

Peer Review

Review of: "The Information Theory of Self-Organization Phenomena in Thermal Systems"

Vasiliy Ryazanov¹

1. theoretical physics, Institute for Nuclear Research, Kyiv, Ukraine

Review of the article

The Information Theory of Self-Organization Phenomena in Thermal Systems

Hongzheng Liu, Zhiyue Wu

The article compares and establishes connections between Information Theory, Thermodynamics, and Complex Science.

The equivalence of a priori information and constraint conditions is shown, the relationship between local randomness and global probability distribution is revealed, and the interaction of local and global dynamics in the process of information transfer is reflected. The concepts of "Energy as Coding" and "Information Temperature" are introduced to clarify how energy distribution determines the information structure. A new approach is to consider energy as an information quantity that determines the a priori probability distribution of system states, thus acting as a form of information coding. The authors introduce the concept of "Equilibrium Flow" to explain the self-organizing behavior of systems under energy constraints and negative information temperature. The authors formulate several theorems regarding equilibrium flow systems related to the criticality of self-organization and the efficiency of energy conversion into information.

The idea of the coding role of energy, acting as an information quantity, seems interesting and promising. This also applies to the introduced concept of information temperature.

A number of comments should be made. Thus, the article is written too briefly, resembling, rather, a thesis than a full-fledged article. Many topics are not covered, and there are essentially no proofs of theorems (except for the Fermi-Dirac distribution theorem), which the authors themselves note in

the Conclusion. They write that "the work...it primarily provides theoretical insights without extensive empirical validation or detailed mathematical proofs, which may limit its immediate applicability." The authors limit themselves to one example, discussing it at a qualitative level. The list of references does not include Stratonovich's "Information Theory" (in Russian), Theory of Information and its Value 1st ed. 2020 Edition, by Ruslan L. Stratonovich (in English).

But, in general, as the authors write in the Conclusion: «Using theoretical analysis and theorem proofs, we offer new perspectives for understanding the dynamics of complex systems, enriching the theoretical framework of information theory, thermodynamics, and complex science and providing a new theoretical basis for further research in related fields».

The article may be published in "Qeios".

V. Ryazanov

Declarations

Potential competing interests: No potential competing interests to declare.