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# ULTRASONIC ATTENUATION DETERMINATION OF THE MAGNETIC PHASE DIAGRAM OF MnP

by

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# ULTRASONIC ATTENUATION DETERMINATION OF THE MAGNETIC PHASE DIAGRAM OF MnP

The compound MnP presents an interesting variety of magnetic orderings. Its crystal structure is orthorhombic (a > b > c) of the distorted NiAs type. Magnetization and magnetic susceptibility measurements (1) show that the system orders ferromagnetically below 291.5 K, with the c axis being the easy axis. Below 47 K, the system assumes a helical spin arrangement, in which the a axis is the screw axis (2,3). At temperatures below $\sim$ 45 K, the application of a magnetic field $H > H_1(T)$ along the b axis causes the system to enter a phase in which the spin direction oscillates harmonically (4) along the field direction (fan phase) (5). Furthermore, for magnetic fields greater than a field $H_2(T) > H_1(T)$, the system enters a third phase in which the spins are aligned with the magnetic field. The application of an external magnetic field along the c axis may cause the system to pass from the screw phase to the ferromagnetic phase. The magnetic phase diagram of MnP has previously been studied by magnetization (1,2) and magnetostriction (6) measurements.

Using standard pulse-echo techniques, the ultrasonic attenuation was measured for temperatures between 4.2 and 130 K and magnetic fields up to 70 kOe. Longitudinal and transverse sound waves, with frequencies between 10 and 150 MHz, were propagated along the b and c axes. For the transverse waves, the particle displacement was along one of the principal axes perpendicular to the propagation direction. In all cases, sharp changes in the ultrasonic attenuation were observed for all phase transitions between 4 K and 130 K. Although these changes were definite at all phase transitions, accurate measurements of the form of the attenuation changes could not be obtained because of the unsuitability of the sample for acoustic measurements. For the magnetic field along the b axis, these sharp changes allowed us to determine the magnetic phase diagram of Fig. 1. In particular, it was possible to resolve the different transitions near the triple points. We obtained zero-temperature critical fields $H_1(0) = 6.8 \pm 0.5$ kOe for the screw-fan transition and $H_2(0) = 38.5 \pm 1.0$ kOe for the fan-parallel transition. We locate the lower triple point (screw-fan-ferro) at $44.5 \pm 0.8$ K and $3.1 \pm 0.5$ kOe and the upper triple point (fan-ferro-parallel) at $108 \pm 3$ K and $17.5 \pm 1.0$ kOe. These values are in reasonable agreement with those obtained by other methods (1,2,6). It must be pointed out, however, that these are values of the applied field. Demagnetizing corrections can be estimated noting that the sample was nearly a parallelopiped with dimensions 0,6 cm, 0,3 cm and 0,6 cm along the a, b and c axes, respectively.

For the magnetic field along the c axis, sharp changes in the attenuation were also observed at the screw-ferromagnetic transition. At 4.2 K, the critical field obtained was $2.5 \pm 0.3$ kOe. This critical field decreases with increasing temperature and no change in the attenuation could be observed above about 45 K.

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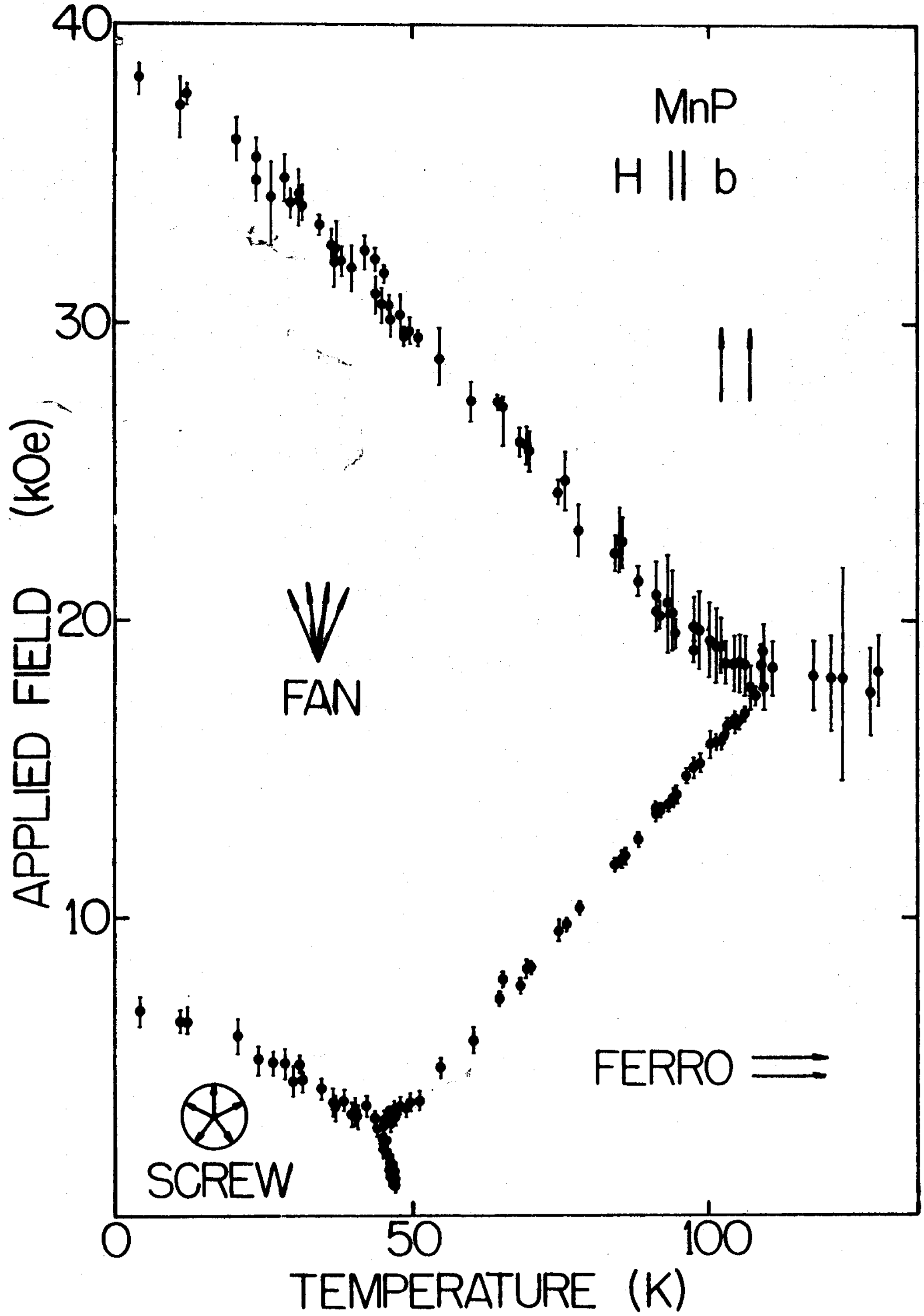
## FIGURE CAPTION

Fig. 1: Magnetic phase diagram of MnP for H//b, as determined from the ultrasonic attenuation. The bars indicate the observed width of the transition.



MnP
H || b
FAN
FERRO
SCREW
APPLIED FIELD (kOe)
TEMPERATURE (K)
0
50
100
10
20
30
40