for vaccination were discussed by D. S. Rowe (World Health Organisation, Geneva) but it is too early yet to assess the potential of purified or crude antigens as vaccines against the more important parasitic diseases. The successful vaccination of cattle and sheep against *Schistosoma bovis* using irradiated whole larvae was described by M. G. Taylor (St Albans) but a more cautionary story was told by G. M. Urquhart (University of Glasgow) who discussed the success of the irradiated *Dictyocaulus viviparus* vaccine and the lack of success with a similar *Ancylostoma caninum* vaccine which was due not to any defect in the vaccine but to the fact that American veterinarians preferred drugs which are very effective against this worm. For most of the parasitic diseases of man effective drugs are not currently available and until they are immunological research must not be allowed to decline; those present at the Grignon meeting will ensure that this does not happen. □

Fly's eye view of cosmic rays

from K. J. Orford

AN interesting and elegant new experimental technique, designed to take 'pictures' of the tracks in the atmosphere of very high energy cosmic rays, has borne its first fruit. The results of a pilot experiment (Bergeson *et al. Phys. Rev. Lett.* **39**, 847; 1977) have demonstrated that such tracks may be observed using the very weak atmospheric nitrogen fluorescence light. Its significance is that the effective size of detectors of the very rarest cosmic rays has been increased by this technique to the volume of the atmosphere which can be seen from a point on the ground.

The main aim is to measure the energy spectrum of cosmic rays up to energies difficult to attain with any other technique. A continuous spectrum of energies is found to come from all parts of the sky up to an energy of about 10^{20} eV (about 16 J) per particle. The cosmological problems centre on the sources of these particles, whether they are local or universal, and on how much such prodigious energies can be given to individual particles. If, for example, these cosmic rays are universal, then a limit is placed on the energy spectrum. At an energy near 6.10^{19} eV a proton will interact strongly with the 2.7 K universal microwave background, and will lose a large amount of energy. The spectrum will then rapidly fall in the region of 10^{20} eV. There are indications from current experiments that it does not (Cunningham *et al., 15th Int. Conf. on Cosmic Rays,* Plovdiv 1977), at least up to nearly 10^{20} eV.

Just to detect the arrival of these cosmic rays is very difficult, mainly as a result of the small flux. A cosmic ray of energy greater than 10^{20} eV falls on a square kilometre somewhere between once per year and once per century, such is the present uncertainty. Such a low rate is detectable only because the cosmic ray particle causes a shower of up to 10^{11} electrons and other particles to build up along its track as it passes through the air. This shower has a lateral extent of a square kilometre or more, enabling particle detectors to be widely spaced on the ground to provide samples of the shower particles. For about 20 years, ever larger arrays of such detectors have been deployed around the world to sample large showers.

Some of the best information to date has come from the UK array at Haverah Park, near Harrogate. This has a sampling area of 12 square kilometres and has recorded showers of energy up to 10^{20} eV. However, there is a limit to the size which such arrays can be made, the cost increasing with the area covered.

The new technique uses the whole atmosphere visible from any point as a detector. It exploits the fact that most of the energy of the primary cosmic ray does not reach the ground, but is dissipated as ionisation in the air. About 0.05% of this energy is released as nitrogen fluorescence light which produced a very short (μs) flash of light along the cosmic ray track. A detector designed to measure this flash was first proposed in 1965 (Greisen *Int. Cosmic Ray Conf.*, London, 1965). However, the technical problems are severe. The light output is very small and difficult to detect against the background light of the night sky (each electron in the shower gives only four fluorescence photons per metre of track).

The pilot experiment of Bergeson *et al.* involved the use of concave mirrors of 1.5 m diameter, each focusing a small section of sky onto the faces of 12 photomultipliers. Each tube views an area of sky about 6° across. Showers detected by a conventional particle array at Volcano Porch, New Mexico, were compared with the images seen by the mirror assemblies and found to be in agreement. Following this, a full-scale experiment is being constructed on a mountain top in Utah, consisting of 67 mirror units. Thus a whole sky image is obtained with a resolution of better than 0.007 steradians. This many-faceted experiment, early dubbed the 'Fly's Eye', should detect the highest energy showers at a distance of 50 kilometres. The effective collecting area of about 8,000 square kilometres should allow an energy spectrum to be measured with high statistical precision.

This would be enough by itself to justify the experiment, but other results of no less significance may be forthcoming. Because the track of ionisation is seen for most of its length, the point at which the primary cosmic ray particle first interacted with a nucleus in the air may be found. The observation of a large number of such points should reveal the mean free path of the primaries for interaction in air, and hence their atomic weight. The composition of high energy cosmic rays is at present an open question, and compositions other than a simple 100% proton flux bring their own problems concerned with production, acceleration and propagation from the sources to the Earth.

Finally, the mean free path of the primaries could enable the total cross section for nucleus–nucleus, and from that possibly proton–proton, interactions to be found at energies more than 10^7 times higher than those at present available. □

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Negative strand viruses

from T. Barrett

A meeting on Negative Strand Viruses and the Host Cell was held at King's College, Cambridge, from 1–5 August, 1977. The proceedings will be published by Academic Press early in 1978.

NEGATIVE strand viruses are responsible for many important human and animal diseases, including influenza, Lassa fever, measles, mumps, distemper, fowl pest and rabies. This group of viruses has in common the possession of a single-stranded RNA genome which is of opposite polarity to the messenger RNA (mRNA). One of the most striking points brought out at the meeting was the great advance that has been made in the understanding of the nature of the genome of these viruses, in particular the genome of the influenza A viruses which consists of

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