Resonant Inelastic Soft X-ray Scattering Applied to Free Atoms and Molecules

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Resonant inelastic X-ray scattering (RIXS) reflects fine details in electronic structure and dynamics. The process is site specific on the atomic length scale (sub-nanometer) and time specific on the timescale for nuclear and electronic rearrangements (femto- to attoseconds). Consequently, RIXS spectroscopy has a tremendous potential in atomic and molecular, chemical and condensed matter physics. RIXS techniques have, however, suffered from the lack of adequate radiation sources. In practice this has limited the spectral quality and only a fraction of the inherent advantages have been exploited.

Here RIXS spectra of free molecules (O_2 and CO_2) with an energy resolution ($E/\Delta E \sim 10000$) that allows for separation of individual vibrational excitations [1] are presented. This opens a wealth of new possibilities, provides detailed information about ultrafast dynamics, and facilitates accurate mapping of the final state potential surfaces.

The measurements were made with the SAXES spectrometer [2] at the ADRESS beamline [3] at the Swiss Light Source of the Paul Scherrer Institut, using a gas/liquid cell with an ultrathin membrane. The data is discussed in terms of *ab-initio* multimode scattering calculations.

RIXS opportunities at soft X-ray free-electron-lasers are briefly discussed, with emphasis on non-linear processes such as multi-photon excitations, stimulated RIXS and four-wave mixing [4].

References

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