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SHORT NOTES

THE MAGNETIZATION OF SUBSTANCES CONNECTED TO THE STOCHASTIC ZERO POINT FLUCTUATIONS

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Abstract. In this paper is followed the study of the magnetization for the ferromagnetic substances depending on temperature. The curves of magnetization and the derivative curves were obtained for three types of ferromagnetic materials, pointing out the nonlinear modifications of magnetic proprieties depending on temperature. These revealed variations can represent an experimental background for new theoretical models, connection between nonlinear variations and ZPF (Zero Point Field) or the confirmation for theoretical models already proposed, connected to these phenomena.

Key words: magnetic permeability, magnetization curve.

1. THEORETICAL BACKGROUND

The stochastic processes connected to ZPF evidenced relativistic and quantum phenomena based on classical physics through the model of SED (Stochastic Electrodynamics) [1]. If we accept the real existence of ZPF, then we can propose experimental arrangements to evidence the interaction between this. The connection between magnetic proprieties and ZPF can be studied, in our example, trough dependency of magnetization on temperature.

A substance introduced in magnetic fields is magnetized. The magnetization of the substance can be temporary (it is present only when the sample is introduced in magnetic field) or permanent (it is present also after the disappearance of exterior magnetic field) and depend on the intensity of the external magnetic field. In macroscopic treatments is admitted that the magnetism is caused by the stationary movement of electric charges from magnetic substances, producing a current with constant intensity. The electric current exist only at molecular and atomic level, appointed as bonded current. To bonded currents, with intensity I, correspond a magnetic moment

$$\vec{m} = I\vec{S} = IS\vec{n}\,, \tag{1}$$

where S is the contour of the area limited by the current and $\vec{n}$ is the unit vector attached to the approximately plane surface S [2].

To bonded currents we can attach a magnetic moment because they behave as a small magnet, named magnetic dipole. The acting forces on magnetic dipole placed in magnetic field has zero resultant in the case of uniform magnetic fields and non-zero in the non-uniform fields. The moment of forces couple is

$$\vec{C} = \vec{m} \times \vec{B}\,. \tag{2}$$

The current knowledge demonstrates that in practice the magnetic properties of the substances are based on the orbital and spin movement of the electrons and the nucleons.

Afterwards are discussed the magnetic properties of the substances using the model of bonded current which offers a more intuitive and simple description. The magnetization of the substances is characterized through the magnetization vector (or magnetization intensity), that value represents the magnetic moment of unit of volume

$$\vec{M} = \lim_{\Delta V \to 0} \frac{\Delta \vec{m}}{\Delta V} = \frac{\mathrm{d}\vec{m}}{\mathrm{d}V}\,. \tag{3}$$

Generally, with the exception of the group of ferromagnetic substances, the magnetization change proportional to the intensity of the magnetizing field where the substance is placed

$$\vec{M} = \chi\vec{H}\,, \tag{4}$$

where χ represents the magnetic susceptibility, a material characteristic that depends on the temperature and structure of investigated sample.

As opposed to electric susceptibility that takes only positive values, the magnetic susceptibility can be as much negative how much positive. Depending on the sign and the value susceptibility, the substances can be classified as follow:

- diamagnetic substances with $\chi < 0$ (Bi, Hg, Cu, He, Ne, Ar),
- paramagnetic substances with $\chi > 0$ (Na, K, Ca, Mg, Al),
- ferromagnetic and ferrimagnetic substances with $\chi >> 0$ (Fe, Ni, Co, Gd).

All elementary magnetic moments of an ideal ferromagnetic substance are aligned. Though, looking the entire sample, the total magnetic moment can be much less than the saturation moment and to obtain a saturated sample is necessary to apply an exterior magnetic field. Weis explain this behavior supposing that all the real sample are compounded by great number of small regions (domains) and only inside these domains the local magnetization is saturated. The magnetization directions of ale these areas are parallel. The magnetic domains are formed in all type of ordered magnetic crystals, and sometimes in metals influenced by the strong Haas-van Alphen effect [3].

2. THE EXPERIMENTAL SETUP AND DATA ACQUISITION

To obtain the magnetization dependency on temperature we used the block-scheme represented on Fig. 1. The samples were introduced in a calorimetric enclosure and the temperature was controlled and measured by a computer interface. In the same time the magnetic field intensity was measured by a Hall-probe and the values were digitized through a capturing device.

The dataset obtained experimentally were digitized and processed with proper software (The visual information was processed by Z Scanner, software created by authors to resolve special problems of the experimental setup).

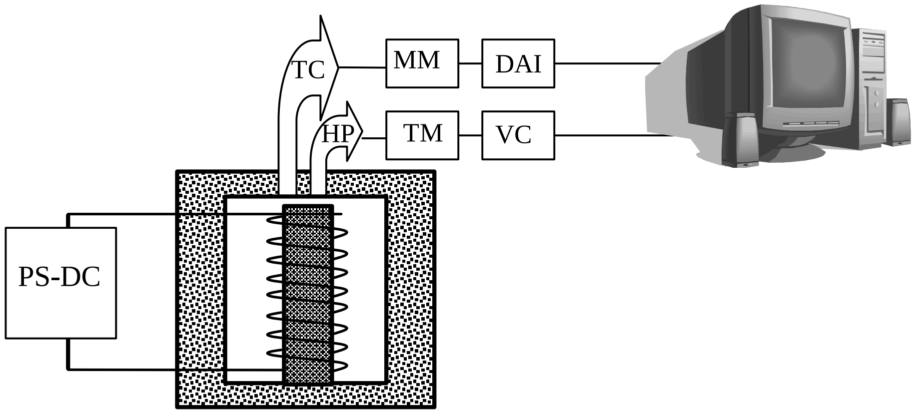

Fig. 1 – The experimental setup with the connections between apparatuses.

The connections between these apparatuses are represented in Fig. 1, where the significations of abbreviations are: PS-DC – Power Supply (DC - Direct Current), TC – Thermocouple, MM – Multimeter, TM – Teslameter, DAI – Data Acquisition Interface and VC – Video Camera.

The magnetic induction and the temperature being acquired separately, to represent one depend on other, was necessary to eliminate the time variable from dependency functions.

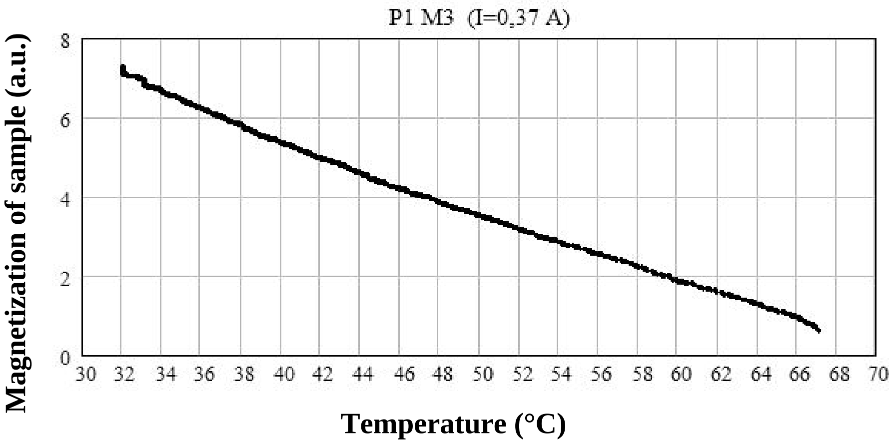

Fig. 2 – The magnetization dependency on temperature for Sample 1 Series 3 for a current intensity in solenoid I = 0.37 A.

Were analyzed three probes (codified by P1, P2 and P3 – the nature and structure of this materials is object of current contracts) and were effectuated a number of repetitive measurements for different values of external magnetic field intensity. An example of graphical result for P1 is represented on Fig. 2.

The magnetization of probes is usually linear but through first derivative we can evidence nonlinear first order variations of magnetization represented in Fig. 3. The temperature interval was the same for all probe and the repeated measurement for each probe assure the probabilistic certainty of number of maximums on the first order derivative of the analyzed curve.

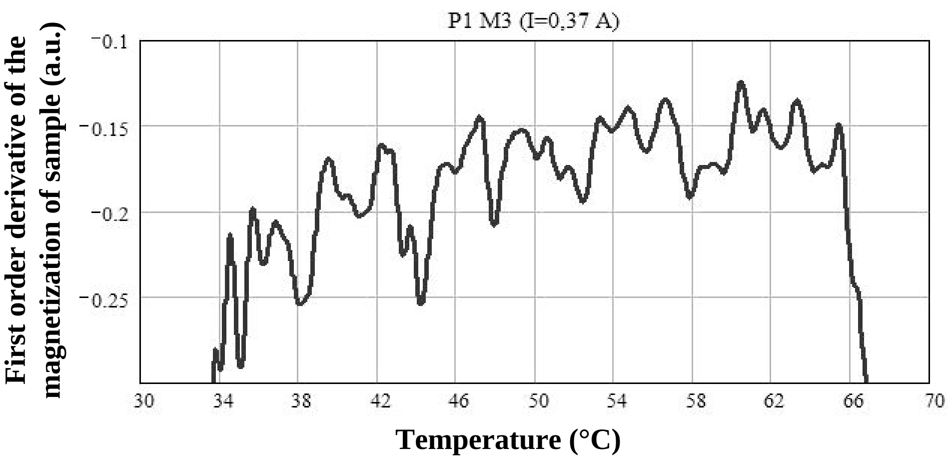

Fig. 3 – First order derivative of the magnetization for Sample 1 Series 3, variation that pointing out the nonlinear dependency of magnetization by temperature.

We used arbitrary units for magnetization (a.u.) because our proposal, to determine the temperatures of maximums or minimums, not implies these units. The analyzed interval for temperature was approximately $25\,^{\circ}\mathrm{C} \div 100\,^{\circ}\mathrm{C}$ and the direct current for generate the external magnetic field don't exceed $1\mathrm{A}$ to limit the self heating of the field generating coil trough Joule effect. The time to increase the temperature from low limit to upper limit is about $2 \div 5$ hours.

Where, the curve on Fig. 3, have a minim for the same variation of the temperature the magnetization decrease most rapidly that elsewhere. In the same way where the magnetizations tend to keep his value against to variation of temperature the first order derivatives have a maximum.

After these maximum were inventoried the temperatures for each sample can be systematized in Tabel 1. These temperatures must be corresponding to theoretical values obtained from a valid model of interaction between the ZPF (or other models that describe this phenomenon) and the ferromagnetic substances temperature, placed in external magnetic field, changing slow in time. In this substances the thermal oscillations of elementary magnetic dipoles are overlapped by the external magnetic field and the CZP field, reflecting modifications in sample magnetization. These dependencies can be studied also using the hysteresis, first magnetization and Stoletov curves [4, 5].

Table 1

The representative temperatures for maximum variations of magnetization by temperature for the analyzed samples with absolute errors

No.	Sample 1 (P1)		Sample 2 (P2)		Sample 3 (P3)	
	Temperature	Absolute error	Temperature	Absolute error	Temperature	Absolute error
1	37.75	±0.26	38.78	±0.09	36,59	±0,09
2	41.22	±0.21	41.59	±0.14	41.53	±0.13
3			47.37	±0.06	47.33	±0.06
4	49.90	±0.28				
5	52.32	±0.13				
6					54.95	±0.02
7	55.62	±0.03				
8	67.26	±0.24	68.47	±0.30		
9	71.51	±0.30				
10			76.60	±0.11	76.38	±0.13
11	81.94	±0.50	81.88	±0.25	81.78	±0.22
12	89.39	±0.24				
13			96.85	±0.07	96.78	±0.06
	9 values		7 values		7 values	

3. CONCLUSIONS

In this experiment were evidenced nonlinear modifications of magnetization of different samples by temperature. Same identified temperatures are the same for all materials (independents on material – for our interval 41.5°C and 81.8°C). As we can see from Table 1, this regularities show that Samples P2 and P3 have same structural composition. Theoretical explanation of these variations for different materials is subject of a future paper.

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