Using the standard calculations for a Friedmann universe with the Hubble constant taken as 75 km s^{-1} Mpc^{-1} and q_0 equal to 1·5, the best value yet obtained from the redshift/magnitude relation, Peach and Beard have found that the diameters of distant clusters are inconsistent with any reasonable value for q_0. But once the systematic underestimating of the size of distant clusters, which results from the definition of diameter used, can be removed, it seems likely that this technique will yield an estimate for q_0 at least as accurate as those already available. The problem remaining is just how to obtain more accurate measures of the diameters of distant galaxy clusters.

PULSARS

Neutron Star Still Favoured

from a Correspondent

THE Accademia Nazionale dei Lincei at Rome brought together the leading pulsar observers and theorists from December 18 to 20 to exchange results, to think about the Crab Nebula and to try to solve the outstanding problem of how the pulses are generated. Although the solution is still far off, there has been real progress. The continuing flood of results from radio observations—particularly pulse profiles, measurements of polarization, and accurate timing—suggests a rotating beam from a neutron star.

The most exciting pulsar of the fifty so far known is, of course, in the Crab Nebula. Its radio emission has unique characteristics, and it also emits optical and X-ray pulses; the real excitement, however, comes from the visible nebula surrounding it, which is evidently continually supplied with energy from the pulsar.

The radio pulse from the Crab Nebula pulsar has three parts. Two correspond to the sharp optical pulses, while the third is longer and occurs just before one of the sharp pulses. This third pulse is very variable and highly polarized. It is suspected that this is the kind of pulse given out by other pulsars, while the sharp optical pulses are the real distinguishing characteristic. Observers are trying hard to find such sharp pulses, either optical or radio, emitted by other supernova remnants, such as Cass A or Tycho Brahe's supernova, so far without success.

Very accurate timing of the pulses is now becoming routine: the Crab optical pulses can be timed to about 3 microseconds by averaging over some hours. Both optical and radio results are now showing irregularities in arrival times. There is possibly a periodic irregularity amounting to 300 microseconds peak to peak, with a period of a few months. On September 28 a startling change of period was observed, amounting to 77 picoseconds. This strange step, referred to as the "glych", is considered to be a reorganization of a thin solid crust on the surface of the pulsar. The period settled down to a new value, with the original rate of change, after five days. There was no effect on the radio or optical pulses.

It has long been known that the Crab Nebula itself shows a remarkable activity in the form of bright wisps moving near the centre. The pulsar is clearly responsible for the energy supply, and the effects of energy injection at the centre can be seen through the whole nebula. There is a suspicion that other supernova have a hidden source of energy of the same kind, which again encourages radio observers to search for more supernova pulsars. Radio searches have recently turned up eight more pulsars, but none associated with a supernova remnant. The searches are becoming so thorough that no other strong pulsars are to be expected, apart from some with short periods for which present detection systems are not very appropriate.

Theories of the pulse emission are rudimentary. It seems likely that the source is some distance from the pulsar, so that the beam is formed by the high speed of a source located near the "velocity of light circle". But there are still theories involving amplification in the very dense plasma close to the surface. Some interesting electrodynamics has to be worked out for both regions; hardly a start has been made on the radiation mechanism itself. The most obvious simple question about the pulsars still remains: how do they make pulses? There ought to be a simple answer, which might be very interesting to plasma physicists trying to make plasmas behave in highly ordered ways. Perhaps pulsars can show how to make the plasma containers for controlled nuclear fusion.

BACKGROUND ASTRONOMY

X-Rays and Infrared Excess

by our Astronomy Correspondent

SPACE is not as empty as people think. Among other things, the second half of the nineteen sixties has shown that between stars, and possibly between galaxies as well, there is a witch's brew of cosmic ray particles and photons representative of most parts of the electromagnetic spectrum interacting through processes such as Compton scattering and Bremsstrahlung. So far, discussion has centred on the mix within the galaxy and the task of disentangling the ingredients is only just beginning. An immediate problem is to sort out the effect of the unexpectedly large flux of infrared radiation between 0·4 and 1·3 mm reported in 1968 by the NRL–Cornell group. On two rocket flights the infrared telescope recorded a flux corresponding to a black body temperature of something like 8 K instead of the 3 K expected.

Last year Cowsik and Pal, and independently Shen, pointed out that the infrared excess might give rise to the flux of high energy gamma-rays detected by OSO-3, through inverse Compton scattering of the infrared photons off cosmic ray electrons (see *Nature*, **223**, 779; 1969). Since then the infrared result has been verified by the second flight of the NRL–Cornell equipment, and, encouraged by this, Cowsik and Pal have now looked further at the implications of the infrared excess (*Phys. Rev. Lett.*, **23**, 1467; 1969). First, they agree with the group at the University of Leicester that the infrared flux might also be the cause of the X-ray background in the galactic plane which the Leicester group reported in October, again by the inverse Compton effect (Cooke, Griffiths and Pounds, *Nature*, **224**, 134; 1969). Second, a way of checking the existence of the infrared flux from further observations of galactic X-rays is put forward.

The starting point of the discussion is the energy spectrum of the cosmic ray electrons, which is thought to fall off less steeply below 1·5 GeV than over the interval 1·5–300 GeV, which, according to Cowsik and Pal, and Shen, is responsible for the gamma-ray flux.