EXPERIMENTAL CONFIRMATION OF THE INFLUENCE OF LOCALIZED SPIN FLUCTUATIONS (LSF) ON SUPERCONDUCTIVITY

A.F. Prekul, V.A. Rassokhin, and N.V. Volkenshtein
Institute of Metal Physics, USSR Academy of Sciences
Submitted 22 February 1973
ZhETF Pis. Red. 17, No. 7, 354 - 356 (5 April 1973)

The theory of Benneman and Garland [1] deals with the influence of the localized spin fluctuations (LSF) on the temperature T_c of the superconducting transition. It is shown that T_c of a number of transition-metal alloys is lowered by the LSF by an amount

$$\Delta T_c^{sf} = T_c^{bs} - T_c^{sf},$$

where T_c^{bs} is the calculated value of T_c corresponding to allowance for only the band structure of the alloy. $T_c^{sf} \equiv T_c$(expt) is the critical temperature with allowance for the LSF.

On the basis of an experimental study of the temperature dependence of the resistivity $\rho(T)$ in the alloy system $Ti_x - V_{1-x}$, we have established a relation between the anomalous properties of these alloys.

On the one hand, the $\rho(T)$ curves have negative slopes in the temperature range 20 - 300°K. According to many theoretical and experimental studies [2], this is a symptom of LSF.

On the other hand, the transition from the superconducting to the normal state exhibits a typical broadening [3], and traces of superconductivity are preserved up to $T \simeq 2T_c$.

Using the scheme of Fig. 1, we have separated a temperature interval ΔT_c intermediate between the fully conducting and fully normal state, and set it in

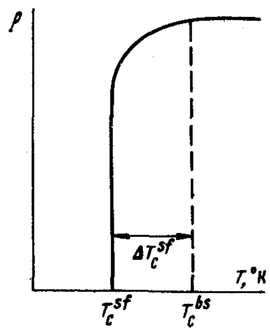

Fig. 1

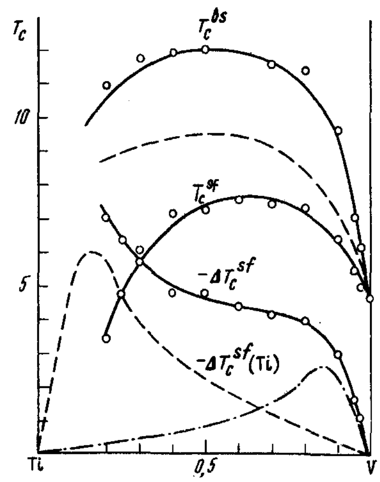

Fig. 2

Fig. 1. Scheme of transition into the superconducting state.

Fig. 2. Concentration dependences of T_c^{bs}, T_c^{sf} and ΔT_c^{sf}. Dashed curves - theoretical plots of T_c^{bs} and ΔT_c^{sf} [1].

correspondence with ΔT_c^{sf}.

Our experimental results, which are shown in Fig. 2, are in good qualitative agreement with the theory (see Fig. 2 of [1]).

We believe the causes of the quantitative discrepancies between the experimental and theoretical T_c^{bs} and the noticeable quantitative disparity be-between the theoretical and experimental T_c^{sf} to be the following: (1) The experimental values of ΔT_c^{sf} contain, in addition to the contribution from the LSF, also a contribution due to thermodynamic fluctuations of the superconducting ordering parameter, which may not be small in this case. (2) In the Benneman-Garland theory, the entire effect of the suppression of T_c is ascribed to LSF on V atoms, and this effect is linear in concentration up to ~10 at.% V.

It is seen from Fig. 2 that a similar situation obtains also for Ti atoms at $x \leq 0.1$.

In other words, the experimental ΔT_c^{sf} curves contain, besides the contribution $\Delta T_c^{sf}(V)$, also a contribution $\Delta T_c^{sf}(Ti)$, which is shown schematically by the dash-dot line in Fig. 2. This shows once more that the anomalies described above are due to LSF.

It is interesting to note that the theoretical estimates $T^{bs}_{c\,max} = 12°K$ in Ti-V alloys, made back in 1961 [4], are in full agreement with our results.

[1] K.N. Benneman and J.W. Garland, Intern. J. Magnetism 1, 97 (1971).
[2] N. Rivier and V. Zlatic, J. Phys. F: Metall. Phys. 2, 87 (1972).
[3] A.F. Prekul, V.A. Rassokhin, and N.V. Volkenshtein, Abstracts of 17th All-Union Conference on Low-temperature Physics, Donetsk, 1972.
[4] J.K. Hulm and R.D. Blaugher, Phys. Rev. 123, 1569 (1961).

CROSS SECTION RATIO OF THE REACTIONS $He^4(\gamma, p)H^3$ AND $He^4(\gamma, n)He^3$ IN THE REGION OF GIANT RESONANCE, AND CHARGE SYMMETRY

Yu.M. Arkatov, P.I. Vatset, V.I. Voloshchuk, V.A. Zolenko, I.M. Prokhorets, A.F. Khodyachikh, and V.I. Chmil'
Physico-technical Institute, Ukrainian Academy of Sciences

Submitted 26 February 1973
ZhETF Pis. Red. 17, No. 7, 356 - 358 (5 April 1973)

A number of recent publications, by Berman, Fultz, and Kelly [1] and by Berman, Firk, and Wu [2] have been devoted to the reaction $He^4(\gamma, n)He^3$ in the γ-quantum energy range from threshold to 32 MeV. Berman et al [1, 2], using their own data on the total cross section of this reaction and the cross sections given by others [3 - 5] for the (γ, p) reactions, have calculated their ratio as a function of the γ-quantum energy. The average ratio for giant resonance turned out to be 2.0.

Berman et al. used the expressions of Barker and Mann [6], which connect the ratios of the cross sections of these reactions with the amplitudes characterizing the states with isospin T = 0 and T = 1

$$\frac{\sigma_p}{\sigma_n} = \frac{P_p(E_p)}{P_n(E_n)}\left|\frac{a_1 + a_0}{a_1 - a_0}\right|^2$$