Experimental studies at high P-T in the diamond anvil cell

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Experimental studies at high pressures and high temperatures in a diamond anvil cell (DAC) have seen a large growth in the last ~20 years thanks to numerous technical developments and their availability at an increasing number of laboratories such as synchrotron radiation facilities. The simultaneous generation of high pressure and high temperature allows addressing long-standing scientific issues such as the determination of the phase diagram, thermodynamic and dynamic properties of components of planetary interiors, bond and chemical stability at very high density, and have made possible the discoveries of novel phenomena such as molecular-to-superionic, insulator-to-metal and molecular-to-polymeric transitions in simple molecular solids and fluids.

This lecture will cover both technical and scientific topics related to experimental studies at high temperature in the diamond anvil cell. This includes:

- An overview of the DAC techniques based on resistive heating (RH-DAC)
- Pressure and temperature metrology in the RH-DAC
- Going beyond the temperature limit of the RH-DAC: induction and laser heating
- Making in-situ measurements at high P-T: examples of some x-ray and spectroscopic setups

I will illustrate the above topics with some examples of applications in the domains of fundamental and planetary physics, including melting line measurements, phase diagrams and chemical stability of simple molecules, structure of dense fluids and liquid-liquid transitions. Finally, I will discuss some prospective high P-T studies which should be made possible with the advent of the Extreme Brilliant Source of the ESRF.

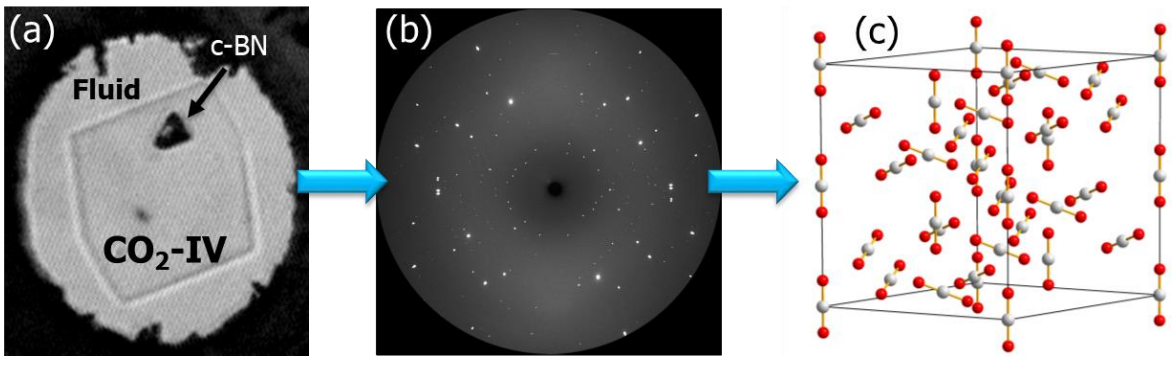

Figure 1: Structure of the high P-T solid phase IV of carbon dioxide. (a) Single crystal of phase IV grown in equilibrium with the fluid at 830 K, 12 GPa, as seen through the diamond anvils. (b) X-ray diffraction image measured at ESRF (c) Representation of the unit cell comprising 24 CO_2 molecules (C in white, O in red). After F. Datchi et al, Phys. Rev. Lett. 103 (2009)