New Opportunities in Fundamental Atomic Physics, Solid State Theory and Experiment and Synchrotron Science, including Discovery of new satellites using extended range High Energy Resolution Fluorescence Detection

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The fundamental process at the heart of X-ray Emission Spectroscopy [XES], after the absorption of a photon which leaves the atom in an excited state, is the subsequent emission of photons of varying energies dependent on the electronic structure of the atom. Recent highlights include Theory and Measurement of plasmon-coupling [1]; XES for fluorescence and self-absorption [2,3]; X-ray Absorption Spectroscopy [XAS] for binary crystals [ZnSe] and Thermal Diffuse Scattering [4]; and XAS for high resolution nanostructure of Zn [5,6,7].

Many-body processes can occur during absorption and relaxation which result in satellite structures, which distort the spectra and limit the detailed insight from X-ray Absorption Spectroscopy. Identification and characterisation of many-body processes can shed light on these spectra and how to interpret them, and hence how to measure the dynamical nanostructure observable with these technologies. Resonant Inelastic X-ray Scattering and High Energy Resolution Fluorescence Detection have recently developed as high-resolution fields of X-ray Spectroscopy and very powerful probes for bonding, nanostructure and oxidation state. Currently unavailable in Australia, we report recent COVID measurements in the UK, and report the discovery of a new satellite in manganese using the technique, which we call extended range High Energy Resolution Fluorescence Detection, XR-HERFD. This is foundational for many future studies and for novel X-ray spectroscopy. Identification and characterisation of many-body processes will shed light on analysis approaches and structure observed in major experimental techniques, and a new light on Mn.

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