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THE MAGNETIC STRUCTURE OF MANGANITE MnOOH AT 4.2 °K

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Résumé. — Les diagrammes de diffraction neutronique à 4,2 °K obtenus à l'aide de monocristaux de manganite présentent des raies de surstructure magnétique. Une méthode photographique semblable à la méthode des oscillations en rayons X a été utilisée pour déterminer les pics magnétiques. Les intensités de ces pics ont été mesurées avec un compteur. La structure magnétique du manganite peut être décrite par une modulation à grande distance d'un arrangement avec des moments parallèles des ions aux sommets et au centre de la maille. Le vecteur de propagation est dans le plan ZX et fait un angle de 3°20' avec l'axe Z. La modulation a une périodicité de 4.88 Å.

Abstract. — Neutron diffraction patterns obtained from single crystals of manganite showed at 4.2 °K magnetic superlattice lines. A photographic method similar to the oscillation method in X-ray work was used to search for the magnetic peaks. The intensities of the detected peaks were measured with a counter. The magnetic structure of manganite can be described as a long range modulation of an arrangement with parallel moments of the ions in the corner and the centre of the unit. The propagation vector lies in the XZ plane and is tilted 3°20' from the Z axis. The modulation has a periodicity of 4.88 Å.

Neutron diffraction patterns were obtained from single crystals of manganite at 293 °K, 77 °K and 4.2 °K. At 4.2 °K magnetic superlattice lines were found. A photographic method like the oscillation method in X-ray work was used to search for the magnetic peaks. A LiF-ZnS phosphorus — as described by C. G. Shull [1] — was used to produce the photographs.

The structure of manganite (MnOOH) is a superstructure based on the markasite (FeS2) type [2, 3]. The weak deformation of the markasite type structure to a larger unit is caused by the difference of the O and OH ions. Till now no influence of this deformation on the magnetic structure was observed. Therefore the smaller markasite type unit was used here for indexing the reflections. The dimensions of this orthorombic unit are : a = 4.44 Å, b = 5.25 Å, c = 2.85 Å. In the unit there are two threavalent ions of manganese, one in the corner and one in the center.

At 4.2 °K oscillation photographs around the three principal axes were obtained. They proved a nearly ferromagnetic order in the X and Y directions and a nearly antiferromagnetic order in the Z direction.

Counter measurements and photographs of higher resolution showed a splitting of the magnetic peaks in the X direction. It was also necessary to assign irrational l-indices to the magnetic peaks. The carefully tested peaks required the following indices:

(0.052 0 0.572), (0.052 0 1.428), (0.052 1 0.428),
(0.052 1 1.572), (0.052 2 0.572), (1.052 0 0.428),
and (0.948 0 0.428).

The two components into which the magnetic peaks split were not exactly equal. For example (0.052 0 0.572) and (—0.052 0 1.428) were stronger than (—0.052 0 0.72) and (—0.052 0 1.428). (See fig. 1.)

![Fig. 1. — Section of the reciprocal lattice of manganite.](http://dx.doi.org/10.1051/jphys:01964002505056300)

The position and the periodic intensity changes characterize the magnetic peaks as satellites of the nuclear peaks (000), (002), (011), (020) and (101). Manganite has a magnetic structure of the long range modulation type at 4.2 °K with a periodicity of 4.88 Å. The propagation vector lies in the XZ plane and is tilted 3°20' from the Z axis. Consequently there are two possible orientations of the propagation vector. Both occur, but not with equal frequency. To the two possible orientations belong the two patterns of the stronger and weaker...
components of the magnetic peaks. There are no satellites belonging to peaks with

\[ h + k + l = 2n + 1. \]

This means that the long range modulation is superposed on a ferromagnetic structure with parallel moments on the corner and center ions. (The same structure can be described as a modulation of an antiferromagnetic structure if a different propagation vector is used.)

A further publication will treat the intensity measurements. The temperature dependence of the magnetic intensities indicates a Néel-temperature close to 40 °K.

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Discussion

Pr Rundle. — Pouvez-vous nous parler de la déviation de la symétrie octaédrique autour des ions Mn³⁺ ?

Dr Dachs. — Il y a des déformations dues à la différence entre les rayons de O et OH, et d’autres dues à l’effet Jahn-Teller. Celles-ci sont traitées dans mon article cité dans ce résumé.

REFERENCES

