Hereinafter we will refer to $0.9 \leq x \leq 1.0$ as the first-order region and to $0 \leq x < 0.9$ as the second-order region.

In Fig. 4, the initial pressure derivative of the FM to PM transition temperature, $\partial T_c/\partial P$, is plotted as a function of concentration. The pressure derivatives were determined to within ±0.15°K/kbar. For MnSb our measured pressure derivative of -3.0°K/kbar is in good agreement with the value -3.2°K/kbar as reported by Hirone et al.[26] It is observed that $\partial T_c/\partial P$ changes almost precipitously in a very narrow concentration range (~3%) demarcating the first and second-order regions. It should be remarked that the $x = 0.88$ material exhibited no thermal hysteresis at 4.5 kbar -- indicating that the transition remained second-order up to this pressure limit. (According to the Bean-Rodbell model,[27] it is possible that a second-order transition can be forced into a first-order transition under sufficient pressure; we shall comment more on this in Sec. IV.)

In Fig. 5 a portion of the temperature versus pressure magnetic phase diagram for MnAs and $MnAs_{0.9}Sb_{0.1}$ is shown. Our results for MnAs are in good agreement with the result of Menyuk et al.[1] It is observed, as speculated in Sec. I, that the substitution of 10% Sb for As does indeed increase the critical pressure required to stabilize the orthorhombic phase. The increase in critical pressure is approximately 0.75 - 1 kbar.

IV. DISCUSSION

In part A of this section we will discuss the solid solutions which exhibit second-order behavior. The results on these materials will be analyzed in terms of the itinerant FM model as presented in Sec. II. In part B the alloys which exhibit a first-order behavior will be discussed in terms of the model proposed by Goodenough and Kafalas.[6] In addition, some comments will also be made on the Bean-Rodbell model[27] prediction of pressure induced second-order to first-order behavior and on the equivalence of the itinerant electron FM and the Bean-Rodbell models.

A. Second-Order Behavior

In Fig. 6, $\partial T_c/\partial P$ is plotted as a function of T_c for the $MnAs_xSb_{1-x}$ solid solutions in the concentration range $0 \leq x \leq 0.8$. For comparison, the Fe-Ni, Fe-Pd, and Fe-Pt Invar alloys data of Wayne and Bartel[22] are included. Similar to the Invar alloys, we observe a T_c^{-1} type of behavior as predicted by Eq. (12) when the second term in Eq. (12) dominates.

The volume derivative of T_c is calculated from $\partial T_c/\partial P$ where the compressibility for the solid solutions was obtained by a linear extrapolation between the values of $2.2 \pm 0.5 \times 10^{-3}$ kbar^{-1} for MnSb[28] and 4.55×10^{-3} kbar^{-1} for MnAs.[1] The values for Γ are given in Table I. We observe that the values of Γ increase with increasing As concentration and that the magnitude of Γ is of the same order of magnitude as the first term in Eq. (10). In previous works on the Invar alloys[11] and $ZrZn_2$[9-12], it was observed that $\Gamma \gg 5/3$ and so the first term of Eq. (10) could be neglected. In the case of the $MnAs_xSb_{1-x}$ solid solutions, this factor of 5/3 must be included in any calculation of band parameters.

In Table I we give the results of the calculation of $\bar{I}_{max}$ from Eq. (15) for the solid solutions $0 \leq x \leq 0.80$ where we assume $\partial \ln I_b/\partial \ln V = 0$. The quoted error in the compressibility for MnSb will introduce an uncertainty of ± 0.03 in the values for $\bar{I}_{max}$. We observe that $\bar{I}_{max}$ decreases with increasing As concentration. According to Wohlfarth's[29] classification, these values of $\bar{I}_{max}$ indicate that MnSb is approaching a strong itinerant FM, and the solid solutions are becoming weaker itinerant FM's with increasing As concentration. These values of $\bar{I}_{max}$ for the $MnAs_xSb_{1-x}$ solid solutions are comparable with the values for the Invar alloys.[30]

From Eq. (3) and using the value of $\bar{I}$ and T_c for MnSb from Table I, we calculate $T_F = 1380°K$. Thus for MnSb we see that $T_c \cong 0.4\ T_F$ which indicates the Sommerfeld expansion is converging; however, the convergence is slower than one would desire. For the materials with $x > 0$, the convergence is more rapid than for $x = 0$.