

T_N , for localized electron AFM increases with the transfer integral, b , since the exchange interaction is proportional to b^2 ; whereas, it has been shown that T_N for a band AFM decreases with increasing bandwidth^{33,34} where the bandwidth is proportional to b . Goodenough concludes that the magnetic moment and T_N should vary continuously in going from a localized to a band description.

We expect b to increase with increasing pressure; hence, we expect that for the localized electron description T_N should increase with increasing pressure, and for the itinerant description T_N should decrease with increasing pressure.³⁴ Furthermore, we expect that the general arguments for an AFM apply to the FM case of interest here. The observed decrease in the FM to PM transition temperature in the $MnAs_{1-x}Sb_x$ compounds suggests that the itinerant description is the appropriate one. Although these alloys are anisotropic, the isotropic model discussed in this paper describes the pressure effects quite well.

B. First-Order Region

Previous experimental studies⁶ on $MnAs$ and $MnAs_{1-x}P_x$ have established that a first-order hexagonal FM to orthorhombic PM transition occurs only if the molar volume at T_c lies within a narrow critical range $V_t - \Delta V < V < V_t$, where $\Delta V/V \cong 0.025$. This narrow molar volume range is related through the thermal expansion to the temperature range $T_t - 125^\circ K < T < T_t$, where T_t is the second-order orthorhombic PM to hexagonal PM transition temperature. This, coupled with the fact that there is a low-spin \rightleftharpoons high-spin transition in this temperature interval, led Goodenough and Kafalas⁶ to postulate the existence of a maximum critical bandwidth that would support spontaneous FM and the existence of a volume dependent intra-atomic exchange interaction. This model predicts the existence of a critical pressure, P_c , above which the PM orthorhombic phase is stabilized to absolute zero; a $P_c = 4$ kbar has been found for $MnAs$.^{1,6} If P is

substituted for As, then one expects P_c to decrease since the substitution of P decreases the lattice parameters (the molar volume), and thus the bandwidth increases. Furthermore, if sufficient P is substituted for As, $P_c \rightarrow 0$. These effects have been observed.^{5,6} However, if Sb is substituted for As, the lattice parameters (molar volume) increase and the bandwidth decreases. Therefore, the substitution of Sb should cause P_c to increase, which is in accord with our experimental results.

Now if more than 10% Sb is substituted for As, then the molar volume will be larger than the critical volume required for a first-order transition, and the resulting solid solutions exhibit second-order transitions. If this model is correct, then at sufficiently high pressure one might expect to induce a first-order phase change in the materials with concentration $x \leq 0.9$. At the time this work was done, the pressures available to us (~4 kbar) were insufficient to check conclusively this prediction on the $x = 0.88$ solid solution. Estimations based on the isotropic Bean-Rodbell model²⁷ indicate a second-to-first-order transition pressure of approximately 16 kbar for this material. This number must be taken lightly, however, since there have been objections to using the Bean-Rodbell in its isotropic form for MnAs.¹ We are planning to continue the search for a second-to-first order transition pressure at higher pressure in the solid solutions with concentrations $x \leq 0.9$.

The Bean-Rodbell model,²⁷ which is based on a localized spin picture, has been used to describe qualitatively the first-order nature of the transition in MnAs. A similar situation arises in the itinerant electron model when the exchange and electron-lattice forces are balanced against the elastic forces. The result of this balance is that the bandwidth and exchange interaction become temperature dependent; then, depending on the parameters, the