# NONCOLLINEAR MAGNETIC STATE IN HEISENBERG FRUSTRATED ANTIFERROMAGNETIC ALLOYS OF $\gamma$-FE

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The concentrated magnetic systems with the competing interactions (ferro- or antiferromagnetic) are characterized by various magnetic phases depending on the alloy component concentration and on the temperature. The main interest represents the double PM—FM—SG transition in which arising of

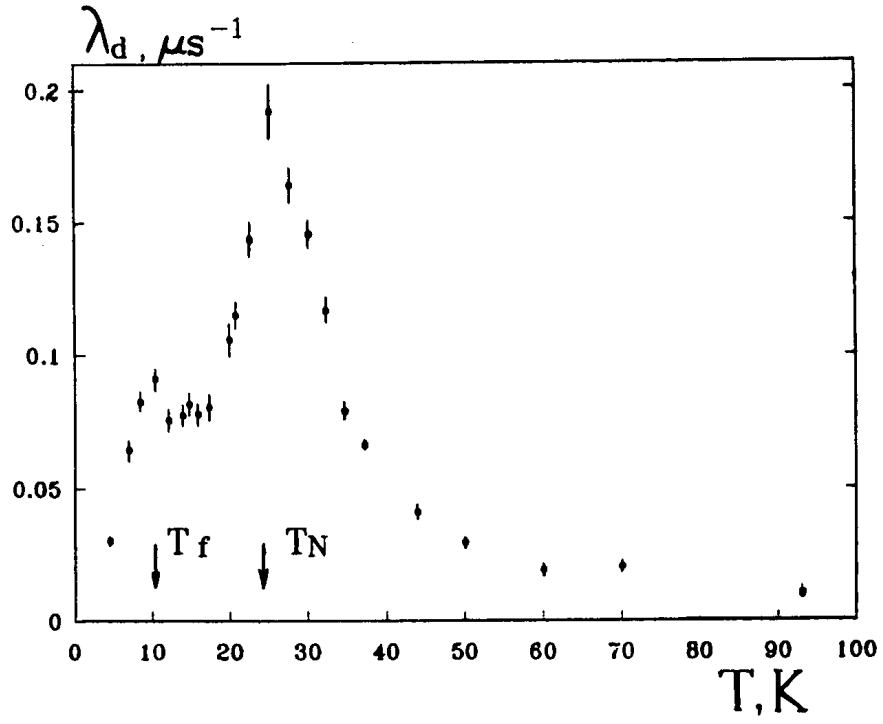


Fig.1. Temperature dependence of muon spin relaxation rate $\lambda d$ for $Fe_{64}Ni_{16}Cr_{20}$ alloy

asperomagnetic state is observed. The investigations of the frustrated $Fe_{80-x}Ni_xCr_{20}$ alloys with $x =$ (16—20) *at*%, the $Fe_{65}(Ni_{0.85}Mn_{0.16})_{35}$ alloy and the amorphous $(Fe_{0.7}Mn_{0.3})_{75}P_{16}B_6Al_3$ alloy by the $\mu$SR-method permitted to identify magnetic states and to define the phase transition temperatures.

The experiment was performed at muon channel of the Leningrad Nuclear Physics Institute. The measurements were done at the zero external magnetic field at the temperatures above 4.9 *K*. As it is known interaction of the muon spin with the local magnetic momenta in the target leads to relaxation of the initial polarization. The depolarization function $G(t)$ was chosen as a product of the two functions $G(t) = G_d(t)G_s(t)$, where $G_d(t)$ describes relaxation from dynamic processes of the intraction and $G_s(t)$ is the relaxation function in the static fields. Near the phase transition temperature the correlation time of interacting spins increases and the life time of critical fluctuations also increases. This leads to an increase of dynamic depolarization rate $\lambda_d$ defined from $G_d(t) = \exp(-\lambda_d t)$. From $\lambda(T)$ dependencies the phase

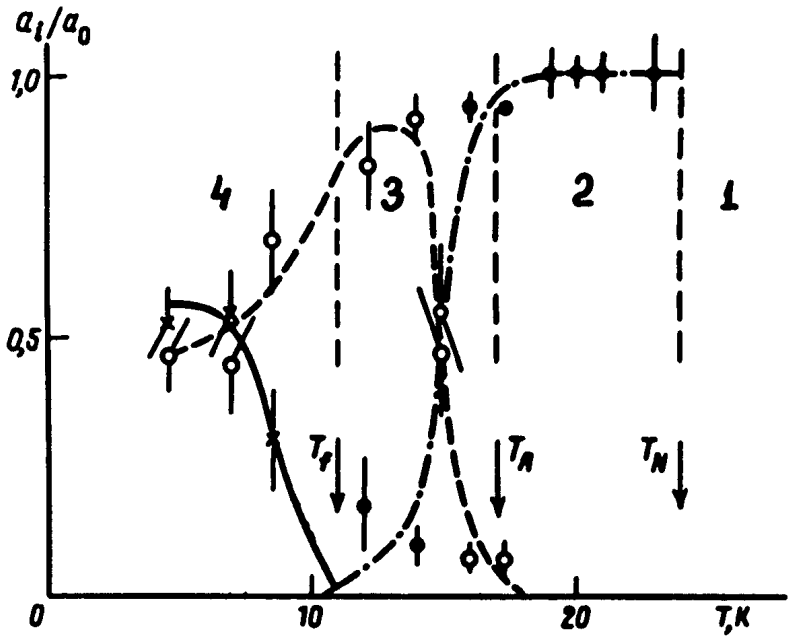


Fig.2. Temperature behaviour of volume parts $a_i / a_0$ of the magnetic phases for $Fe_{64}Ni_{16}Cr_{20}$ alloy: *1* — paramagnet, *2* — collinear antiferromagnet, *3* — noncollinear antiferromagnet (antiasperomagnet), *4* — spin glass state, $TN$ — Neel temperature, $TA$ — antiasperomagnetic temperature, $Tf$ — spin glass freezing temperature

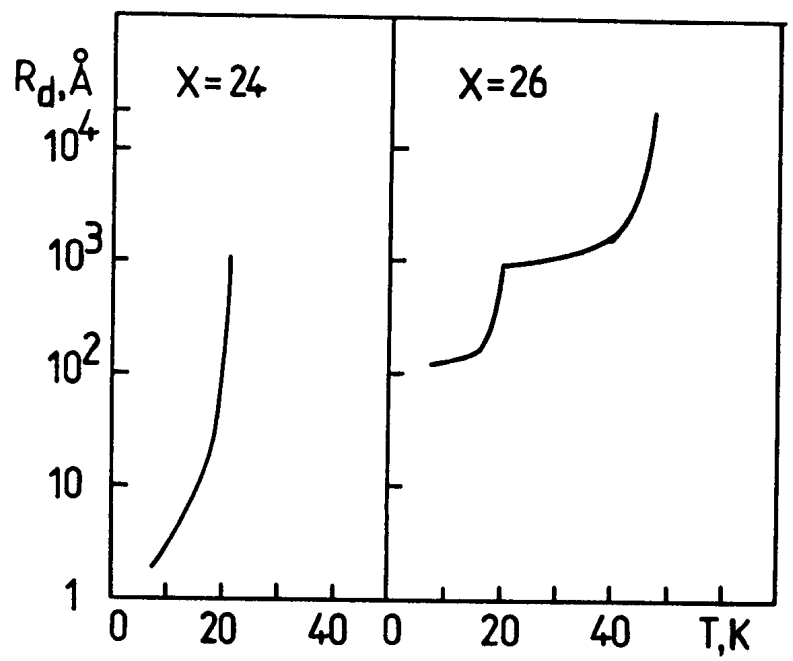


Fig.3. Temperature dependence of size $R_d$ of magnetic cluster in $Fe_{80-x}Ni_xCr_{20}$ alloys for $x$ = 24.26

transition points $T_C$ (or $T_N$) and $T_g$ were found easily (see fig.1). For all the samples under investigations the peak in $\lambda_d(T)$ is absent in the temperature interval from $T_C$ (or $T_N$) to $T_g$ due to arising of the ASM state. The essential information about phase states was extracted from the analysis of the static relaxation function $G_S(t)$ for the series of $Fe_{80-x}Ni_xCr_{20}$ alloys. For such magnetic system the transition from the PM phase to the reentrant spin glass state is carried out through the FM phase for $x \geq 25\%$ and through the AFM phase for $x \leq 18\%$. In both cases the ASM state arising precedes the SG state. The ASM state can be considered as a superposition of ferro- (or antiferro-) magnetic ordering along Z-axis and spin glass ordering of transversal spin components. Fig.2 shows the temperature dependence of the volume parts of magnetic phases for alloy with $x = 16$ *at.*% from the $\mu$SR-data. The $T_A$ is a temperature of the ASM phase arising. It is seen that $T \leq T_g$. ASM state coexists with the SG state which has a Gaussian disribution of local static field and the zero average field value ($B_o$).

For $20 \leq x \leq 24$ *at.*% interval the transition from the PM phase to only the SG phase with the Gaussian local field distribution and $B_0 = 0$ takes places. The dynamic relaxation function at this transition is the same as for dilute spin glass systems.

The joint analysis of the $\mu$SR-data and the result of the neutron depolarization measurements determine the temperature dependence of the size $R_d$ of the magnetic cluster in the spin glass ($x = 22$ *at.*%) and ferromagnetic ($x = 26$ *at.*%) region of $Fe_{80-x}Ni_xCr20$ alloys (see fig.3).