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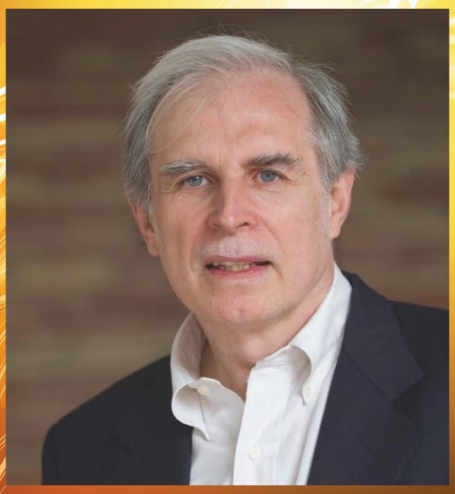

Wednesday
September 30, 2020
3:30 pm

Prof. Jorge J. Rocca

Colorado State University

Relativistic Nanophotonics: Creating Extreme Plasma Conditions and Fields with Ultrafast Lasers

Ultra-high-energy-density (UHED) matter (>10^8 J cm^{-3}, >10^9 bar) is encountered in the center of stars but is difficult to create in the lab. We show that irradiation of high aspect-ratio aligned nanowire arrays with ultra-high contrast Joule-level fs laser pulses provides nearly complete absorption and enhanced light penetration into near-solid density targets, and allows volumetric heating into the UHED regime. Using ALEPH (Advance Laser for Extreme Photonics), a PW laser at CSU, we demonstrate that fs laser pulses of relativistic intensity volumetrically heat near-solid density plasmas to multi-keV temperatures, with pressures surpassed in the lab only in the hot-spot of fusion plasmas. The physics of relativistic laser pulse interactions with nanostructures and promising applications will be reviewed. Electron densities >100x that of the critical density are achieved. Extraordinarily high degrees of ionization (e.g., Au^{+72}) occurs at solid densities using laser pulses of <10 J, producing return currents through the nanowires that create giga-Gauss magnetic fields. The large electron density and plasma volume produce 20% energy conversion into ps x-ray pulses. Acceleration of deuterons from nanowire arrays to multi-MeV resulted in quasi-monochromatic fusion neutron production 500x that of irradiating flat sold targets. 3-D PIC simulations of relativistic laser pulse interactions with nanostructures will be discussed.

About the Speaker: Dr. Jorge Rocca is a University Distinguished Professor in the Electrical and Computer Engineering and Physics Departments at Colorado State U. His research interests are in the physics and development of compact X-ray lasers and their applications; the development of high power lasers, and the study of high power laser interactions with matter. His group is known for the development of the first bright table-top soft X-ray lasers, and their applications to nanotechnology and the diagnostics of dense plasmas. His group has developed a multi-Hz PW-class laser, and kW-level average power, high pulse energy picosecond solid state lasers. Prof. Rocca has 270 peer review journal papers. He received the Arthur L. Schawlow Prize in Laser Science from the APS, and the Willis E. Lamb Award for Laser Science and Quantum Optics. He is Fellow of APS, OSA and IEEE. He received an IEEE LEOS Distinguished Lecturer Award. Early in his career, he was a National Science Foundation Presidential Young Investigator.