that persistent patterns of sensation give rise to 'models' of static and dynamic environments the disruption of which by unfamiliar stimulus patterns releases emotional behaviour in the form of fear responses. J. P. Kruijt, in a second contribution to the symposium, spoke on imprinting in relation to drive interactions in Burmese red jungle fowl, and showed that the ability to integrate attack and escape into ambivalent behaviour is an important factor in the performance of successful copulatory behaviour. Dr. P. E. Guiton (Edinburgh) gave a demonstration of the development of sexual responses in the domestic fowl in relation to the concept of imprinting. He claimed that sexual attachments may be formed as a

consequence of the parent-young bond apparently before overt sexual behaviour is normally possible. Persistent sexual attachments to human beings can be induced in domestic cocks by early social contact with man. There is evidence that endogenous androgens are secreted by chicks.

The symposium was wound up by a discussion on some of the controversial aspects of imprinting initiated by Dr. W. H. Thorpe (Cambridge). Both sessions excelled by the quality of the papers and illustrations by slides and film, and there were some most useful and informative discussions in those instances when speakers allowed sufficient time for them.

O. E. LOWENSTEIN

GEOPHYSICAL MEASUREMENTS IN THE UPPER ATMOSPHERE

A GEOPHYSICAL discussion on the subject of the upper atmosphere was held at the Royal Astronomical Society, London, on November 24, with Mr. J. A. Ratcliffe, director of the Radio Research Station, Slough, as chairman.

There were four main speakers. The first, D. G. King-Hele (Royal Aircraft Establishment, Farnborough), discussed atmospheric density and its variations at heights of 180-700 km., as revealed by the changes in satellite orbits. The air drag acting on a satellite near its perigee point causes its orbit to contract, and by measuring the rate of contraction the air density near perigee can be deduced. The results obtained by this method have been very consistent and satisfactory, and have shown that the density tends to fluctuate in response to solar activity, the density being greatest when the Sun is most active. At heights above 300 km. there is also a large variation between day and night, the maximum day-time density exceeding the minimum night-time density by factors of $2\frac{1}{2}$ at 400 km. and 8 at 600 km.

The second speaker was H. Rishbeth (Radio Research Station, Slough), whose subject was "Atmospheric Composition and the F -layer of the Ionosphere". The electron distribution in the upper atmosphere is controlled by photochemical processes—the production and loss of ionization—which are dominant in the E - and F -layers, and by movements, such as electromagnetic drift and diffusion, which are important in the F_2 -layer. Dr. Rishbeth also discussed the seasonal anomalies in the F -region: the peak electron density is much greater in winter than in summer; the electron density near the F_2 -peak increases at sunrise more rapidly in winter; and the midnight electron density is greater in summer than in winter. Finally, he touched on the effect of magnetic storms.

The third speaker was K. Woakes (University of Exeter), who discussed the results obtained from the distribution of ionization above the maximum of the F -region. This ionization can be derived by three methods: (a) study of the Doppler effect and Faraday rotation on the radio signals emitted by satellites; (b) incoherent scattering by free electrons; (c) the Faraday method applied to Moon echoes. Method (a) gives the scale-height of positive ions as about 60 km. at heights of 300-600 km. Method (b) has given scale-heights of 55 km. at 400 km. rising to 90 km. at 700 km. height, corresponding to temperatures of 900-1,500° K. There is, however, no indica-

tion as yet from these results of the change in temperature between day and night suggested by the changes in density revealed by satellite orbits.

The fourth speaker was R. L. F. Boyd (University College, London), who described the measurement of electron temperature by means of Langmuir probes on rockets or satellites. The electrode is negatively biased, and the current flowing depends on the ability of the electrons to surmount this bias. The method has three advantages: it gives instantaneous values, can detect differences between electrons and neutral particles, and measures temperature directly. Dr. Boyd then gave some recent results obtained from a firing of a *Black Knight* rocket to a height of more than 500 km., at a time $2\frac{1}{2}$ hr. after sunset. The temperatures obtained increased from about 1,000° K. at 300 km. to nearly 2,000° K. at heights of 500-600 km. At the lower altitudes, these values agree with the night-time values deduced from the analysis of satellite orbits, but at the higher altitudes they are nearer the day-time values, suggesting possibly that the decrease in temperature after sunset is not so rapid at these heights.

In the subsequent discussion, G. V. Groves (University College, London) commented on the rather puzzling fact that changes in air density revealed by satellite orbits at the time of the great magnetic storm in November 1960 seemed to be almost independent of latitude and longitude, whereas one might have expected the effects due to particles from the Sun would be stronger near the poles. Mr. Ratcliffe suggested that if the heating were due to hydro-magnetic waves, the fairly uniform distribution would be more intelligible.

J. M. Stagg (Royal Meteorological Society) referred to the existence of another variation in air density at heights above 200 km., namely, an annual variation with a minimum in June and a rather flat maximum in October-December, and other speakers mentioned somewhat similar effects in the ionosphere.

After considerable further discussion, on topics which included upper-atmosphere winds, the intermediate ' $F_{1\frac{1}{2}}$ ' peak in electron density and changes in atmospheric composition, Mr. Ratcliffe summed up. The meeting had been a fruitful one, he thought, and particularly because it had brought together three groups: those who are working with rockets and satellites, the ionospheric physicists, and the meteorologists. He thanked the Royal Meteorological Society for sending a strong delegation, which contributed much to the discussion.

D. G. KING-HELE