東京大学理学系研究科物理学専門課程

# 24. Nuclear Magnetic Properties of Solid $^3$He

K. Matsumoto

**Abstract**

Ultralow temperature physics have been developed in the last decade. Conventional theories of magnetism of solid $^3$He are based upon the cyclic exchange hypothesis. In the case of bcc $^3$He, the four particle exchange of the planar type together with the triple exchange are assumed to be essential. In the case of hcp $^3$He, the cyclic exchange model retaines only the triple exchange is assumed to be large.

We propose the double pair exchange model mediated by virtual phonons of solid $^3$He. In this model tunneling motion for particle exchange is assumed to be strongly coupled with zero-point lattice vibrations. The exchange of a nearest neighbour pair of helium atoms is supposed to grow rapidly when the third atom closest to the pair is displaced to make enough space for the exchange tunneling. The effective spin couplings obtained in this model are rather long ranged.

The high temperature behaviour of the susceptibility of the hcp phase shows ferromagnetic Curie-Weiss temperature.

It is shown, however, that the hcp solid $^3$He does not exhibit the simple ferromagnetic spin order in the low temperature phase.

The model is extended to bcc $^3$He. If the uudd structure is stable, we can show that lattice distorsion is observed.

Some experiments which may confirm our hybridization model are suggested. Among others pressure measurement in magnetic fields would be fruitful.