REPORT ON AN INTERNATIONAL SYMPOSIUM ON NEUTRON INELASTIC SCATTERING, VIENNA 17–21 OCTOBER 1977

The symposium was attended by 181 participants and 10 observers from 30 countries and 3 international organizations. Seventy-seven papers were presented in 10 scientific sessions.

Neutrons in Condensed Matter Research

Neutrons provide a powerful and sometimes unique method to investigate the structure and properties of matter. When a sample of material is put into a neutron beam, neutrons interact in various ways with matter; they lose or gain energy, change direction of flight or are scattered. When the energy of the neutron remains unchanged after the interaction, the process is called elastic scattering or diffraction. When there is a change in the neutron energy, the term inelastic scattering is used. From the way neutrons are scattered, it is possible to draw conclusions from the phenomena about the properties of matter, its structure, vibrations of atoms and molecules, the energy levels, phase transformations and so on.

The use of neutrons for these studies goes back to the 1950's, when research with neutron beams became possible. The IAEA has paid close attention to this field, and organized its first symposium on this topic in 1962. The most recent symposium was the fifth in the series.

Until now the great majority of studies that have been performed by neutron scattering techniques can be classified as basic research, however, more and more work on practical applications is being carried out. The symposium concentrated on the technique itself, neutron sources and instrumentation, and the various branches of materials science where this method is used. In the field of neutron scattering in applied research, the IAEA convened in 1976 an Advisory Group Meeting, and the findings of that meeting and subsequent information has been published in the Atomic Energy Review, No.4 1977, and in the IAEA Technical Reports Series No.204.

The symposium reflected well the recent developments and plans on neutron sources and new experimental methods as well as the various experimental studies. It could be stated that neutron scattering has made an impact on almost all branches of condensed matter science. For this reason, the whole field of neutron scattering could not be surveyed in this meeting. For example, lattice dynamics and small angle scattering applications were given less emphasis because these topics had already been covered in other recent meetings (International Conference on Lattice Dynamics, 5–9 September, Paris, France, and 4th International Conference on Small Angle Scattering of X-rays and Neutrons, 3–7 October, Gatlinburg, USA).

Papers given in the scientific sessions were on neutron sources and instruments, which really was the cohesive element throughout the meeting, molecular spectroscopy, liquid crystals and polymers, monoatomic liquids, magnetic excitations and phase transformation, hydrogen in metals and surface phenomena. Five invited papers reviewed important developments in rotational excitations and tunnelling, hydrodynamic instabilities, dynamic properties of simple liquids, charge density wave instabilities and incommensurate phase transformations, and the dynamics of hydrogen in metals.

Since the previous symposium on this topic, held in 1972 in Grenoble, a large development of the technique and the scope of activities was observed. The neutron scattering technique has now reached such a degree of maturity that some results can also be presented at topical conferences on condensed matter research. Furthermore, several of the papers presented were the result of team work between materials scientists and neutron scatterers, the neutron scattering establishment acting as the centre for the experimental part of the work. Although large centres seemed to dominate as far as the number of papers was concerned, medium-flux facilities also offer the possibility of good original work provided that the instrumentation and data acquistion systems are up-to-date.

In order to open new areas for neutron scattering research, it is necessary to construct new sources with a higher neutron output to make certain high-resolution experiments feasible, and to extend the spectrum of neutrons into higher energy ranges. Several new sources are presently being proposed, already funded or under construction. The pulsed reactor IBR-2 at the Joint Institute for Nuclear Research in Dubna will soon be operational, the UK linear accelerator at Harwell will be completed in 1978, and the powerful spallation neutron source at the Rutherford Laboratory in the UK has received approval for funding. The Rutherford spallation source is based on shooting high-energy protons into a uranium target. It is calculated to be some two orders of magnitude more powerful than any pulsed source currently being used for condensed matter research, and thus can equal or outperform the highest flux, steady-state reactors, both operating and envisaged. During the discussions, it was stressed that instrumentation and data acquisition systems must be further developed in order to get the full benefit of these new sources. New ultra-cold neutron sources were reported, and these seem to have applications, for example, in molecular spectroscopy studies.

Major trends and achievements in the application of neutron scattering to studies of tunnelling phenomena, the dynamical behaviour of molecular crystals and the conformation of polymers were reported. It was demonstrated that novel ideas can effectively be tested with neutron scattering techniques, but one should bear in mind that the results are not always easy to interpret and sometimes it is not possible to obtain experimental results that enable one to distinguish between different theories with neutron scattering techniques alone. Actually some neutron scattering instruments are now so powerful that, for example, within a few hours one can measure the radius of gyration of several polymer samples using the small angle neutron scattering instrument at the Institute Laue-Langevin.

The new neutron sources will become operational in the next few years, and it was recommended that there will be a need after 4—5 years for an international meeting on the experiences with these new sources. It was mentioned that celebrating the 50th anniversary of the discovery of the neutron in 1982 should not pass without noticing the contributions neutron scattering has done for materials research.