guess, and a highly resonant Moon is the first idea that springs to mind. It is not the only possible explanation, however. Perhaps the impact triggered off numerous fractions which acted as an earthquake sequence. Explosions occasionally trigger earthquakes, but the only large scale triggering on Earth has been after megaton tests in Nevada (*Nature*, **223**, 773; 1969). By analogy the Moon should not be expected to quake after such a minor impact, but who knows ? Exciting as the result is, a certain amount of unwilling suspension of judgment is necessary.

Whatever the conclusions reached from the smash-down records, it does seem at first sight as if the signals recorded by Apollo 12's seismometer before it went off the air were of entirely local origin. Many had thought they were probably landslides or venting from the lunar launchpad. This view is now strengthened by the knowledge that even fairly modest lunar events generate so substantial a seismic record. So perhaps there are no moonquakes worth mentioning. If so, exploration of the lunar interior will need artificial sources. It is a pleasant relief that nothing enormous will be needed. The idea of a nuclear explosion on the Moon "to see what happens" has already been semi-seriously canvassed. At least there will be no demand from lunar seismologists for such fearfully large and politically nonsensical experiments.

IONOSPHERE

Petrel on Target

from our Astronomy Correspondent

By all accounts, the success of an investigation into the auroral ionosphere earlier this year has been a good advertisement for the British Petrel rocket built by Bristol Aerojet Ltd. Eight Petrels were launched during February and March in a campaign organized by the Science Research Council which took place at the European Space Research Organization (ESRO) range at Kiruna in Sweden. Preliminary scientific results from the campaign were discussed last week at a meeting in the Department of Physics at the University of Sheffield. For the first time in the history of the range, all the rockets in a campaign fell within the designated area. In the past, rockets such as Skylark and Arcas have been launched from Kiruna, and firings have been known to land not only outside the range but sometimes outside Sweden. Rockets have fallen in Finland, which meets Norway and Sweden not far from Kiruna. Despite reaching a greater height than normal—150 km instead of 125 km—because of a combination of meteorological factors and the altitude of the range, all the Petrels remained substantially on course, and it seems that their performance might earn them a place in the ESRO armoury.

Although only 7·5 inches in diameter and small enough to be launched from a tube, Petrel can carry enough instrumentation to make most ionospheric scientists happy. And with one rocket per experiment they have made their contribution to a pleasant life on the range by ending the awkward problems of integrating experiments from different groups.

It is now becoming easier to measure electric fields in the ionosphere, and several groups were preoccupied with the techniques. What seems to be the most promising method so far was described by the group from the University of Birmingham (J. W. G. Wilson, J. H. Wager and C. P. van Zyl) and is based on measurements of the voltage difference between two spherical probes. Unfortunately, however, in the firing which they described the probes seem to have caused the rocket to precess more than normal, and the results are therefore not as good as they might have been. Another way to evaluate the field is to observe the drift of an artificial cloud of ions relative to a neutral cloud, and a joint team from the Universities of Sussex and Southampton (J. Hunter, G. Martelli, K. Martin and P. Rothwell) has been extending this method to lower altitudes than normal. Clouds released in the E-region often do not separate into neutral and ionized components, yet nevertheless it seems possible to estimate the electric field from the way the cloud deforms.

The Sheffield group (P. Beckingham, W. Gibbons and T. R. Kaiser) is concerned with direct measurements of the fine structure of electron density in auroras which has been inferred from radar work. To do this the group has developed a Langmuir probe which in theory has a spatial resolution of a few tens of centimetres, but which in practice, because of telemetry limitations, has a height resolution of about 1·5 m. The group is looking for the role in auroras of irregularities about a metre across and perhaps tens of metres long aligned along the magnetic field.

There is also the question of the mechanism that accelerates electrons to energies of tens of keV and leads to very bright aurorae. Another group at Southampton (P. Rothwell *et al.*) and a group from the Radio and Space Research Station (D. A. Bryant, G. M. Courtier and G. Bennet) have been looking at electrons of these energies at times when acceleration is believed to be taking place.

Oddly enough, informal discussions of the results of a campaign before anything is published is the exception rather than the rule and people are hoping that the Sheffield meeting will set a trend.

APOLLO

New Broom on the Moon

from a Correspondent

Now that the main task of Dr George Mueller, the National Aeronautics and Space Administration's Associate Administrator for Manned Space Flight, of getting an American safely on to the Moon by 1970 is accomplished, there is every justification for his retirement. This was announced on November 10, four days before the departure of Apollo 12.

NASA has praised his achievement handsomely in an announcement that reads a little like an epitaph. "It is due to Dr Mueller's creative leadership of the magnificent manned space flight organization that the flight of Apollo 11 in July 1969 achieved the national goal set in May 1961: the landing of men on the Moon and their safe return to Earth by the end of the decade." Dr Mueller, it is claimed, was responsible for the largest research, development and operational programme ever undertaken by man. At its peak the Apollo programme employed 400,000 people. Among his principal achievements were devising methods for cutting down the interval between launchings. For

the first Moon landing, economizing on time was the essential feat. An outstanding engineer such as Mueller was a logical choice.

But even with the second manned Moon landing, speed begins to take second place. Quality of results is becoming the criterion. Indeed, the lunar strategy review of the National Academy of Sciences Space Sciences Board (see *Nature*, **224**, 529; 1969) specifically urged that there should be longer intervals between missions to give time for results to be digested and fed into the programme of future flights and that more time should be spent on the Moon with more selectivity in data collection. Several of these points have already been adopted for this week's Apollo 12 mission. Twice as long is to be spent on the surface, and twice as much material is aimed for, with emphasis on sample selection. Six experiments are being performed instead of three.

Dr Mueller's successor has yet to be announced, but most of the other personalities behind the Apollo 11 flight have already been replaced. There was even some speculation about how the Apollo 12 mission would get on with so few of the old familiar faces.

SCIENCE RESEARCH COUNCIL

Shoe Pinches in Physics

THE Physics Committee of the Science Research Council, responsible for dispensing roughly £1 million a year on physics research in British universities and institutes, has produced a modest echo of the complaint elsewhere that other sources of support "for good fundamental work" have diminished. The committee has carried out and now published a review (to be had free of charge from the Science Research Council) of the fields in which it is at present engaged and of the directions in which it may find its work developing. It says that "on the national level . . . support from sources other than the SRC has decreased rapidly" chiefly because various government agencies have lost enthusiasm for various projects. The committee says that solid state physics and plasma physics have suffered most, no doubt because of the concentration of the defence research laboratories on practical applications of electronics and because of the decision by the UK Atomic Energy Authority to cut down on work at Culham, the laboratory particularly concerned with thermonuclear research. The committee estimates that it would take an extra £200,000 to £300,000 in the next two to three years to make sure that the national effort continues at "a reasonable though reduced level". One of the ironies of which the committee complains is that the short commons for solid state physics and plasma physics have come about precisely when the importance of these subjects is growing and when it is clear that "it is precisely from these fields that new technologies can confidently be expected to emerge".

The Physics Committee is not concerned with support for high energy physics or for astrophysics in the strict sense. In its review of the opportunities available, it has given prominence to the need for better facilities for neutron beam research, and spells out the advantages which may be obtained by a fuller exploitation of neutron beam experiments. Neutron diffraction in crystallography is already widely used, but the committee points to possible applications to crystals of biological molecules and the determination of magnetic structures. But there are also benefits to be won from studies of dynamical processes in crystals—phonons, magnons and the vibrations of polymer chains, for example. The committee says that the importance of this work "cannot be overemphasized" and that there is an urgent need of a high flux beam reactor.

The committee seems also to have been captivated by the potentiality of synchrotron radiation in the study of gases and solids and has spent £150,000 on a national facility for synchrotron radiation at the Daresbury Laboratory. Elsewhere, the committee promises more help for ion implantation studies in semiconductors and other solids, the study of the amorphous state and new developments in surface physics. It also seeks to encourage the use of on-line computers as a part of the general improvement of laboratory facilities. Further ahead, the committee is proposing to look carefully at opportunities in collisions between atoms and heavy particles at low energy, principally on account of their interest in chemistry and astrophysics; the development of dye lasers, in part because of the way in which such tunable lasers can provide selective excitation in atomic physics; energy transfer processes in solids; mode locked lasers which give pico-second pulses; ferro-electric materials and what is called "technological magnetism"; electronic structures in alloys; spectroscopy by laser scattering and non-linear optics; the electronic properties of polymers; inert gas solids; critical phenomena at low temperatures and tunnelling in superconductors. On the whole, the Physics Committee gives a convincing impression that it knows where it would like its pensioners to go. The review deals also with matters such as the growth and supply of crystals for research in solid state physics, now helped along by work supported by the Science Research Council at Oxford, Strathclyde and Birmingham as well as by the Electronic Materials Unit of the Ministry of Technology at Malvern. The committee promises to pay attention to the development of instruments. On training, it says with pride that "very nearly 50 per cent of our postgraduate students are working on applied rather than fundamental physics" and promises to foster cooperative research and training between industry and universities by directing something like 20 per cent of new research studentships towards work of this kind.

COMMUNICATIONS SATELLITES

Skynet Ahoy

from a Correspondent

THE logic of providing a communications satellite system for defence purposes just as Britain is completing its withdrawal of forces east of Suez is not immediately obvious. The chief object of the Skynet satellite, of which the first of two was successfully launched on November 22 by the American Thor-Delta, is to maintain instant interference-free voice communication between Whitehall and forces in the Middle and Far East. It may, however, provide Britain with valuable experience in designing and building advanced communications satellites components, and this is certainly an expanding technological field with substantial export possibilities.