MODELING M-SHELL X-RAY EMISSIONS OF XENON IN INTENSE LASER-PRODUCED XENON CLUSTER PLASMAS*

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When femto-second laser pulses with intensities in excess of 10^{19} W/cm^2 interact with clusters of Xe atoms, a complicated propagation and ionization dynamics takes place. For example, highly amplified line emissions have been observed at and around 2.86 Å in plasmas that were created by this dynamics[1]. One possibility for producing such amplifications that involves the Ni-like ionization stage of xenon has recently been investigated[2] and shown to produced gain coefficients comparable to those seen experimentally under a specific set of assumptions. The ionization dynamics by which this amplification is achieved is yet to be fully understood and correlated to measured x-ray outputs from these experiments. Xe M-shell ions emit x rays into three well separated x-ray wavelength regions. Emissions that fill n=2 hole states lie in the 2.5-3.1 Å region, n=4 to n=3 transitions lie in the 9-20 Å region, and n=4 to n=4 transitions lie in the 100-130 Å region. All have been observed, and in a transition at 99.8 Å, a Ni-like amplified emission was observed[3]. One goal of the work described in this talk is to correlate the three emissions occurring in the Ni-like ionization stage of xenon to the time dependent evolution of the Xe plasma. In this work, we study Xe's ionization dynamics both from the points of view of molecular dynamics[4] calculations (MD) and of hot-spot (HS) rate equation cluster calculations. A second goal of this work is to compare and to correlate these two sets of calculations. From the MD calculations, electron distribution functions, heating rates, the cluster expansion dynamics, free-free x-ray energy losses, and approximate cluster ionization rates are calculated that are inclusive of tunneling ionization. From the HS calculations, x-ray loss rates, x-ray spectra, heating rates, and ionization rates are calculated. Outputs like expansion rates from MD calculations will be used as inputs to the HS calculations. Similarly, outputs like bound-bound and bound-free x-ray loss rates from HS calculations will be used as inputs to the MD calculations. The MD and HS dynamics surrounding the Ni-like ionization stage are studied and benchmarked against each other and against measured x-ray spectra.

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