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Creating X-ray laser beams and ultra-high energy density matter on a table-top JORGE ROCCA, Colorado State University — Intense soft x-ray laser beams and a new ultra-hot matter regime can both be created by irradiating materials with ultrafast pulses from compact optical lasers. Rapid transient heating creates highly ionized plasmas in which soft x-ray radiation is amplified into powerful laser beams. Advances in ultrafast solid state lasers now make it possible to create these plasmas at up to 100 Hz repetition rate, resulting in the table-top generation of high average power soft x-ray laser beams. These compact soft x-ray lasers can modify, analyze, and image matter with nano-scale resolution. We have also recently demonstrated that trapping of femtosecond optical laser pulses of relativistic intensity deep within ordered nanowire arrays can volumetrically heat dense matter into a new ultra-hot plasma regime. Near solid density arrays of metallic nanowires were heated to multi-keV temperatures using laser pulses of only 0.5 J energy. We obtained extraordinarily high degrees of ionization (eg. 52 times ionized Au), and gigabar pressures only exceeded in the central hot-spot of highly compressed thermonuclear fusion plasmas. These plasmas are efficient emitters of hard x-ray radiation. Scaling to higher laser intensities promises to create plasmas with temperatures and pressures approaching those in the center of the sun. Work supported by U.S Department of Energy, the National Science Foundation, and the Defense Threat Reduction Agency.

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