what Dr Dror and his colleagues call the policy sciences are likely to contribute more to the improvement of political governments than, say, political movements themselves. Indeed, if the policy scientists talk too much as Dr Dror has written, there is a serious danger that they will be thought to be as overweening in their pride of knowing how to put society right as were the physicists only a short time ago. In short, they seem well on the way to spoiling a good idea with too much ambition, too little thought and too much bad language (in the sense of jargon).

PALAEOMAGNETISM

Permanent Non-dipole Fields

from our Geomagnetism Correspondent

THERE has been a quiet revolution in geomagnetism during the past few years. Spherical harmonic analysis, for example, which has dominated geomagnetic thinking for more than a century and is still far from redundant, has begun to give way to physically more meaningful models which are, in principle if not in detail, strangely akin to early theories for the origin of the field. Ideas on the variation of the field are changing too. The oversimplified view of a westward-drifting non-dipolar field is coming to terms with the fact that some components do not seem to drift at all and that in the past the drift may even have been eastwards. The theory of the standing as well as drifting field, developed by Professor Yukutake of Japan in recent years, is an attempt to reinterpret some of the finer details of field behaviour.

Most of these ideas have inevitably been concerned with the Earth's field as directly observed, simply because direct measurement gives the most detailed picture of the real field. But Wilson (*Geophys. J.*, **19**, 417; 1970) has made an important contribution to the new ideas by extending their observational basis backwards by means of palaeomagnetic data. Lest it be thought that palaeomagnetic data are, *a priori*, too crude for this type of work, it should perhaps be said that Wilson has selected only the best results according to predetermined criteria. Chief among these are that each mean palaeomagnetic pole position should be derived from at least twenty oriented rock samples and that the error (α_{95}) of the final mean pole should be no greater than 12°. The analysis has also been limited to the Holocene, Quaternary and Upper Tertiary. These criteria are not, of course, particularly stringent but they nevertheless exclude a high proportion of palaeomagnetic data.

Several interesting features of the ancient geomagnetic field emerge from Wilson's analysis of the eighty-three "acceptable" pole positions. The first is that, although the overall mean pole coincides almost exactly with the geographic pole, the individual mean poles from each source area fall systematically on the side of the geographic pole far from the source. The persistence of this phenomenon over several million years naturally casts doubt on the validity of the geocentric axial dipole hypothesis which is the basis of palaeomagnetic interpretation. The fact that the geographic and grand mean palaeomagnetic poles coincide confirms that since at least the Upper Tertiary the Earth's main field has been axially symmetric. But the other evidence suggests that it has not been exactly centred.

This deduction is supported by the second feature to emerge from the data (now including those from sea cores), which is that the overall palaeomagnetic inclination is shallower in the northern hemisphere, and steeper in the southern hemisphere, than would be expected from a geocentric axial dipole. If the main field really has been geocentric, axial and dipolar over the period considered, these results would imply a northward component of crustal movement which would have amounted to about 400 km during the past two million years. This would have produced obvious geological disturbances which are not in fact observed.

Wilson's analysis can only mean that since the Upper Tertiary the geomagnetic dipole has not been quite centred. One can then devise any number of models to accommodate the non-central dipole, but the simplest one to account satisfactorily for all the data is to displace the central dipole northwards along the rotational axis. Wilson shows that the displacement derived from palaeomagnetic data on rocks less than two million years old is 191 ± 38 km. The displaced dipole model is, moreover, amenable to multipole analysis, which shows that the off-centre dipole is equivalent to a centred dipole together with a centred quadrupole. The non-central dipole thus contains "the essence of a non-dipole field component"; and it is tempting to equate this with Yukutake's standing non-dipole field.

Does this model, then, invalidate the geocentric axial dipole hypothesis which is essential to palaeomagnetism? Clearly it does; but it should be noted that the dipole displacement is small enough to make it only a second order effect. Angular deviations in low and middle latitudes, for example, are only a few degrees. Nevertheless, as Wilson points out, even this is sufficient to put paid to one use of palaeomagnetic data—testing for Earth expansion. Non-central dipole deviations will easily obscure the very small effect of an expanding Earth on palaeomagnetic directions.

HIGH ENERGY PHYSICS

New Tracks for Fast Particles

SPURRED on by the drive towards accelerators of ever higher energy, A. I. Alikhanian *et al.* of the Yerevan Physical Institute in the Soviet Union have proposed a new method for measuring the energies of very high energy particles by detecting the emission of X-rays in a streamer spark chamber (*Phys. Rev. Lett.*, **25**, 635; 1970). Although the possibility of extracting information on particle energies from transition radiation has been recognized for many years, it is only since the completion of the 70 GeV accelerator at Serpukhov about two years ago that interest has focused on exploiting this technique.

The usual method of measuring energies by Cerenkov radiation becomes impractical at ultrarelativistic energies. It becomes almost impossible to distinguish between particles with the same momentum and different velocities at these energies, and the problem of sorting out K mesons from π mesons, for example, becomes a real headache. The advantage of measuring transition radiation, on the other hand, is that the