Workshop summary on inelastic and elastic scattering

R. K. Crawford
Argonne National Laboratory
Argonne, Illinois
USA

This workshop session was designed to be non-selective in subject matter, but with an emphasis on description of scattering instruments (as opposed to instrument components or data analysis). As such, it attracted a large number of papers. To accommodate these papers, the workshop format was abandoned to a large extent, discussion periods were limited, and the session was run primarily as a formal presentation session. Even with these restrictions, the presentations carried over through the first thirty minutes originally scheduled for the following session. Although this arrangement was more formal than originally intended or desired, it did provide an opportunity for presentation of a wide variety of topics at an early stage of the conference, which it is hoped stimulated subsequent private discussions.

The first presentation was by Andrew Taylor, who discussed the status and performance of the ISIS inelastic instruments: HET (high-resolution high-energy chopper spectrometer), TFXA (crystal analyzer spectrometer), IRIS (high-resolution backscattering spectrometer)—all of which are operational and regularly scheduled; and EVS (electron-volt resonance spectrometer), PRISMA (multi-angle crystal analyzer spectrometer for single-crystal excitation), and MARI (multi-angle chopper spectrometer), all of which are in various stages of development or construction. Details of these instruments are provided in the paper, "Developments in Inelastic Instrumentation at ISIS" by A. D. Taylor, C. J. Carlile, Z. A. Bowden, M. Hagen, R. S. Holt, J. Mayers, R. Osborn, U. Steigenberger, Y. Todute, J. Tomkinson, and W. G. Williams in these proceedings.

Next, Masa Arai discussed the new chopper spectrometer INC under construction at KENS. Despite the severe spatial constraints imposed by adjacent instruments and the intensity limitations of the KENS source, Masa estimated that when completed, this instrument will provide an intensity similar to that of HET at ISIS, while having an energy resolution that is only 1.5 times that of HET. This instrument is described in detail in the paper "Chopper Spectrometer at KENS" by M. Arai, in these proceedings.

Rob Robinson discussed the kinematics and resolution of a chopper instrument for Brillouin scattering at relatively high neutron energies. These kinematics impose severe constraints upon an instrument designed for this purpose and, in particular, require very small scattering angles. The chopper spectrometer PHAROS being designed at LANSCE is intended to operate at scattering angles down to 0.5° both to cover this Brillouin-scattering regime and to serve as a more general-purpose chopper spectrometer. This work is presented in the paper "On the Kinematics and

Resolution of Spectrometers for Neutron Brillouin Scattering" by R. A. Robinson, in these proceedings. Details of the PHAROS chopper spectrometer can be found elsewhere in these proceedings.

Following Rob's paper, Peter Egelstaff presented some general comments on Brillouin scattering and showed some low-energy Brillouin scattering data he had recently collected. This experiment and data have been submitted for publication elsewhere ("Neutron Brillouin Scattering in Dense Nitrogen Gas" by P. A. Egelstaff, G. Kearlye, J. B. Suck, and J. P. A Youden), and so will only be summarized here. Peter suggested that there are three distinct regimes for neutron Brillouin scattering:

(a) $\gamma \sim 5$ Å, for which a reasonable instrument can be made by placing the ILL D11 area detector in the forward-scattering direction at the ILL IN5 instrument. This can be used to study systems with sound velocities ~600 m/s.
(b) $\gamma \sim 2$ Å, for which a reasonable instrument could be made by placing the ILL D17 detector system (detector and movable mount) on the ILL IN4 instrument. This could be used to study systems whose sound velocities are ~1000 m/s.
(c) $\gamma \sim 0.65$ Å, which would require modifications of the HET instrument at ISIS to achieve the small scattering angles necessary. This regime, which could presumably also be studied by the PHAROS instrument at LANSCE when it comes on line, is appropriate for the study of systems with sound velocities ~4500 m/s.

If a minimum scattering angle of 1° can be achieved in each case, the Q_{min} is ~0.02 for case (a), ~0.05 for case (b), and ~0.15 for case (c). Peter and collaborators managed to convince the ILL management to make the instrument rearrangement necessary to achieve case (a). The IN5 chopper system produced a neutron beam with ~100-μeV bandwidth and 0.5° collimation. The 65 cm x 65 cm area detector from D11 was centered on this beam at a distance of 4 m downstream from the sample. Figure 1 shows typical Brillouin scattering data they obtained from N_2 gas at two different pressures, and Fig. 2 summarizes the dispersion relations measured for the two gas pressures. This experiment shows that good Brillouin scattering data can indeed be generated, at least in the low energy case, if an instrument can be configured to provide low-background data at sufficiently small scattering angles. Extension of the technique to the higher energy cases awaits the development of new instruments, such as PHAROS, or the modification of existing instruments, such as those indicated in cases (b) or (c) above.

This Brillouin-scattering discussion was followed by John Copley's presentation of techniques for improving the intensity transmitted through a disk-chopper system on a neutron guide. In particular, John discussed the gains that might be achieved by using multiple-slot disk shippers and presented an analysis of some of the problems that are unique to such multiple-slot choppers. This work can be found in the paper "The Effects of Chopper Jitter on the Time-Dependent Intensity Transmitted by Multiple-Slot Multiple Disk Chopper Systems" by J. R. D. Copley in these proceedings.

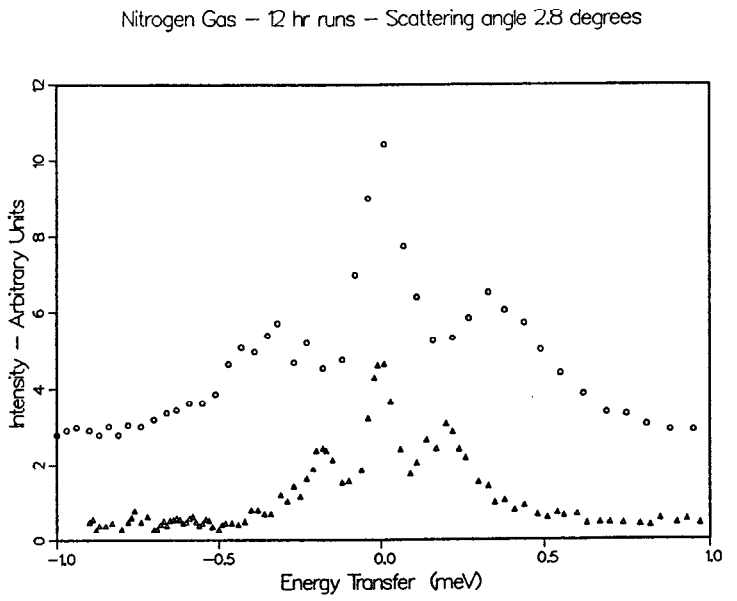

Fig. 1 Typical Brillouin scattering data (from Peter Egelstaff). Circles are data at $\gamma = 4.7$ Å and a gas pressure P = 51 MPa. Triangles are for $\gamma = 6.0$ Å and P = 27 MPa.

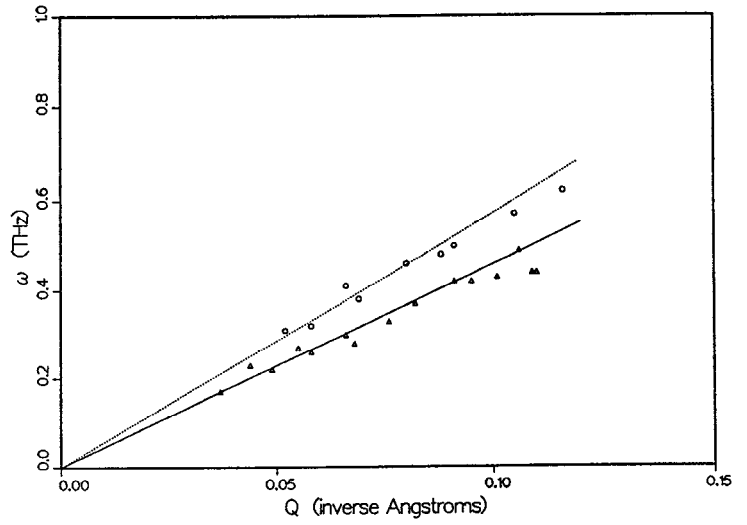

Fig. 2 Dispersion relations in dense N_2 gas (from Peter Egelstaff). Circles are for P = 51 MPa and triangle are for fP = 27 MPa. Lines are extrapolations of the sound velocity relations for these pressures.

Susumu Ikeda then indicated how the complementary techniques of resonance absorption of eV neutrons by the sample and resonance detection of eV neutrons scattered by the sample could be used to determine the kinetic energy of each of the individual types of atoms in a multi-component system. The method was illustrated by data obtained on the RAT instrument at KENS for the high-temperature superconductors La_2Cu0_4 and $YBa_2Cu_3O_7$. The techniques and results can be found in the paper "Application of eV Neutron Scattering and eV Neutron Absorption Techniques" by S. Ikeda in these proceedings.

Alan Soper discussed the current performance of the liquid and amorphous materials diffractometer (LAD) at ISIS. He then described the SANDALS instrument being constructed at ISIS and discussed the features of SANDALS that should make it much better than LAD. SANDALS will use the new ZnS scintillator detectors being developed at ISIS to cover a much greater angular range than in LAD; it will also have much greater data rates than those of LAD. These instruments are described in the paper "Future Perspectives of Liquids and Amorphous Materials Diffraction at ISIS" by A. K. Soper in these proceedings.

Michihiro Furusaka outlined one alternative being considered for small-angle scattering instrumentation at the proposed new Japanese pulsed-neutron source KENS II. This alternative involves two instruments: an 11-m flight path medium-resolution instrument, (Q_{min} = 0.006 Å^{-1}), and a 40-m flight path high-resolution instrument, (Q_{min} = 0.002 Å^{-1}).

Finally, Rex Hjelm discussed the important features of the newly developed user-interface software for the LQD small-angle diffractometer at LANSCE. This comprehensive software package provides for on-line assessment of the data, data reduction in absolute units, basic data manipulation and analysis procedures, and corresponding graphic representations—all within a user friendly framework. This system is described in the paper "Time-of-flight Small-Angle-Neutron-Scattering Data Reduction and Analysis at LANSCE with Program SMR" by R. Hjelm in these proceedings. Rex's paper served as a natural lead into the following workshop session on detectors and data acquisition.