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Parallels of Belated Recognition: Bolyai János and Károlyházy Frigyes

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Abstract: There was an obvious parallelism between the lives of the two Hungarian men of science: János Bolyai a genial geometer and Frigyes Károlyházy a missionary of education in the field of modern physics. Both of them selected and solved a complex problem that was too difficult for the majority of scientists of their times. Their work was criticized authoritatively by high rank scientists of their discipline, which led to their withdrawal from science. The belated recognition of the Non-Euclidean geometry and the gravity inspired quantum-mechanical state reduction put these excellent achievements to their deserved right place.

Keywords: János Bolyai; Friedrich Gauss; non-Euclidean absolute geometry; gravity and quantum-mechanics; uncertainty of space-time intervals; reduction of quantum-mechanical state

1. Introduction

János Bolyai (1802–1860) was one of the greatest Hungarian mathematicians, explorer of the non-Euclidean geometry, working in parallel with but independently from Nikolai Lobachevsky of Russia. János Bolyai was the son and mathematics student of Farkas Bolyai, who became a friend of the great German mathematician Carl Friedrich Gauss during their common university student years in Göttingen.

Frigyes Károlyházy (1929–2012) was a professor of theoretical physics at the Budapest Eötvös Loránd University (ELTE), and a compulsive physics teacher of high commitment on all levels of education from the elementary school to the university. He was an admirer of the creative work of János Bolyai.

2. Absolute Geometry of Bolyai

2.1. Axiom of Parallels

The work of Bolyai was connected to one of the most investigated mathematical problems of those times, the two millennia old dilemma of the fifth axiom of Euclid, the so called axiom of parallels. The axiom says: "Through a given point P not on a line L, there is one and only one line in the plane of P and L which does not meet L". The dilemma inside the Euclidean geometry originated from a suspicion of many mathematicians, that the independence of the fifth axiom might be doubted that is it might be a provable consequence of the other four axioms. To find an acceptable proof was an ambitious goal for researchers in the field of geometry, including Gauss and the two Bolyais.

A possible method of indirect proof could be the finding of a contradiction when trying to prove, in the framework of the first four axioms, a statement that is opposite to the fifth axiom. The contradicting statement could be: "Through a given point P not on a line L, there is no line or there are more than one lines in the plane of P and L which do not meet L". In the framework of the Euclidean geometry, no contradiction could be found by a number of mathematicians who tried to prove the validity of the statements that are opposite to the axiom of parallels. Gauss left this research field quite early and it can not be excluded that he found some unpublished results in the field of non-Euclidean geometry, as he mentioned later after getting acquainted with the work of János Bolyai.

2.2. Appendix of Bolyai

Only Bolyai and independently Lobachevsky were able to perceive the importance of the lack of the mentioned contradiction, which opened up a way towards the exploration of geometrical formations that were independent from the axiom of parallels and different from the well established Euclidean geometry. The first sign of the fundamental work of Bolyai on the absolute geometry, irrespective of the fifth axiom, emerged around 1823, when he wrote a letter to his father telling: "out of nothing I have created a new, different world". In 1826 he sent a "written composition" containing the elaborated foundations of the absolute geometry to his former teacher J. W. Eckwehr, but this German language manuscript has never appeared again. In 1832, a textbook of elementary mathematics, titled "Tentamen" [1], written by Farkas Bolyai was published, and the 26 page summarizing work of János Bolyai was attached to it in Latin language with the title: "Appendix scientiam spatii absolute veram exhibens", that is, "Annex exhibiting the absolutely true science of space". This publication has become famous as the "Appendix" of János Bolyai.

In 1831, Farkas Bolyai sent the Appendix to Carl Friedrich Gauss asking his comments. Gauss wrote an ambiguous letter to Farkas Bolyai in 1832 with the following text [2] concerning the Appendix: "Now something about the work of your son. You will probably be shocked for a moment when I begin by saying that I can not praise it, but I can not do anything else, since to praise it would be to praise myself. The whole content of the paper, the path that your son has taken and the results to which he has been led agree almost everywhere with my own meditations which have occupied me in part already for 30–35 years. Indeed I am extremely astonished. I had an intention that from my own work I do not release anything to the public in my life. Most of the people do not have the right sense towards the point this issue depends on ... I had the intention, however, to write later everything in order to preserve them at least for times after my own dissolution. Hence I am quite amazed that now I have been saved the trouble, and I am very glad indeed that it is exactly the son of my ancient friend who has preceded me in such a remarkable way." Bolyai was never informed about another letter [3] of Gauss to C. L. Gerling of the Marburg University, in which Gauss wrote: "I consider this young geometer, Bolyai, a first class genius."

The letter of Gauss to Farkas Bolyai exerted a shocking and crushing effect on young Bolyai. Instead of recognizing the significant prominence of the results described in the Appendix Gauss expressed his doubts on the priority and the originality of the work, and apparently he did not want to introduce the young genius into the wider European society of geometry experts. Bolyai was unable to make his ideas understood for his social environment; in 1833, he asked for retirement from the army, withdrew to his homeland, and did not publish anything thereafter in his life.

2.3. Belated Recognition

It was 36 years later, in 1869, that József Eötvös, Minister of Education in a letter to his son, Loránd Eötvös reported about the appreciating fame of Bolyai among French and Italian mathematicians. Buoncompagni, a mathematician of the Italian Academy, wrote a letter to the minister praising the creative work of Bolyai and asking to pay attention to the valuable written heritage of the two Bolyais, which was then in Marosvásárhely and was inaccessible for investigation by historians of mathematics. The familiarity of Bolyai among foreign mathematicians emerged after the correspondence of Gauss was published in 1859, mentioning the absolute geometry of Bolyai in a letter. The minister wrote to his son Eötvös Loránd: " ... now I am not sure whether we should be proud of Bolyai or we should be ashamed with red face ... "

Then, the Bolyai written heritage was transferred to Budapest. The Appendix was translated and published in Hungarian language in 1897, when in the world already French, Italian, English translations had been published. In 1913 the comprehensive book about the two Bolyais by Paul Staeckel appeared in German and Hungarian [4,5], and this German language book has been the only source about them for foreign historians up to the present times.

3. Study of General Relativity and Quantum-Mechanics by Károlyházy

3.1. Physics Professor and Theoretical Physicist

Frigyes Károlyházy as a professor of theoretical physics was able to enlighten through actual everyday examples and metaphors the experimental facts and theoretical concepts of the theory of relativity and quantum mechanics, which are practically irreconcilable with common sense, so clearly that even the lay outsider audience could convince oneself that these complicated, but with any rigorous measure proved to be valid, physical facts and deductions can be after all reconciled with a common sense elevated up to a level of higher points of view. He was a missionary of physics education, his book "Igaz Varázslat—True Magic", his university lectures, his high school textbooks, and his popular public presentations all prove his devotion to this field. His name as a professor, teacher and propagator of physical knowledge is well known among people concerned with science, but only a very narrow group of physicists know about his original research and results in fundamental theoretical physics.

In 1966, Frigyes Károlyházy published a paper [6], in which he discussed the relation between quantum mechanics and relativity theory. He applied the quantum-mechanical uncertainty relation to an interval of space-time of general relativity theory. Prior to anyone else he proposed a procedure for the spontaneous collapse or reduction of the quantum-mechanical wave function without and independently from a measurement process carried out by human interference. In the literature, his paper of 1966 in Nouvo Cimento has received more than 200 citations since 1975 according to the "Web of Science" database. In 1974 he published this work also in Hungarian language [7] as his thesis for an Academy degree.

3.2. Theoretical Physics Results by Károlyházy

One important result of his 1966 paper concerns the relative uncertainty of measured distances and time lengths that is space-time intervals. Connecting the quantum-mechanical Heisenberg uncertainty principle to space-time intervals he could deduce a formula for the relative variation of the interval, which has been called in the referring papers as the "Karolyhazy uncertainty relation". From his deduced equations it can be seen that the larger the magnitude of the quantity to be measured, the smaller the uncertainty of its value will be.

Another, perhaps even more important result of the paper concerns the change of the quantum-mechanical state that is the collapse of the quantum-mechanical wave function when governed by the Schrödinger equation, or in a different interpretation the reduction of the quantum-mechanical state vector of the Hilbert space being acted upon by operators of physical quantities. For an elementary particle its wave function describes the probabilities of different values of different physical quantities and the Schrödinger equation governs the time development of these probabilities. This coherent unitary time development can be terminated by the act of a measurement of one physical quantity and this act selects randomly one value from the possible values of different probability. This randomly selecting measuring act is called the reduction or collapse of the wave function [8], which changes the probability of the measured value to unity that is to one. For the act of measurement, a human intention and intervention is presumed. Károlyházy found that the time interval of unitary development before the collapse or spontaneous reduction is dependent on the mass of the quantum objects. For an elementary particle, this time interval may be larger than the time span of the universe, therefore only a human intervention can stop the unitary time development, in contrast to a particle assembly of 1 gram mass whose wave function bears about 100,000 spontaneous reductions per second, while it follows its classical macroscopic path with an uncertain "change" of 10^{-18} m per reduction [9].

In the late sixties, Károlyházy could discuss his work with Richard Feynmann visiting to Budapest [10], whose comment was that it is not worthwhile to deal with the problem of the relation between quantum-mechanics and gravity, many very talented physicists could not reach success in this field. Perhaps the opinion of world-famous Feynmann was a possible reason why Károlyházy practically withdrew from fundamental research and became a missionary of physics education.

3.3. Belated Recognition

It was about 20 years later that Károlyházy et al. published a paper in a conference proceeding titled "Quantum Concepts in Space and Time" and edited by Roger Penrose. After this paper, Penrose, an Italian group and Lajos Diósi took serious notice and consideration of the idea of gravity dependent spontaneous reduction of quantum-mechanical states as described by Károlyházy in 1966. The number of citations mentioning the "Karolyhazy uncertainty relation" started growing after 1986. Roger Penrose in some of his recent publications on consciousness intends to connect conscious events with gravitation related "Diósi-Penrose Orchestrated Objectiv Reduction". It is true, that the formalism of "OrchOR" is different from that of the spontaneous reduction of Károlyházy, but the priority of the idea of spontaneous reduction actuated by gravity without intentional human interference remains with Frigyes Károlyházy.

4. Conclusions

There is an obvious parallelism between the lives of the two Hungarian men of science, the first class genius geometer and the missionary of the creation and propagation of knowledge in the field of modern physics. Both of them selected and solved a problem which had been considered up to their date too complex to attack for the majority of other scientists. Their work was criticized authoritatively by persons of very high rank of their discipline, which led to their withdrawal from their cultivated scientific field. After a long time of silent oblivion the belated recognition of the absolute geometry and the Károlyházy uncertainty relation put these excellent achievements to their deserved right place.

Conflicts of Interest: The author declare no conflict of interest.

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