Ballistic resonance and zero energy ontology

M. Pitkänen
Email: matpitka6@gmail.com.
http://tgdtheory.com/.

July 16, 2020

Abstract

Vitaly A. Kuzkin et al have published an article with title "*Ballistic resonance and thermalization in the Fermi-Pasta-Ulam-Tsingou chain at finite temperature*" about very interesting findings challenging the second law of thermodynamics. What has been observed is an amplification of oscillations for a chain of coupled mechanical oscillators in absence of external energy feed and being due to the conversion of thermal energy to the energy of oscillations. This is difficult to understand in standard thermodynamics allowing fixed arrow of time, and the findings could provide a direct application of zero energy ontology (ZEO) based theory of self-organization.

1 Introduction

The popular article "*Scientists have discovered a new physical paradox*" (https://cutt.ly/lp6VL4l) tells about the work of Vitaly A. Kuzkin et al published in Phys Rev E (https://cutt.ly/Jp8XHYY) as an article [D1] with title "*Ballistic resonance and thermalization in the Fermi-Pasta-Ulam-Tsingou chain at finite temperature*".

What has been observed is an amplification of oscillations for a chain of coupled mechanical oscillators in absence of external energy feed and being due to the conversion of thermal energy to the energy of oscillations. This is difficult to understand in standard thermodynamics with fixed arrow of time, and the findings could provide a direct application of zero energy ontology (ZEO) based quantum theory of self-organization in which arrow of time is not fixed. The reason is that TGD predicts hierarchy of phases of ordinary matter with arbitrarily large value of effective Planck constant $h_{eff} = nh0$ meaning that quantum coherence in arbitrarily long scales realized at the magnetic body of the system is possible [L4] [K1].

In ZEO based theory of self-organization ordinary state function reductions induce change of the arrow of time. This forces to generalize thermodynamics to allow both arrows of time. For non-standard arrow of time dissipative processes look like generation of coherent structures for the observer with standard arrow of time. Dissipation in turn looks like energy feed to the system necessary serving as a prerequisite for self-organizing. The ballistic resonance would be due to the conversion of thermal energy to ordered energy: the isolated mechanical system would extract thermal energy from its internal thermal environment by this mechanism.

2 ZEO based model for the ballistic resonance

In the following the findings of Kuzkin et al are first briefly summarized and a ZEO based explanation for them is proposed.

2.1 The findings and their explanation provided by experimenters

Researchers from the Peter the Great St. Petersburg Polytechnic University (SPbPU) have discovered a new physical effect: the amplitude of mechanical vibrations can grow without external influence in which system converts its thermal energy to mechanical energy. The phenomenon is

known as ballistic resonance. The description of the phenomenon involves also an abnormally high heat conductivity - one speaks of ballistic heat conductivity.

The electromagnetic analogy is very high electric conductivity: the work of Bandyopadhyay related to effects of oscillating voltage on currents flowing along microtubules demonstrates ballistic conductivity possibly reflecting underlying super-conductivity [L1].

This behavior seems to be in conflict with second law of thermodynamics telling that the vibrations should be attenuated. The researchers propose also a theoretical explanation of this paradox (`https://cutt.ly/Cp6V52j`) based on a model assuming ballistic heat conduction. One can of course wonder whether the notion of ballistic heat conduction is consistent with second law in its standard form.

Fermi-Past-Ulam-Tsingou problem (`https://cutt.ly/cp8CxtA`) was a finding about a theoretical model of a vibrating string with a non-linear dynamics. The expectation was that the situation develops ergodic so that energy is evenly divided between the modes of the string. It however turned out that the behavior was essentially periodic. The model explaining the behavior relies on solitons assignable to Korteveg-de-Vries equation. This phenomenon is different from the ballistic resonance observed in the experiments. In Korteveg de-Vries equation there is no dissipative term and the unexpected phenomenon is that wave pattern preserves it shape. Dissipation without energy feed would attenuate the wave.

2.2 ZEO based model for the findings

TGD suggests that a genuine explanation requires a profound change in the thinking about time- in particular the relationship between geometric time and experienced time must be updated. I call the new conceptual framework zero energy ontology ZEO) [L4]. The identification of these two times in standard ontology is in conflict with simple empirical facts, and leads to a paradox related to state function reduction (SFR) taking place in quantum measurement. The non-determinism of SFR is in conflict with the determinism of Schrödinger equation.

1. According to ZEO in ordinary state function reduction (SFR) the arrow of time subsystem changes: this solves the basic paradox of quantum measurement theory. The experiments of Minev et al [L2] give impressive experimental support for the notion in atomic scales, and sow that SFR looks completely classical deterministic smooth time evolution for the observer with opposite arrow of time. This is just what TGD predicts. Macroscopic quantum jump can occur in all scales but ZEO takes care that the world looks classical! The endless debate about the scale in which quantum world becomes classical would be solely due to complete misunderstanding of the notion of time.

2. Non-standard arrow of time forces a generalization of thermodynamics. For time reversed system generalized second law applies in reverse direction of time. Dissipation with reversed arrow of time extracts energy from environment, in particular thermal energy from internal thermal environment. The energy feed necessary for self-organization reduces to dissipation in reversed arrow of time.

   This explains why self-organization is possible [L3]. Standard form of the second flow would imply that also energy flows between systems go to zero: this would mean thermodynamical equilibrium everywhere - heat death. This has led to desperate theoretical proposals such as life as gigantic thermodynamical fluctuation. The recent empirical understanding suggests that this giant fluctuation would have occurred in the scale of the entire Universe and continue forever!

3. Macroscopic quantum coherence is however a necessary prerequisite for macroscopic effects. TGD predicts hierarchy of phases of ordinary matter residing at magnetic body (MB) of the system with value of effective Planck constant $h_{eff} = nh_0$ ($h = 6h_0$) of h_{eff} behaving like dark matter and controlling ordinary matter. The larger the value of h_{eff}, the longer the scale of quantum coherence scale at MB. MB acts as master for ordinary matter in the role of slave and induces coherent behaviour. This gives rise to self-organization.

This picture could explain the observations of self induced resonance using thermal energy. A subsystem or its MB in time reversed mode would extract the thermal energy. There are many

other applications. The phenomenon of stochastic resonance in which system extracts energy from external noise could have explanation along these lines. Stochastic resonance plays an important role in sensory perception by making possible amplification of weak signal in large background. There is evidence for it even in astrophysical scales. In biology metabolic energy could be extracted from metabolites and maybe also from thermal energy by time reversed dissipation by some subsystems related to metabolism.

TGD picture does not exclude the possibility of delicate models mimicking this behavior in the framework of thermodynamics. The basic challenge in this kind of effective model is to describe the presence time reversed dissipation inducing self-organization and the presence of dark matter at magnetic body phenomenologically. Energy feed as parameter gives rise to states far from thermodynamical equilibria.

For instance, the thermodynamics of ion distributions inside and outside cell is far far from thermodynamical equilibrium and and non-equilibrium thermodynamics has been developed for the modelling of this kind of systems utilizing the notions of ionic pumps and channels. The phenomenological description introduces chemical potentials as parameters to describe the non-equilibrium situation in the framework ordinary thermodynamics. Chemical potentials would model the neglected presence of $h_{eff} \geq h$ phases of dark matter at magnetic body of the system.

REFERENCES

Condensed Matter Physics

[D1] Kuzkin VA and Krivtsov AM. Ballistic resonance and thermalization in the Fermi-Pasta-Ulam-Tsingou chain at finite temperature. *Phys Rev. E.*Available at: `https://journals.aps.org/pre/abstract/10.1103/PhysRevE.101.042209`, 101(042209), 2020.

Books related to TGD

[K1] Pitkänen M. Construction of Quantum Theory: More about Matrices. In *Towards M-Matrix: part I*. Available at: `http://tgdtheory.fi/pdfpool/UandM.pdf`, 2012.

Articles about TGD

[L1] Pitkänen M. New results about microtubules as quantum systems. Available at: `http://tgdtheory.fi/public_html/articles/microtubule.pdf`., 2014.

[L2] Pitkänen M. Copenhagen interpretation dead: long live ZEO based quantum measurement theory! Available at: `http://tgdtheory.fi/public_html/articles/Bohrdead.pdf`., 2019.

[L3] Pitkänen M. Quantum self-organization by h_{eff} changing phase transitions. Available at: `http://tgdtheory.fi/public_html/articles/heffselforg.pdf`., 2019.

[L4] Pitkänen M. Some comments related to Zero Energy Ontology (ZEO). Available at: `http://tgdtheory.fi/public_html/articles/zeoquestions.pdf`., 2019.