since demonstrated (Monckton *et al.* *Phys. Rev. Lett.* **39,** 1164; 1977) that the order is ferromagnetic.

It is impressive (and to some people surprising) that these properties of $ErRh_4B_4$ can be given a convincing discussion (Jarlborg *et al. Phys. Rev. Lett.* **39,** 1032; 1977) in terms of a calculated electronic structure. That any reasonable form of band structure calculation for a compound containing three types of atom and eighteen atoms per crystal unit cell can now be carried out is a testimony to the enormous progress made in such calculations by the combination of intelligent choices of calculational schemes and large amounts of computing capacity. The superconductivity seems to be associated with a high density of 4d-electron states (per unit energy) at the Rh atom sites, just as in the superconductivity of pure V and Nb (although for other reasons not in pure Rh), while the rather small density of states for 5d electron states on the Er sites, provides a magnetic coupling like that in pure Er between the local 4f moments on these sites. This, while not as strong as that between the larger 4f moments which completely suppresses superconductivity in favour of magnetic ordering in $GdRh_4B_4$, does finally, below 0.9 K, enable magnetic order to appear.

It seems not unreasonable that a long range magnetic order of ferromagnetic character should be incompatible with superconductivity since there is no sharp separation between two types of conduction band electrons (4d-like on Rh and 5d-like on Er), and the long-wave-length (zero wave-vector) spontaneous parallel spin pairing which is the essence of ferromagnetism cannot coexist with the Fermi surface antiparallel pairing which is the essence of normal superconductivity. The other forms of pairing which parallel the superfluidity of liquid ^3He are, as yet, only gleams in the eyes of theoreticians.

In other groups of compounds, the Chevrel phases RE Mo_6S_8 and RE Mo_6Se_8, there has, however, been some evidence for the coexistence of superconductivity and long range magnetic order. Thus, the La Jolla group (see the review by Maple in *Transition Metals,* 655; 1977 (Inst. Physics Conf. Series No. 39, 1977)) have found specific heat anomalies below T_c in RE Mo_6Se_8 for Sm, Gd, Tb, Dy and Er, which they ascribe to the formation of a state of magnetic long-range order, probably antiferromagnetic, within the superconducting phase field. In view of the important theoretical implications of such a coexistence (in formal terms a divergence in the wave-vector dependent susceptibility $\chi(q)$ at some antiferromagnetic wave vector q_0 while $\chi(0)$ goes to zero) it is of great interest that it has proved possible very recently to show the antiferromagnetism of the Dy compound unambiguously by neutron diffraction techniques.

In a recent paper (Monckton *et al. Phys. Rev. Lett.* **41,** 1133; 1978), research workers from the pioneer Geneva group, from Bell Labs and from Brookhaven have used the Brookhaven neutron scattering facilities to examine a specimen of $DyMo_6S_8$ down to a temperature of 50 mK, and have shown conclusively that this material (which becomes superconducting at 2.05 K) develops long-range antiferromagnetic order at 0.4 K. Conventional powder diffraction patterns taken above and below this temperature, together with high resolution scans of certain peaks, have permitted the identification of the detailed magnetic structure and yielded estimates of the ordered moments, which show some suppression by crystal field effects from the free Dy^{3+} ion values.

The coexistence of superconductivity and antiferromagnetic long-range order is now proven; a theoretically satisfactory account of such coexistence has yet to be produced. ☐

A star called M

from S. Jocelyn Bell Burnell

IN THE good old days (that is more than 10 years ago) people believed that neutron stars would only be detectable (if at all) through their steady, thermal optical emission. Calculations of the expected brightness are difficult to perform realistically; heat is generated in bizarre circumstances by friction between charged particles and a neutron superfluid in the interior of the star and there is heat loss by radiation from the surface, but the character of this radiation is drastically modified by the presence of a magnetic field of about 10^{12} gauss. Indications are that the surface temperature should be about 10^6 K and that the most readily detectable neutron stars would, optimistically, be within the grasp of the world's largest telescopes or, more realistically, might be just beyond them.

In the event, however, neutron stars were detected much more readily by radio astronomers (as pulsars) and soon afterwards by X-ray astronomers who concluded that many of the strong X-ray sources in our Galaxy were powered by a neutron star's gravity. Radio astronomers now know of some 300 pulsars. All pulse regularly, and their periods range from 33 ms to about 4 s. But only two of these three hundred have been detected at optical wavelengths. They are two of the most rapid pulsators—those in the Crab and Vela nebulas—and it was through their pulsed optical emission that the star responsible was ultimately identified in each case.

The Vela pulsar proved difficult to detect at optical wavelengths. At one stage astronomers despaired of detecting pulses and looked for a star whose emission might be accounted for as steady thermal radiation of a hot neutron star. On these grounds Lasker suggested as candidate a star he called M. That star called M turned out to be the pulsar.

Now events have taken another interesting turn bringing us back, almost, to where we started. The group that discovered the optical pulsations from Vela report (Peterson *et al.* *Nature* **276,** 475; 1978) that some 50% of the optical emission from this star is unpulsed. A series of frames taken during the pulsation cycle of the star shows quite clearly the double-pulsed profile which is its signature, and some residual light during the 'off' part of the pulsar's duty cycle. However, there is too much steady emission for it to be thermal emission from the surface of the star and they are forced to consider other possibilities. Perhaps it is the pulsar emission reflected off a cloud of gas or off the surface of the star; perhaps there are several sources of emission around the star which blur together; perhaps there are very broad pulses which fill the whole cycle.

They find a similar but perhaps less dramatic effect for the Crab pulsar. Here again there were technical difficulties, but this time it was the detection of the weak, steady emission in the face of the short but bright flash from the pulsar. Whereas the Vela pulsar needed 8 hours' observation with the 3.9 m Anglo-Australian Telescope, the Crab pulsar needed only 10 minutes' observation with the telescope stopped down to approximately half aperture! The conclusion is that the Crab too has steady optical emission, and although it's a smaller proportion of the total emission once again it is too copious to be accounted for by a thermal mechanism.

It will be interesting to see whether the latest generation of EUV and soft X-ray astronomy satellites can observe a similar effect. Meanwhile these incredible stars continue to puzzle, and occasionally to surprise. Less surprising will be the inevitable spate of papers which endeavour to explain this latest result. ☐

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