TABLE-TOP TIME-RESOLVED X-RAY SPECTROSCOPY USING A LASER PLASMA X-RAY SOURCE AND TRANSITION-EDGE SENSORS

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We present a table-top instrument capable of ultrafast time-resolved x-ray absorption spectroscopy (TR-XAS) and emission spectroscopy (TR-XES). A laser plasma source provides better than 6 ps time resolution, while superconducting transition-edge sensor (TES) microcalorimeters are used for efficient, broadband, high-energy resolution x-ray detection. With TR-XAS, we have studied the photoreduction of ferrioxalate, supporting a framework in which the reduction of the central ion is complete within 100 ps and contradicting a theory in which the photoreduction occurs on much longer timescales. With TR-XES, we have studied spin cross-over in photoexcited iron tris-bipyridine and accurately measured the lifetime of the quintet state from simultaneous observation of Kα and Kβ features. The x-ray source and detector are currently being upgrading to enable new capabilities and probe chemical dynamics with increased time and energy resolution. Upgrades to the laser plasma source will result in a 10-40x improvement in the x-ray flux and time resolution on the order of 100s of fs. The energy resolving TES microcalorimeter will also be upgraded to achieve a 2x improvement in the energy resolution. The end result will be a laboratory tool capable of ultrafast time-resolved x-ray spectroscopy, with time resolution previously achievable only at free electron lasers.