ID: 6.1e

Title: Molecular Dynamics Simulations of Dense Plasmas

Name: da Silva Schneider, Andre

Affiliation: Center for Exploration of Energy and Matter and Physics Department - Indiana University

Inside stars we find hot plasmas, mixtures of ions immersed in a degenerate electron gas. In the core of white dwarfs (WD) or the crust of neutron stars (NS) this plasma is so dense that it crystallizes. As this happens, chemical separation occurs. We used large classical molecular dynamics simulations to study this chemical separation. Ion interactions were modeled by a screened coulomb potential and the phase diagram for mixtures involving liquid and solid phases were obtained. Assuming carbon and oxygen to be the most abundant elements in WD and using observations from NGC 6397 by Winget \textit{et al.}\cite{1} we estimated the upper limit for the oxygen composition by number in the core of WD to be $\approx55\%$\cite{2}. NS in a binary system can accrete matter from its companion. That matter undergoes a variety nuclear reactions which form a complex range of chemical elements including heavy elements such as selenium and light elements such as oxygen. Using these two elements as representatives of the composition of the NS crust we determine that the liquid ocean on the surface is enriched in light elements while the crust, solid phase, is greatly enriched in heavier elements. Understanding this phase separation is important to determine the thermal conductivity and temperature profile of the star.
\begin{thebibliography}{} \bibitem{1} D.E. Winget \textit{et al.} {\it Astrophys. J.} \textbf{693}, L6 (2009) \bibitem{2} C.J. Horowitz, A.S. Schneider, and D.K. Berry, {\it Physical Review Letters} \textbf{104}, 231101 (2010) \end{thebibliography}