Thermodynamical and transport properties of dense H-He mixtures

Franois Soubiran[1,2], Christophe Winisdoerffer[1], Stphane Mazevet[2,3], and Gilles Chabrier[1]

[1]Ecole normale suprieure de Lyon, Lyon, France
[2]Commissariat l'Energie Atomique, Bruyres-le-Chtel, France
[3]Laboratoire de l'Univers et THories, Meudon, France

March 22, 2012

Abstract

Hydrogen and helium are the main components of giant planets like Jupiter or Saturn. Although the properties of pure hydrogen and helium are reasonably well understood nowadays, the behavior of the mixture at high pressure remains poorly known. However, this is of fundamental importance to understand the structure and the evolution of these giant planets. For instance, the scenarios of cooling for Saturn are not compatible with its age, unless a demixing process of H-He occurs in the interior. But the existence of such a phase separation still needs to be confirmed by numerical simulations and/or laser-driven experiments.

We will present quantum molecular dynamics (QMD) simulation results of equimolar mixtures of hydrogen and helium, exploring densities from 0.24 to 3.5 g/cm^3 and temperatures from 1000 K to 17400 K ($\sim$ 0.1 to 1.5 eV). This is a range of parameters for which the mixture is a partially pressure-ionized plasma.

First, we will present thermodynamical properties as well as structural analysis which characterize the behavior of the plasma. Secondly, we will present results on the transport properties (electrical and thermal conductivities and reflectivity) of the H-He mixture: these quantities are important observables for the laser-driven experiments dealing

with hydrogen-helium mixtures. Finally, we will discuss the relevance of all these diagnostics for the detection of a phase separation in H-He mixtures experimentally as well as in simulations.