experimental errors, with the exponent $\gamma = 0.66$ characterizing the translational diffusion $D_t \sim \varepsilon^{\gamma}$ [7, 8]. It is not clear whether this agreement is accidental or not.

In the theory of Brownian motion, the coefficients of translational and rotational diffusion D_t and D_r are expressed by the well-known Einstein formulas $D_t = kT/6\pi\eta r$ and $D_r = kT/8\pi\eta r^3$, where r is the radius of the particle, η is the viscosity, and $\tau_1 = 1/6D_r$ is the anisotropy relaxation time. These relations were extended to include also molecular processes, and it was obtained in the theory of critical phenomena that $D_t = kT/6\pi\eta\xi$, where ξ is the correlation radius. It follows from our investigation that for rotational diffusion in the region of the critical point, either the formula for D_r with r replaced by ξ does not hold near the critical point, or else the correlation radius for the orientational motion differs strongly from the correlation radius for the translational motion, and one should thus assume the existence of another characteristic dimension.

All the questions raised here can be solved, in our opinion, only by investigating this phenomenon experimentally and theoretically. Such investigations can yield valuable information both on the behavior of substances near critical points and on the physical nature of the kinetic processes that lead to the appearance of a complex spectrum of depolarized scattering.

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OBSERVATION OF FERROMAGNETIC INTERACTIONS IN ANTIFERROMAGNETIC PEROVSKITES BY THE MOSSBAUER EFFECT

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Submitted 18 December 1972
ZhETF Pis. Red. 17, No. 2, 98 - 100 (20 January 1973)

It is known that indirect exchange interactions in oxides of transition metals are the main factor governing the antiferromagnetic mutual orientation of the magnetic moments of the cations. A positive (ferromagnetic) interaction has been predicted, for phenomenological considerations [1], only for the case of the $Fe^{3+} - O^{2-} - Cr^{3+}$ interaction (linear chain). Experimentally, however, no such phenomenon has been observed so far to our knowledge.

To observe the proposed interaction, we have investigated, by the nuclear gamma resonance (Mossbauer effect) method, the magnetic fields induced at Sn^{119} nuclei introduced in small amounts (2.5 at.%) as "observers" in the compound $LaFe_{1-x}Cr_xO_3$. To balance the valence, a suitable number of Ca^{2+} ions was introduced. In perovskite structures, the Sn^{4+} ions occupy the same octahedral positions as the magnetic cations. The Ca^{2+} ions enter into the rare-earth

sublattice. We investigated four compounds with x = 0, 0.06, 0.13, and 1. The samples were produced by the usual sintering method. The structure was checked by x-ray diffraction. The NGR spectra of all four compounds, obtained at 78°K with an $Sn^{119m}O_2$ source, are shown in the figure. The marked position compounds were obtained by computer resolution.

In the analysis of the spectra and in the identification of the lines we assumed the following:

1. The main contribution to the hyperfine field at the Sn^{119} is made by indirect induction from six nearest neighbors (in analogy, e.g., with [2]).

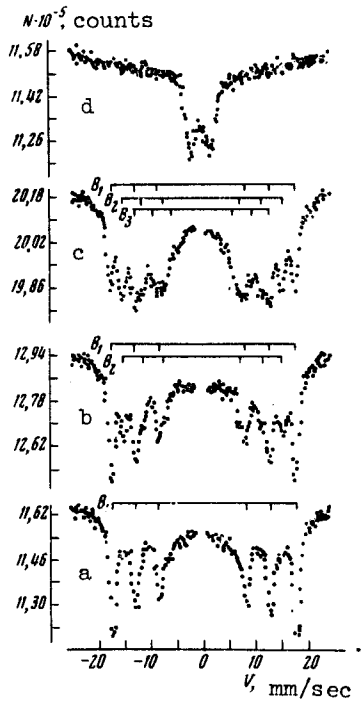
2. The contributions from each of the equivalent cations are equal and isotropic (it is known, for example, that for pure $LaFeO_3$ the Fe - O - Fe bonds are equivalent [3]).

3. The cations Fe^{3+} and Cr^{3+} in the mixed compounds (x = 0.06 and x = 0.13) are statistically distributed.

In this case the components B_1, B_2, and B_3 should pertain to the ions Sn^{4+} with surroundings (6Fe), (5Fe1Cr) and (4Fe2Cr), respectively. The hfs field in each of these positions is determined by the simple relation

$$H_n = (6 - n/h_{Fe} + nh_{Cr} \text{ where } n = 0, 1, 2, 6$$

h_{Fe} and h_{Cr} are the contributions from each bond with Fe^{3+} and Cr^{3+}, respectively.



NGR spectra of Sn^{119} in the compound $LaFe_{1-x}Cr_xO_3$ + 2.5% Sn: a) x = 0, b) x = 0.06, c) x = 0.13, d) x = 1. B_1, B_2, and B_3 are the components of the fine-structure fields at the Sn^{119} nuclei with nearest surroundings (6Fe), (5Fe1Cr), and (4Fe2Cr), respectively.

The contributions made to the spectra by other configurations are small and are therefore disregarded. The results for the samples with x = 0, 0.06, and 0.13 are in good agreement and give mean values h_{Fe} = 42 ± 0.2 kOe and h_{Cr} = 8 ± 1.5 kOe. At x = 1 (H_6 = 35 ± 15 kOe) the value $6h_{Cr}$ = 48 ± 9 kOe is close to the experimental value of the field. The maximum value of the field (component B_1) is H_0 = 252 ± 0.8 kOe.

Using the methods for calculating hyperfine-structure interactions by the theory of molecular orbitals [4], we can show that the fields h_{Fe} and h_{Cr} are described by the expression

$$h_{Fe,\,Cr} = 525N^4 \cdot 3f_\sigma \cos^2\phi \left[- \sum_{n=1}^{4} S_{ns}\,\Phi_{ns}(0) + a_{5s}\,\Phi_{5s}(0) \right]^2 \text{ kOe}$$

where N is a normalization factor, ϕ is the superexchange angle of Fe - O - Sn or Cr - O - Sn, $\Phi_{ns}(0)$ are the atomic ns functions of tin in the region of the nucleus, f_σ is the unpaired spin density on the $2p_\sigma$ orbit of the oxygen, S_{ns} is the $\langle 2p | \Phi_{ns} \rangle$ overlap integral, a_{5s} is the covalence parameter of the 2p - Φ_{5s} bond. We have here $f_\sigma = (\gamma_\sigma^{\downarrow} + S_\sigma)^2/3 = +0.049$ for the

↑Fe - O bond and $f_\sigma = [(\gamma_\sigma^\downarrow + S_\sigma)^2 - (\gamma_\sigma^\uparrow + S_\sigma)^2]/3 = -0.007$ for the ↑Cr - O bond. Here $S_\sigma = \langle 2p_\sigma | d_\sigma \rangle$, $\gamma_\sigma^{\uparrow,\downarrow}$ is the $p_\sigma^{\uparrow,\downarrow} - d_\sigma^{\uparrow,\downarrow}$ transport parameter. In the calculation, ϕ was assumed to be equal to the superexchange Fe - O - Fe or Cr - O - Cr angle (∿156°) [3]. The overlap integrals S_{ns} were calculated from the approximate Slater functions. The values of the wave functions $\Phi_{ns}(0)$ and of the remaining parameters were taken from [5, 4, 6].

The total polarization of the 3s, 4s, and 5s shells of tin at parameter values $a_{5s} = 0.25$ yields hfs fields $h_{Fe} = 41 \pm 2$ kOe and $h_{Cr} = -6 \pm 0.5$ kOe, i.e., values close to the experimental ones, but with opposite signs.

There are published measurements of the hfs fields induced at nuclei of nonmagnetic atoms on a linear magnetic ion - ligand - nonmagnetic ion chain. In particular, ENDOR measurements [6] for the Al^{27} nuclei in the chains $Fe^{3+} - O^{2-} - Al^{3+}$ and $Cr^{3+} - O^{2-} - Al^{3+}$ have shown that in these two cases the magnetic fields induced at the Al^{27} nuclei have opposite signs.

The significant fact in our experiment is that the contributions h_{Cr} to the hfs field at the tin have the same sign as the contributions h_{Fe}. It follows therefore that, in accord with the foregoing calculation, the magnetic moments of the Fe^{3+} and Cr^{3+} ions in the first coordination sphere of the tin should be oppositely directed. It is easily seen that a magnetic structure of this type is realized only when the superexchange interaction $Fe^{3+} - O^{2-} - Cr^{3+}$ has a positive sign.

The authors thank V.I. Gol'danskii for interest in the work and G.V. Ionov for help with the calculations.

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USE OF EXTRACTED SYNCHROCYCLOTRON BEAM TO INVESTIGATE SCATTERING OF 1-GeV PROTONS BY NUCLEI

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Submitted 8 August 1972; resubmitted 19 December 1972
ZhETF Pis. Red. 17, No. 2, 101 - 102 (20 January 1973)

The success of Glauber's theory has increased appreciably the interest in experiments on the scattering of high-energy protons by nuclei. To perform such experiments it is necessary to have apparatus with sufficiently high energy resolution, determined by the distance between the excitation levels of the nucleus. Palevsky's experiment [1, 2] remained until recently the only one performed at an energy close to 1 GeV, in which the elastic scattering was reliably separated from scattering with excitation of low-lying levels of ^{12}C and