Breakdown in accommodation of the dynamic magnetic susceptibility of $Zn_xCd_{1-x}Cr_2Se_4$ spin glasses with $x \sim 0.4$

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Experiments reveal effects of a breakdown in accommodation of the real and imaginary parts of the susceptibility of $Zn_xCd_{1-x}Cr_2Se_4$ spin glasses when square magnetic pulses are applied to a sample. The breakdown in accommodation can be described by a power law.

A magnetic viscosity arises in spin glasses at temperatures below the "freezing" point T_f; i.e., in response to an abrupt change in the external magnetic field, the magnetic moment of the glass does not change exponentially rapidly but instead slowly relaxes to the new steady state.[1,2] In the present experiments we have observed that this relaxation is accompanied by a sharp increase in the dynamic magnetic susceptibility, which then slowly relaxes to its new steady state, which depends on the external field.

We studied the real (χ') and imaginary (χ'') parts of the dynamic magnetic susceptibility of spin glasses of the $Zn_xCd_{1-x}Cr_2Se_4$ system with $x \sim 0.4$ ($T_f \sim 21$ K) at 4.2 K in an alternating magnetic field $h \sim 15$ Oe of frequency 600 Hz during the imposition on the sample of magnetizing-field pulses H parallel to the alternating field h. Figures 1 and 2 show the behavior of χ' and χ'' when subjected to a square field pulse of height $H = 800$ Oe and length 250 s. At the leading and trailing edges of the field pulse there are sharp increases in both the real and imaginary parts of the suscep-

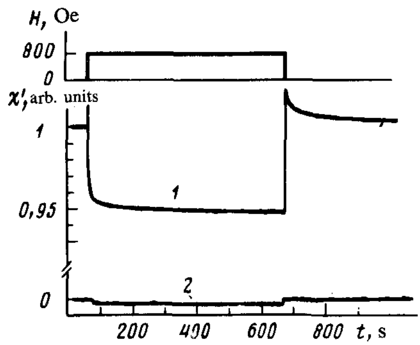

FIG. 1. 1—Behavior of the real part of the dynamic magnetic susceptibility, χ', upon the imposition of a square magnetic-field pulse 800-Oe high; 2—behavior of the zero level during the adjustment of the apparatus corresponding to the measurement of χ'.

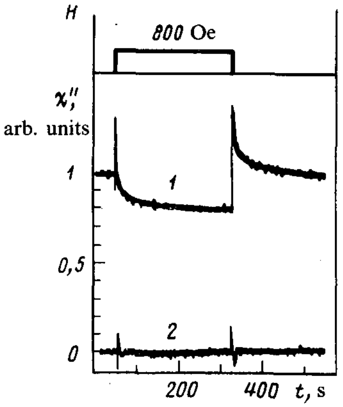

FIG. 2. 1—Behavior of the imaginary part of the dynamic magnetic susceptibility χ'' upon the imposition of a square field pulse 800-Oe high; 2—behavior of the zero level during the adjustment of the apparatus corresponding to the χ'' measurement.

tibility, which then slowly relax to steady-state values determined by H. It can be seen from Figs. 1 and 2 that the relative change in χ'' is $\sim 30\%$, while that in χ' is only $\sim 1\%$. For χ'' we were able to determine the relaxation law (Fig. 3): $\chi''(t) = \chi_0'' + At^{-\alpha}$, where t is the time that has elapsed since the removal of the field, χ_0 is the susceptibility before the imposition of the H pulse, and the parameters A and α depend on H. With $T = 4.2$ K, $H = 800$ Oe, and a pulse length of 250 s, the exponent α is ~ 0.35. At 4.2 K, after a field pulse of the same height and length, the magnetic moment of the given sample relaxes in a power-law manner with an exponent ~ 0.13 in the absence of external magnetic fields.[1]

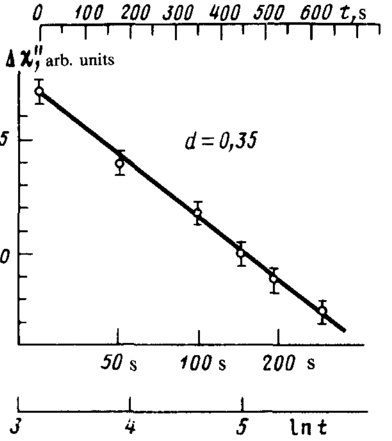

FIG. 3. Logarithmic plot of $\Delta\chi'' = \chi''(t) - \chi_0''$ versus the time t (see the text proper).

[1] V. G. Veselago, A. A. Minakov, and A. V. Myagkov, Pis'ma Zh. Eksp. Teor. Fiz. **38**, 255 (1983) [JETP Lett. **38**, 303 (1983)].
[2] A. Berton, J. Chassy, J. Odin, J. Peyrard, and J. Souletie, Solid State Commun. **37**, 241 (1981).

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