P03

Modelling non-thermal XFEL heating of solids

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Over the past two decades, X-ray free-electron lasers (XFELs) have made significant progress, achieving peak brightness in the XUV and X-ray regions that were previously only attainable in the optical and infrared ranges. This advancement has opened up new possibilities in high-energy density science. It enables the creation of solid-density plasmas with larger volumes, greater uniformity, and well-defined properties, including temperature and density.

To better comprehend experimental results, such as x-ray spectra, Collisional Radiative Models (CRM) have been extensively employed. This study focuses on simulating middle Z materials, specifically transition metals when subjected to XFEL irradiation. For this purpose, simulations have been carried out using BigBarT.

BigBarT is a CRM, already validated for the calculations of thermal opacities [1], that incorporates self-consistent treatment of the non-thermal effects in electronic distribution [2] together with degeneracy in the continuum electrons. These tools together will lead to a better understanding of collisional processes in extreme conditions relevant to inertial fusion and compact astrophysical objects.

[1] A. G. de la Varga, P. Velarde, High Energy Density Physics **7**, 163-168 (2011).
[2] A. G. de la Varga, P. Velarde, High Energy Density Physics **9**, 542-547 (2013).