Temporological Analysis of the Distinguished Mathematicians

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***Abstract*—This study presents further exploration of the temporological approaches and four-elements models described in *Cartography of Emotions* and tested on the personal data of the Nobel laureates in literature [1-3]. Comparison of the characteristics of the recipients of prestigious prizes in mathematics (Fields, Wolf, Abel and Lobachevsky) with the Nobel laureates sheds new light on the processes of creativity and on our perception of the world in general. One of the results of this analysis reveals measurable differences between the Nobel laureates in literature and their mathematical counterparts.**

Keywords— Abel Prize, Nobel Prize, elements, mathematical thinking, measurements in humanities

I. INTRODUCTION

Analyzing the personalities of mathematicians is much more difficult than analyzing the worldview of writers or poets, whose metaphors and imagery are reflected in their publications. Jacques Hadamard (1865-1963) was one of the first scientists to draw attention to the importance of studying the worldview of mathematicians and to contradict their stereotype as the absent-mind professor. He suggested that mathematical ideas, discoveries, and inventions are but a special case of a creative process in general, be it in sciences, in literature or in art. In his pioneer research "Psychology of Invention in the Mathematical Field" (1945) he discussed the results of a survey of a large number of his fellow mathematicians [4]. It turned out that mathematical thinking is not limited to a chain of logical reasoning but is the result of several complex and often intuitive processes of unknown nature. Like Pythagoras, most of the great mathematicians were also skilled in sciences, poetry and music. Mathematicians were also active in political life. For example, the French mathematician and statesman Paul Painlevé (1863-1933) served twice as Prime Minister of the Third Republic. Hadamard himself was not only a prominent mathematician, but also a professional violinist. He was also showing passion about social affairs, including taking a Dreyfusard stance and being an avid supporter of the Hebrew University of Jerusalem.

One of Hadamard's important observations was that mathematicians themselves often think differently and come to different conclusions. Hadamard's communication with Henri Lebesgue (1875-1941) led both mathematicians to accept their basic differences: "We could not avoid the conclusion that evidence – that starting point of certitude in every order of thinking – did not have the same meaning for him and for me. Only, of course, we were never tempted to despise each other merely because we recognized the impossibility of understanding each other" [4, p. 92].

Hadamard could not outline the most common types of thought for all mathematicians. Nevertheless, in the present work we are not studying all mathematicians, but only those of them who have achieved fame and the most prestigious awards. Significantly, the most impressive qualities of such mathematicians were also inherent in Hadamard, including his exceptionally long and active life. The following section reviews age dynamics in mathematical prizes (all data are updated for January 2021).

II. MATHEMATICAL PRIZES AND AGE DYNAMICS OF LAUREATES

It is symbolic that the first award of the prestigious Lobachevsky Prize took place in 1897, during the Phoenix Hour of 1885-1900 (i.e. during a period of radical and long-term historical changes [3, 5]). Since then, the prize has been awarded irregularly, and 28 people have become its laureates. Their average age at the time of award was 57, and the oldest of them was 91.

The Fields Medal is regarded as one of the highest honors a mathematician can receive, and has been described as the mathematician's Nobel Prize. It was established in 1936 by the Canadian mathematician John Fields (1863-1932), who demanded an age limit: a recipient must be under the age of 40 on the first of January, on the year in which the medal is awarded. The laureates receive a gold medal and ~ $ 11.000. Since 1950, the prize has been awarded every four years. 60 people have become its laureates, and their average age is 34.8.

The Wolf Prize in Mathematics, established in 1978 in Israel, is considered the most prestigious award after the Nobel Prize. The prize is $ 100,000 and is paid from a fund created by the chemist Ricardo Wolff (1887 - 1981) and his wife Francisca. 64 people became its laureates in mathematics. The average age of the laureates at the time of award is 66.5. The youngest laureate was 43 years old, and the oldest – 89 years old. The average age of 30 laureates, who had died before 2020, was 82.7 years; the oldest of them, Henri Cartan, who had died at the age of 104.

The annual Abel Prize is about $ 693,200 and it is named after the distinguished Norwegian mathematician Niels Henrik Abel (1802 - 1829). It was established in 2002 by the Norwegian government and modeled after the Nobel Prizes. The prize was first proposed in 1899 by the mathematician Sophus Lie (1842 - 1899) to be part of the celebration of the 100th anniversary of Abel's birth. The incentive was Nobel's decision to exclude mathematics from the areas in which the prize was awarded. Unfortunately, Lee's sudden death occurred at the very end of the Phoenix Hour of 1885-1900, and it took almost a century before the prize was finally established. All in all, 22 laureates have received the prize, of which four have already died. Their average life span was 91 years, which is higher than the current life expectancies (from 82.6 in Israel to 84.1 years in Japan).

The average age of the living laureates is 79.1 years. The oldest of them is 96 years old, and the youngest is 67. The average age of the laureates in the year they were awarded the Abel Prize is 77.1 years. The oldest recipient was 90 years old in the year of the award, and the youngest – 63 years old.

For comparison, the average age of Nobel Prize laureates in literature is 65; the youngest at the time of the award was 42 years old, and the oldest – 88 years old.

On the one hand, such data show that intensive math studies did not hurt health, but, on the contrary, contributed to longevity. On the other hand, each of the mathematical awards has its own preferred range, and together they cover almost the entire life span of scientists.

Temporological analysis of the laureates' birth data revealed several impressive coincidences. Traditionally, the first sign of the zodiac (Aries) is associated with youth and the pioneering of new beginnings. Indeed, the Aries-born mathematician Sir Andrew John Wiles became the youngest laureate of the Wolf Prize (43 years old) as well as the youngest laureate of the Abel Prize (63 years old). In physics, he was preceded by Sir William Lawrence Bragg, the youngest ever Nobel laureate in sciences (25 years). In addition, Aries-born Lars Ahlfors was the first Fields Prize recipient. Aries-born scientists were also the first to be awarded the Nobel prizes in physics (Wilhelm Roentgen) and in economics (Jan Tinbergen).

Pisces is the closing sign of the zodiac, and Pisces-born scientists usually wait longer to get recognition. At the most venerable age (90), the Abel Prize was received by Louis Nirenberg (1925 - 2020). Pisces-born John Torrance Tate (1925 - 2019), who was just two weeks younger than Nirenberg, got his Abel Prize at the age of 85. Both died 95 years old, with Nirenberg surviving Tate by just three months. As in the case of Ernest Hemingway and his translator Ivan Kashkin, the temporological indicators of the birth data of Nirenberg and Tate (their Theta factors) are so close that these laureates can be considered as partial celestial twins [6].

Mathematic laureates also demonstrate that pioneers often must wait for decades to be understood by others. For example, Fermat's last theorem waited 300 years to be proved by Wiles in 1994. and then Wiles waited another 22 years to be awarded the Abel Prize for this proof.

Back to Hadamard, at the venerable age of 91 he was awarded the highest scientific research award in France. He remained active until his death at the age of 97. It should be stressed that all the prizes are not awarded to discoveries, but to living people and to be awarded a prize a nominee must first of all stay alive and promote his ideas. It means that the longevity is an important quality for any scientist.

III. CITIZENS OF THE WORLD

Like Hadamard, most mathematicians-laureates can be described as itinerant travelers, changing countries, universities, and even citizenships. For example, here is a partial list of places where the French mathematician and first Abel Prize winner Jean Pierre Serre (b. Virgo, Earth) taught: Sorbonne, Princeton, Harvard, Algeria, Bonn, Geneva, Göttningen, McGill, Mexico, Moscow, Singapore and Utrecht [7].

The Abel laureate Sathamangalam Varadhan (b. Capricorn, Earth) studied in Madras but worked at the Courant Institute in the USA. He wrote: "I like to travel. I like the pleasure and experience of visiting new places, seeing new things and having new experiences" [8].

Unlike Earth-born Varadhan, Pisces-born Nireneberg had a dominant Water element. Like Varadhan, Nirenebrrg was fond of travelling, but his reason for this was different: " One of the wonders of mathematics is you go somewhere in the world and you meet other mathematicians, and it's like one big family. This large family is a wonderful joy" [9].

Another Water-born prominent American laureate John Milnor (Pisces) at times lived in France and was also a member of the Russian Academy of Sciences. He believes that mathematicians are very fortunate because "ideas often travel from country to country very rapidly" and that in spite any political confrontations mathematics always stays "much more open than most scientific subjects" [10].

IV. NUMEROUS AWARDS

Within the options of his times, Hadamard was awarded the most prestigious international awards, among them the Poncelet Prize and Feltrinelli Prize. The example of Abel laureates shows that this is not accidental: mathematicians who get the highest recognition are rewarded periodically and repeatedly throughout their life. Of the 22 Abel Prize laureates 16 (72.7%) have won at least two most prestigious prizes (14 – Wolf, 1 – Fields, and 1 (John Nash) – prior to Abel Prize had received the Nobel Prize in economics). Five laureates have won three most prestigious prizes (Wolf, Abel, and Fields). The remaining 6 laureates were awarded prior to Abel with such prestigious awards as the Lobachevsky, Leroy Steele, or Gauss Prize.

V. PERSONAL LIFE

On average, Abel's laureates were married once and had 2 children. Behind these averages there are many creative couples and family dynasties. For example, Milnor's wife – Dusa McDuff – is an English mathematician, FRS and the first recipient of the Ruth Lyttle Satter Prize in Mathematics.

Jean Pierre Serre's wife Josiane is a professor and specialist in quantum chemistry. She has encouraged Serre to write a mathematical textbook for her chemical research.

VI. LAUREATES AND THEIR CELESTIAL TWINS

A quick search detects that each Abel Prize laureate has at least one well-known celestial twin ("celestial twins" – people who were born simultaneously or within an interval of 48 hours [11]). It suggests that such people are more predisposed for searching recognition. Each of these detected couples or groups of celestial twins deserves a separate study, but the scope of this work allows us to mention just a few striking examples.

John Nash (1928-2015) was the only person to be awarded both the Nobel Prize (economics) and the Abel Prize. In Belgium, his well-known celestial twin was the theoretical physicist Robert Braut (1928-2011), who received several prestigious awards, including the Wolf Prize in Physics. In Russia, their celestial twin Eduard Vladimirovich Evreinov (1928-2011) was a mathematician famous for his work in informatics. He was a laureate of the Lenin Prize and many international awards.

Jacques Tits is an influential French mathematician of Belgian origin. He has been awarded the Wolf and Abel

Prizes. Tits also served on the committee awarding the Fields Medal. His celestial twin is the Hungarian-born American influential investor and philanthropist George Soros who has studied economics at the University of London.

Grigory Margulis is a professor of mathematics at Yale University who has been awarded all the mathematical prizes known today. His celestial twin, Terry Allen Winograd, is a professor of computer science at Stanford University. Winograd is a recipient of the SIGCHI Lifetime Research Award. He is widely known as an adviser to a number of companies started by his students, including Google.

In 2020, Margulis shared the Abel Prize with Hillel Fürstenberg, professor of mathematics at the Hebrew University of Jerusalem. Fürstenberg's celestial twin was Walter Greiner, a renowned theoretical physicist. Like Fürstenberg, Greiner has an impressive list of awards, including the Max Born, Otto Hahn and Humboldt medals.

Celestial Twins reveals a story about two mathematicians (Hermann Weil and Theodore Kaluza) and their poetical celestial twin Velimir Khlebnikov [11]. Multitalented Khlebnikov as if mirrored both his celestial twins: Weyl ("a mathematician with a soul of poet") and Kaluza ("a mathematician and consummate linguist"). Such mirroring effect presents also in the case of Hadamard, whose most famous celestial twin was the outstanding composer Jan Sibelius. As a child, Sibelius showed extraordinary abilities in mathematics, but then switched to music. On the contrary, Hadamard made his living in emigration by playing the violin.

Many Abel laureates were fond of music, literature and poetry. In the case of the distinguished American mathematician Isador Singer, we find that his famous celestial twin was the laureate of The Israel Prize, an outstanding poet and translator, Yehuda Amichai. It is indicative that Singer was fond of poetry too, and his first choice at the university was to take a poetry course [12]. Concluding this section, I would like to add that understanding our celestial twins can help each of us to discover oneself more fully.

VII. In Accordance with one's elements

Previously it was shown that Nobel laureates in poetry have preferred metaphors in accordance with the basic concepts of their major element, be it Air, Fire, Water or Earth [1-3]. Similar differences between the representatives of the four basic elements are observed among mathematicians.

The first group includes representatives of the Fire element. In mathematics, they, like Hadamard, are attracted by the novelty of marvelous insights. For example, trying to solve Fermat's theorem – an enigma that mystified the greatest minds for centuries – Wiles (b. Aries, Fire) experienced exaltation: "suddenly, totally unexpectedly, I had this incredible revelation" [13].

The representatives of the Earth element see mathematics differently. For them it is most important to deal with the problems of applied mathematics. Jean-Pierre Serre (b. Virgo, Earth) – the laureate of Wolf, Abel and Fields prizes – wrote: "I don't know what "inspiration" really means. <...> Mathematics can be seen as a big warehouse full of shelves. Mathematicians put things on the shelves and guarantee that they are true. They also explain how to use them and how to reconstruct them. Other sciences come and help themselves from the shelves, mathematicians are not concerned with what they do with what they have taken, this metaphor is rather coarse, but it reflects the situation well enough" [7].

Representatives of the Air element are attracted to mathematics by the beauty of its language. Pierre Rene Deligne (b. Libra, Air) loves mathematics, "of course, because it is beautiful!" Robert Langlands (b. Libra, Air) is an enthusiastic learner of languages, both for a better understanding of foreign mathematical publications, and just "for fun."

Representatives of the Water element admire mathematics because for them, like for Louis Nirenberg (b. Pisces, Water) mathematics is a wonderful joy to be a member of a large family of mathematicians. Yves Meyer (b. Cancer, Water) said: "I like people. I like discussing with people – meeting, admiring people. I would say the pleasure to do mathematics is related to the pleasure of joint work" [14].

Different views of mathematics can provoke conflicts, similar to those between Hadamard (Fire) and Lebesgue (Water). For example, the Hungarian Abel Prize laureate, Endre Szemeredi (Fire), was encouraged by the Wolf laureate Pal Erdös (Fire) but was discouraged by his thesis adviser – another Wolf laureate, Israel Gelfand (Earth), who told Szemeredi: "Just try to find another profession; there are plenty in the world where you may be successful" [15].

Comparing his thinking with the Wolf laureate Luis Caffarelli (Fire), Luis Nirenberg (Water) felt himself inferior: "Fantastic intuition, just remarkable. I had a hard time keeping up with him" [9].

VIII. Comparing Abel and Nobel laureates

In 2017, I discussed the uneven distribution between the elements in which the Nobel laureates in literature were born [3]. Meanwhile, a few names have been added, but the distribution of their birth data by element has not been changed. The Nobel Prize in Literature was first awarded in1901, and by 2020, 115 people with confirmed elements of birth became its laureates. 39 – more than one third of them – were born in the Air element. Fig.1 shows that they were twice as numerous than Earth-born recipients.

To compare similar periods of awarding the prizes and compatible number of mathematicians, the lists of the Lobachevsky, Wolf, Fields and Abel prizes were combined. As a result, 133 laureates with confirmed elements of birth were identified. The pattern of their distribution by elements, shown in Fig. 2, significantly differs from the previously obtained distribution of writers and poets.

For further comparison, I analyzed the birth data of the Nobel laureates in physics, chemistry, medicine and economics. Assuming the relative distribution of elements among mathematicians as a "standard," for each discipline the ratio of the specific weight of each element in relation to the selected standard was calculated (Table 1).

It turns out that physicists are closest to mathematicians in terms of the distribution of the elements. Perhaps this explains why modern physics is accused of excessive "mathematization."

We find the "earthliest" (predominance of Earth) laureates in chemistry, and the greatest dreamers (predominance of Air) in literature.

TABLE 1

	Fire	Earth	Air	Water
Mathematics	1	1	1	1
Physics	0.97	1.03	1.19	0.86
Economics	1.12	1.09	1.11	0.75
Medicine	0.88	1.13	1.28	0.79
Chemistry	0.91	1.29	1.17	0.74
Literature	1.05	0.76	1.51	0.75

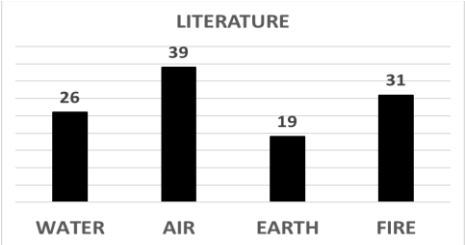

Fig.1 Nobel laureates in literature by elements

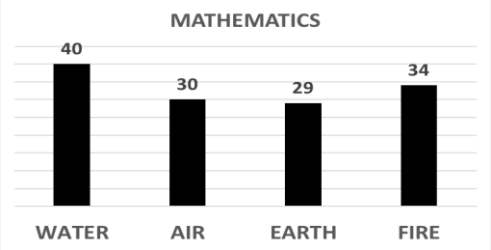

Fig.2 Laureates in mathematics by elements

This model suggests that the farthest from mathematics is the profile of the writer or poet. This suits the fact that the writers are free to create their own imaginary worlds and are least of all bound to adhere to the Truth.

In short, in comparison with literature, mathematical studies require from a laureate more practicality and reality (1.3 times more Earth), less imagination (almost 1.5 times less Air), more faith in success and the existence of Truth (1.3 times more Water).

This observation is consistent with Hadamard's appeal to mathematicians: "Although the truth is not yet known to us, it preexists and inescapably imposes on us the path we must follow under penalty of going astray" [4, p. xii].

IX. CONCLUSIONS

John F. Nash (b. Gemini, Air) supposed that "rationality of thought imposes a limit on a person's concept of his relation to the cosmos" [16].

Using alternative thinking, temporological approaches makes it possible to identify a number of common features of the mathematicians-laureates which are in accordance with Hadamard's earlier observations as well as with the philosophy of the four elements.

Ennio De Giorgi – a distinguished Italian mathematician – once noted that mathematics is the key to discovering the secrets of God. I hope that the application of the temporological methods to the study of the world's perception of outstanding mathematicians will help us to find such keys and establish a new logic that will bring us closer to the understanding of the cosmic laws.

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