In practice, the statistical bias is confirmed. Out of 23 section transects covering 41 chilled margins each, 19 transects (TRE) showed a preponderance of margins chilled to the east over margins chilled to the west and 4 transects (TRW) showed a preponderance the opposite way. The chance of obtaining such a bias from a system which actually contains equal numbers of TREs and TRWs is less than 1 in 200. This suggests that the statistics reflect a real physical effect, namely, that the Troodos dyke unit was produced as part of the seafloor spreading process. This conclusion is further supported by the number of chilled margins actually in excess within each transect. For transects with margins predominantly to the east the average number of margins in excess within each transect is 2–3, whereas for transects with margins predominantly to the west the corresponding figure is only 1.

Finally, since the predominant chilled margin direction is the direction away from the spreading centre, it follows from the data above that the spreading axis should have lain relatively to the west of the Troodos complex. It is necessary to say 'relatively' here because Moores and Vine (*Phil. Trans. R. Soc.*, **A268**, 443; 1971) concluded from palaeomagnetic evidence that the complex has rotated through 90° in an anticlockwise direction since it was formed, which implies that the dykes within the diabase unit were originally intruded in an east–west direction and that any spreading axis would have lain to the north. But although the orientation of the supposed spreading system is important, it is far more important for the time being to show that spreading took place at all. The simple, but elegant, piece of work carried out by Kidd and Cann provides further evidence that it did.

Copernicus and X-ray astronomy

from A. C. Fabian

THE Copernicus satellite launched in 1972 carries an 80 cm ultraviolet telescope-spectrometer from the Princeton University Observatory measuring interstellar absorption lines superimposed on stellar spectra. The small companion X-ray package from the Mullard Space Science Laboratory at University College, London, contains three grazing-incidence telescopes and a collimated proportional counter of about 15 cm² aperture. Both sets of instruments are pointed to the same location in the sky to fractional arc second accuracy by the inertial guidance system. Thus the ultraviolet telescope sometimes observes X-ray sources, and the X-ray systems spend some of the time viewing hot stars.

In spite of this apparent clash of interest, much of the work with the X-ray package has depended upon the Princeton telescope. Fifty per cent of the light incident on the Princeton spectrometer is used in a fine error sensor to provide the primary pointing control for the satellite and a stellar reference system for the X-ray experiment. The resultant accurate pointing has allowed maps of supernova remnants and clusters of galaxies to be made. Scans of a number of X-ray sources in our Galaxy and the Large Magellanic Clouds have enabled their positions to be pinpointed within a few arc minutes. Identification with optical, radio or infrared counterparts is proceeding.

The failure of two of the X-ray telescopes in July 1973, owing to a jammed shutter blocking the light paths, has caused mapping operations to cease. Nevertheless, the collimated proportional counter which operates over a 2.5–10 keV range has not been idle. It is well known that the binary X-ray sources are highly time variable. The stable platform provided by Copernicus has allowed careful studies to be made of some of these X-ray binaries. The data so obtained are superior to those from scanning instruments such as *Uhuru* on time scales exceeding several minutes, owing to this accurate pointing. The larger area X-ray detectors on the recently launched Ariel-5 that view along the spin axis also enjoy some pointing stability, but drift of the spin axis will introduce uncertainties.

Source identifications can still be made through correlated X-ray and optical or infrared observation. Lunar occultations also provide a powerful technique, and have been successfully applied from Copernicus to a galactic centre source, GX5-1 and the Crab nebula. The motion of the satellite allows several passages of the Moon across these sources to be observed.

Many more X-ray observations have been proposed for 1975. At least one complete 'on'-state of the 35-d cycle of Hercules X-1 will be followed. This enigmatic binary system has been intensively studied optically over the past two years but the mechanism behind its 35-d cycle is still unclear; complete and accurate X-ray data are lacking. Several other binaries and suspected binaries will be monitored for extended periods. The tight schedules of the other X-ray detectors in orbit do not permit extended study of particular objects because of the need to conserve stabiliser gas in the case of UK-5 and the viewing constraints for the ANS. It is hoped that the X-ray observing programme of Copernicus will continue, for there is no lack of sources wanting investigation.

Nuclear spectroscopy

from P. E. Hodgson

STUDIES of nucleon transfer reactions have long been established as one of the most powerful nuclear spectroscopic techniques. The angular distribution is characteristic of the angular momentum transfer L and the magnitude of the cross section is a measure of its single-particle strength. If the target nucleus has spin zero and the transferred particle is initially in a state of zero orbital angular momentum the spin of the final state is simply given by the vectorial sum of the relative orbital and spin angular momenta in the transfer process. For a (d,p) reaction, for example, $\mathbf{J}=\mathbf{L}+\frac{1}{2}$ giving $J=L\pm\frac{1}{2}$. Thus a $L=2$ transfer can go to a $J=3/2$ or to a $J=5/2$ state. The ambiguity in sign can often be resolved from the known systematic behaviour of single-particle states but in other cases it remains a difficulty. Measurement of the polarisation of the outgoing proton together with distorted wave calculations or a simple comparison with the proton polarisations in reactions leaving the residual nucleus in states of known spin resolves the ambiguity, but is time consuming.

It has however proved possible in some cases to resolve the ambiguity by examination of certain features of the differential cross sections and it is found that they are characteristic of $J=L+\frac{1}{2}$ or $J=L-\frac{1}{2}$ final states. Such features are sometimes difficult to reproduce by distorted wave calculations but nevertheless can be used as empirical guides provided that they can be calibrated by studies of transitions to states of known spin.

These J-dependent effects, as they are called, are sufficiently distinctive to be used with confidence only for particular reactions in restricted energy ranges, so it is always valuable to find new circumstances or new reactions that display them prominently. Two recent papers have provided evidence of this type.

In the first paper, Kong-a-Siou and Chien of Michigan State University (*Phys. Lett.*, **52B**, 175; 1974) measured the angular distributions of several $L=3$ transitions in the (p,d) reaction on ^{61}Ni and ^{62}Ni at 40 MeV and found a very stable J dependence over a range of intensities and excitation energies. Some of their results are shown in Fig. 1, and it is clear that the angular distributions fall sharply into two classes, one characteristic of $J=L-\frac{1}{2}=5/2$ and the other of $J=L+\frac{1}{2}=7/2$, and that in each case the data fall quite definitely on one or the other. The data for ^{62}Ni(p,d)^{61}Ni thus allow the spins of the states of ^{61}Ni to be determined.

The results for ^{61}Ni(p,d) ^{60}Ni to states