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Non-thermal evolution of dense plasmas driven by intense x-ray fields

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The advent of x-ray free-electron lasers (XFELs) has enabled a range of new experimental investigations into the properties of matter driven to extreme conditions via intense x-ray-matter interactions. The femtosecond timescales of these interactions lead to the creation of transient high-energy-density plasmas, where both electrons and ions may be far from local thermodynamic equilibrium (LTE). Predictive modelling of such systems remains challenging because of the substantially different timescales on which electrons and ions thermalize, and because of the vast number of atomic configurations that are required to describe the resulting highly-ionized plasmas. Here we present work discussing the evolution of systems driven to high energy densities using CCFLY, a non-LTE, Fokker-Planck collisional-radiative code. We use CCFLY to investigate the evolution dynamics of a solid-density plasma driven by an XFEL, and explore the relaxation of the plasma to local thermodynamic equilibrium on femtosecond timescales in terms of the charge state distribution, electron density, and temperature.

Reference

S. Ren, Y. Shi, Q.Y. van den Berg, M. Firmansyah, H.-K. Chung, E.V. Fernandez-Tello, P. Velarde, J.S. Wark, S.M. Vinko, arXiv:2208.00573 (2023).

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