The influence of "strange" radiation on Mössbauer spectrum of Fe^{57} in metallic foils.

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Abstract

Mossbauer investigations of thin foils of metallic iron exposed to "strange" radiation generated by electric explosion of thin wires in liquid are presented. The method of conversion electron spectroscopy has been used to determine the nature of detected particles admittedly named magnetic monopoles. The experiment has shown that the number of monopoles absorbed by the sample is enough to detect its influence on the Mossbauer spectrum. Determined changes of the effective magnetic field on iron nuclei essentially exceed of measurement inaccuracies. The following has been determined: a) the effect value depends on time from irradiation moment; b) the change of effective magnetic filed on iron nuclei correlates with the direction of the external magnetic field applied to the sample during the irradiation, that is the magnetic field separates N- and S-monopoles.

Introduction

The work of Urutskoev and co-workers on electric explosion of metallic wires in liquid has demonstrated the existence of "strange" high-energy radiation detected by photoplate located outside of experimental chamber [1]. Also it has been shown experimentally that the radiation interacts with magnetic field.

The authors of this work have proposed the possible hypothesis that the electric explosion in liquids produce magnetic monopoles. In 1972 Martemyanov and Khakimov [2] have shown theoretically the possibility of accumulation for magnetic monopoles in ferromagnetic materials in magnetic field. Following them we'll call "strange" radiation as "monopoles".

The idea to use the Mössbauer spectroscopy to detect absorption of magnetic monopoles in ferromagnetic foils looks very perspective for us. We used this method in our work and now we have concentrated on analysis of the results obtained.

Measurement methodology

Mössbauer spectroscopy is an instrument to measure a density of s-electrons on a nucleus, the value of gradient of electric field as well as a value and direction of magnetic field on the resonance nucleus.

The transmission experiments have a limit on sample thickness related to non-resonance absorption of gamma-quanta. Furthermore, big concentration of resonance nuclei leads to expanding of lines of Mössbauer spectrum owing to self-absorption processes. But there is an alternative approach that overcomes such limits. It is a possibility of registration of the Mössbauer spectrum by the secondary emission following by primary absorption of resonance gamma-quanta. It was be shown on nucleus Fe^{57}.

The types of secondary radiation after relaxation of excited states of nucleus are shown in Table 1. The coefficient of intrinsic conversion of Fe^{57} is about 10.

Table 1.

Radiation type	**Energy, keV**	**Intensity on 100 decays**
γ_m – radiation	14,41	10,8
Fe K_α- characteristic radiation	6,42	26,3
K - conversion electrons	7,3	79,3
L - conversion electrons	13,56	8
KLM - Auger-electrons	6,3	52,8
KLL - Auger-electrons	5,4	

The depth of analyzed layer of metallic iron for Mössbauer spectrum registered by γ_m- and K_α-radiation is about 10 micron, while this value for conversion electrons is about 0.2 micron.

In order to reduce time and increase accuracy of the Mössbauer measurements samples are enriched with resonance isotopes. For example, natural concentration of Fe^{57} is 2.2%, but it can be increased up to 90%.

Experiment and samples

In our experiments electric explosion of metallic wires or thin foils is produced in a plastic beaker placed into the cylindrical channel in massive non-magnetic metal. If we suppose that the explosion in liquid produces magnetic monopoles then we have to place the magnetic trap on the external surface of the plastic beaker. It gives the minimal distance from the source of emission. In this case it's not possible to use a static magnet to separate monopoles. It has been proposed to use pulse magnetic field generated by electric currency through the exploding channel.

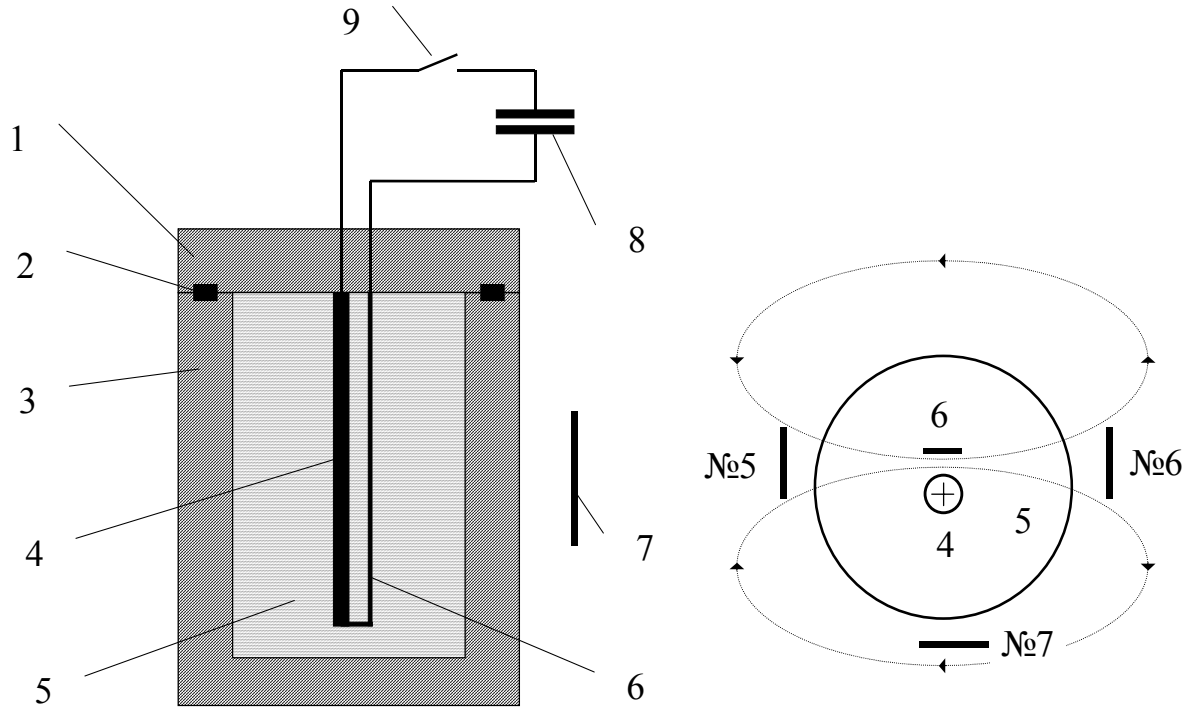

Fig. 1. Scheme of the radiation experiment for Fe-metal foils and magnetic field configuration on studied probes.

1 – the lid (polyethylene),
2 – filling,
3 – exploding chamber (polyethylene),
4 – conducting rod (titan),
5 – distilled water,
6 – exploding foil (iron),
7 – irradiated sample,
8 – capacitor bank,
9 – discharger.

The fig.1 presents a scheme of the experiment and disposition of the samples during the explosion of the conductor and the direction of magnetic field on the irradiated samples. The current of 150kA gives the strength of magnetic field H on samples No.5(S) and No.6(N) of about 120 Oe, but on sample No.7(L) - about 150 Oe.

As the samples we used the iron foil of 20-micron thickness enriched with Fe^{57} to 94%. The size of foils was 15x15 mm.

Mössbauer measurements have been done in Kazan State University with a spectrometer specially prepared to detect small changes of local hyperfine magnetic field on resonant nuclei.

Mössbauer spectrometer

Taking into account possible accumulating of magnetic monopoles in thin surface layer of ferromagnetic [2] we have decided to register Mössbauer spectra by Auger- and conversion-electrons [4].

The low energy of these electrons made us to put the sample directly into the electron detector chamber. We have used a flat proportional counter with He and 5% of CH_4 gas flow. All measurements have been done on the side of foils exposed to the exploding chamber.

The Fig.2 shows the scheme of Mössbauer experiment. This is scheme of the spectrometer based on the flat proportional detector with 2 wire anodes.

We used Co^{57} (Cr) gamma-quanta source with activity of 20 mCi.

To avoid influence of temperature drift in the laboratory on measured values we have made temperature stabilization of sensitive parts of the spectrometer – the conversion electron detector with the sample (at 35±0.5C) and the electrodynamic vibrator (at 32±0.5C).

The time of Mössbauer spectra measurement was always the same, 3 hours. Standard deviation value of effective magnetic field $\mathbf{H_{eff}}$ on iron nuclei for our 3-hour measurements was ±50 Oe.

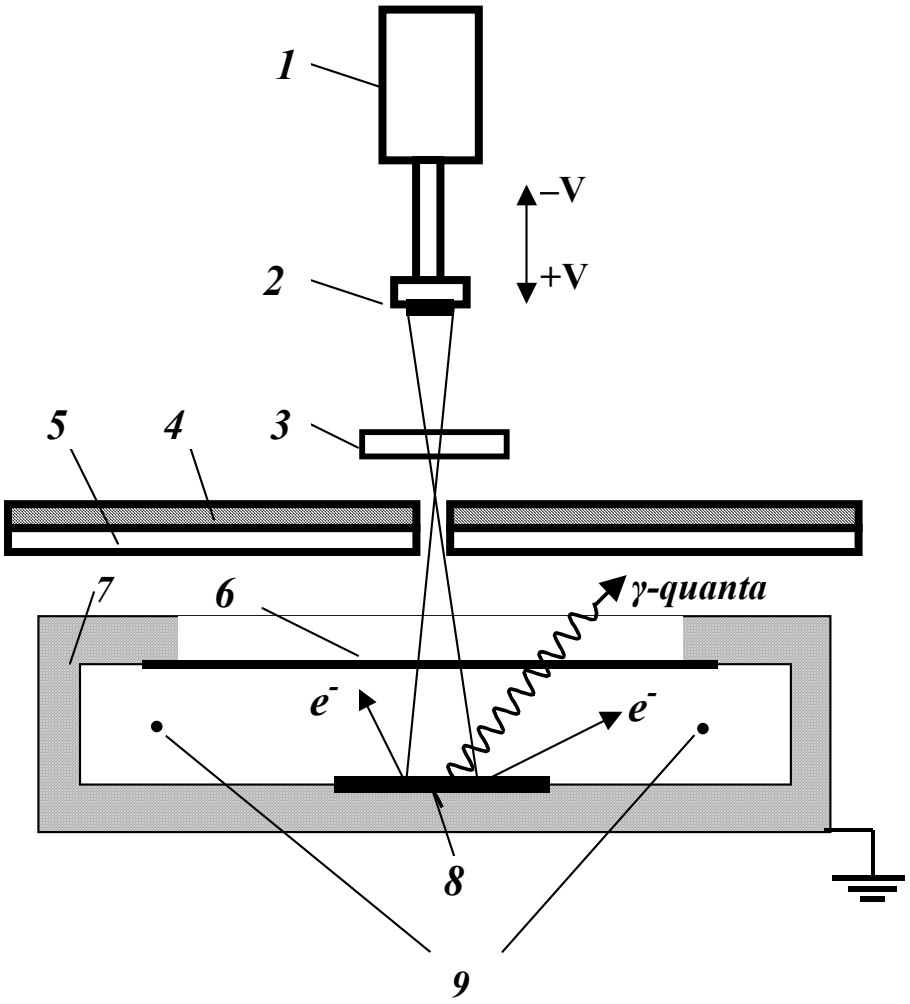

Fig. 2. Scheme of Mossbauer measurement by conversion electrons.

1 – electro-dynamic vibrator, 2 – Mossbauer source (Co^{57}), 3 – filter (A1), 4 – protection cover (Pb), 5 – additional filter (A1), 6 – input window (Be), 7 – counter case (A1), 8 – sample under investigation, 9 – anodes (W).

Experimental results and discussion

The figure 3 shows the typical Mossbauer spectrum with registration of conversion electron for our samples.

This spectrum consists of hyperfine magnetic structure (sextet) with quite narrow lines what is typical for uniform ferromagnetic sample. The value of magnetic field $\mathbf{H_{eff}}$ on an iron nucleus is about 330 kOe. Line intensity ratio in spectrum is close to 3:4:1:1:4:3, which shows that the direction of magnetization coincides with a plain of a foil.

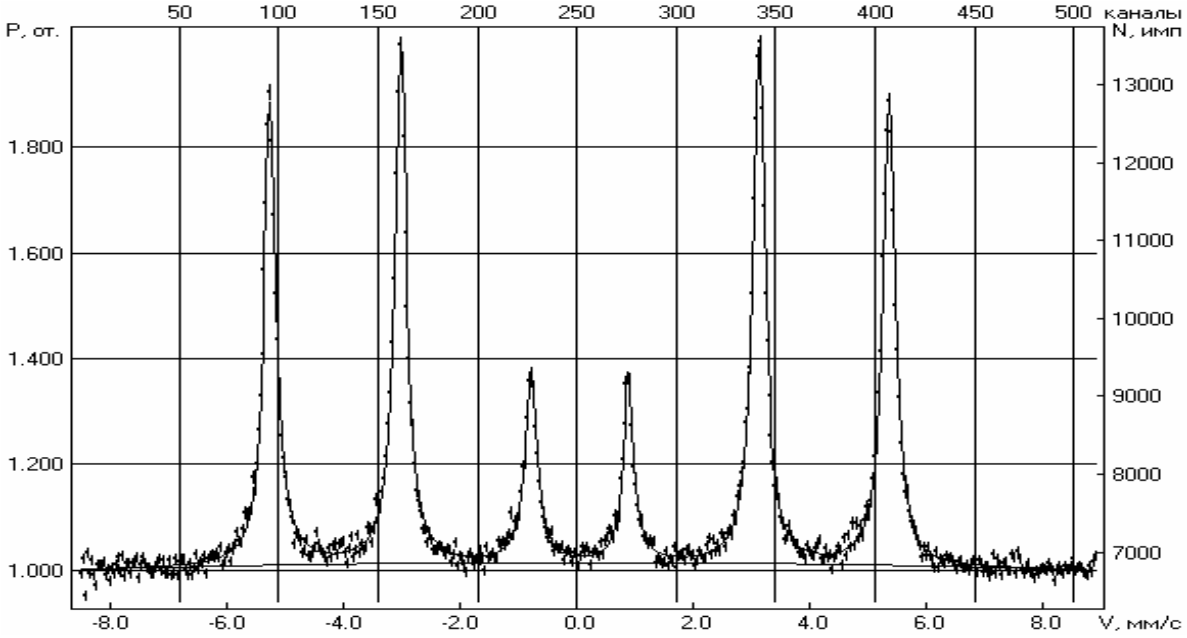

Fig. 3. Mossbauer spectra of conversion electrons for Fe^{57}-metallic foil.

There were 14 experiments with variation of irradiation and of transportation conditions of samples. As a rule Mössbauer measurements were done sequentially, 3 hours each, and then we measured the Mössbauer spectrum of the control sample that has not been exposed to radiation.

The first results that showed valuable change of effective magnetic field on the iron nucleus pleased us. But second measurement of the same samples in 2 days later did not show any difference between control and irradiated samples. That's why we assumed that the first Mössbauer measurements were mistake. But when the same happened in next experiments we made an assumption that the construction of ferro-metal and monopole decays in less than 1 day.

In the following experiments we made Mossbauer measurements continuously for several days, changing samples every 3 hours.

Let's see the results of the experiment carried in December 2002 as an example. We use our working numbering of samples with the direction of magnetic field during the explosion shown in brackets.

The figure 4 shows the time dependence of $\mathbf{H_{eff}}$ for samples No.5(S), No.6(N), No.7(L) in comparison with control sample No.1.

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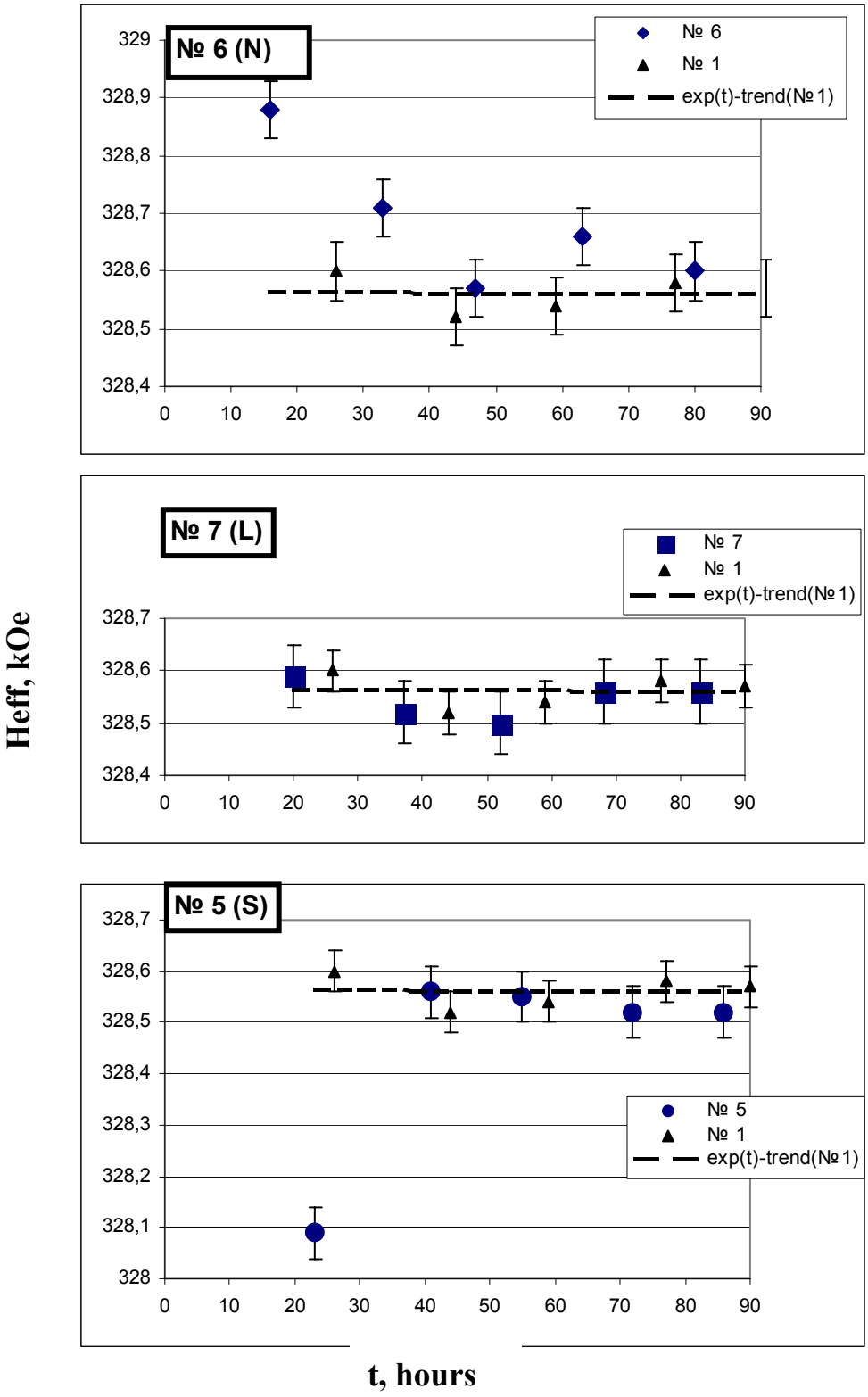

Fig. 4. Time dependence of H_{eff} on the nucleus of Fe^{57} for irradiated metal foils with comparison of control probe.

dashed line shows the trend of $\mathbf{H_{eff}}$ of the control sample.

The time from irradiation to time of measurement is taken as parameter **t** in hours.

The control sample No.1 and sample No.7(L) did not show any time dependence of $\mathbf{H_{eff}}$ for 80 hours of measurements. Values of magnetic fields for these samples vary within measurement error.

The behavior of $\mathbf{H_{eff}}$ in time of the sample No.6(N) can be describer by exponential decay with characteristic time of 16±5 hours. The starting experimental point $\mathbf{H_{eff}}$ at 16 hours is higher than $\mathbf{H_{eff}}$ in final point at 80 hours on 280±70 Oe.

The behavior of $\mathbf{H_{eff}}$ of the sample No.5(S) can not be described by exponent similar to the one of the sample No.6(N). Only the first experimental point H_{eff} escapes from the background of the following values on 460±70 Oe.

Such initial deviation of $\mathbf{H_{eff}}$ for samples No.5(S) and No.6(N) can not be explained by temperature instability. The thermal coefficient of isomer shift δ(T) is +0.65 mcm/s/K, i.e. it has opposite direction to temperature change of local magnetic field (-40 Oe/K)[3]. The change of δ in time for all samples of this series is shown on Figure 5.

One can see on the graphs of δ(t) for samples No.5(S) and No.6(N) have tendency very similar to $\mathbf{H_{eff}}$(t) behavior. Therefore, that is not related to a temperature factor. The value of changes of δ(t) is very close methodical error of measurements so we cannot give any interpretation.

The value quadruple splitting for all samples was equal zero that was typically for undisturbed cubic crystal structure.

From this results we can resume that the shown exchanging of magnetic fields was determine by absorption of monopoles with different sign.

There were similar results with different relaxation types and with the value of initial deviation of $\mathbf{H_{eff}}$ above 3 values of standard error also in the other 4 series of experiments.

Conclusions

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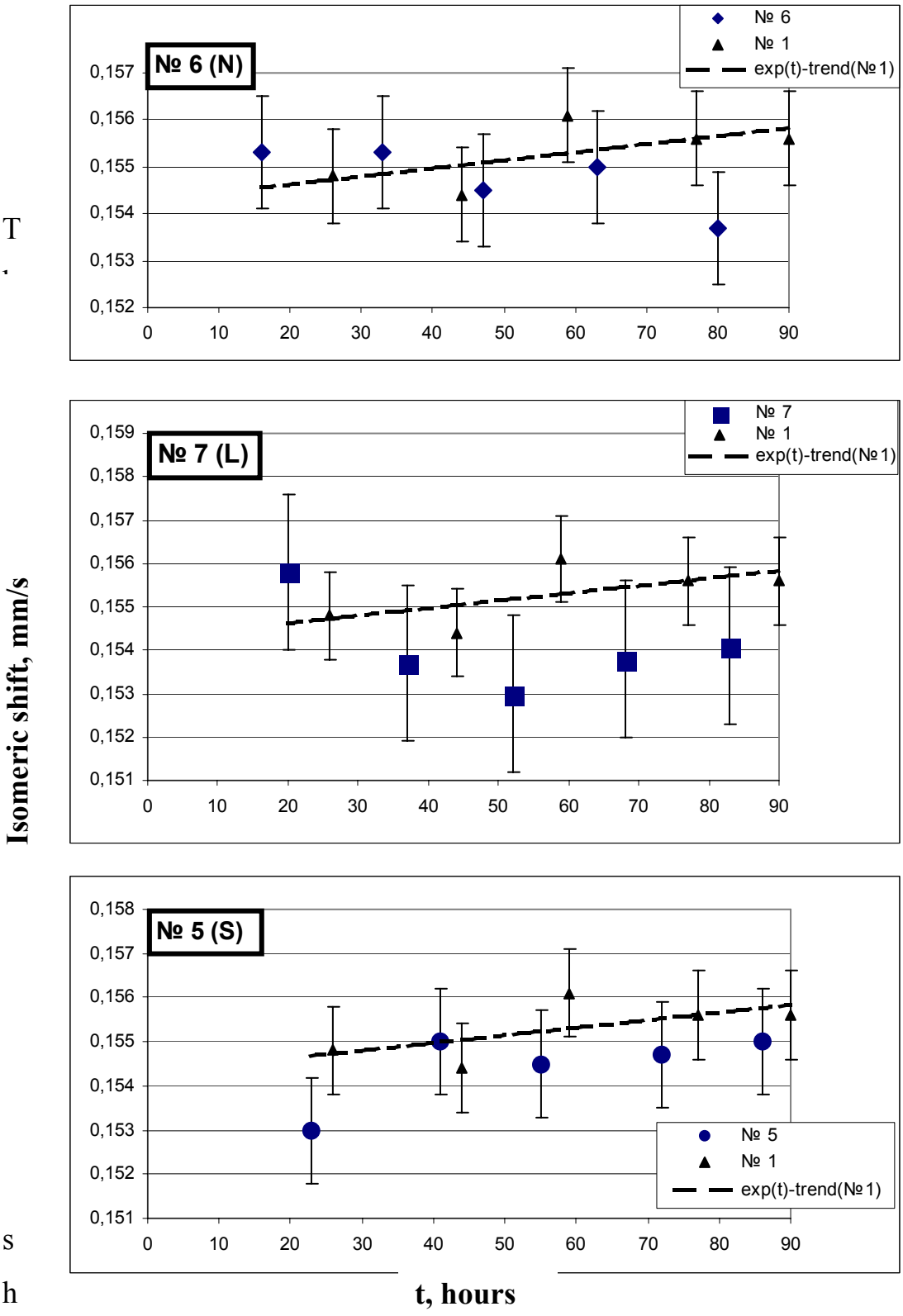

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Fig. 5. Time dependence of isomeric shift δ(t) on the nucleus of Fe^{57} for irradiated metal foils with comparison of control probe.

n that the number of monopoles absorbed by the sample is enough to detect its influence on the Mossbauer spectrum. Determined changes of the effective magnetic field on iron nuclei essentially exceed of measurement inaccuracies.

2. The effect value depends on time from irradiation moment.
3. The change of effective magnetic filed on iron nuclei correlates with the direction of the external magnetic field applied to the sample during the irradiation, that is the magnetic field separates N- and S-monopoles.

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Коля! Нет ссылки на работу 3!