X-ray Scattering Studies of Electron Dynamics in Strongly Correlated Electron Systems: From Femto-seconds to Minutes

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Synchrotron x-rays offer an unparalleled probe of electron dynamics in strongly correlated electron systems. In this talk, I will present a number of examples of this. First, recent resonant inelastic x-ray scattering (RIXS) results from the cuprates are discussed. In particular, a previously unobserved mode in the excitation spectrum of $La_{2-x}Sr_xCuO_4$ and Nd_2CuO_4 at 500 meV is reported. The mode is peaked around the (π, 0) point in reciprocal space and is observed to soften, and broaden, away from this point. Samples with x=0, 0.01, 0.05, and 0.17 were studied. The new mode is found to be rapidly suppressed with increasing Sr content and is absent at x=0.17, where it is replaced by a continuum of excitations. This mode is only observed when the incident x-ray polarization is normal to the CuO planes and the polarization of the scattered photon is found to be rotated by 90 degrees. In the second half of the talk, I will discuss the use of coherent soft x-rays to probe dynamics at a much longer time scale – specifically minutes. An example will be shown in which the dynamics of orbital domains are studied on warming through the orbital order transition in $Pr_{0.5}Ca_{0.5}MnO_3$. The domains are observed to be static and short range ordered at low temperatures. On warming through the transition, a small dynamic component is observed with a decay time of several minutes. Finally, I will conclude with a brief discussion of NSLS-II, the new synchrotron to be built at Brookhaven National Laboratory. The ultra-high brightness of this new source will greatly facilitate the study of dynamics and I will give a number of examples of instruments to be built there.