	Experiment title: Phonon spectrum of the intermediate valence compound SmS under pressure	**Experiment number**: HE-1027
Beamline: ID 28	**Date of experiment**: from: 18-avr-01 to: 28-avr-01	**Date of report**: 18/9/01
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Report:

SmS is an archetypal intermediate valence compound that undergoes a transition from a divalent to a mixed valence state slightly below 1 GPa [1]. A concomitant transition from an insulating (black phase) to a metallic state (gold phase) occurs. By further increasing the pressure, a trivalent state of a Kramer ion will appear and a yet unknown magnetic phase is expected. The valence transition of SmS gives the opportunity to study the interplay between electronic, magnetic and lattice properties of strongly correlated electron systems. Inelastic neutron scattering (INS) performed on SmS up to 0.7 GPa indicates a softening of the longitudinal acoustic modes along [111] [2]. These measurements were performed on the borderline of the INS technology. Inelastic X-Ray scattering (IXRS) is the key probe to pursue these studies at higher pressures.

A platelet of SmS ([110],[001]) was put in a diamond anvil cell with He pressure transmitting medium. Measurements were performed in transmission geometry through the diamond at room temperature up to 80 kbar. The valence transition is monitored via the variation of the a lattice parameter of the cubic structure as measured on the 222 Bragg reflection. Its pressure variation is shown in Fig.1. A drastic reduction of about 5% occurs at the valence transition. The phonon spectrum is characterized by a softening of about 1 meV near the zone boundary at the transition. Rough data obtained at **Q**=(0.5, 0.5, 0.5) for 0.7 and

9.3 kbar are shown in Fig.2. By further increasing the pressure, this softening persists and hardening occurs near the zone center as expected for a metal. This is shown in Fig.3 for **Q**=(0.15, 0.15, 0.15) at 12 and 60 kbar. Finally the dispersion curve of the LA [111] mode is shown at 0.7 and 35 kbar were both effects (hardening at low q and softening at high q) are observable.

Our present results mostly confirm and extend the previous neutron scattering data. The global trend is similar for measurements performed with INS or IXRS but an important discrepancy is observed. INS indicates a softening of the [111] modes from q=0.2 to 0.4 but not at q=0.5. This is clearly not the case in our measurements. Up to now, the phonon softening at the valence transition of SmS is semi-quantitatively understood from breathing modes due to the hopping of electrons from the f to the d shells. Further experiments and theoretical insight in the phonon anomaly near the valence transition of SmS are needed to fully understand the present data.

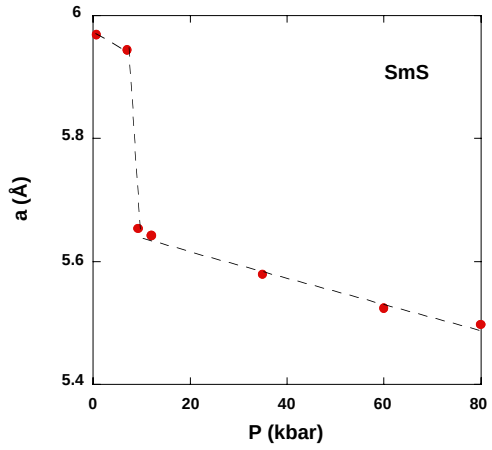

Fig. 1 : Pressure variation of the lattice parameter a.

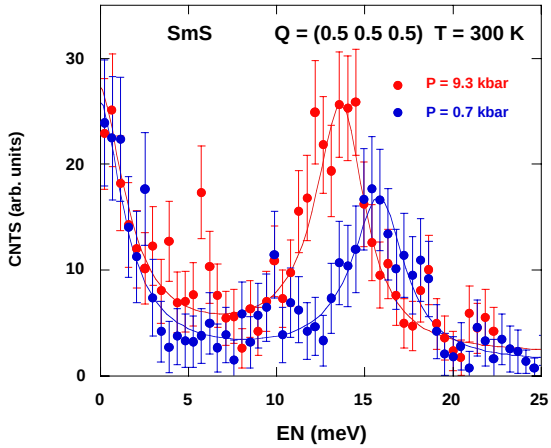

Fig.2 : Phonon spectra at $(0.5)^3$ for 0.7 and 23 kbar.

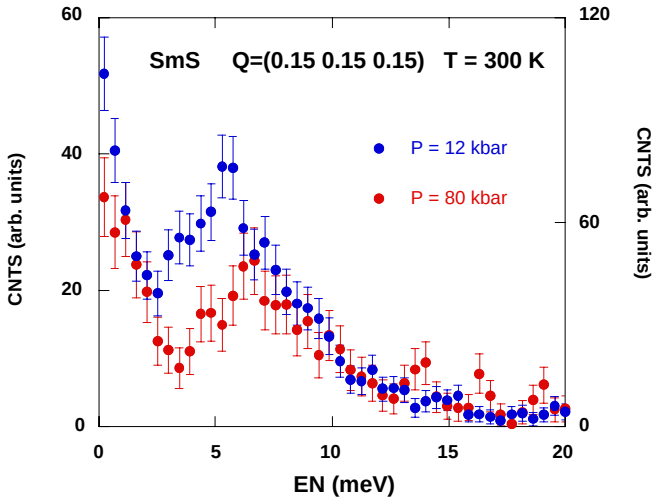

Fig. 3 : Phonon spectra at $(0.15)^3$ for 12 and 80 kbar.

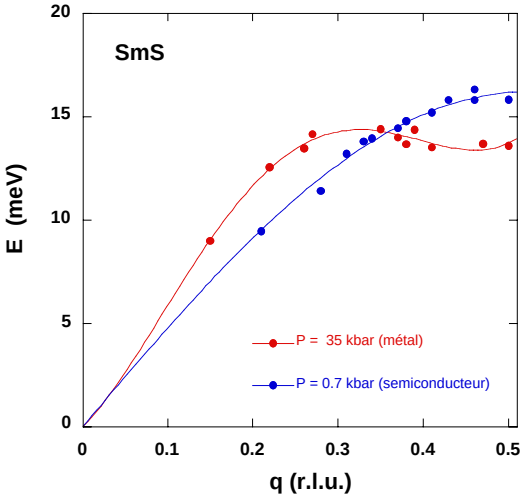

Fig.4 : Phonon dispersion curves at 0.7 and 35 kbar.

[1] A. Jamarayan et al., Phys. Rev. Lett. 25 (1970) 1430.

[2] H. Mook et al., Phys. Rev. B 25 (1982) 4321.