CSU PHYSICS COLLOQUIUM

"Relativistic nanophotonics: creating extreme plasma conditions and fields with ultrafast lasers"

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Monday, Dec. 2nd at 4:00 p.m.

120 Engineering (Hammond Auditorium)

Abstract

Efficient heating of dense matter to extreme temperatures and pressures could create solid density environments in which heavy atoms such as gold are stripped of most of their electrons. Such ultra high energy density environments exist in the center of starts but are difficult to create in the laboratory. Using one of the world's most intense lasers, ALEPH (Advance Laser for Extreme Photonics) developed at CSU, we have demonstrated that high contrast femtosecond laser pulses of relativistic intensity can volumetrically heat solid density matter into a new ultra-hot plasma regime. Electron densities more than 100 times greater than the critical density with temperatures of several hundred million degrees are achieved heating aligned nanostructures [1] with ultrashort laser pulses of < 10 Joule energy. Extraordinarily high degrees of ionization (e.g. 72 times ionized Au^{+72}) are observed with gigabar pressures. Return currents induced through the nanowires by the laser pulse creates quasi-static Giga-Gauss magnetic fields [2]. The large electron density combined with the large plasma volume results in record 20 percent conversion efficiency into picosecond x-ray pulses [3]. In a different set of experiments the acceleration of deuterons from CD_2 nanowire arrays to multi-MeV energies resulted in quasi-monochromatic fusion neutron production 500 times larger than that obtained irradiating flat solid targets of the same material [4]. 3-D particle-in-cell simulations that aid the understanding of the physics of relativistic laser pulse interactions with nanostructures will be discussed.

Biography

Jorge Rocca is a University Distinguished Professor in the Departments of Electrical and Computer Engineering and in the Department of Physics at Colorado State University. His research interests are in the physics and development high power lasers, x-ray lasers, and the study of high intensity laser interactions with matter. He has published more than 250 peer-review journal articles that have been cited more than 12,000 times in Google Scholar. Prof. Rocca received the Arthur. L. Schawlow Prize in Laser Science from the American Physical Society in 2011, and the Willis Lamb Prize for Laser Science and Quantum Optics in 2012. He is a Fellow of the American Physical Society, the Optical Society of America, and the IEEE. He also received an IEEE LEOS Distinguished Lecturer Award. Early in his career he was an NSF Presidential Young Investigator.

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