apparatus they recorded the fairly frequent decays of the form $K_L^0 \rightarrow \mu^\pm + \pi^\pm + \nu$. Muons from this decay passed through the magnet in one of the two arms of the apparatus and their range was measured in a stack of steel plates interleaved with scintillators. The possibility of systematic error was eliminated by reversing the fields in the magnets so that particles of both signs were recorded in each arm of the apparatus.

The distribution of the momenta of muons of each sign stopping at any point in either scintillator/plate stack could thus be built up and the difference in the mean momenta for each sign calculated.

After the necessary corrections had been made, the weighted mean of the fractional difference in range turned out to be $(2.28 \pm 0.20) \times 10^{-3}$ at the average momentum of 800 MeV/c.

CRYSTALLOGRAPHY

What Lies Ahead?

from a Correspondent

CRYSTALLOGRAPHERS of the future will have to broaden their horizons both to be able to gain support for their research and to obtain jobs in industry. This was a recurring theme in the conference on the role, support and organization of crystallography in the 1970s, arranged by the Crystallography Group of the Institute of Physics under the auspices of the United Kingdom Crystallographic Council and held in London on November 24. The point was made most forcibly by Professor R. Mason (University of Sussex), who until recently was chairman of the Chemistry Committee of the Science Research Council. He told the conference that support for research projects by the SRC will in future depend a great deal on the impact that the project is likely to have on the main stream of chemistry or physics.

Traditionally, the chief application of crystallography in chemistry has been single crystal structure analysis, but techniques have now developed to such an extent that structure-solving is in many cases a routine matter. To be worthy of SRC support such projects must emphasize the implications of the crystallographic results, for example, in new theories of chemical bonding. The same point was taken up by Professor J. D. Dunitz (Eidgenössische Technische Hochschule, Zürich) who said that although some crystallographers regret the fact that their principal art is becoming a routine, they should be glad that non-specialists can now solve crystal structures, leaving crystallographers free to make more sophisticated studies of crystals. Such studies

might include the investigation of intramolecular and intermolecular forces and their application in predicting crystal structures, and the extension of crystallographic ideas of close packing and linking of atoms into polyhedra to the study of liquids and solutions.

Many speakers emphasized the fact that crystallography is already a broad interdisciplinary subject. Dr M. F. Perutz (MRC, Cambridge) spoke about the important part that crystallography is playing in biology and medicine. The determination of the structure of DNA has led to an understanding of the genetic code and the mechanism of protein synthesis. Much progress has recently been made towards elucidating the structure of viruses and in understanding in molecular terms biological processes such as the aggregation of haemoglobin molecules in sickle cell anaemia. The whole intellectual background of biology and medicine has been transformed by the fact that these subjects can now be studied at an atomic level.

Professor J. Zussman (University of Manchester) discussed the role of crystallography in the earth and materials sciences. In these areas crystallography has moved away from being predominantly concerned with determinations of structure and is now also used to study texture and disorder and changes taking place during thermal transformations. Neutron diffraction and elec-

tron microscopy as well as X-ray diffraction are making important contributions in these fields.

A similar but more extreme dissociation of crystallography from structure determination was reported by Dr P. G. Owston (Polytechnic of North London) as having taken place in industry. His remarks were based on a survey he had carried out on the present and future industrial use of crystallography. Very little single crystal research is carried out, and the emphasis is chiefly on powder diffraction and electron microscopy. The materials studied seem to be principally inorganic substances, metals and polymers. The contrast between this industrial scene and university research, which concentrates on the determination of organic crystal structures, may help to explain the criticism sometimes expressed by industrialists that crystallographic training in universities is not as relevant as it should be. The most discouraging feature is that few industrialists can foresee any expansion of the applications of crystallography, a view that has serious implications for the future employment of crystallographers.

The conference concluded with a lively and sometimes controversial discussion initiated by a panel of young crystallographers. This not only recognized the need, but also expressed the readiness, to take a broader view of the subject.

Six Pulsars Observed at 2.8 cm

THE new Max Planck Institute 100-m radio telescope has been successfully modified to operate at wavelengths down to 2.8 cm. In next Monday's *Nature Physical Science* (December 11), Wielebinski and colleagues report the first observations made by the instrument at this short wavelength; they are also the first observations of pulsars at 2.8 cm.

The telescope is designed on the homology principle (see *Nature*, **228**, 507; 1968), which requires continuous adjustments to allow for elastic de-

formations of the dish. It was not expected that the telescope would work as efficiently at 2.8 cm as at, say, 11 cm; but tests proved so successful that the Max Planck team immediately decided to concentrate first on pulsar studies where the large surface area is most advantageous.

Six pulsars were observed at 2.8 cm: CP 0329, AP 0823, CP 1133, PSR 1929, BP 2020 and JP 2021. Measurements carried out between October 21 and October 23 this year show that the steep spectrum characteristic of pulsars at longer wavelengths extends to 2.8 cm; above 1,420 MHz CP 1133 has the steepest spectrum and JP 2021 the flattest of the six so far studied. PSR 1929 is still highly linearly polarized at these high frequencies, and on the whole the pulse shapes of these pulsars are much the same at high frequencies as at lower ones (see diagram). Now that the 100-m instrument has proved effective at 2.8 cm, a series of studies at that wavelength, 6 cm and 11 cm will be made to provide more complete spectra on which more detailed models of pulsars can be built.

Pulse shape of pulsar JP2021 at 2.8 cm.