DEPARTMENT OF
CHEMISTRY
UNIVERSITY OF NEBRASKA-LINCOLN

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Dr. Russell J. Hemley
Carnegie Institution of Washington

November 14, 2014

3:15 Reception
3:30 Seminar
112 Hamilton Hall

"New Views of Structure and Bonding in Extreme Environments"

Structure and bonding in chemical systems under extreme conditions are fundamental to many problems in physical science. Studies of a broad range of molecular systems as a function of pressure and temperature, for example, have provided new insights into structure, bonding, and reactivity, and have led to new classes of materials. Due to its quantum character and simple electronic structure, hydrogen is of particular interest, with intriguing if not unique properties predicted at multimegabar pressures. Understanding hydrogen in these extreme environments is also crucial for planetary science and astrophysics. Experimental advances over the years have revealed the persistence of molecular bonding to above 300 GPa over a range of temperatures, but solid phases with unexpected properties have been identified and characterized. With recent improvements in techniques, the range of extreme conditions over which hydrogen can be studied experimentally has been significantly extended, and the material has been studied under static pressures reaching 360 GPa using synchrotron infrared, Raman, and other optical spectroscopies, and new phases are documented. Recent studies also reveal unexpected findings in the electronic structure and bonding properties of other IA elements as they pass through semiconducting, semimetallic, and metallic states on compression and decompression. The common tendency of compressed alkalis to adopt three-fold coordinated structures is a manifestation of their *aromacity and closed shell effects*, leading to a unified picture of the insulator-metal transition in these elements. Further information obtained from studies of hydrogen-rich molecular systems and related materials reveal a richness of chemical phenomena under extreme conditions.

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