52nd EHPRG Meeting, Lyon, France, 7-12 September 2014

Equations of state of l-Hg and l-Ga from acoustic measurements

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Measuring and understanding physical properties of liquid metals are a challenging issue. Indeed, liquid metals are reactive and melt at high temperature, so they impose technical requirements. In addition, they are disordered systems so they are considered to be complex from a theoretical point of view.

Recent technical achievements in picosecond acoustics associated with a diamond anvil cell permit to measure elastic properties at high pressures [1]. The acoustic waves are generated by picoseconds optical pulses at one side of the sample from a point source; they are detected on the opposite side and visualized by surface phonon imaging. The analysis of the images gives the sample thickness and the sound velocity. From sound velocities we extract the equation of state $\rho(P,T)$ by a numerical procedure. Those achievements have been applied to metals which melt at low temperature, such as liquid mercury and liquid gallium.

Concerning liquid mercury, we present sound velocity data from which we derive the equation of state up to 7 GPa and 520 K [2]. We tested the validity of two theoretical models on the density-velocity relation: the Bohm-Staver model and the charged hard sphere model. We have found them to be not reliable in the case of liquid mercury. We show that a power law describes accurately the data on a wide range of densities, from 9 g/cm^3 to 15.5 g/cm^3.

We also present work-in-progress measurements on liquid gallium. This metal combines unusual properties: a melting line negatively sloped as in water, many metastable liquid phases, and a possible first order liquid-liquid transition. We discuss briefly the impact of these properties on the equation of state.

1. *Picosecond acoustics method for measuring the thermodynamical properties of solids and liquids at high pressure and high temperature*
   F. Decremps, M. Gauthier, S. Ayrinhac, L. E. Bove, L. Belliard, B. Perrin, M. Morand, G. Le Marchand, F. Bergame, J. Philippe, Ultrasonics (2014)
2. *Equation of state of liquid mercury to 520 K and 7 GPa from acoustic velocity measurements*
   S. Ayrinhac, M. Gauthier, L. E. Bove, M. Morand, G. Le Marchand, F. Bergame, J. Philippe, and F. Decremps, J.Chem.Phys. (2014)

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Keywords: liquid metals, equation of state, picoseconds acoustics, thermodynamic properties