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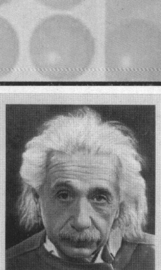
ABSTRACTS



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DQ-11/12 Interpretation of Influence of Magnetic Nuclei Concentration On Longitudinal Relaxation in YIG

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The increase in the longitudinal relaxation rate caused by the enrichment of magnetic nuclei in YIG films has been observed experimentally at the temperature T = 77 K [1]. The aim of the present report is the analysis of possible mechanisms, responsible for this phenomenon.

The similar problem has been discussed early for lithium ferrite [2] and hematite [3]. The main idea of the approaches of works [2, 3] is based on an assumption about impure ions, which cause the valence change of ions responsible for magnetic properties of studied materials. In the scope of this approach, the strong requirement is imposed to the magnetic ion of changed valence: ion must have energy levels in a distance, which equals to the NMR frequency. This provides interaction between ion and magnetic nuclei by means of virtual magnons.

Analyzing nuclear relaxation in YIG, we will proceed from the assumption about uncontrollable technological impurities. The diamagnetic impure ion, which replaces main Fe^{3+} ion in garnet lattice, on the one hand, reduces exchange interactions. On the other hand, this ion results the appearance of iron ions of other valence, for example, Fe^{2+} ions. The excess electron migrates from one iron ion to another ion in the region near impurity, what can be considered as a migration of ion of other valence. Such migrations really take place [4] and correlation time of the corresponding stochastic process is less the reverse NMR frequency [4].

The valence change results in the change of both exchange and spin-orbital interactions and, consequently, in the change in local magnetic anisotropy. As a result, migrations of the other valence ions produce fluctuations in magnetization direction. This conclusion is supported by computer simulation.

Taken into account the mechanisms discussed above, we can divide all nuclei into three types. The first-type nuclei are localized in the area of valence migration. The size of this area $R \leq 10a$ (a – lattice constant). Nuclei of second type are localized in the area of size about $(10^2 \div 10^3)a$ near first area, what is determined by Suhl-Nakamura (SN) interactions. The third-type nuclei are all other nuclei of a sample.

The first-type nuclei demonstrate the shorter relaxation times what is caused by direct contribution from fluctuated magnetization. Relaxation for second-type nuclei is determined by interactions with fluctuated magnetization (by means of virtual magnons) and spin diffusion, which appears as a result of SN interaction between first-type and second-type nuclei. The main relaxation contributions for the third-order are caused by SN interactions with second-type nuclei and spin diffusion. We suppose that the impurities concentration is so small that the third-type nuclei only contribute into experimental signal. Taken into account theory of work [2] and experimental relaxation times from work [1], we receive the average distance between impure ions $R \approx 0.5 \cdot (10^3 \div 10^4)a$.

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