problem of the differential rotation of the Sun was approached by Dr F. H. Büssé (Max-Planck Institute) as one of convection: his analysis of the stability problem for a spherically symmetrical rotating fluid heated from below shows that the onset of convection takes place primarily in the equatorial zone, and that as convection proceeds, the rotational constraint and the spherical geometry give rise to an equatorial acceleration of the correct order of magnitude.

The discussion of flow in stratified fluids, which included several papers on observations of internal waves in the oceans, was enlivened by two excellent films, one by Dr T. N. Stevenson (University of Manchester) of laboratory-produced internal waves and the other by Dr S. A. Thorpe (National Institute of Oceanography) of the instability of accelerating shear flows in stratified fluids.

Dr B. A. Warren (Woods Hole Oceanographic Institution) discussed a possible mechanism for the branching of the Gulf Stream in the region south-east of the Newfoundland Grand Banks, where the contours of the ocean bottom topography separate markedly. He finds that the Gulf Stream will follow the contours of topography (and thus branch where the contours separate) provided that the fractional change of ocean depth across the current exceeds a certain critical value depending on the speed and width of the current.

The *pièce de résistance* of the conference was undoubtedly the paper by Dr A. A. Mills (University of Leicester) on fluidization phenomena, in which he sought to relate the surface features of the Moon to the results of laboratory experiments on fluidized beds of powdered rock. When the gas flow rate in such a model fluidized bed is gradually reduced to zero, the surface of the powder takes on features remarkably similar to those on the Moon, and most of the known lunar surface features can be reproduced in the model. Although only exploratory, these experiments have given sufficiently exciting results to warrant further investigation of the phenomenon.

UPPER MANTLE

First Derivatives

from our Geophysics Correspondent

TEN years ago, a symposium on the upper mantle of the Earth was very much the fashionable thing as the Upper Mantle Project got under way. Bigger computers, the mushroom growth of marine geophysics, free vibrations of the Earth, the rebirth of continental drift and questions about its mechanism were all ingredients in the search for a more precisely defined structure of the crust and upper mantle. It would be naive to think we now have all the answers, but a clue to possible next steps came from the discussion meeting at the Royal Astronomical Society on May 2. The subject was the anisotropy of the upper mantle and the implication was that there is broad agreement on the average elastic properties, and the problem is now to find if these have significant directional characteristics at any given point. In mathematical terms, are the first angular differential coefficients significant? This is not purely an academic question. Anisotropy carries with it information about evolution within the Earth and so is potentially a very worthy subject for intensified interest.

Two types of anisotropy were discussed. They could be termed "inherent" and "environmental". A distinction between the two would be that the first deals with media which are anisotropic by virtue of their fabric, the second with media which have lateral inhomogeneities and therefore appear anisotropic, although not in a sense that can be classified by crystallography.

Inherent anisotropy can arise from the properties of olivine whose seismic velocity varies between 7.7 and 9.9 km/s for propagation along different crystal axes. As Dr M. A. Lappin (University of Aberdeen) pointed out, the mineralogy of the upper mantle is dominated by olivine, so even a small degree of preferred orientation of olivine crystals would have clear effects on the elastic behaviour of the upper mantle. In 1964, Professor H. H. Hess of Princeton, from whom quite a few of the good ideas of geophysics have emerged, proposed such an orientation to explain seismic observations in the Pacific. Dr Lappin, viewing the orientation as arising from flow processes and defining "tectonic axes" of crystals, proposed that under different temperature, pressure and flow regimes in the upper mantle orientation would be along different axes. This, he concluded, should yield distinguishable anisotropies in different oceanic areas.

Dr T. J. G. Francis (UKAEA, Blacknest) described a very detailed experiment performed by the Scripps Institution of Oceanography (San Diego) in which he had participated. The aim had been to investigate Hess's proposition in an intensive study of the Mohorovičić discontinuity off California. Sources of error such as topography on the discontinuity itself had been carefully extracted and the seismic refraction results show a distinct azimuthal variation of the form $\sin 2\theta$ where θ is the azimuth. The mean velocity was the characteristic 8.1 km/s and the peak to peak fluctuations were about 0.4 km/s. The "fastest" direction was perpendicular to the magnetic lineations in the area.

Dr R. B. Whitmarsh (National Institute of Oceanography) has compiled mantle velocities from other oceans where seismic work has been done within 200 km of the ridge crest. His data are necessarily much more heterogeneous and sparse, but analysis showed an azimuthal variation similar to that shown by Francis. A recent experiment by the Bedford Institute of Oceanography, Nova Scotia, had, he reported, also revealed azimuthal variation of comparable magnitude. The importance of all these experiments is not merely that anisotropy has been found but that its magnitude and character permit speculation about its origin.

The theory of wave propagation in anisotropic media was discussed by two speakers. Dr E. R. Lapwood (University of Cambridge) described the extensions to our conventional concepts needed to deal with even the relatively simple "transverse isotropy" in which the elasticity tensor has five independent elements instead of two in the isotropic case. Rays, wave fronts, phase and group velocity all need careful attention. Dr S. Crampin (Institute of Geological Sciences, Edinburgh) drew attention to the coupling that can exist between surface waves of different type when anisotropy is introduced. Separate Love Rayleigh waves can lose their identity and be merged into a single wave train. Anisotropy had to be invoked to explain examples of this with waves crossing the Russian platform.