High-Intensity Coherent Vacuum Ultraviolet Source Using Unfocussed Commercial Dye Lasers

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ABSTRACT

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Using two or three commercial pulsed nanosecond dye lasers pumped by a single 30 Hz Nd:YAG laser, generation of 0.10 mJ pulses at 125 nm (6 x 10^{13} photons/pulse) has been demonstrated by resonance enhanced four-wave mixing of collimated (unfocussed) laser beams in mercury (Hg) vapor. Phase matching at various VUV wavelengths is achieved by tuning one laser in the vicinity of the $6\ ^1S_0 \rightarrow 6\ ^3P_1$ resonance near 253.1 nm. A number of different mixing schemes are characterized. Our observations using broadband lasers (~0.15 cm^{-1} bandwidths) are compared to previous calculations pertaining to four-wave mixing of low intensity laser beams. Prospects for further increases in pulse energies are discussed. We find that VUV tuning curves and intensities are in good agreement with theoretical predictions. The utility of the VUV light source is demonstrated by "soft universal" single-photon VUV ionization in crossed molecular beams studies and for generation of light at 130.2 nm for oxygen atom Rydberg time-of-flight (ORTOF) experiments.