Measuring fundamental properties of dense plasmas on X-ray Free-Electron Lasers

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The past few years have seen a revolution in the field of X-ray science. The advent of the world's first hard X-ray free-electron laser (FEL) – the Linac Coherent Light Source free-electron laser at SLAC – in one step in 2009 increased the spectral brightness of X-ray sources over that of any synchrotron on the planet by a factor of a billion. Spatially coherent, monochromatic, femtosecond X-ray pulses can now be routinely produced over a wide spectral range, enabling access to spatial and temporal scales of atomic processes in plasmas simultaneously for the first time. Importantly, focused FEL pulses are intense enough to create solid-density plasmas at temperatures of several 100 eV on ultra-short, inertially confined timescales, akin to the conditions found half-way into the centre of the sun [1]. The capability of creating such systems in a controlled manner has allowed for the first detailed measurements of several fundamental properties of dense plasmas, such as the ionization potential depression [2,3] and electron collisional ionization rates [4]. Here I will discuss some of these advances and show how obtaining accurate experimental data in the notoriously challenging dense-plasma regime is needed to advance our understanding of systems of crucial importance to a range of astrophysical and inertial confinement fusion investigatio

References

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