4. Discussion

Kittel's theory was repeatedly used for the explanation of the magnetic field influence on the AF–FM-type transition temperature. In this case the fulfilment of the basic conclusion for this theory was experimentally verified. It may be possibly written as

$$\frac{M^2}{\Delta C} = \text{const}\,, \tag{2}$$

where M is the sublattice magnetization, ΔC the lattice parameter change accompanied by the transition.

At present one can consider it proved that condition (2) is fulfilled in the $Mn_{2-x}Cr_xSb$ system [5]. This is also true for the $Mn_2Ge_ySb_{1-y}$ system as evidenced by the experimental results reported by us. Thus Kittel's theory quite satisfactorily describes the magnetic field influence on the transition temperature, which is accompanied by an exchange interaction inversion. But it is not clear how this theory is applicable to the description of the pressure influence on the transition temperature. This subject must be solved separately for each investigated system as in theory it is assumed that with transition the lattice parameter changes only along the c-axis, while in reality any other lattice parameter may change. We consider the verification of the theory logically justified, when the calculated value $(\partial T_k/\partial P)$ is comparable with the measured one.

The temperature dependence of T_k on pressure, in accordance with Kittel's theory, is described by the following expression:

$$\frac{\partial T_k}{\partial P} = \frac{C}{\gamma}\,\frac{\partial C_T}{\partial T}\,, \tag{3}$$

where γ is the Young modulus, $(\partial C_T/\partial T)$ the thermal expansion coefficient of the crystal cell along the c-axis.

In order to use expression (3) for calculations one has to make use of two relations obtained in Kittel's work [6]:

$$\frac{M^2}{\Delta C} = \frac{\gamma}{2\,C^2}\,\frac{\partial \alpha}{\partial C} \tag{4}$$

and

$$\Delta S = 2\,\frac{\partial \alpha}{\partial C}\,\frac{\partial C_T}{\partial T}\,M^2\,. \tag{5}$$

Thus for calculation of $(\partial T_k/\partial P)$ it is necessary to know the entropy change ΔS of transition, the sublattice magnetization M, and the lattice parameter change ΔC at transition. The value of ΔC is to be found from X-ray diffraction investigations, the remaining quantities can be found from magnetic measurements in strong magnetic fields.

A thermodynamical analysis of phase transitions of the first kind gives the following transition temperature dependence on magnetic field strength [7]:

$$T_k = T_{k\,0} - \frac{H\,\Delta\sigma}{\Delta S}\,, \tag{6}$$