Yu. A. Izyumov. *Symmetry of magnetically ordered crystals and the scattering of slow neutrons.* The magnetic structures of crystals can be classified, and methods of decoding them from neutron-diffraction patterns can be given, on the basis of the theory of representations of the space group G of the original paramagnetic crystal. The magnetic structure is represented in the form of basis-function expansions of irreducible representations with a specified wave vector. Symmetry analysis of many different types of magnetic structures (orthoferrites, spinels, garnets, rare-earth metals, etc.) has shown that they can be described in the overwhelming majority of cases by a single irreducible representation of the group G in accordance with Landau's phase-transition theory. Thus, the magnetic structure can be completely defined by a small number of parameters—the mixing coefficients of the basis functions of the relevant irreducible representation.

In the reduction of neutron-diffraction patterns, it is not the components of the magnetic moments σ of the atoms in the primitive cell of the crystal that are subject to variation, but the mixing coefficients, the number of which is equal to the dimension l of the irreducible representation. It is the reduction of the number of varied parameters from 3σ to l that is one of the advantages of symmetry methods in neutron diffraction; it is the more effective the more complex the crystal being investigated, i.e., the larger is σ. Convenient working expressions have been derived for calculation of the basis functions in the magnetic representation of a crystal, such as are needed for symmetry analysis of magnetic structures.

It has been shown that magnetic structure is generally characterized not by a single wave vector, but by a set of star rays for which the corresponding radial contribution is nonzero. This set, which we shall call the transition channel, defines the magnetic lattice of the crystal. The Shubnikov-symmetry lattices obtained in all channels of Lifshitz stars were recomputed for all initial Bravais lattices, and the corresponding magnetic reflections were indicated in each case.

Polarization effects in the scattering of neutrons by an arbitrary magnetic structure were investigated: the dependence of the scattering cross section on the orientation of the polarization vector of the initial beam and the appearance of a spontaneous-polarization vector in the scattered beam. It is shown how the magnetic structure can be decoded in its entirety from a single magnetic reflection (if the structure is characterized by a single wave vector) with the aid of symmetry analysis on the basis of the measured polarization effects. Generally, the smallest necessary number of magnetic reflections is equal to the number of rays of the wave-vector star.

Certain examples of magnetic structures that can be described by two or more irreducible representations are analyzed. It is shown that there are symmetry reasons for this in some cases. One of these reasons is the additional (with respect to the symmetry of the initial crystal) symmetry of the exchange Hamiltonian—invariance under rotation of all spins. It results in additional degeneracy of exchange energy, which is manifested in the existence of exchange multiplets. Examples of magnetic structures characterized simultaneously by several irreducible group G representations that enter into a single exchange multiplet are given.

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