senior fellow at the University of Rostock and the Deutsche Elektronen Synchrotron (DESY) in Hamburg, Germany. Glenzer authored and co-authored over 550 journal publications and a textbook on Thomson scattering. He is a fellow of the American Physical Society and was awarded the society's 2003 and 2022 John Dawson Award for Excellence in Plasma Physics Research. In 2014, he received the Ernest O. Lawrence Award of the U. S. Department of Energy. In 2019, 100 years after Einstein and Planck, he received the honorary Ph.D. from the University of Rostock, and in 2021 he was nominated courtesy professor for Mechanical Engineering at Stanford University.