news and views

High resolution interferometry

from F. G. Smith

THE angular accuracy of radio astronomical maps of celestial objects has progressed beyond all optical measurement, but it has reached a natural limit. This limit is provided by the available intercontinental distances between the component radiotelescopes used in Very Long Baseline Interferometry (VLBI). The observations reported on page 17 use multiple baselines between the 100-m radiotelescope in Germany and three American radiotelescopes, at Green Bank, Owens Valley, and Fort Davis. At a wavelength of 2.8 cm a source diameter of only 0.25×10^{-3}″ can be resolved by this multi-element interferometer, which uses all of the six independent baselines between the four telescopes. The combined efforts of 13 radioastronomers, and doubtless many supporting staff, at these telescopes now give us a map of the central radio source in the galaxy NGC1275, well known optically as a Seyfert galaxy with very large internal velocities. The radio map only covers the nucleus of the galaxy, with a total extent of 5 pc, but the resolution is 0.1 pc. Longer wavelength radio emission, as mapped by the 5-km radiotelescope at Cambridge, comes from much more extensive regions, while the whole galaxy extends to a diameter of more than 50 kpc. It is the very core of the galaxy that is being explored in this new map.

The technique of VLBI does not give the same full and unambiguous map as does aperture synthesis. For example, the nucleus of NGC1275 is elongated, with components whose sizes, shapes and relative dispositions are now fairly well determined: but it would be equally possible for the whole map to be rotated by 180°. This is of no consequence in the physics of this radio source, which is known to be active on a very short time scale. Most of the radio emission has appeared during the last 15 yr, since the time that measurements started on short wavelengths.

Rapidly changing radio sources present further problems in interpreting VLBI measurements. If a single baseline is used for measuring an apparent source diameter, the source can appear to grow or shrink alarmingly rapidly.

An effect of this sort has even led to the suggestion that some components of radio galaxies are expanding outwards with velocities greater than that of light. Such an interpretation requires the various components of a source to retain their relative intensities, and to change only their relative positions. The isolation of several small components within the nucleus of NGC1275, which must be the seat of the large intensity changes observed since 1960, suggests that it is premature to interpret any changes of configuration of radio galaxies as due to "super-light" velocities.

The physical processes in the nucleus will provide much food for thought. Large parts of the galaxy are moving with relative velocities of over 3,000 km s^{-1}. Many theorists consider that the kinetic energy of this motion comes from an explosive event in the nucleus, where the radio emission now demonstrates the active generation of high energy particles and magnetic fields.

Behaviour of the ionosphere and plasmasphere during geomagnetic storms

from T. B. Jones

THE interaction of the solar wind with the Earth's outer environment involves complicated processes many of which are not yet fully understood. The geomagnetic and ionospheric storms produced by enhancements of the solar wind are particularly interesting since they give rise to major changes in both the ionosphere and magnetosphere. These in turn, disrupt long range radio communications and navigation systems which depend on the reflection of radio waves from the ionosphere.

Solar disturbances frequently produce an increase in the velocity and concentration of the particles of the solar wind. When this enhanced wind reaches the Earth's magnetosphere it produces several phenomena which include modification of the Earth's field, increased auroral activity and marked changes in the electron density distribution of the ionosphere. The arrival of the enhanced solar wind at the magnetosphere boundary increases the compression of the geomagnetic field which is observed as a sudden commencement geomagnetic storm on the Earth's surface. Simultaneously, the number of energetic particles in the magnetosphere trapping regions increases as particles are injected into the magnetosphere by transport across the magnetic shells. The increased ring current due to the particle enhancement is responsible for the main phase of the storm. A detailed account of the dynamical processes which govern the behaviour of the trapped particle belts can be found in *Particle Diffusion in the Radiation Belts*, (Schulz, Lanzerotti and Roederer, Springer-Verlag, 1974).

Changes of shorter duration known as 'polar substorms' can occur in the polar magnetic field. These disturbances are a feature of the 'auroral oval' which corresponds to the region where the field lines that leave the Earth's surface stretch out into the magnetotail. The role of the north-south component of the interplanetary magnetic field in substorm processes