Electron-ion coupling in Warm Dense Matter

Andrew Ng
Department of Physics & Astronomy, University of British Columbia, Canada

While many studies have been focused on equilibrium Warm Dense Matter in which the electrons and ions are thermalized to the same temperature, there is a growing interest in the investigation of non-equilibrium Warm Dense Matter with different electron and ion temperatures. From a purely theoretical standpoint, non-equilibrium physics is clearly more encompassing and hence more informative, with equilibrium physics representing its asymptotic limit. On the other hand, there is also a pragmatic need that is providing a strong impetus to study non-equilibrium Warm Dense Matter. In the laboratory, Warm Dense Matter is generally created by the rapid heating of solids, with shock waves, optical lasers, X-rays or energetic charged particles as the input energy source. In all of these cases, the initial energy deposition occurs in only one of the two subsystems of the state produced. In shock compression the ions are heated first whereas in the case of radiation or energetic particles, the initial heating is limited to the electrons. Accordingly, such laboratory Warm Dense Matter begins in a non-equilibrium state. Equilibrium is reached in a relaxation process due to electron-ion coupling. Since the time for thermal equilibration between electrons and ions may exceed tens of picoseconds under Warm Dense Matter conditions, the availability of diagnostics with femtosecond to picosecond resolution offers an exciting opportunity to examine the transition states before equilibrium is reached. This also enables us to study states in regions of the phase diagram far beyond that can be accessed under equilibrium conditions and opens a rich new frontier for exploration. This talk is a discussion of experimental studies of the electron-ion coupling factor in non-equilibrium Warm Dense Matter produced by different laboratory techniques.