Transient atomic kinetics of a neon photoionized plasma

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We report on a modeling study of time-dependent atomic kinetics for a neon photoionized plasma. The neon atomic model considers several ionization stages of highly-charged neon ions as well as a detailed structure of non-autoionizing and autoionizing energy levels in each ion. Atomic processes populating and de-populating the energy levels consider photoexcitation and photoionization due to the external radiation flux, and spontaneous, stimulated and collisional atomic processes including plasma radiation trapping. Relevant atomic cross sections and rates are computed with the HULLAC suite of codes. The calculations are performed at constant particle number density and driven by the time-histories of temperature and external radiation flux. These conditions are selected in order to resemble those achieved in current photoionized plasma experiments at the Z facility of Sandia National Laboratories. For the same set of time-histories, calculations are done in a full time-dependent mode and also as a sequence of instantaneous, steady states. Differences between both calculations are useful to identify transient effects in the ionization and atomic kinetics of the photoionized plasma, and its dependence on the atomic model and plasma environmental conditions. We also calculate transmission and emission spectra in an effort to identify time-dependent effects in observed spectral features. In addition, synthetic transmission spectra computed with the model are used to test a method employed to analyze experimental transmission spectra using a novel application of genetic algorithms to plasma spectroscopy.

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