Thermodynamic properties of heavy alkali liquid metals measured by picoseconds acoustics

S.Ayrinhac[1], M.Gauthier[1], D. Antonangeli[1], M.Morand[1] , Y.Garino[1], P. Rosier[1], P. Parisiadis[1], and F.Decremps[1]

[1] *Institut de Minéralogie, de Physique des Matériaux et de Cosmochimie (IMPMC), Sorbonne Université, Paris, France*

Currently, the existence of liquid–liquid phase transition (LLPT), i.e. the transition between two liquids with different local structure, is one of the most interesting topics in condensed matter physics. LLPT are rare or controversial because they occur in highly reactive systems or metastable phases and more generally in challenging P-T conditions. Alkali liquid metals present complicated phase diagram with occurrence of many maxima in the melting line which can underlie possibly a LLPT.

Picosecond acoustics technique associated with a diamond anvil cell permit to measure elastic properties at high pressures in liquid metals [1,2,3]. 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. Improvements of the set-up are being made currently, adding laser heating to reach T in the range 1300-4000 K, ongoing monitoring of P/T combined with acoustics measurements, and also enhancing the speed and efficiency of data acquisition.

This technique have been applied firstly to liquid mercury [2] and liquid gallium [4]. In the case of l-Ga, our measurements do not show a LLPT expected around 300 K and 2 GPa [5,6]. We also studied heavy alkali metals, considered as simple metals at ambient pressure but which get intriguing properties at high pressures. Among alkali metals, liquid rubidium is interesting because it presents a little-known phase diagram and simulations revealed the existence of a LLPT at 573 K and 12.9 GPa [7]. In addition, l-Cs present anomalies in the equation of state of liquid around 5 GPa [8], but this is controversial [9]. We will present sound velocity measurements in l-Cs [11] and in l-Rb which can bring new informations on these two issues.

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