of the pump energy beyond the threshold of saturation of the rubidium Q-switch, the giant pulse was followed by several (from 1 to 60) pulses of much smaller amplitude. The number of these pulses and the distances between them varied with the pump intensity.

Fig. 2

Figure 2 shows a cumulative interference pattern of the ruby-laser radiation in the described regime after five flashes of the pump lamp. It was obtained with an interferometer having a base of 20 cm (distance between orders 0.025 cm^{-1}). The measured width of the laser radiation spectrum in the monopulse regime and the frequency of the radiation frequency from flash to flash did not exceed the apparatus width of the measuring system ($\sim$150 MHz). In order to verify the stability of the described generation regime at the temperature of the shift of the ruby luminescence-line frequency [2], and also to verify the possibility of tuning the laser frequency, the latter was measured at different temperatures of the water used to cool the ruby rod. It was found that the laser radiation frequency remains constant when the water temperature changes by 3°, and with further change of this temperature the frequency changes abruptly by several tenths of a cm^{-1}. It should be noted that under conditions when the pump greatly exceeded the threshold of the bleaching of the rubidium filter, in the multiple-pulse generation regime, the laser emission spectrum contained additional frequencies besides the stabilized giant-pulse frequency.

The results show that molecular systems with inhomogeneously broadened absorption bands can be successfully used for simultaneous passive Q-switching and frequency stabilization of lasers with a relatively broad spectrum of the generation band.

[1] A.M. Bonch-Bruevich, N.N. Kostin, and V.A. Khodovoi, Paper at 3rd All-union Symp. on Nonlinear Optics, October 1967, Erevan.
[2] I.D. Abella and H.Z. Cummins, J. Appl. Phys. 32, 6 (1961).

EFFECT OF SMALL-ANGLE MAGNETIC SCATTERING OF NEUTRONS IN IRON-NICKEL ALLOYS

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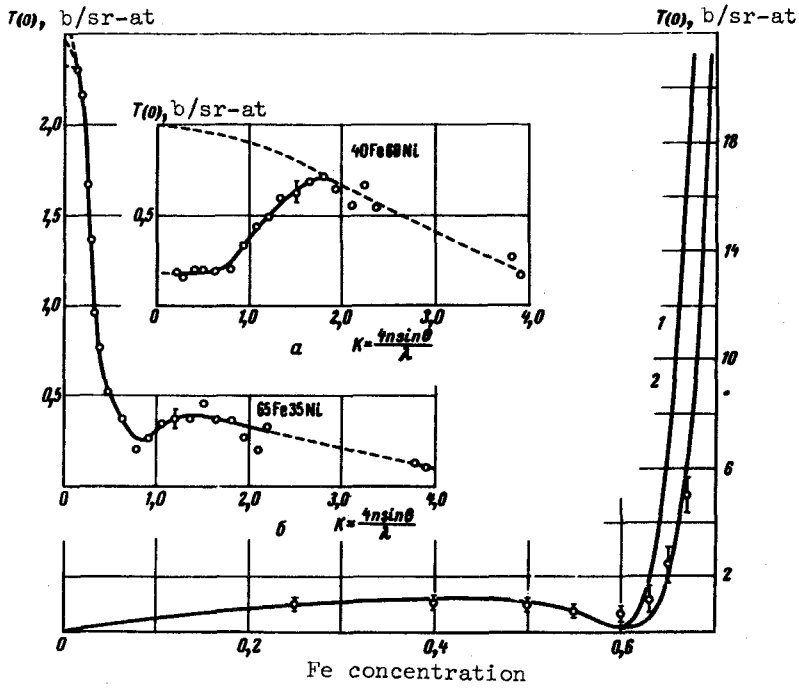
In order to determine the features of the magnetic structure of invar alloys, we investigated magnetic elastic diffuse scattering of neutrons by fcc iron-nickel alloys containing 25, 40, 50, 55, 60, 63, 65, and 67 at.% iron.

The alloys were molten in vacuum from pure components and subjected to prolonged homogenization at 1100°C. The samples were parallelepipeds measuring 20 × 20 × 2 mm and were quenched in water from 1100°C. The diffuse scattering was investigated at 100°C using a neutron diffractometer mounted in the horizontal channel of the IVB-2 reactor. The magnetic diffuse scattering was separated with the aid of a 5000 Oe magnetic field. The neutron beam collimation was such that a minumum angle $2\theta = 1°30'$ could be reached at $\lambda = 1.13$ Å.



Concentration dependence of the differential cross section of the forward magnetic scattering for fcc FeNi alloys. Curves 1 and 2 - theoretically calculated plots of T(0) on the concentration for $\varepsilon_{22} = 0$ and $\varepsilon_{22} = -0.02$, respectively. Light circles - experimental values; a - angular dependence of the diffuse magnetic scattering for the alloy 40Fe60Ni, b - the same for the alloy 65Fe35Ni.

The figure shows two characteristic spectra of the magnetic diffuse scattering in fcc FeNi alloys. All the alloys exhibit the first type of scattering (insert a) up to 60% Fe, and the second type (insert b) at higher concentrations. Thus, the alloys of the invar region (60% Fe and above) show an appreciable effect of magnetic small-angle neutron scattering, which increases with increasing iron concentration. Such small-angle scattering is characteristic of alloys containing magnetic inhomogeneities.

The theory of diffuse neutron scattering by inhomogeneous magnetic structures was considered by Marshall[1].In the nearest-neighbor approximation with allowance for the correlation in the alloy, the differential forward magnetic scattering cross section can be written, apart from a coefficient, in the form

$$T(0) = c(1-c)\left(\frac{\partial \bar{\mu}}{\partial c}\right)^2 + \frac{2c^2(1-c)^2}{z}\left(\frac{\partial \bar{\mu}}{\partial \epsilon_{22}}\right)^2 ,$$

where the c is the concentration of the atoms of species 2 (in our case, iron atoms), $\bar{\mu}$ is the average magnetic moment per atom of the alloy, z is the number of nearest neighbors, and ε_{22} is the correlation parameter.

The expression for the average magnetic moment in completely disordered FeNi alloys was obtained by Sidorov and Doroshenko [2, 3] in the nearest-neighbor approximation and in the approximation of antiferromagnetic interaction between the iron atoms [4, 5]. If account is taken of the correlation in the alloy, then the formula for the average magnetic moment is:

$$\bar{\mu}(c, \epsilon_{22}) = \left\{1 - c - z^2\lambda_1\lambda_2 c\left(c + \frac{\epsilon_{22}}{c}\right)^{12}\left[1 - \left(c + \frac{\epsilon_{22}}{c}\right)^{12}\right]\right\}\mu_1 + \left[c - zc\left(c + \frac{\epsilon_{22}}{c}\right)^{12}\lambda_2\right]\mu_2 ,$$

where μ_1 and μ_2 are the partial magnetic moments of the iron and nickel atoms, equal to 0.6 and 2.8 μ_B, respectively, and λ_1 and λ_2 are numerical parameters, a method for the calculation of which is given in (3). To calculate T(0) it is necessary to know the derivatives $\partial\bar{\mu}/\partial c$ and $\partial\bar{\mu}/\partial\varepsilon_{22}$, which equal

$$\frac{\partial\bar{\mu}}{\partial c} = \left[1 - 13z\lambda_2\left(c + \frac{\epsilon_{22}}{c}\right)^{11}\left(c - \frac{11}{13}\frac{\epsilon_{22}}{c}\right)\right]\mu_2 - \left[1 + 13z^2\lambda_1\lambda_2\left(c + \frac{\epsilon_{22}}{c}\right)^{11} \times \left(c - \frac{11}{13}\frac{\epsilon_{22}}{c}\right) - 25z^2\lambda_1\lambda_2\left(c + \frac{\epsilon_{22}}{c}\right)^{23}\left(c - \frac{23}{25}\frac{\epsilon_{22}}{c}\right)\right]\mu_1 ,$$

$$\frac{\partial\bar{\mu}}{\partial\epsilon_{22}} = -12z\lambda_2\left(c + \frac{\epsilon_{22}}{c}\right)^{11}\left\{\mu_2 + z\lambda_1\left[1 - 2\left(c + \frac{\epsilon_{22}}{c}\right)^{12}\right]\mu_1\right\}.$$

The solid curves 1 and 2 in the figure represent the theoretically calculated values of T(0) for disordered alloys ($\varepsilon_{22} = 0$, curve 1) and for alloys with correlation[1] ($\varepsilon_{22} = -0.02$, curve 2). The light circles show the experimental values of T(0) obtained by extrapolating to K = 0 the angular dependence of the cross section for magnetic scattering of the neutrons. For alloys with the first type of scattering, T(0) was determined by extrapolation in accord with the form-factor dependence, since the magnetic moment of these alloys is independent of the correlation.

In spite of the inaccuracies in the determination of T(0) by extrapolation, and in spite of the rather high temperature of the samples (100°C), it is possible to state with assurance that there is good agreement between the experimental and theoretical relations.

Thus, we have observed for the first time, and substantiated theoretically, the effect of small-angle magnetic scattering of neutrons in invar iron-nickel alloys, an effect pointing to the existence of an inhomogeneous magnetic structure in these alloys.

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[1] W. Marshall, J. Phys. (Proc. Phys. Soc.), CI, No. 1, 88 (1968).
[2] S.K. Sidorov and A.V. Doroshenko, Fiz. Met. Metalloved. 19, 786 (1965).
[3] S.K. Sidorov and A.V. Doroshenko, ibid. 20, 44 (1965).
[4] E.I. Kondorskii, Zh. Eksp. Teor. Fiz. 37, 1819 (1959) [Sov. Phys.-JETP 10, 1284 (1960)].
[5] M. Hatherly, K. Hirakawa, R.D. Lowde, I.F. Mallet, and M.W. Stringfellow, Prox. Phys. Soc. 84, 55 (1964).

[1] The correlation in the alloys was determined by us from the diffuse scattering of neutrons by similar alloys, using the isotope Ni^{62}. It turned out to be negative with an approximate value 0.02 - 0.01.