The general mood of the speakers on this first day of the symposium was that innovation at all levels of chemical education ought to place greater emphasis on the educational value of courses in terms of the intellectual skills and attitudes which they ought to develop. Also a more liberal attitude ought to be encouraged towards the types of future employment for which chemistry graduates are suited and, as B. M. Kingston (University of Edinburgh) pointed out in his talk, the chemical industry must accept the responsibility of steady recruitment. It was felt that such measures would secure the place of chemistry in the educational system.

The highlight of the second day was undoubtedly the lecture given by J. A. Campbell (Harvey Mudd College, California). He spoke about the CHEM Study project, which, with its stress on a practical approach, has been a major innovation in secondary level chemical education in America. His talk marked the inauguration of joint meetings between the Education Division and the Chemical Education Section of the American Chemical Society. In a most entertaining and stimulating lecture, he accounted for the project's national and international success as indicated by the large scale adoption of the materials. Professor Campbell stressed that the CHEM Study had not been expected to solve all the problems and that its main aim had been to cause 'movement' in chemical education at the secondary level, and it is in this respect that the project has been most successful.

Interplanetary dust cloud

from David W. Hughes

ONE of the main problems in understanding the nature of the interplanetary dust cloud is that most of the observations are made on or near the planet Earth which is stuck in the ecliptic plane at 1 AU from the Sun. If all the orbital parameters of the dust particle can be measured these can then be extrapolated backwards in time and with care a spatial distribution of particles can be built up. But the resulting dust cloud models obtained by different researchers differ widely. The value of the density, ρ, of the cloud at 1 AU is about 1.5×10^{-22} g cm^{-3}. Its variation with distance from the Sun, r, is under considerable debate. Calculations have produced ρ=constant ($0<r<3.5$ AU), $\rho \propto r^{-1}$, $\rho \propto r^{-1.5}$ and $\rho \propto r^{-2.5}$, ample proof of the present confusion.

Luckily interplanetary space probes have come to the rescue: one easy way out of the dilemma is to measure ρ using detectors on Mariner and Pioneer spacecraft as they travel towards Mercury and Jupiter. Rhee, Berg and Richardson (Goddard Space Flight Center, Greenbelt) report the results in a recent article in *Geophysics Research Letters* (**1**, 345; 1974). They find that the spatial density of particles with mass greater than 10^{-13} g is independent of heliocentric distance between 0.75 and 1.09 AU and that there is no enhancement around 1 AU. This result agrees with the Mariner II and IV data analysed by Alexander, McCracken and Bohn (*Science*, **149**, 1240; 1965) who found ρ constant between 0.72 and 1.56 AU.

Going further out, data from penetration cells on board Pioneer 10 and 11 indicate that the density varies as r^{-1} from 1 AU out to Jupiter's orbit, this experiment however having a mass threshold of 10^{-9} g. Alvarez, Humes, Kinard and O'Neal (NASA Langley Research Center) reported these results at the 1974 COSPAR meeting. They also found a peculiar Kirkwood-type gap in the dust cloud between 1.16 and 1.35 AU and a two order of magnitude increase in the dust density near Jupiter.

Looking at still larger particles (diameter 35 μm to 10 cm) Soberman, Neste and Lichtenfeld (General Electric Space Science Laboratories, Philadelphia) found $\rho \propto r^{-1.7}$ for the smallest to $\rho \propto r^{-3.2}$ for the largest. Using photometers on the same spacecraft (Pioneer 10) the zodiacal light brightness was found to vary as r^{-2} out to 2.25 AU and then to decrease more rapidly (1974 COSPAR meeting).

Obviously the problem is far from simple, with the variation in spatial density being a function of particle size (this is clearly seen when considering asteroidal sized particles at one extreme and solar wind particles at the other). It also seems a shame that Mariner 10 did not carry a particle-detecting experiment on its way to Mercury because extending the data into 0.3 AU would be very useful. The results from the recently launched West German–US solar probe Helios A which goes in this far will be awaited with great interest.

Very deep fault planes?

from Peter J. Smith

ALTHOUGH earthquakes are being studied ever more intensively, the physical mechanism of deep events still remains uncertain. The patterns of first motions and amplitudes of P and S waves radiated from deep shocks suggest strongly that the double-couple component of the source mechanism dominates other components, but the proposition that the double-couple results from shear dislocation along a fault plane is less easy to substantiate. Moreover, there are other possibilities to consider. Evison (*Bull. seism. Soc. Am.*, **53**, 873; 1963), for example, suggested that deep earthquakes may be produced by rapid phase transitions; and models involving changes of state throughout a finite volume were later analysed by Knopoff and Randall (*J. geophys. Res.*, **75**, 4957; 1970).

Nevertheless, Fukao (*Bull. Earthq. Res. Inst.*, **48**, 707; 1970) and others came down in favour of the more traditional explanation (in spite of the difficulty of envisaging fault motion at great depth) on the basis of their studies of azimuthal variations of the duration of P and S pulses. Even more direct evidence was obtained by Oike (*Bull. Disast. Prev. Res. Inst., Kyoto Univ.*, **21**, 153; 1971) and others who found that some deep events closely related in both space and time lie along a plane roughly coincident with a nodal plane of the focal mechanism solution for one of the events.

The difficulty in attempting to locate possible deep fault planes by observing the spatial distribution of deep earthquakes is that foci must be determined very accurately. In a new study of deep (~600 km) events in the northern part of the Tonga Island Arc, Billington and Isacks (*Geophys. Res. Lett.*, **2**, 62; 1975) have therefore used the method of Joint Hypocenter Determination (JHD) —a method developed by Dewey in 1971 and based on the assumption that for a set of closely grouped foci the combined station and path correction for each station is a constant. To cut a long story short, the use of this technique has enabled relative locations of foci to be determined with a precision of less than 5 km.

With this accuracy, Billington and Isacks show that in two separate cases the earthquakes within a deep cluster lie along, or parellel to and very close to, one of the nodal planes of a large-magnitude event within the cluster. They therefore suggest that these two planes are, in fact, fault planes and that there are probably other such planes corresponding to other clusters. Be that as it may, the two observed planes are nearly vertical and have linear dimensions of about 40 km, which means that the vertical dimension of the lithospheric slab in this particular deep section of the Tonga Arc must also also be at least 40 km (corresponding to a lithospheric thickness of at least 35 km). For the time being, however, the way in which supposed faults relate to the tectonics of the subducting lithospheric slab remains completely unknown.