S. K. Sidorov. *Neutron-diffraction study of alloys of transition metals with mixed exchange interaction.* Mixed exchange interaction is understood as the occurrence of a set of interatomic exchange interactions of different signs (ferro- and antiferromagnetic) in an alloy. Competing interactions of this kind give rise to numerous physical-property anomalies in alloys, and this accounts for the interest in such substances.

Ferro- and antiferromagnetic interactions in an alloy should result in progressive disorientation of the magnetic moments and eventually in the disappearance of spontaneous magnetization at a certain concentration of the component that introduces the antiferromagnetic interactions. A phenomenological theory of the magnetization of such alloys has been advanced on the basis of these considerations and has been confirmed quantitatively in experiments

The disorientation of the magnetic moments in the alloy depends on the local environment of the crystal-lattice node. Therefore an alloy with mixed exchange interaction should be spatially inhomogeneous with respect to magnetization. This has been confirmed by neutron-diffraction experiments.

Superstructural magnetic reflections that indicate the establishment of antiferromagnetic order at Neel temperatures of 10–20 K, depending on alloy composition, were first detected by neutron diffraction by polycrystalline and single-crystal specimens of an Ni-(60–70) at-% Fe alloy at helium temperature. Detailed analysis indicated that the components of the magnetic moments of the iron and nickel that are perpendicular to the spontaneous magnetization direction form a type IV antiferromagnetic structure in the fcc lattice. On the whole, the magnetic moments of the alloy components form a complex noncollinear structure that produces ferro- and antiferromagnetic reflections on the neutron-diffraction pattern simultaneously.

Neutron-diffraction and x-ray studies of iron-nickel-alloy single crystals with 60–75 at-% of iron have indicated weak superstructural satellites. This implies that structural changes that can be regarded as preparatory for the martensite transition to follow take place at temperatures and concentrations far short of those of the martensitic transformation. The first satellites and the γ' phase appear at temperatures around 900 K. A new group of satellites that characterizes the γ'' phase appears simultaneously with a magnetic transition at a lower temperature. The satellites appear to originate from "condensation" of acoustic phonons in the fcc lattice. This static displacement of atoms from their ideal positions at the lattice points is obviously related to an increase in the volume of the alloy. This is evidently justification for again bringing up the question as to the cause of the invar effect. The alloy should expand on heating from low temperatures. But since the reflections of the γ' and γ'' phases decrease with temperature, thermal expansion will be offset by the volume decrease associated with the decrease in the static displacements of the atoms from their equilibrium positions, and it is this that constitutes the invar effect.

It was found that the γ''-phase satellites in the reciprocal fcc lattice are disposed regularly in such a way that the γ'' phase ensures symmetry coupling between the γ and α phases, since the set of α-phase reciprocal-lattice points is determined by the combination of reflections from the original γ phase and the wave vectors of the γ''-phase satellites. This automatically yields the well-known Nishiyama relations for the mutual orientation of the γ and α phases in the martensite transformation.

[1]S. K. Sidorov, Fiz. Met. Metalloved. **45**, 532 (1978).
[2]A. Z. Men'shikov, S. K. Sidorov, and V. E. Arkhipov, Zh. Eksp. Teor. Fiz. **61**, 311 (1971) [Sov. Phys. JETP **34**, 163 (1972)].
[3]S. F. Dubinin, S. G. Teplouchov, S. K. Sidorov, Yu. A. Izyumov, and V. N. Syromyatnikov, Phys. Stat. Sol. Ser. A **61**, 159 (1980).
[4]S. F. Dubinin, S. G. Teplouchov and S. K. Sidorov, *ibid.* **54**, 239 (1979).
[5]S. F. Dubinin, S. G. Teploukhov, Yu. A. Izyumov, V. N. Syromyatnikov, and S. K. Sidorov, Fiz. Met. Metalloved. **50**, 1276 (1980).