Physics Seminar

Compact high repetition rate soft x-ray lasers:

a doorway to high intensity coherent soft x-ray science on a table-top

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This talk will review recent advances in high repetition rate soft x-ray lasers that allow the generation of very high brightness soft x-ray beams using table-top set ups. The peak spectral brightness of some of these new lasers can surpass that of third generation synchrotrons by orders of magnitude in the 25-100 eV photon energy region, enabling new applications. These advances include the demonstration of 5 Hz repetition rate table-top soft x-ray lasers producing intense beams at wavelengths ranging from 13.2 to 32.6 nm, and the observation of lasing at wavelengths down to 10.9 nm. The results were obtained by collisional electron impact excitation of highly ionized atoms in dense plasmas efficiently heated with picosecond optical laser pulses of only 1 J energy. The recent seeding of these soft x-ray laser amplifiers with high harmonic pulses has further increased their brightness and has generated laser pulses with essentially full spatial and temporal coherence at these wavelengths. In a separate development, the first of a new generation of extremely compact desk-top size capillary discharge soft x-ray lasers was demonstrated. It emits intense pulses of λ=46.9 nm light at 10 Hz repetition rate producing an average power of ~0.15 mW. The laser occupies a table area of about 0.4×0.4 m^2.

These new compact lasers are allowing a number of table-top experiments with intense soft x-ray light. These include the demonstration of broad area imaging with resolution down to 38 nm, nanoscale ablation of material, single photon ionization spectroscopy of molecules and nanoclusters, the metrology for the fabrication of the future generations of microprocessors using extreme ultraviolet lithography, and the diagnostics of dense plasmas by soft x-ray laser interferometry. Moreover the compact size of these new laser sources promises to make intense coherent soft x-ray light widely available, opening doorways to intense coherent soft x-ray science experiments on a table-top and to the development of new nanoscale metrology and processing tools for industry.

Questions? email: jan.chaloupka@unco.edu