in more senses than one—in the study of membranes just now concerns transformed cells in tissue culture, which as all the world knows show enhanced agglutinability by lectins. Noonan and Burger (*J. Biol. Chem.*, **248**, 4286; 1973), aside from showing that the phenomenon is not only (as has been suggested) the result of greater membrane fluidity, but also of a greater number of available binding sites, have demonstrated a precipitous change in the amount of concanavalin A bound at 15° C, which again is a manifestation of a bilayer phase transition.

For students of the tricks of bilayers, Michaelson, Horwitz and Klein (*Biochemistry*, **12**, 2637; 1973), have demonstrated a tendency of particular phospholipids to collect preferentially on the inside or outside surface of vesicles, according to their ionic nature, and McNamee and McConell (*ibid.*, 2951) have found that in electroplax membrane vesicles there is a continuous migration of phospholipids back and forth between the inner and outer surface on a time scale of a few minutes at 15° C.

LOCUSTS

Pheromone Identified

from a Correspondent

PHASE transformation in locusts refers to the changes induced when solitary hoppers (juvenile locusts) become gregarious. The process is reversible in the instar stages because it is dependent upon the insect's population density. Gregaria hoppers are more active, need more food and are darker in colour than the solitaria hoppers (the latter are a green to fawn colour); and the gregaria adults assume longer wings and broader heads than their solitary counterparts. There is, however, one feature of the gregaria phase that can be measured more accurately than behavioural and physiological phenomena; during meiosis in the swarming adult male, the frequency of chiasmata (genetic crossing over) is increased as much as 30% over that of solitary males (Nolte, *Chromosoma*, **21**, 123; 1967).

Chemical communication plays a dominant part in the behaviour of locusts. In the desert locust, *Schistocerca gregaria*, olfactory information is important for food seeking, for synchronizing maturation, and for localizing oviposition. It was on this basis that Nolte (*Nature*, **200**, 660; 1963) postulated the liberation of a pheromone (a substance secreted to the outside of an individual and received by a second individual of the same species, in which it releases a specific action) by massed locusts that would trigger off gregarization processes. Nolte *et al.* (*Chromosoma*, **29**, 462; 1970) later found that the postulated pheromone was excreted in the faeces of solitary and gregarious hoppers (but not of the adults). The production of the pheromone was found to be related to the crop section of the alimentary tract and perception of such a stimulus appeared to be through the spiracles directly into the haemolymph.

Nolte *et al.* (*J. Insect Physiol.*, **19**, 1547; 1973) have now obtained evidence that this pheromone is 2-methoxy-5-ethylphenol, a derivative of guaiacol, which is a degradation product of the metabolism of the lignin of plants. They postulate that lignin is ingested in grass or shrubs and degraded in the crops of the larvae to guaiacol, some of which is excreted in the faeces, and the rest changed to the active pheromone (called "locustol") and also excreted.

The pheromone and some other substances were extracted by steam distillation and pentane extraction of hopper faeces. Gas chromatography of the pentane extract and preparative thin-layer chromatography of a more intensely purified extract disclosed two major and several minor components. Mass and nuclear magnetic resonance spectroscopy suggested that the two major substances are guaiacol (O-methoxyphenol) and 2-methoxy-5-ethylphenol, and this was confirmed by comparison of the effects of the two extracts and the two synthesized suspected compounds (and some of their isomers) on gregarization.

Four characteristics of gregarization in *Locusta migratoria migratorioides* were used in the identification of the pheromone: colour change during the various instars; chiasma frequencies during the first few days after becoming adult; adult morphometric ratios; and behavioural traits. Chiasma frequencies of the eight largest autosomes (the three shortest invariably exhibit one chiasma per pair) provided the most sensitive index of gregarization. Of the other criteria involved, pigmentation is influenced by other external factors (for example, humidity) as well as by chemicals, morphometric ratios are somewhat restrained under laboratory conditions and behaviour is difficult to standardize.

Considering these four criteria, locustol was shown to be the most active constituent of hopper faeces, although several other substances were shown to possess varying degrees of activity on one or more of the gregarization traits. Thus in a congregating group of hoppers gregarization will be triggered off by the accumulation of locustol in the atmosphere around the group. Previously, gregarization was found not to be so prominent a phenomenon in well ventilated laboratories. The ecological significance therefore in field conditions of a phenomenon that seems to depend on the build-up of a substance in a confined space has yet to be assessed.

SOLID STATE PHYSICS

Energetic Phonons

from our Condensed Matter Correspondent

IN a recent issue of *Physical Review Letters* (**31**, 215; 1973) Welte and Eisenmenger of Stuttgart University report that they have succeeded in generating extremely energetic phonons, with frequencies ν in the region of 1 THz (10^{12} Hz), by using superconducting aluminium tunnel diodes.

The thermal energy of a crystalline solid takes the form of quantized lattice vibrations, known as phonons. From the thermodynamic point of view, a simple solid may be regarded as an empty box containing a large number of phonons, each of energy $h\nu$, behaving very much like a gas of rapidly moving free particles. Phonons of low frequency and energy travel at the velocity of sound. Their velocity falls with increasing frequency until, at the so-called Debye cutoff frequency ν_D, which is characteristic of the material, their velocity becomes zero. Phonons of frequency greater than ν_D are not a very meaningful concept since they would have wavelengths shorter than the interatomic spacing.

At high temperatures the mean free path λ of the phonons is very short because phonon-phonon collisions are frequent. But at temperatures near 1 K, at which relatively few thermal phonons are present, λ can become comparable with the dimensions of the specimen; this situation is analogous to the molecular flow regime of a low pressure gas. A high energy phonon introduced at one end of the specimen has, therefore, a high probability of continuing in a straight line until it strikes a boundary so that, by using a suitable phonon generator and detector, the passage of a pulse of phonons across the specimen can be investigated. Unfortunately, conventional techniques for generating phonons are either restricted to relatively low frequencies, much less than ν_D, or produce phonons which are not monochromatic but spread over a wide range of frequencies.

While working with A. H. Dayem at the Bell Telephone Laboratories, however, Eisenmenger was able to report in an earlier paper that a superconducting

Correction

As the result of editorial error, Professor J. Yvon, of the Commissariat à l'Energie Atomique (CEA) in Paris, was inadvertently described in the News and Views article "Molecular Motions" (*Nature*, **244**, 256; 1973) as coming from the University of Paris; so, too, was Dr P. Lallemand, of the École Normale Supérieur.

tin tunnel diode can be used as a generator of relatively high energy phonons (*Phys. Rev. Lett.*, **18**, 125; 1967). Such a junction consists of a sandwich of two thin layers of superconductor separated by a very thin layer of insulator, and is prepared by evaporating the materials under high vacuum. When a suitable voltage V is applied between the electrodes, electrons are able to "tunnel" through the insulator, and arrive in the positive electrode with an excess energy of eV. It was found that, if the bias voltage was chosen so that eV was greater than twice the energy gap Δ (separating the ordinary electron states from the lower energy, paired, superconducting states) of the tin, most of the injected electrons gave up their excess energy in a two stage process: they fell first to the top of the energy gap by emission of a phonon or phonons whose maximum energy must be $eV-2\Delta$, and then dropped into a paired state with emission of another phonon whose energy was always 2Δ.

The experimental arrangement consisted of a diode formed on the end of a sapphire rod, so that the phonons which were generated could escape and propagate freely in the sapphire. A second diode was used to detect their arrival at the other end of the rod. Unfortunately, it turned out that phonons generated by the first process, known as relaxation phonons, were unable to escape from the diode, being strongly absorbed by the tin and giving rise, ultimately to further phonons of energy 2Δ, which is a great deal less than ν_D for most materials.

In their latest experiments, the Stuttgart group has been able to show that, for aluminium junctions, the energy of the emitted phonons is not limited to 2Δ, probably because the electron-phonon interaction is smaller than for tin, so that the relaxation phonons have a better chance of escaping.

The phonons were allowed to propagate in a silicon crystal. In order to show convincingly that they really were dealing with phonons of energy up to $eV-2\Delta$, they "doped" the silicon with a little oxygen, since infrared studies have shown that there is then a very strong resonant absorption of energy at 29 cm^{-1}; and they report that they did indeed observe a phonon absorption line at an energy within 1% of the predicted value, which was at about 24Δ, corresponding to a frequency of 0.87 THz. Forkel *et al.* believe that their technique should enable phonons to be generated right up to the Debye limit of $\nu_D=9.5$ THz for aluminium. If they are right, there should follow a whole series of elegant experiments designed to investigate the behaviour of very high energy phonons in a variety of different materials.

PALAEOMAGNETISM

Misidentified Dyke

from our Geomagnetism Correspondent

It is a long time since palaeomagnetism surprised most of the geological community by giving the first convincing quantitative evidence in favour of continental drift and thus setting the scene for the new global tectonics. But it can still come up with a geological surprise, albeit a more minor one, from time to time, even in a country as much studied geologically as Britain. Much of the more obvious geology of Britain was investigated in detail during the nineteenth and early twentieth centuries, of course; but it would appear from recent work that even its well and long established tenets are not necessarily immune to the onslaught of modern techniques.

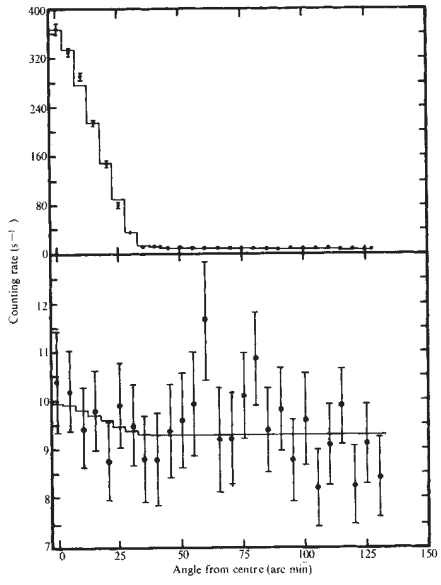
Consider, for example, the Wackerfield Dyke near Staindrop in County Durham, which was studied in detail many years ago by Holmes and Smith (*Durham Geol. Mag.*, **58**, 440; 1921). Although this roughly WNW-trending dyke is not exposed continuously, it is fairly obvious from field relations that it forms part of the Cleveland-Armathwaite Dyke. The latter, in turn, is part of the Eocene Mull Dyke Swarm which, though intense in western Scotland, thins out across southern Scotland and northern England into a much smaller number of larger dykes. Northern England, however, also contains an earlier generation of basic dykes and sills exemplified by the Upper Carboniferous Whin Sill, a system of transgressive quartz dolerite sheets which are intermittently exposed. Generally speaking, the Whin Sill and associated exposures do not follow the clear WNW trend of the Mull Dyke Swarm extension, although, being more erratic in direction, some of the exposures near the Cleveland-Armathwaite Dyke do lie roughly WNW. In spite of this superficial confusion, however, the Wackerfield Dyke has always been regarded as part of the Tertiary activity.

But Tarling *et al.* (*Earth planet. Sci. Lett.*, **18**, 427; 1973) have now used palaeomagnetic and isotopic dating techniques to show that this long-cherished belief must be discarded. The critical palaeomagnetic data come from fresh, unweathered samples of the Wackerfield Dyke exposed by quarrying, although comparative tests were also carried out on samples from the zone of surface weathering. Both thermal and alternating field demagnetization tests show that the natural remanent magnetizations of the fresh samples are extremely stable, and this is confirmed indirectly by the petrology. In the fresh samples, titano-

Are There Two Kinds of Radio Star?

It is not long since the discovery of a radio source associated with a star ranked as an event of major importance in astronomy. Now, however, several such associations are known, and astronomers have moved on to the next stage in studying these objects—trying to find family relationships between them. The numbers are still too small for satisfactory statistical analysis; but it does now look, according to Bahcall and Kellogg, as if there are two kinds of radio source associated with binary systems, one of which is a strong X-ray source and the other of which is not (see *Nature Physical Science* next Monday, August 27).

Perhaps it would be misleading to call these two kinds of source "classes", however, for of seven systems described by Bahcall and Kellogg six fall in one category and the other, HDE226868, stands alone. Although their calculations assume a thermal bremsstrahlung mechanism, the suggestion that there are two types of radio star (cool sources with $T \lesssim 10^7$ K and HDE226868 sources with $T \sim 10^7$ K) is independent of that hypothesis. Some of the differences between the two categories are brought out in the figure, which compares the X-ray emission from Cyg X-1 (top), the X-ray counterpart of HDE226868, with the lack of X-ray emission from RY Scuti (bottom). The possibility that the identification of HDE226868 with Cyg X-1 is wrong remains, of course, but, say Bahcall and Kellogg, "the present weight of evidence is strongly against this suggestion".



X-ray observations from Uhuru of Cyg X-1 (HDE226868, top) and the region of RY Scuti. The lack of X radiation from systems like RY Scuti suggests that these are fundamentally different from HDE226868.