Melson and Thompson (*Science*, **168**, 817: 1970) suggests that it does. One dredge haul, for example, produced a heterogeneous collection of basalts, dolerites, gabbros, serpentinites and partly serpentinized peridotites. One of the gabbros, which showed a well-developed cumulate texture, consisted of three textural components—large poikilitic pyroxene crystals, cumulus plagioclase crystals, and intercumulus material. The poikilitic augite grains present were about the same size as the larger mineral grains in various cumulate rocks of the Skaergaard intrusion, East Greenland, and similar to grains in the Stillwater complex, Montana. This particular gabbro was fine grained, but others in the dredge haul were coarser, reaching average grain sizes greater than 1·5 cm. In continents, large grains such as these are typical only of very large intrusions.

Chemical analysis of the fine grained gabbro showed that it was strongly fractionated. The elements expected to be enriched in residual liquids were low, whereas those usually enriched in mafic crystalline fractions were high. This is similar to fractionated gabbros from the Stillwater complex but quite different from a gabbro from the Indian Ocean. There is thus little doubt that some fractionation has occurred in the oceanic crust, a fact which Melson and Thompson have demonstrated directly for the first time. On the other hand, failure to find gravity differentiated samples before now does not necessarily indicate that fractionation in the oceanic crust is exceedingly rare. After all, by their very nature, plutons under the ocean are likely to be very difficult to reach, and tectonic movements, such as the fault movements in the Romanche Fracture, are necessary to expose them.

Petrographic and chemical similarities between the dredge gabbros and continental plutons thus suggest the presence of layered intrusives in the oceanic crust. Furthermore, the mere presence of layered intrusives suggests that in some areas large gravity differentiated complexes may form the bulk of the oceanic crust because corresponding complexes on land are usually very thick. The Stillwater complex, for example, is 8,200 m thick. As the normal oceanic crust is only about 5,000 m thick, an oceanic complex of this thickness would imply the extension of gabbro into the Earth's mantle.

Finally, taking into account the nature of all recorded dredge samples, Melson and Thompson suggest that there may be four processes by which new crust is formed at the mid-oceanic ridges—volcanism, intrusion of basic magma, emplacement of ultramafic rocks and hydrothermal metamorphism of fresh mafics and ultramafics. The relative importance of these various processes does, of course, differ from one mid-oceanic ridge to another.

PULSARS

Escapees from Binary Systems

by our Astronomy Correspondent

THE view that pulsars are high-velocity fragments from the break-up of binary systems—having the same origin as Blaauw's runaway stars, in other words—will be strengthened by a paper from J. R. Gott, J. E. Gunn and J. P. Ostriker of Princeton in which two pulsars are traced back to a common starting point (*Astrophys. J. Lett.*, **160**, L91; 1970). Part of the attractiveness of the hypothesis is that it might, of course, be verifiable by measuring the proper motion of pulsars. Gott *et al.* also predict the rate of change of the period for the pulsar NP 0527, one of the two pulsars which they have traced to an origin in Gemini, from its estimated age. The other pulsar is NP 0532, immersed in the Crab Nebula supernova remnant, and obviously in this case the explosion must have occurred after the original star was ejected from the binary system.

The accepted explanation of the runaway stars, which are single stars with high velocities of up to hundreds of kilometres per second but otherwise perfectly normal, is that they are the remaining members of binary systems that became unbound when the other component exploded. After the explosion the remaining star is ejected at something like its orbital velocity. It also happens that if anything is left behind by the supernova—and, of course, this is believed to be how pulsars are created—then the remnant trails the runaway.

This is the explanation of Gott and his colleagues for the proximity of NP 0527 and NP 0532, separated by only a degree or so and always difficult to understand, particularly as NP 0527 is the slowest pulsar with a period of nearly four seconds while NP 0532 is the fastest (33 milliseconds). In this case what must have happened is that the runaway star that remained intact after the break-up of the binary system itself eventually exploded. (In fact, the Crab Nebula supernova was observed by the Chinese to have occurred in 1054 AD.)

Starting from the large proper motion observed for the Crab Nebula pulsar, Gott and his colleagues have traced the two pulsars back to a point in Gemini, and they estimate the time interval between the two explosions to be three million years. This naturally leads to a prediction for the rate of slowing down of the NP 0527 pulses, and Gott *et al.* also give an estimate for the proper motion of NP 0527.

Obviously it would be worth trying to measure the proper motions of pulsars which are nearer than 5,800 light years to the Crab Nebula. Gott and his colleagues point out that the proper motion of CP 0950 at about 325 light years ought to be about 0·1 seconds per year if it has a similar origin, and this is well within the capabilities of radio interferometers.

SURFACES

Twixt Crystal and Vacuum

by our Solid State Physics Correspondent

A NEW way of treating the surface states of transition metals has been put forward which provides a clue as to why the surface layers of a ferromagnet are apparently non-magnetic and how the recently collected photoemission spectra of nickel comes to have such a marked peak in the density of states. By matching the wave-function in the vacuum outside the surface with that inside the crystal, F. Forstmann and V. Heine (*Phys. Rev. Lett.*, **24**, 1419; 1970) have found that the surface wave-function is confined essentially to the outer two atomic layers of the solid and that the energy of the narrow surface band corresponds well with the photoemission peaks in both nickel and copper.

This seems to be the first fundamental calculation of the surface states of a transition metal. Forstmann and