Origin of Theoretical Physics in Bulgaria

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Abstract. Some results in physics, produced in Bulgaria in the first half of the 20th century are thematically displayed. Scientific results in the areas of analytical mechanics, mathematical physics, physical chemistry, astronomy, meteorology, and theoretical physics coming from Sofia University have their origins in the specialization abroad. Historical nebula above Bulgarian theoretical physics elucidates the Maneff's dynamical reaction principle and its creation comes into the open.

Keywords: History, Theoretical physics, Bulgaria

1. Introduction

Theoretical physics has disseminated in Bulgaria by publications, physicists and institution. First Bulgarian University one and only provided education for physicists from 1889 to 1949. This period will be historical frame in this work. Sofia University initiated the sole institution in the area of theoretical physics during the first half of 20 century [1]. Faculty of Physics and Mathematics opened in 1889 [2] had one theoretical physics department (1921) [3], five experimental physics departments (experimental physics – 1889, astronomy – 1892, nuclear physics – 1919 meteorology – 1920, and technical physics – 1927), and five mathematical departments (high algebra – 1889, analytical geometry – 1889, differential and integral calculus – 1890, analytical mechanics – 1891, foundations of high mathematics – 1904) up to 1949 [4].

Theoretical physics department created in 1921 has great importance for university physics in Bulgaria. Sofia University initiated master degree (1921) and scientific council in physics in 1933 [5]. Georgi Ivanoff Maneff [6-16] initiated department of theoretical physics and headed it 23 years (1921 – 1944) [17]. Although nobody took any notice of Georgi Maneff during the second half of 20 century [18-19], his name has rehabilitated now [20]. This work aims to show origins of theoretical results in physics obtained in Bulgaria during the first half of 20 century, and especially Maneff's dynamical reaction principle.

2. Theoretical Specialization

The most physicists from the Sofia University preferred theoretical method [21] more then experimental one [22-23]. They made theoretical research in physics after specialization abroad [24]. Postgraduate, Ph.D, and postdoctoral programs have used for theoretical education in the area of physics. Six Sofia University assistants specialised theoretically in physics (5) and analytical mechanics (1) without scientific degree by postgraduate programmes (Kowatschew, Stoyanoff, Tzenoff, Maneff, Zaycoff, and Christov). Theoretical theses defended and doctoral degree in physics obtained nine Bulgarian students (Datzeff, Popoff, Staikoff, Khristov, Stranski, Boneff, Kaischew, Krastanow, and Malcheva). Three Ph.D. diplomas in mathematics (analytical mechanics) have awarded to Ganew, Bradistiloff, and Dolapchieff. Postdoctoral programs studied abroad four theoretical physicists from Sofia University (Popoff, Stranski, Kaischew, and Krastanow).

Fields of theoretical specialisation were astronomy (7), theoretical physics (5), analytical mechanics (4), physical chemistry (3), meteorology (2) and mathematical physics (ballistics and geodesy) (Tabl. 1).

	Germany	France	Sofia
Theoretical Physics	1 / 0	4 / 1	-
Astronomy	3 / 2	3 / 1	1 / 1
Analytical Mechanics	2 / 1	2 / 1	0 / 1
Physical Chemistry	2 / 2	-	1 / 1
Meteorology	2 / 1	-	-
Mathematical Physics	2 / 0	1 / 0	

Table 1. *Number of assistants with theoretical specializations by areas, countries, and effectiveness*

Bulgarian Government granted scholarships all assistants from the Sofia University to specialize abroad. Rockefeller and Humboldt foundations gave in addition three scholarships (Zaycoff, Stranski, and Kaischew). Two Bulgarian professors worked abroad after that (Zaycoff and Stranski). Bulgarian students specialised in physics theoretically in France and Germany up to 1949.

2.1. Theoretical Specialization in Germany

German universities educated theoretically twelve students from Bulgaria in six areas of physics. Six of them graduated Ph.D’s in physics and one defended his dissertation in mathematics in Bulgaria.

Theoretical physics specialisation in Germany has one Bulgarian assistant (Zaycoff). German theoretical physics centers, the universities in Berlin and Göttingen, educated **Raschco Zaycoff** in 20^s of 20 century. He learned Military College in Austria (1914 – 1922). Later on, he chose civil education in mathematics and physics, and attended courses of David Hilbert, Emy Nöter, Max Born in the University of Göttingen (1922 – 1924), and courses of Max von Laue, and Albert Einstein in the University of Berlin (1924 – 1925). Raschco Zaycoff is the first Bulgarian student with scholarship in physics by the Humboldt’s foundation (1926 – 1928). He assisted to Professor Grotrian in the new Einstein’s Astrophysical Observatory in Nöesbabelsberg (1927) [25].

Mathematical physics specializations in Germany have two professors from the Sofia University (Kowatschew and Popoff). **Yordan Kowatschew** specialized in Potsdam Institute of Geodesy six months (1909). **Dr. Kyrille Popoff** worked in Berlin in the field of ballistics under leadership of R. von Mizes (1920). He lectured courses on external ballistics in the Universities of Paris and Berlin (1925).

Astronomy was preferable subject for theoretical specialization by the Sofia University professors. Three of them worked in German astronomical observatories in Potsdam, Leipzig, Munich, Göttingen, and Berlin and two obtained doctoral degree in German universities (Khristov and Boneff). **Dr. Kyrille Popoff** studied celestial mechanics (1907 – 1910). He worked under leadership of Hugo Zelinger (1849 – 1924) in Munich 5 months in 1906. Later on, he trained to use theory and practice of passage instruments and Poancare theory of perturbations in Göttingen. **Dr. Vladimir K. Khristov** studied astronomy in Leipzig. He investigated orbits of comets 1896 in his Ph.D. (1925). **Dr. Nicolas Boneff** specialized in the Potsdam Institute of Geodesy (1926 – 1928) and received doctorship in the University of Berlin (1927). The topic of his dissertation was “*Potential of Neumann and retrograde satellites of Jupiter and Saturn*”. Dr. Nicolas Boneff defended his thesis in 1928 [26, p. 755-762].

Physical chemistry diplomas awarded two professors from Bulgaria – Dr. Ivan Nikoloff Stranski (1925) and Dr. Rostislaw Kaischew (1930 – 1932) by German universities in Berlin, and Breslau (Wroclaw now). **Dr. Ivan N. Stranski** studied medicine in the University of Vienna (1917 – 1918) and chemistry in the Sofia University (1918 – 1922). He was Ph.D. student on physics in Berlin under leadership of Pawl Gunter. The title of his dissertation is *Roentgen spectral analysis* (1925). Rockefeller’s foundation granted him postdoctoral specialization in the Institute of Physical Chemistry at the High Technical School in Berlin under leadership of Professor Maks Folmer (1930). **Dr. Rostislaw Kaischew** studied physics in Breslau with Rockefeller’s scholarship (1930). Professor Fransis Sayman was director of his Ph.D. study. His dissertation thesis examined thermal properties of fluid and solid helium (1932). Dr. Rostislaw Kaischew specialised physical chemistry under leadership of Dr. Ivan N. Stranski in department of physical chemistry at the Sofia University [26, p. 298-302].

Meteorology in Germany specialised two Bulgarian professors (Staikoff and Krastanow). **Dr. Staiko Staikoff** studied meteorology in Berlin (1908 – 1912). He defended his Ph.D. thesis “*Contribution to Bulgarian climatology – temperature distribution*” in 1914. Meteorological Institute in Potsdam invited him to work there but he rejected invitation. **Lubomir Krastanow** specialised meteorology in the Geophysical Institute of Leipzig and in the Geophysical Observatory of Wansdorf near Dresden (1940) [26, p. 352-355].

Analytical mechanics studied in German speaking universities two assistant professors from the Sofia University. All of them graduated Ph.Ds. **Dr. Georgi Bradistiloff** studied analytical mechanics in Munich (Ph.D. 1938) [26, p. 84-87]. **Blagovest Dolapchieff** studied hydro and aero dynamics in Göttingen (1935 – 1937), and Budapest (1942 – 1943). Returning in Bulgaria he defended thesis “*Contribution to stabilization of Kármán vortex streets*” and became doctor in mathematics (1937) [26, p. 211-214].

2.2. Theoretical Specialization in France

French universities trained theoretically ten Bulgarian physicists in four areas (theoretical physics, astronomy, analytical mechanics, and mathematical physics). Two of them graduated doctoral degree in physics and one obtained Ph.D. in mathematics.

Theoretical physics specializations in France have four Bulgarian assistants. Only one of them graduated Ph.D. in physics (Datzeff). The oldest centre of theoretical physics was University of Toulouse where Nicola Stoyanoff (1904 – 1906) and Georgi Maneff (1913 – 1914) studied before the First World War. University of Paris became centre for theoretical physics in the thirties of the 20th century when two Bulgarian students (Datzeff and Christov) studied theoretical physics there.

Nicola Stoyanoff is the first Bulgarian student with scholarship in theoretical physics from the Sofia University. He graduated bachelor degree in physics and mathematics from the High School in Sofia (1892 – 1895) and master degree from the University of Toulouse (1899 – 1901). Later on, he specialised theoretical physics in Toulouse two years (03.01.1904 – 16.01.1906). He did not occupied the new chair of theoretical physics at the Sofia University. He took part in the competition unsuccessfully in 1910. There are some reasons for that. The first one was that he worked in astronomy at the same time [27]. However, more significant was the fact that he became professor in astronomy during the Sofia University crisis in 1907.

Georgi Maneff is the second Bulgarian student from the Sofia University with state scholarship in theoretical physics. His specialization in theoretical physics at the University of Touloussa under the leadership of H. Bouasse was for one year (31.09.1913 – 09.1914) only. Georgi Maneff founded first Bulgarian department of theoretical physics at the Sofia Univeristy in 1921 [6]. He was assistant (01.09.1919), associate (21.04.1921), extraordinary (27.04.1925), and full professor (13.07.1935) there. Georgi Maneff was dean of the Faculty (1926 – 1927 and 1930 – 1931), rector of the University (1936 – 1937), and minister of the education (24 January 1938 – 14 November 1938) [10, 12].

Dr. Assene Datzeff studied under Louis de Broglie leadership in Sorbone, Paris (02.12.1934 – 03.1936). He got doctoral degree in physics (1938) [28, p. 190]. The subject of his dissertation was "*Sur le problème des barières de potential et la résolution de l'équation de Schrödinger*". It has 94 pages. Refered publications were 16. Rector of the Academy was G. Boussy. Dean of the Faculy of Science was Ch. Maurain. Chair of the examination board was MM. Garnier. F. Perrin (Professor of mechanical theory of fluids) and L. de Broglie were the examiners [4, p. 52].

Christo Y. Christov studied simultaneously two specialities (physics and mathematics) at the Sofia University (1934 – 1938). He had 8 months specialization under Fransis Peren's leadership in Sorbonne, Paris (1938 – 1939). Sofia University appointed him assistant professor (05.01.1942 – 1946), private professor (1946 – 1947), associate professor (1947 – 1951), and full professor (1951 – 1984). Bulgarian Academy of Sciences elected him corresponding member (1952), full member (1961), and Vice-President (1974 – 1976) [28, p. 232].

Mathematical physics specialization in France has one Sofia University Professor. **Yordan Kowatschew** studied high geodesy in Paris (1906 – 1908).

Astronomy was subject for theoretical specialization in the choice of three assistant professors from the Sofia University. They worked in French astronomical centres. One doctoral thesis has conferred successfully in the University of Paris (Popoff). **Dr. Kyrille Popoff** worked in meridian office in Nice (1907) and wrote Ph.D. thesis in Sorbonne (1907 – 1910). Under leadership of Andoae, he investigated "*Movement of 108 Hekuba one particular case in the problem of three bodies*" (1912). **Dr. Nicola Boneff** studied astronomy at the Sorbonne in Paris two years (1924 – 1926). **Nicolas Stoyanoff** was an additional assistant in the Astronomical Observatories of Toulouse (1899 – 1901) and Marseille in France during the summer semester of 1907 – 1908 [27].

Analytical mechanics studied in France two professors from the Sofia University **Dr. Spyridon Ganew** defended Ph.D. (Liege, 1893). **Ivan Tzenoff** specialised analytical mechanics in Paris (1911 – 1913). Returning in Bulgaria, he wrote his habilitation paper "*Movement of rotating solid, heavy, homogenous body in case of Lagrange*" and became professor of analytical mechanics (01.10.1914).

3. Theoretical Results in Bulgaria

Sofia University physicists and mathematicians obtained some new scientific results in mathematical and theoretical physics (analytical mechanics, ballistics, geodesy, physical chemistry, astronomy, meteorology, and classical dynamics). Theoretical physics investigations in Bulgaria have three stages – mathematical physics (1842 – 1924), classical theoretical physics (1924 – 1944) and modern theoretical physics (after 1944) [29].

3.1. Bulgarian Results before 1924

Analytical mechanics was research area for three professors in Bulgaria. **Ivan Tzenoff** examined holonomic systems equations and solved problem of nonholonomic systems (an example is bicycle wheel). Equations of nonholonomic systems are called first and second Tzenoff's equations now. Ivan Tzenoff became corresponding member (1925) and full member (1929) of the Bulgarian Academy of Sciences [26, p. 789-792; 30]. **Dr. Georgi Bradistiloff** described the external shape of crystals by non-linear theory of vibrations [26, p. 84-87; 31]. **Dr. Blagovest Dolapchieff** investigated fluid mechanics. His contributions are in stability and induction of vortex formation and vortex drag of streamlined bodies, beyond which they are formed [26, p. 211-214; 32].

Mathematical physics is a subject of investigation for three professors in Bulgaria. **Dr. Kyrille Popoff** used mathematical methods to solve physical problems up to the end of his life. In the area of internal and external ballistics, he investigated gunfire during the First World War. He improved precision of shooting vastly taking in account magnetism of the ground and resistance from the air. French Academy of Sciences awarded Dr. Kyrille Popoff with premium "*Montion*" (1926). He investigated planetary orbits too. The last field of his investigations was non-reversible thermodynamics [26, p. 573-578; 33]. **Yordan Kowatschew** investigated motion of the Earth Poles (1903), disturbances of atmosphere caused by the Earth rotation (1906), reasons of magnetic perturbations (1906), accuracy of Russian geodetical measurements in Bulgaria 1877 – 1878 (1909), the Earth crust structure, and variations of the force of Earth attraction [34]. **Dr. Vladimir Kirilov Khristov** investigated theory of geodetical coordinates and defined the reference ellipsoid [26, p. 755-762; 35].

Astronomy was the area for theoretical investigations in which one professor worked on in Bulgaria. **Dr. Nicolas Boneff** examined gravitational law in relative theory and problem of Bertrand (1934) as well as one Euclidean extended Universe (1935). He made some considerations about Heisenberg's principles of causality and indefiniteness. He modified Laplace hypothesis for Solar system creation. Using Neumann potential, he analyzed problem of eccentricity, and structure and evolution of the Saturn rings. Dr. Nicolas Boneff examined number and distribution of Moon's craters. He determined volcanic origin of the big craters [30, p. 66-69; 36].

Theoretical physics was an area of investigation for five professors in Bulgaria. **Nicola Stoyanoff** published some theoretical papers in 1910 – 1911 [27]. **Raschco Zaycoff** investigated five dimensional general relativity, unified field theory, and quantum mechanics (1928 – 1935). He worked in applied mathematics (mathematical statistics), and natural philosophy in Bulgaria [37]. **Dr. Assene Datzeff** solved many theoretical problems in quantum theory, potential barriers, theory of solid bodies, classical heat conductivity, and the problem of Stephan [26, p. 187-190; 38]. **Christo Y. Christov** investigated many problems in electrodynamics, gravity, energy of contemporary physics, and laws in classical physics in Bulgaria [26, p. 773-775; 39].

3.2. Maneff's "*Reaction*" Theory

The most remarkable theoretical result during the first quarter of the 20th century, I think, is a work of Georgi I. Maneff. He has a new idea of great importance for understanding the Universe. He published it in Bulgarian language at the first time (1924), and sent its German manuscript to "*Zeitschrift für physics*" in the beginning of 1925. He has in thise subject more than 30 articles in Bulgarian, French, German, and English scientific magazines after that (1924 – 1935).

Georgi Ivanoff Maneff's theory extended the range of third principle of Newtonian mechanics. Accepting that bodies of the Universe are in uninterrupted motion by rotation and translation of the centre of rotation his theory provided the same good theoretical approximation as general relativity. He used the method of vector calculus to solve problems.

Georgi Maneff introduced his "*substantial dynamic theory about matter and energy*" [40A, **20**, 121 (1924)] by words "*Reaction theory, we will allow to give this name to it … Mathematical problem of our theory is the same as the problem of relativity. When two systems in motion are equivalent kinematically, they are not equivalent in dynamical and physical attitude ... We accept spherical symmetry of the Universe. Gravitation in our theory is a force and an independent gravitation field. The rotation is very important, when we investigate the movement in gravitational field* [40A, **20**, 167 (1924)]. *Our presentation is different from relativity in its initial principles and terms. Our method is different. Einstein's solution is a special case of our substantial solution*" [40A, **27**, 355 (1931)].

Some reviewers evaluated positively Maneff's scientific results, notwithstanding severe remarks (1925 – 1935).

Petar Pentchew, extraordinary professor on radioactivity and experimental physics writes, "*Maneff gives a new and abstract principle. The initiation of the problem is a credit*" [41 a), sheet 40 back].

Dr. Nicola Obreshkoff, professor and head of the high algebra department, compares G. Maneff's and A. Einstein's theories. He writes, "*Mr Maneff obtained*

$$v = c\sqrt{2} > c\,,$$

that all bodies move uniformly with one and the same velocity ... Mr Maneff ... accepts that the mass depends on direction. For radial mass, he writes

$$m_2 = m_0 e^{\frac{2kM}{c^2 r}}\,,$$

[41 b), sheet 20-21 back]. "*About Mercury, the approximates relation given by him is*

$$\overline{E}_{\min} = -\frac{1}{2}\overline{E}_{rot} \quad .$$

It is correct strictly about circular motion, not in case of parabola or hyperbola" [41 b), sheet 23-24].

Dr. Nicolas Boneff writes that Maneff "*reaches two very important astronomical effects … satisfactory interpretation of λ and special case of expanded Universe*" [41 b), sheet 123]. "*About effect of spectral displacement Maneff writes that the effect can only fixed, not measured, because experimental evidences vary in wide range*" [41 c), sheet 84-88].

Ivan Tzenoff writes that Maneff "*compares substantial and structural points of view in gravitation*" [41 b), sheet 88-88 back]. "*Maneff reaches an important differential equation about displacement of the perihelion of planets*" [41 b), sheet 108 back]. "*Therefore with equation*

$$(\frac{dp}{d\alpha})^2 = \frac{C}{\beta^2} + \frac{2kM - 2\beta C}{\beta^2}\rho - (1 + \frac{2\beta kM}{\beta^2})\rho^2 + 2\beta\rho^3$$

he solves simultaneously two effects: displacement of perihelion and spectral lines" [41 b), sheet 87]. "*Law of the mass is correct, but in case when the center of the Sun moves and its mass is variable*" [41 b), sheet 84 back].

Dr. Kyrille Popoff thinks that Maneff's papers contain "*some valuable conclusions. Maneff accepts that the velocity of light*

$$c_1 = ce^{\frac{kM}{c^2 r}}$$

is equal to the tangential component" [41 b), sheet 38]. "*Some results* [40C, **56** 421] *are a hit at the heart of relativity. Its results will be true only if we accept velocity of light for unit. In any other measuring unit, we will receive different result for the velocity of light. Taking in account the great futurity and importance of my note in history of physics, I refuse to accept this results* [41 b), sheet 13 back]. *Maneff's papers are clumsily constructed in mathematical and mechanical sense. I do not speak here about pure physical side of his works. They have strong physical character. Many theories in physics as the law of conservation energy, the law of Carnot, the electromagnetic theory of light, and the pure mathematical theory of Gruna have been presented in bad mathematical frame in the beginning*" [41 b), sheet 14-14 back].

Professor Maneff presented his theory more clearly in his university textbook "*Introduction to the theoretical physics*". The two parts of it were published in 1938 and 1940. First volume "*Principles of matter*" has 554 pages. Mechanics and theory of heat are subjects in it. Second volume of the book has 548 pages. Electricity, magnetism, theory of light and electron theory are included in it [42].

3.3. Bulgarian Results after 1924

Physical chemistry is a subject of investigation for two professors in Bulgaria. They used spiral growth in their models. **Dr. Ivan Nikoloff Stranski** created molecular kinetic theory of crystal growth. He explained crystallization processes, and together with Dr. L. Krastanow examined epitaxial growth of ionic crystals. The model, called Krastanow-Stranski, describes precipitation of univalent ionic crystals on bivalent ionic crystal pad. He determined the dependence of the growth rate from satiation [43]. **Dr. Rostislaw Atanassow Kaischew** created model *Kaischew – Stranski* introducing crystal formation by spiral growth. Dr. R. Kaischew generalized Wolf theorem and developed thermodynamics and kinetics of electro-crystallization and electrolyte crystal formation [26, p. 298-302].

Meteorology is a subject of investigation for two professors in Bulgaria. **Dr. Staiko Dimitroff Staikoff** published 25 scientific articles during his short life. The climatology has been the main field of his research. He investigated vertical temperature gradient, atmospheric perturbations, and optical phenomena in twilight high atmosphere. His book "*Building material for Bulgarian seismography*" examines earthquakes in our lands from 282 B.C. up to 1884. The model of meteorological cell, proposed by him, is in use up to now [44]. **Dr. Lubomir Krastanow** investigated condensation centers, water phase transitions, and atmospheric turbulence in the field of physics of clouds. He found out condensation nuclei and quantitative law for ice crystal growth [26, p. 352-355].

3.4. Theoretical Specialization in Bulgaria

Sofia University started to educate Ph.D. students on physics since 1933. Ten students wrote down for Ph.D. education on physics there up to 1949. Four of them defended their theses – Dr. Lubomir Krastanow (1938), Dr. Razum Andrejchin (1940), Dr. Victor Vranski (1941) and Dr. Malina Malcheva (1949). Half of them used theoretical method (Krastanow, Malcheva). **Dr. Lubomir Krastanow** obtained first doctoral diploma in physics at the Sofia University (1938). Professor Ivan N. Stranski was tutor of his dissertation "*Growth of ionic crystals one on top of the other*". **Dr. Malina Malcheva Popova** wrote Ph.D. thesis under leadership of Professor Nicolas Boneff. She investigated in celestial mechanics "*Determination the meridian direction and some related problems*" (1946 – 1949) [45].

4. Conclusions

The origin of theoretical physics in the Sofia University comes from the first half of 20 century, when many new scientific results are produced in Bulgaria. Spiral dynamical description is a common consideration given by Tsenoff (nonholonomic systems), Stranski (spiral growth), Krastanow (atmospheric turbulence) and Maneff. Kinetic theory of molecular crystal growth and the condensation law grew up in Bulgaria influenced, I suppose, by Maneff's principle during the second quarter of the 20th century. This is the time when Sofia University became the third center of theoretical specialisation in physics for our students. My hypothesis is that Maneff's idea accelerated appearance of the three independent manuscripts [46] and new method of quantum mechanics [47] in 1925.

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