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# On the Analogy Between the Behavior of a Magnetically Ordered Systems and Development of the Evolution Processes

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# Introduction

- Study processes in a large organized systems, such as, for example, social or biological systems, greatly complicated by their complexity.

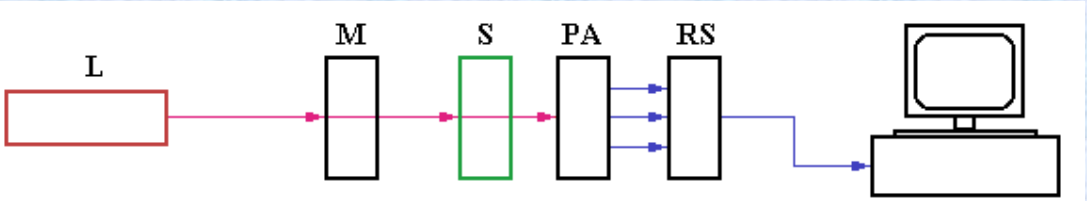
- One way to overcome these difficulties could be to find analogies between the actual complex systems and formations of different nature that allow a more detailed study.

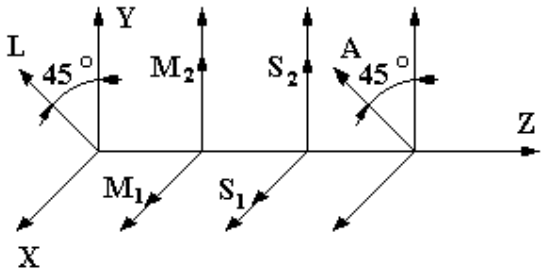
- The present report describes an attempt to find some similarity between the behavior of magnetically ordered structures and the development of the evolutionary processes.

# The report contains two main parts:

- **Experimental studies** of polarization-optical response of magnetized $FeBO_3$.
- **Demonstration of an analogy** between observed response and the development of processes of evolution.

# Experimental setup



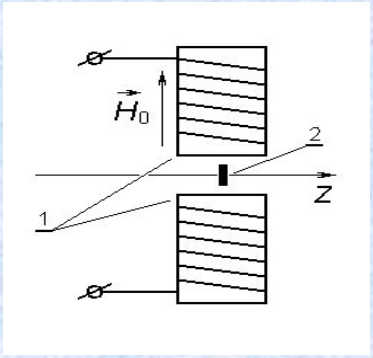

L - laser (λ=0,63 μ);
M - modulator of polarization;
S – sample ($FeBO_3$);
PA – polarization analyzer;
RS – registration system.

The restructuring of the domain structure under the influence of the field leads to a change of

**Polarization-optical response:**

$$\varphi = \varphi_x - \varphi_y = (2l/\lambda)(n1 - n2).$$

Here, **n1, n2** - the principal refractive indices of the sample; **l** - thickness of the sample.

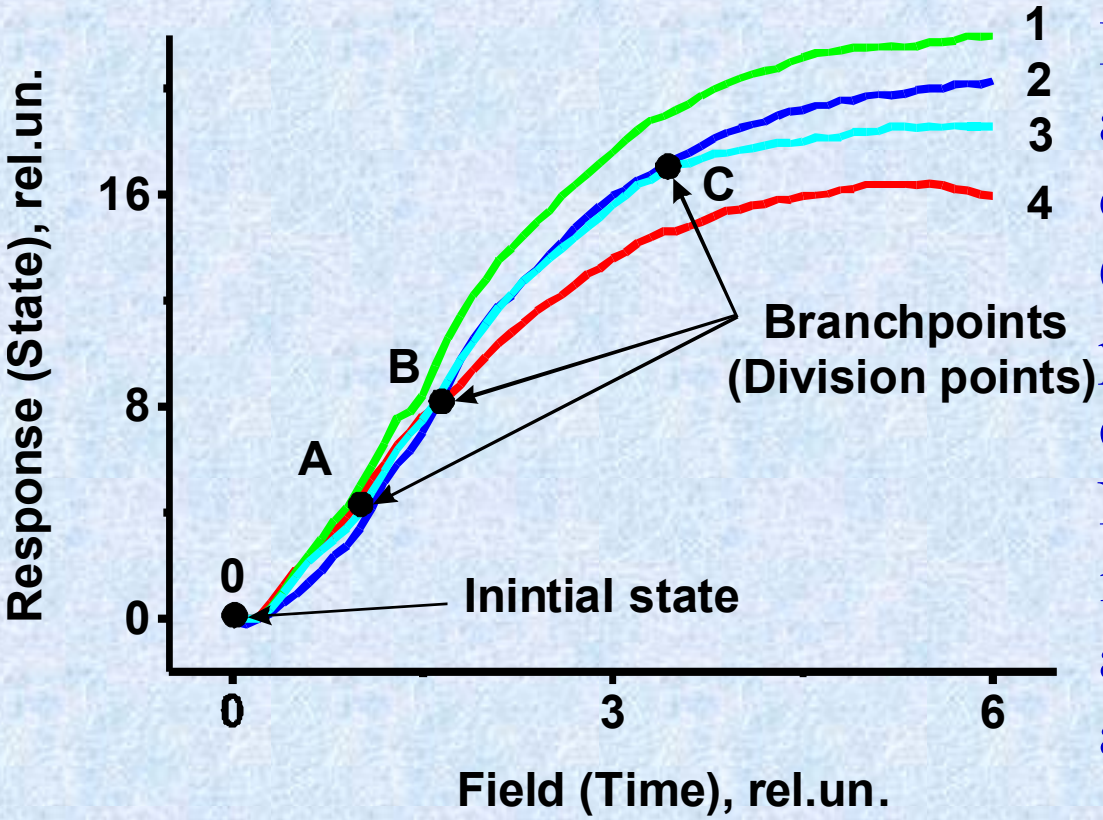



1 – solenoid;
2 – sample ($FeBO_3$),
4×3.5×0.25 mm.


- Diehl R., Jantz W., Nolang B.I., Wettling W. Current Topics in Material Science, **11**, 241 (1984).
- Sokolov I.M., Fofanov Ya.A. J. Opt. Soc. Am. A. 1995. V. 12. No 7. P.1579.
- Fofanov Ya.A., Pleshakov I.V. , Kuzmin Yu. I. J. Opt. Technology. 2012. Sent to print.

# Possible scenarios of the development. Differentiation.

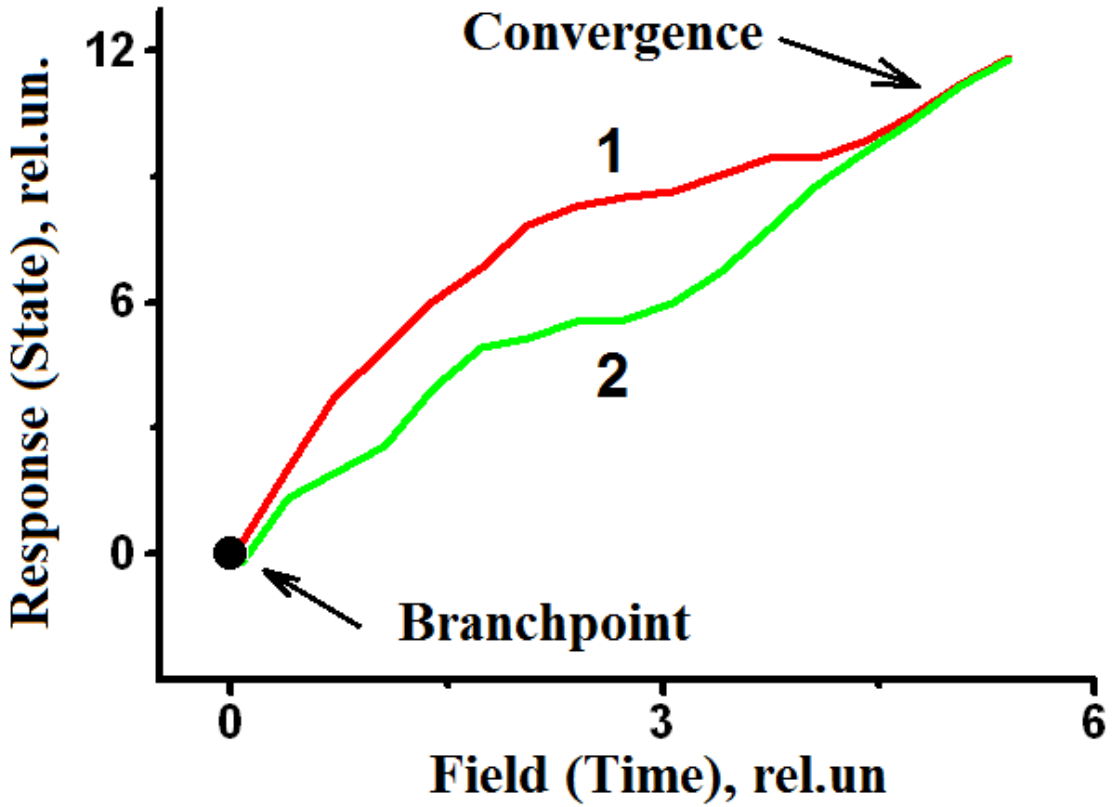
The difference between the curves is due to, for example, the **processes of differentiation**. At the analogy with the systems of cells these points may be, for example, the **points of division.**




In this figure, we can see the amplitude of the response depending on the field. Curves 1-4 show the four possible scenarios. All the curves start at point 0. Next, clearly visible changes in the processes taking place at the branch points A, B, and C.

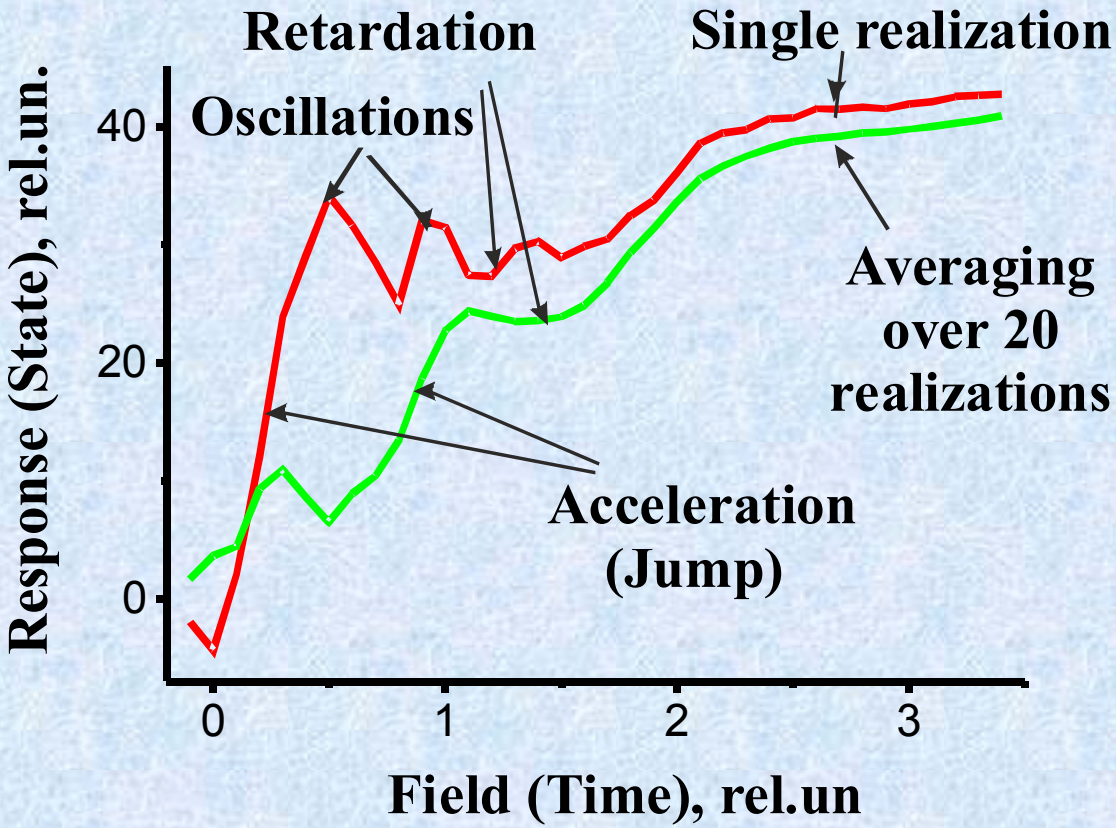
# Possible scenarios of the development. Convergence.

Such magnetic behavior of the sample can be considered, in particular, as **an analogue of the ongoing in wildlife convergence of species.**




Development scenario of the other type – **convergence** is illustrated by curves 1 and 2. The starting point is one of the branch points. Further curves (trajectories of motion of the system under study) can be separated, and after a period of independent development curves drift together again at the point of convergence.

# Processes in the branch points




In this Fig. processes near branch points are shown on a larger scale. Clearly visible periods of acceleration (evolution jumping), alternating with retardation of development. The delay stages are accompanied by characteristic oscillations, indicating the need to find a kind of steady state of systems-analogues.

In addition to the single realization, in this figure presented as an average over 20 such ones. The process of acceleration and retardation are stayed. The oscillations smoothed out, which may indicate a lack of a significant "correlation" in individual implementations

# Discussion

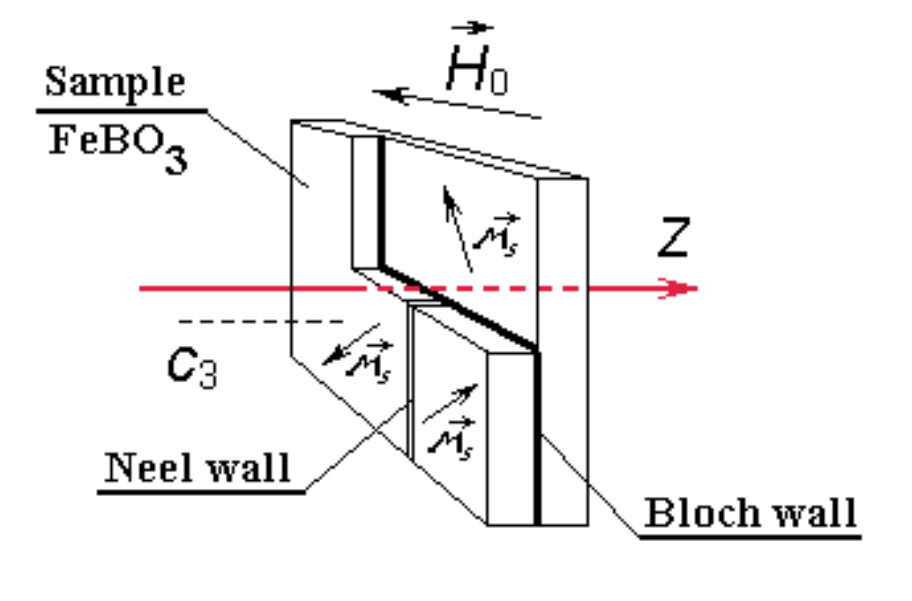
Overall assessment of constructability developed here analogy leads to a natural question:

**"Is the considered analogy only external,**

or there is a much more deep similarity of processes occurring in the magnetically ordered system, we have reviewed, and in the systems-analogues?"

By the attempt to understand this we should take into account that we have studied the object not as trivial as meets the eye.

# Discussion. Domain structure $FeBO_3$




This figure shows the magnetic structure of the sample. One can see the Neel wall and the Bloch wall. The arrows indicate the magnetization $M_s$ within the domains.

The magnetic state of the crystal $FeBO_3$ can be realized **by several differing configurations of the domain structure.**

In the experiments, this is manifested in a **wide variety of development scenarios (trajectories of motion),** from which the above are discussed only some of the most common.

# Discussion

**All this is very similar to events occurring during the evolution of some systems, and can indicate**

**not only the purely external similarity, but also the deeper nature of given here analogies.**

# Conclusion

- **A number of general patterns of behavior of the magnetically ordered materials and processes of evolution occurring in a organized systems have been shown.**

- **The approach developed here may be useful for comparison, the study and predict scenarios for organized systems of various natures (Biological, Society, etc.) and any degree of hierarchical complexity.**


Thank you
for your kind
attention!