ESRF	**Experiment title:** Compton Scattering in the Lithium Ammonia System	**Experiment number**: HE-1364
Beamline: ID15 B	**Date of experiment**: from: 11 Dec 2002 to: 19 Dec 2003	**Date of report**: 2-27-2003
Shifts: 21	**Local contact(s)**: Dr. Marco di Michiel	*Received at ESRF:*

Names and affiliations of applicants (* indicates experimentalists):

*Dr. Clement Burns, Western Michigan University, USA

*Dr Paola Giura, ESRF

*Dr. Abhay Shukla, University of Paris

* Dr. Genevieve Loupias, University of Paris

*Emilie Collart, University of Paris

Report:

We have carried out Compton scattering measurements of the liquid metal system lithium ammonia. This system is formed when lithium metal is put in liquid ammonia. The lithium goes into solution, leaving behind a Li^+ ion as well as a free electron. At low concentrations the system is an insulator, but as additional lithium is added it undergoes a metal to insulator transition.

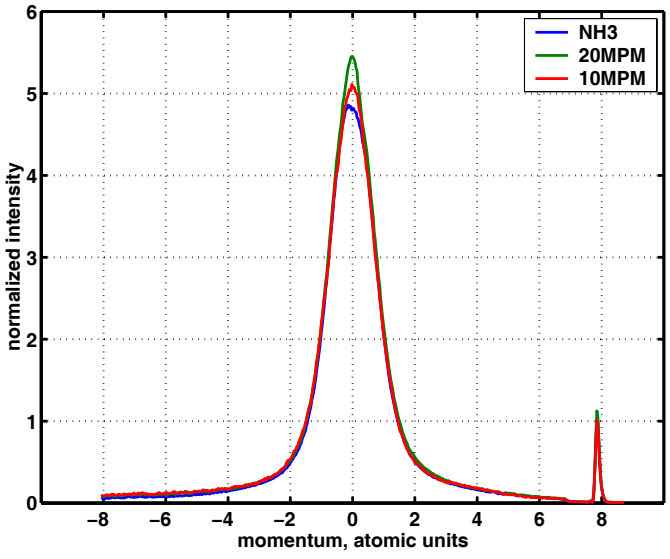

Fig. 1 – Compton Signal

Our data was taken on beamline ID15 B, with an incident energy of about 30 keV at a scattering angle of 168°. Analysis was accomplished by a Si (400) analyzer. The sample was created by placing 0.058 g of lithium metal in a sample cell under inert (helium) atmosphere. This sample cell was placed inside a close cycle refrigerator. The sample was pumped out and then measured amounts of ammonia gas were introduced. Both pure ammonia and lithium ammonia solutions were used. The concentration of the lithium ammonia sample was changed by adding more ammonia *in situ*. The cell had an x-ray path of about 1 cm. Sapphire windows gave access to the sample (and did not react with the mixtures). Sample quality was checked by measuring the structure factor with the MAR detector.

Data was taken in pure ammonia, as well as solutions with 20 and 10 mole percent metal (MPM) lithium in solution. Count rates in the pure ammonia were about 900 CPS in the Compton peak and about 500 cps for the 20 Mpm solution. For the first two we had about 110,000 counts in the Compton Peak, while for the 10 MPM we had only 34,000. The low total count rate was the result of bubble formation; the geometry of the cell resulting in these bubbles being in the beam path. This forced us to eliminate a number of scans. The problem would be easy to correct with a different cell design, but we were unable to do so during the run.

Figure 1 shown above contains data normalized with monitor and corrected for absorption, cross section and then other effects. The area under the profile is then normalized to the number of electrons. We clearly see a large difference that is due to the presence of the delocalized electrons in the metal. Even in the raw data it is visible that there are two separate components in the system.

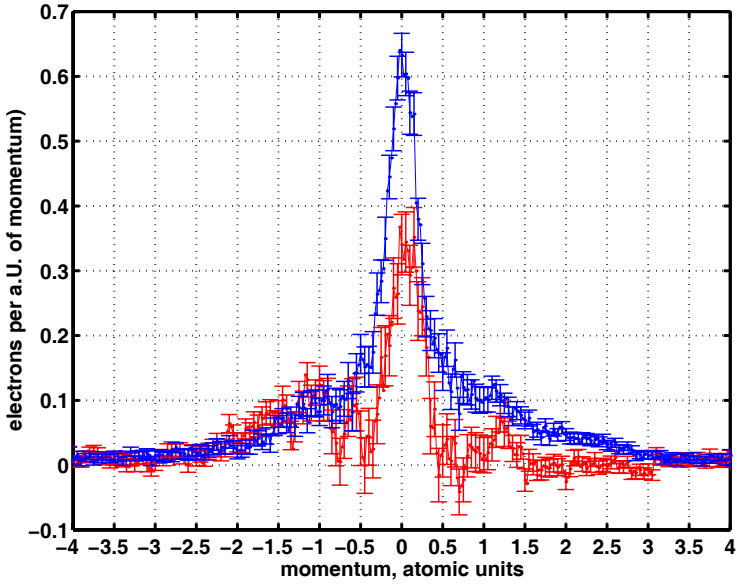

Fig. 2 – Difference Profile

Subtracting off the pure ammonia component leads to the data shown in Fig. 2. The taller, blue curve is the 20 MPM data. We clearly see a sharp central region due to the delocalized electrons, and a broad background that is due to the Li core. While noisier, the 10 MPM also serves to illustrate the same trend. We would expect the 10 MPM to actually have a narrower central distribution since it has lower electronic density (and so a smaller Fermi wavevector). It is likely that the discrepancy is related to the poor statistics, although it is also possible that as we go to lower concentrations and are moving towards the metal insulator transition there are changes in the electronic wavefuctions. A more detailed analysis of the data is underway. Further work on the system, to improve statistics as well as monitor the changes across the metal to insulator transition, is intended.