Analysis of the X-ray emission from well-characterized, NLTE, mid- and high-Z laser-produced plasmas

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Multicharged ions are present in hot dense plasmas and rule the radiation transport in numerous environments, like stellar atmospheres, or plasmas used for inertial confinement fusion. In the past years, non local-thermodynamic-equilibrium (NLTE) collisional-radiative models, often based on the superconfiguration description of the atomic levels, have widely progressed for the calculation of spectra emitted by multi-charged mid-Z ions but several discrepancies still remain. Benchmarking by well-diagnosed experiments is thus still needed for the validation of such codes. In past years, several experiments have been performed at LULI aiming to validate atomic kinetic codes. We concentrated our efforts to testing and enhancing reliability of hydrodynamic diagnostics, beside spectroscopic diagnostics, to fully characterize the plasma emissive region. The hydrodynamic diagnostics permit to constrain hydro-radiative codes, which can then be used as input data for atomic kinetic codes.

In the experiment described in this talk, we irradiated Nb and Ta dots with the two frequency doubled, 1.5 ns duration beams of the LULI2000 laser facility to reach an intensity on target of about $2\cdot10^{14}$ W/cm^2. A conical crystal spectrometer allowed the measurement of the Nb L-shell and Ta M-shell emission, in the 2.5-2.9 keV spectral range. Time-resolved Thomson scattering diagnostics measured the electronic density and temperature, and a rear-face self-emission diagnostic measured the shock speed in the solid. These hydrodynamic measurements have been used to constrain the 1-D MULTI hydro-radiative code. The atomic physics code FLYCHK has then been used as a post-processor of the hydrodynamic code, to reproduce the experimental X-ray spectra. We have also performed more sophisticated 2-D hydro-radiative simulations with the FCI2 code, showing a global coherence with the measured data with no need of laser parameter adjustment. NLTE spectra calculations with the atomic physics code AVERROES have also been realized to have deeper insight in the experimental measurements. The results of these analyses will be presented.