A New Interpretation of Contributions Presented at the Solvay Conference 1911. Can We Falsify the "Geocentric" Foundations of Quantum Mechanics in the Solar System?

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***Abstract* — We have studied the contributions and presentations published in the Proceedings of the Solvay Conference 1911. Based on the lecture of Ernest Solvay on the "gravito-matérialitique" we can distinguish two features of the Earth´s gravitational field – 1. "gravité réelle" described by the Newton´s gravitational law and 2. "gravité potentielle" acting as an agent of the self-organization on quantum particles and creating structures described by the Planck constant h_{EARTH}. From the discussions followed after the presentations of Walther Nernst and Albert Einstein we interpreted the Nernst- Lindemann Formula for the specific heat of solids using the comment of Heike Kamerlingh Onnes (the discoverer of the superconductivity) as two transverse and one longitudinal oscillations of phonon in the surroundings at temperature T. In order to falsify this "geocentric" model of foundations of quantum mechanics in the spirit of Karl Popper we propose to initiate the CURE Project (China – USA – Russia – European Union) (cure = to solve a problem) in order to build quantum laboratories on different orbits around the Earth, on the surface of the Moon and Mars, and in the Lagrange points of the system the Earth – Moon and the Earth – Sun to get new experimental data for the specific heat of solids, the critical temperatures of superconductors, chemical and physical self-organized reactions (Liesegang rings, Belousov- Zhabotinsky waves, chemical clocks, Bose-Einstein condensates, de Broglie waves, etc.). There is space enough for all participants on this CURE Project to collect new valuable data describing this "hidden variable" presented by Ernest Solvay in his forgotten lecture in 1911.**

Keywords — The Solvay conference 1911, Solvay´s lecture, Nernst´s lecture, Einstein´s lecture, "geocentric" foundations of quantum mechanics, falsification of this "geocentric" model, the CURE Project.

I. INTRODUCTION

All historians of modern physics highlighted the decisive significance of the first Solvay conference in 1911 and stressed the start of a collective awareness for the understanding of quantum theory. The meeting took place in the hotel Métropole in Brussels from October 29 to November 3, 1911. The first lecture was given by Ernest Solvay [1] followed by valuable presentations and discussions of invited participants. The proceedings were published both in the French language [2] in 1912 and in the German language [3] in 1914 with addendum with new theories on the specific heat of solids. However, the Ernest Solvay´s paper was not published and not discussed at that Conference. Later no historians of physics gave their attention to the Solvay´s model.

This special event would become a milestone in the history of physics where the foundations of quantum mechanics were openly discussed among top physicists of that epoch and still attracts the attention of new generations of scholars in this field [4]-[14].

One of the main topics of this Conference was focused on the specific heat of solids. This subject was presented by Walther Nernst and Albert Einstein and followed by very fruitful discussions. We know from the literature [15]-[22] that Albert Einstein during his stay in Prague (April 1911 – July 1912) worked mainly on two topics: the specific heat of solids and the gravitational theory. Can we fuse these two Einstein´s Prague topics into one concept?

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II. HOW TO DECIPHER THE MYSTERIOUS CONTRIBUTION OF ERNEST SOLVAY?

Ernest Solvay opened the Conference with his inaugural speech and outlined his contribution "Sur l´Etablissement des Principes fondamentaux de la Gravito-Matérialitique" [1]. Every participant of this Conference received a reprint of this Solvay presentation. However, this contribution is very mysterious and therefore, it was neither discussed at the Conference nor published in the Conference Proceedings. Later no historians of physics tried to analyze the Solvay´s paper with its length of 109 pages.

We might discover the key how to unlock the Solvay´s paper on the page 65 of his Contribution. Solvay introduced two features of the Earth´s gravitational field. The first visible property of the Earth´s gravitational field Solvay termed as "gravité réelle" - this is the very well-known Newtonian gravitational law. The second invisible property of the Earth´s gravitational field termed as "gravité potentielle" might be the missing hidden variable behind those self-organizing processes among quantum particles.

We assume that the effect of the Earth´s gravitational field leads to the "geocentric" interpretation of quantum mechanics. In order to falsify this scenario in the spirit of Karl Popper [23] we have to collect new experimental data for self-organized processes under various combinations of gravitational fields – Earth, Moon, Mars, and Sun.

III. SPECIFIC HEAT OF SOLIDS AT THE SOLVAY CONFERENCE 1911

Albert Einstein and Walther Nernst presented their formula on the specific heat of solids. Albert Einstein already in 1907 contributed to the significance of the newly born quantum mechanics with his Formula [24]-[25]:

$$C_V = 3R\left[\frac{x^2 e^x}{\left(e^x - 1\right)^2}\right] \text{for } x = \frac{h\nu_E}{kT} \tag{1}$$

where C_V is the specific molar heat, R is the gas constant, h is the Planck constant, ν_E is the Einstein´s monochromatic oscillation, k is the Boltzmann constant and T is temperature of the surroundings. Albert Einstein made a breakthrough to the description of the specific heats of solid but was not satisfied with the monochromatic oscillation ν_E of the solid.

Walther Nernst and Frederik Lindemann presented their Formula [26]-[28] that matched better the experimental data at lower temperatures. This Nernst-Lindemann formula was discussed in details at the Solvay Conference 1911 because its physical interpretation was not clear: Equation 2:

$$C_V = \frac{3}{2}R\left[\frac{x^2 e^x}{\left(e^x - 1\right)^2} + \frac{\left(\frac{x}{2}\right)^2 e^{x/2}}{\left(e^{x/2} - 1\right)^2}\right] \tag{2}$$

where x = (h ν_{NL})/(kT) with the two characteristic Nernst-Lindemann oscillations: ν_{NL} and $\nu_{NL/2}$.

Several remarks from the discussion after Walther Nernst presentation at the Solvay Conference 1911 on the meaning of the Nernst – Lindemann Formula.

Walther Nernst: "We assume that the thermal energy is composed from kinetic energy and potential energy."

Albert Einstein: "The formula of Nernst and Lindemann is undoubtedly a great progress, but I am of the opinion that it should not be considered as anything other than an empirical formula."

Heike Kamerlingh Onnes (discoverer of superconductivity in 1911): "We could suppose that two of these oscillations are of the nature of transverse vibrations and the third of longitudinal vibrations."

Heike Kamerlingh Onnes in his lecture on the discovery of the superconductivity mentioned that Nernst–Lindemann Formula might be applicable to explain the decreasing resistance of metals and in the discussion, he noticed on the mechanism of superconductivity [29]: "It is also possible that the modification consists mainly in the change of the period of the vibrations of which I have just spoken."

IV. SOME LATER COMMENTS ON THE NERNST-LINDEMANN FORMULA

There were several remarks to the Nernst–Lindemann Formula after the Solvay Conference 1911.

Arnold Eucken in 1914 [3] in the Addendum of the German translation of the Solvay Conference 1911 added: "Even today, quantum theory remains at its core an unsolved mystery, and views are still thoroughly divided as to where a key can be found." Arnold Eucken on the Nernst–Lindemann Formula: "As surprising as the achievements of this formula were, it could not yet be seen as a definitive solution."

Peter Debye in 1912 on the Nernst–Lindemann Formula [30]: "The introduction of this second oscillation number corresponds to the practical need for a better formula than Einstein´s, but it was not possible to find any valid reason for this value ν/2."

Otto Sackur in 1912 [31]: "Nernst–Lindemann Formula has not yet found a theoretical interpretation."

Fritz Reiche in 1912 in [4]: "By establishing an empirical formula – which, however, must be regarded as obsolete according to the current state of research – W. Nernst and F. Lindemann succeeded in representing also the values deviating from Einstein´s curve."

E.H. Griffiths and E. Griffiths in 1914 [32]: "The Nernst–Lindemann formula is empirical but appears to have been a step in the right direction."

Hermann Sieveking in 1914 [33]: "The formula of Nernst and Lindemann provides at the same time the possibility of a simple derivation of Planck´s radiation formula."

O. W. Richardson in 1914 [34]: "Nernst-Lindemann formula contains only one adjustable parameter, the frequency ν, so that the agreement with the data is quite convincing." p. 359. And "Nernst–Lindemann formula has never received a satisfactorily theoretical explanation." p. 360.

Siegfried Valentiner in 1921 [35]: "Nernst and Lindemann attempted to theoretically interpret their formula, but this was not convincing."

Fritz Reiche in 1921 [36]: "The Nernst-Lindemann formula has now only historical interest."

Frederik Lindemann in 1936 [37]: "The Nernst-Lindemann formula was a pioneer attempt to connect the specific heat of a substance with its characteristic frequencies."

Generally, the Nernst-Lindemann Formula was not later theoretically developed and the guiding principle for the evaluation of the specific heat of solids was formulated by Peter Debye in 1912 [30] and by Max Born and Theodore von Kármán [38].

Both Einstein´s and Nernst-Lindemann´s formulae have been discussed in later papers with the focus on the historical development of the concept of quantum specific heats, e.g., [39]-[46].

V. Modification of the Nernst-Lindemann Formula Inspired by Solvay and Kamerlingh Onnes

We have modified the Nernst-Lindemann Formula based on the discussion comment of Heike Kamerlingh Onnes: "We could suppose that two of these oscillations are of the nature of transverse vibrations and the third of longitudinal vibrations.". The phonon transverse oscillation has two amplitudes per one wavelength and therefore the frequency of the transverse oscillation is ν_{KO}, while the frequency of the longitudinal oscillation is $\nu_{KO}/2$:

$$C_v = R\left[2\,\frac{x^2 e^x}{\left(e^x-1\right)^2} + \frac{\left(\frac{x}{2}\right)^2 e^{x/2}}{\left(e^{x/2}-1\right)^2}\right] \tag{3}$$

where x = (h ν_{KO})/(kT) with the characteristic Kamerlingh Onnes oscillation ν_{KO}.

During our literature search we have rediscovered this identical modification of the Nernst-Lindemann Formula in the paper of Sebastiano Tosto [47] in his Equation 14 and Figure 2 where the comparison with the Debye model is presented. There is no direct citation to the Nernst-Lindemann Formula, only one indirect citation via the book J. Mehra and H. Rechenberg [43] where is the Nernst-Lindemann Formula reviewed. Sebastiano Tosto´s interpretation of this Formula is based on the concept of the "zero-point energy". In our present model we interpret the physical agent acting in the Equation 3 as the Solvay´s "gravité potentielle" that might be the missing "hidden variable" behind self-organizing processes among quantum particles on the surface of the Earth.

This Solvay´s model can be experimentally tested during this decade because we have now a possibility to build quantum laboratories at some special locations in the Solar system where are different intensities and combinations of gravitational fields of the Earth, Moon, Sun, and Mars.

VI. Quantum Physics and Quantum Chemistry in Space

The dream of Max Planck [48] in 1900 was to define natural units "…which, independent of special bodies or substances, necessarily retain their meaning for all times and for all, also extraterrestrial and extrahuman cultures, and which can therefore be called natural units of measurements."

This was the main reason why the International System of Units (the SI) replaced the definition of the kilogram based on the material artefact to the definition based on the Planck constant, e.g. [49]-[51].

One of the conclusions of the concept presented in this contribution is following: we might replace "one special body" (the International Prototype of Kilogram – IPK) by "another special body" representing by the Earth and Her gravitational field. In our epoch we should collect experimental data from Space around the Earth to investigate our natural units (e.g., Planck constant, Boltzmann constant) and other properties of quantum particles how they are dependent on the intensity of gravitational field and combinations of several gravitational fields.

We know from the literature that there exist a lot of initiatives to study quantum physical processes in Space, e.g. [52]-[55]. In several cases, it is very difficult to realize some of those processes as e.g., the interference of the Bose-Einstein Condensates because of the complexity of the needed instruments, the double-slit experiment with individual particles, and the entanglement when both partners are located in Space.

In order to verify the hypothesis in this contribution based on the influence of gravitational fields on the formation of structures among quantum particles we propose to study more easier experimental projects: measurement of the specific heat of solids, the critical temperature of superconductors, the chemical and biological periodic patterns – Liesegang rings (e.g., [56]-[59]), Belousov-Zhabotinsky waves (e.g., [60]-[62]), chemical clocks (e.g., [63]-[66]).

VII. Conclusion

In order to test the "geocentric" foundations of quantum mechanics it will be necessary to organize the Planet Earth Network to build and place quantum laboratories in some special orbits around the Earth, Moon, Mars, the Lagrange points belonging to those objects and to formulate a matrix for those experiments. The "nucleation particle" for these activities might be the joint effort of China, USA, Russia, and European Union as **The CURE Project** (cure = to solve a problem) around which the "**Planetary crystal**" might grow. There is space enough for all participants on this CURE Project.

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