§14. Time-dependent H-like and He-like Al Lines Produced by Ultra-short Pulse Laser

Kato T., Kato M.
Shepherd R., Young B., More R., Osterheld A. (Lawrence Livermore National Laboratory, U.S.A.)

Numerical modeling of time-resolved x-ray spectra from thin foil targets heated by the LLNL Ultra-short pulse (USP) laser has been performed. The targets were aluminum foils of thickness ranging from 250 A to 1250 A, heated with 120 fsec pulses of 400 nm light from the USP laser. The laser energy was approximately 0.2 Joules for a peak intensity near 2×10^{19} W/cm^2. Lyα and Heα, Heβ lines were recorded using a 900 fsec x-ray streak camera.

We calculate the effective ionization and recombination rate coefficients including density effects for H-like and He-like aluminum ions using a collisional-radiative model. The effective emission rate coefficients of the lines of H-like and He-like ions for purely ionizing plasma and purely recombining plasma have also been calculated. The emission rate coefficients in ionizing plasma decrease at high density due to the excitation and ionization processes. On the contrary the emission rate coefficients in recombining plasma increase for high densities at low temperatures due to the increase of the three body recombination as shown in Fig.1. Therefore strong emission is expected in recombining phase at high densities. We calculate time-dependent ion abundances and emissions using these rate coefficients. The time-dependent electron temperature and density used in the calculation are based on an analytical model for the hydrodynamic expansion of the target foils. We used modified scaling for non ideal gas adiabatic expansion which include the large effect of three body recombination energy. The main qualitative feature of observed line intensity is rapid decay of intensity for thick foil and slow decay for thin foil emission. The calculations reproduce the main qualitative features of the experimental spectra as shown in Fig.2.

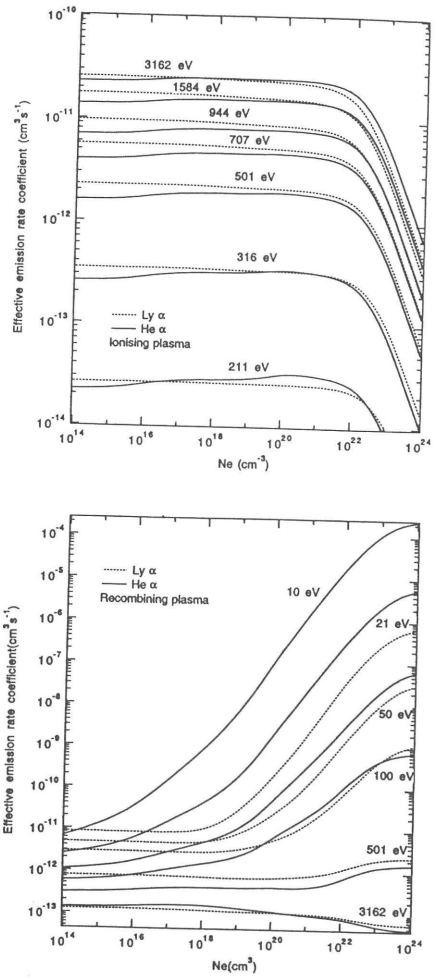

Fig.1 Effective emission rate coefficients in ionizing and recombining plasma as a function of electron density

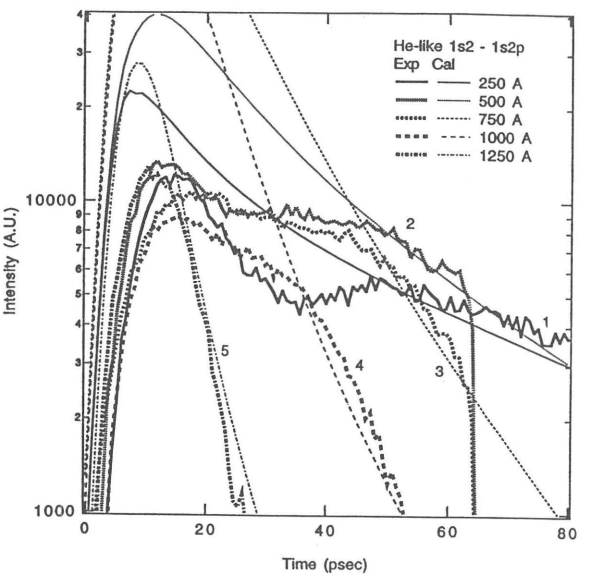

Fig. 2 The comparison of the relative slope with experiment and calculation normalized calculation to the measurement.