A Note on Pressure Effect on the Magnetic Moment

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where α and κ are the linear thermal expansion coefficient and the volume compressibility, respectively.

The term $(3\alpha T/\kappa)T_c^{-1}(\partial T_c/\partial p)$ in eq. (1) is practically small in comparison with 1, so that it may be neglected. Then eq. (3) reduces to

$$\sigma_s^{-1}(\partial\sigma_s/\partial p)=\sigma_{so}^{-1}(\partial\sigma_{so}/\partial p)-(T/\sigma_s)(\partial\sigma_s/\partial T)T_c^{-1}(\partial T_c/\partial p). \tag{2a}$$

Hereafter, $\sigma_{so}^{-1}(\partial\sigma_{so}/\partial p)$, $T_c^{-1}(\partial T_c/\partial p)$ and $\sigma_s^{-1}(\partial\sigma_s/\partial T)$ in eq. (2a) will be denoted as C_1, C_2 and $G(T)$, respectively, in order to simplify the notations. Then eq. (2a) is simply expressed as

$$F(T)=C_1-C_2TG(T), \tag{2b}$$

where $F(T)$ is $\sigma_s^{-1}(\partial\sigma_s/\partial p)$.

The discussions will be made on the basis of eq. (2b).

(I) As is pointed out in a previous section, the values of C_1 and C_2 should be required for investigating the pressure effect on the exchange interaction responsible for ferromagnetism, in either case where this investigation will be made on the basis of the localized electron model or of the collective electron model.

I_a: The values of C_1 and C_2 can be evaluated from more than two observation equations like (2b) constructed by using the observed values of $F(T)$ and $G(T)$ at more than two temperatures. From this point of view, $F(T)$, the temperature dependence of $\partial\sigma_s/\partial p$, is considered as worthwhile to investigate.

I_b: The measurement of $\partial\sigma_s/\partial p$ at a single temperature can determine, from eq. (2b), either of C_1 or C_2, but only when the other is known.

(II) As is found from eq. (2b), the function $F(T)$, which is the basic observable quantity in the present discussion, varies with temperature as does $G(T)$ which is determined by the functional form of $\sigma_s(T)$.

At low temperatures, approximately $T<T_c/5$, the spontaneous magnetization M_s observed has been satisfactorily represented from the spin wave theory by $M_s=M_{so}(1-AT^{3/2})$ with such a numerical constant A as of the order of 10^{-6} deg.$^{-3/2}$ for Ni and Fe, for example. Here, M_{so} is the magnetization at 0°K. Then $F(T)$ is given by

$$F(T)=C_1+C_2T\left(\frac{3}{2}\cdot\frac{AT^{1/2}}{1-AT^{3/2}}-3\alpha(T)\right), \tag{3}$$

where the relation $M_s=\rho\sigma_s$ has been used. In the bracket in eq. (3), the 2nd term $3\alpha(T)$ is practically small in comparison with the 1st term.

In the neighborhood of T_c, M_s varies with T in accordance with $(1-(T/T_c)^2)^{1/2}$ in the collective electron theory by Stoner[6] or with $((T_c-T)/T)^{1/2}$ in the molecular field theory. Then $F(T)$ is given by

$$F(T)=C_1+C_2\frac{1}{2(1-T/T_c)} \quad \text{in the collective electron theory.} \tag{4a}$$

$$=C_1+C_2\frac{(T/T_c)^2}{1-(T/T_c)^2} \quad \text{in the molecular field theory.} \tag{4b}$$