Lectures in Mathematical and Theoretical Physics at the University of Sofia by Professor Georgi Ivanoff Maneff (1921-1944)

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Abstract. Professor Georgi Ivanoff Maneff has made significant contributions to the development of theoretical physics teaching at the University of Sofia. He initiated series of lectures on Theoretical Physics at the Faculty of Physics and Mathematics, which were offered during the period 1921/44. A set of university textbooks in theoretical physics and vector calculus authored by him marked the connection between the old and new science of the 20th century.

1 Introduction

The higher education in mathematical and theoretical physics at the University of Sofia has been an essential part of physics education in Bulgaria [1], since the establishment of a Speciality of Physics and Mathematics at the Higher School in Sofia [2]. Analytical mechanics was the only theoretical subject in physics [3]. For this reason mathematical physics became the cornerstone to physics at the Faculty of Physics and Mathematics [4]. It provided the possibility for developing an independent Speciality of Physics [5]. Professor Georgi Ivanoff Maneff [6-11] was the founder of the Chair of Theoretical Physics [12] at the University of Sofia [13-15]. The purpose of this paper is to list and discuss the courses in theoretical physics lectured by Professor Maneff, whose 120^{th} anniversary was celebrated in 2004.

2 Syllabus on mathematical and theoretical physics (1921-1944)

The establishment of a separate Chair in "Mathematical Physics" was written down in the University law in 1909. The name of the Chair was changed in the Law of the University of 1924 to "Theoretical Physics". Professor Maneff lectured "*mathematical physics*" starting with the academic year 1921/22. He offered two general courses, some special courses and exercises for students in physics and mathematics (for V-VIII semesters). He presented his theoretical physics courses in the University building at Moskovska Street. The programme in theoretical physics achieved considerable progress until 1944.

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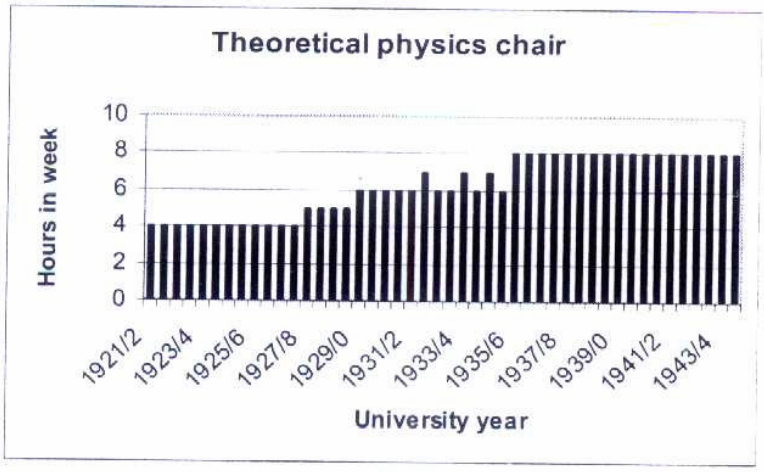

Figure 1.

Three stages can be distinguished in the lecturing activity of the Chair in Theoretical Physics for the period 1921/44 (Figure 1). The Chair made a solid start during the first stage (1921/27). A university course in Mathematical Physics was launched from the beginning. It was four semesters long with four weekly hour lectures during the first two years. The syllabus was reduced by 1 hour, when a new vector calculus course started.

Considerable disputes and beneficial changes mark the development of the Chair in Theoretical Physics during its second stage (1927/35). The Theoretical Physics course had five weekly hours in accordance with the alterations required by the General University Ordinance of July 2, 1927, and six and seven weekly hours in the next years.

The weekly program of the Chair increased regularly during this second stage. Professor Maneff initiated a new course and a set of exercises. His first course in quantum theory started in 1931/32. The students had exercises in theoretical physics beginning with the academic year 1927/28. The university curriculum included exercises in theoretical physics called Seminars instead of the Lectures in Vector Calculus. The first Assistant in Theoretical Physics was Raschco Zayacoff (03.28.1928 – 05.15.1930). Albert Einstein offer a recommendation for him, and the Minister of Public Enlightenment establish for him the Assistant position in the Chair of Theoretical Physics [16]. Raschco Zayacoff participated in unsuccessful competitions for the Chair in Theoretical Physics. He left the University of Sofia, because he did not receive readership in "mathematical physics" and was not elected a Professor in Theoretical Physics.

The Chair in Theoretical Physics underwent a vigorous development in the third stage (1935/44). Eight weekly hours of lectures and exercises were held, and Emil Djakoff and Nikola Karabacheff became Assistants in Theoretical Physics during the period 1935/39. Asen Datseff was an Assistant Professor in Theoretical Physics in the latest period (1939/44). Some new special courses in statistical mechanics and electron theory were initiated during that time.

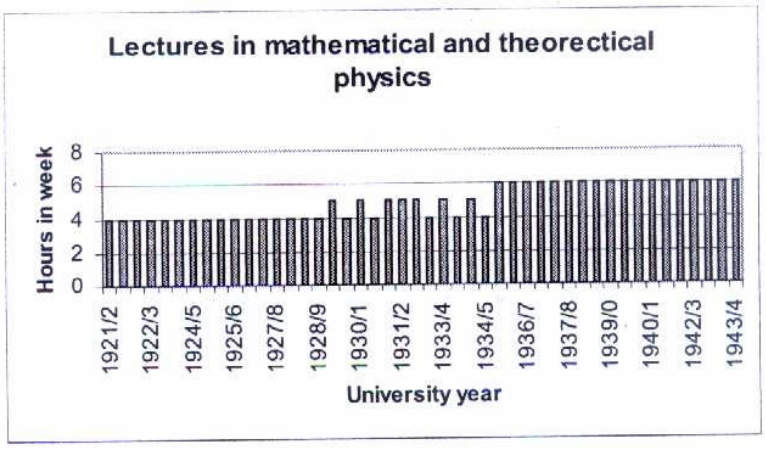

Figure 2.

The syllabus of the basic Course in Mathematical Physics (renamed Theoretical Physics in 1924) grew systematically from 1921 to 1944 (Figure 2).

The curriculum of "mathematical physics" included the following subjects: mechanics, thermodynamics, electricity, magnetism, optics and relativity. There was only one semester on relativity (1922/23). Special courses in quantum theory (1931/32; 1933/34; 1935/36; 1939/40; 1941/42), statistical mechanics (1935/36; 1937/38), and electron theory (1936/37; 1938/39; 1942/43) were lectured regularly throughout the period (Figure 3).

The Course in Vector Calculus was offered beginning 1923 and lectured regularly until 1944. It was one university term long. The horarium in vector calculus increased from one weekly hour (1923/34) to two weekly hours after

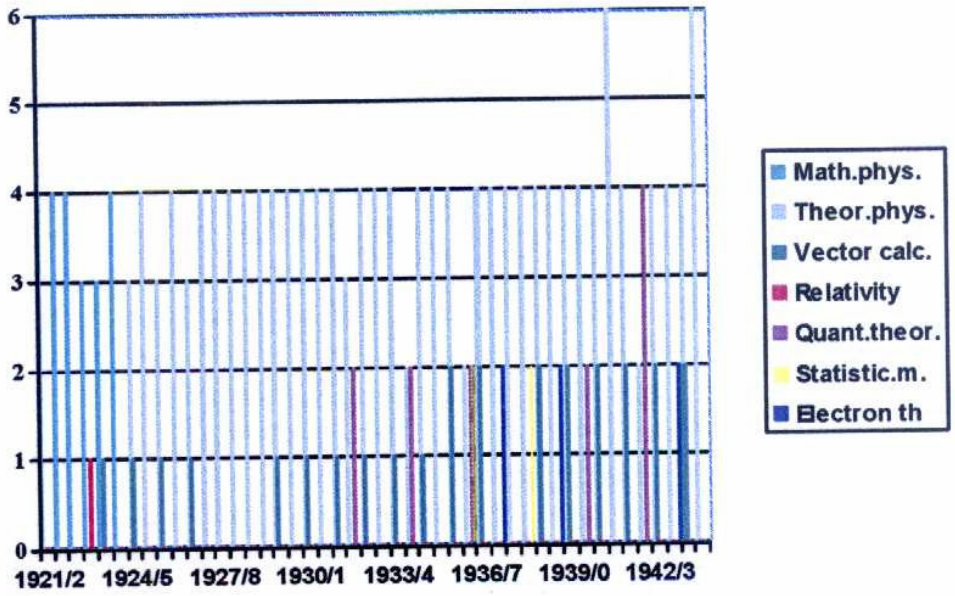

Figure 3.

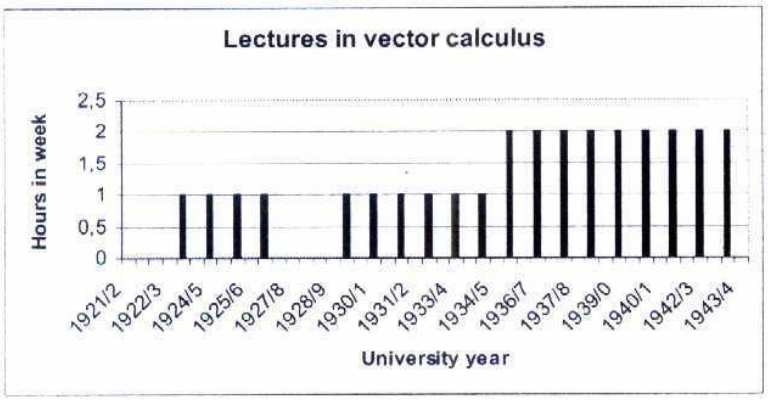

Figure 4.

1935. The course was extended by adding also the new subject "tensor calculus" after 1935 (Figure 4).

Seminars and exercises in theoretical physics and vector calculus were also organised. The university curriculum included "*Seminar in theoretical physics*", "*Exercise in theoretical physics*", and "*Exercise in vector calculus*". The two semesters Seminar in Theoretical Physics started in 1927/28, and its horarium increased from one weekly hour (1927/29) through 1-2 weekly hours (1929/33) and reached two weekly hours for the period 1933/44.

The Exercises in Theoretical Physics were offered starting in 1934. They were one semester long with two weekly hours (1934/38). Vector Calculus began in 1938. The students in Physics and Mathematics had Exercises in Vector Calculus two weekly hours (1938/44) during one university term (Figure 5).

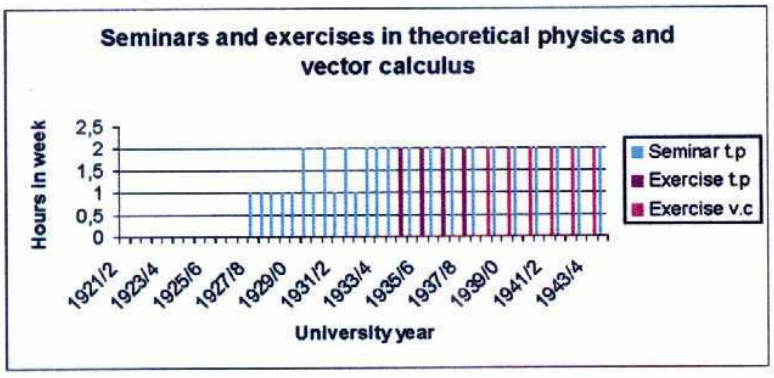

Figure 5.

3 Theoretical physics textbook

The first Bulgarian university textbook in theoretical physics is "Introduction in Theoretical Physics" [17-18]. Professor Maneff published it under two separate numbers: "189" issued in 1938 and "224" issued in 1940 of the series "*Academic library*".

In addition, Prof. Maneff planned a textbook in theoretical physics in three parts. The first part discussed the properties of "*matter*" [17]. The second part examined the properties of physical-space called by him "*ether*" [18]. Professor Maneff divided the motions of physical bodies into corpuscular (physical) and conveyable (portable) and offered the mechanical and electro-magnetic points of view on these grounds. We find the mechanical point of view in the first part of the textbook and the electromagnetic point of view in the second part. The third part was planned to "*contain subjects of modern physics: theory of relativity, quantum theory*" [17], but was never published. We see his aspiration for unity in the second part of the textbook. It ends with the electron theory.

In preparation of his textbooks, Prof. Maneff used German, French and Russian sources. He referred to "*M. Planck, Einführung in die theoretische Physik, Bd. I-V*", "*Cl. Schaefer, Einführung in die theoretische Physik, Bd. I-III*", "*Handbuch der Physik, herausgegeben von H. Geiger und K. Scheel, Bd. I-XXIV*", "*Reimann – Webers, Differentialgleichungen der Physik, Bd. I-II*", "*A. G. Webster – G. Szegö, Partielle Differentialgleichungen der mathematischen Physik, 1930*", "*Encyclopédie des Sciences mathématiques, Tome IV, vol. 1, fascicule 1, 1915*", "*Encyclopädie der mathem. Wissenschaften, Bd. V.*", "*R. H. Weber und R. Gans, Repertorium der Physik, I Bd., I u. II Teil, 1916*", "*Müller – Pouillets, Lehrbuch der Physik, III Bd., II Teil, 1925*", "*К. А. Путиловъ, Курс физики, 1934*", "*G. Jäger. Theoretische Physik, I, II, III u. IV Bd.*", "*Hydro- und Aeromechanik nach L. Prandtl, I u. II Bd.*", "*H. Lamb, Lehrbuch der Hydrodynamik, 1931*", "*G. Joos, Lehrbuch der theoretischen Physik*", "*R. Becker, Theorie der Elektrizität, I-II Bd.*", "*H. Bouasse, Cours de Magnétisme et d'Électricité, t. III*", "*N. R. Campbell, La Theorie électrique moderne*", "*L. Bloch, Précis d'électricité théorique*", "*М. Борн, Оптика*", "*Г. А. Лоренцъ, Теория электроновъ*", "*P. Drude, Lehrbuch der Optik*", "*K. Försterling, Lehrbuch der Optik*" [17-18].

The doctrine of matter is the first part of G. Maneff's textbook "*Introduction in theoretical physics*". It was published by The *Court Press House* in Sofia. The textbook is of 555 pages total and contains 50 Section and 9 Chapters structured into 3 Parts, namely, "*General Mechanics*", "*Mechanics of Changing Bodies*", and "*Theory of Heat*" [17].

The part "*General Mechanics*" considers the concepts of "*point particle*", "*system of point particles*" and "*solid body*" [17]. This section included 146 pages introducing notions such as: potential, relative motion, energy, action and reaction, virtual movement, principles of d'Alembert and Hamilton, geodesic lines, canonical, differential, Hamilton-Jacobby's and Euler's equations.

The second part "*Mechanics of Changing Bodies*" includes the following chapters: "*kinematics, dynamics, elasticity, and acoustics*" [17]. This part is of 235 pages, considering the equations of continuity, energy, tensor of pressure, deformation and stress, bodies with symmetric structure, symmetry of crystal structure, vibration, equations of vibration string, waves of elasticity environ-

ment, seismic waves, Fourier oscillation, physical and physiological character of acoustic vibration, music scales, tone, tone quality - force, pitch and timbre, vortices, viscosity, laminar liquid, capillary phenomena, etc.

The third part "*Theory of Heat*" is of 165 pages and contains three chapters: "*thermodynamics*", "*diathermancy and diffusion*", and "*kinetic theory of gases*" [17].

The Doctrine of ether is the name of the second book of Maneff's university series "*Introduction in theoretical physics*" [18]. The Academic Press printed it as a 569 pages volume comprising 34 Sections and 10 Chapters structured again into 3 Parts. Electricity, magnetism and optics are considered in it along with the Maxwell's equations.

Professor Georgi Maneff explained here the reasons for using the term "*ether*": "*Ether becomes synonymous with physical space or still with electromagnetic field*" [18]. Note that the Bulgarian physicists purged the term "*ether*" from the scientific literature in the second part of the twentieth century.

The "*electricity and magnetism*" part amounts to 196 pages including three chapters: "*electrostatic and magnetic state*", "*permanent electromagnetic field*", and "*alternating electromagnetic fields*" [18]. It presents: capacitors, insulators, energy, integral and differential laws, Thomson's theorem, Maxwell's tensor for electrostatic field, magnetic field, electricity current, electricity measuring systems, induction, dynamic process, electric waves in conductors, spherical waves, standing electrical waves, dynamic processes in moving bodies.

The part "*theory of light*" comprises 152 pages with three chapters: "*optics of pellucid isotropic bodies*"; "*wave optics*"; "*optics of crystals*" [18]. This part examines: flat waves, reflection, refraction, interference, prisms, lenses, diffraction, polarized light, wave function, biaxial and mono-axial crystals, Frennel's law, Frennel's integrals, three dimensional lattices, the theorem of Babinet, the principle of Huigens, the principle of Fermat.

The part "*atomic electrical phenomena*" includes four chapters totalling of 190 pages about "*electron theory*", "*dispersion*", "*electromagnetic processes in the weight bodies*", and "*heat radiation*" [18]. Here we read about: electron, charge, nature of radiation, field equations, the energy principle, electrical polarization, non periodical flat waves, connection between wave optics and wave mechanics, atomic view of magnetism, kinetic theory of electric conductivity, general properties of heat radiation, the laws of Kirhoff, Stefan-Boltzman, W. Wien, energy distribution of a black body, the formulas of Rayleigh-Jeans and Planck.

4 Vector Calculus textbook

Professor Maneff wrote also an university textbook titled "*Introduction in Vector Calculus with Applications and Problems*" [19]. It was published by the University of Sofia under number "135" of the "*Academic library*" and by the

"Court Press House" in 1934. He adopted the notes of A. Sommerfeld for vectors, of J. W. Gibbs and F. Emde for vector functions and of A. Einstein about analytical forms of tensors. References are given to the textbooks of: "*R. Gans*", "*J. Spielrein*", "*V. Ignatowsky*", "*M. Lagaly*", "*S. Valentiner*", "*L. Graetz*", "*A. A. Эйхенвальд*", "*M. Planck*", "*R.v. Mises-Henning*", "*A. S. Eddington*", "*H. Weyl*", and "*H. Becquerel*".

The textbook contains: "*preface*", "*table of more important formulas*", "*index*" and seven chapters with 49 sections. They include the subjects of: vector algebra, vector analysis, special cases of vector fields, essential elements of tensor calculus, and analytical theory of tensors [19]. There are also 319 solved problems in vector calculus. The total volume of the book is 375 pages.

The following subjects are considered in the first part of "*vector algebra*": definitions and symbols, addition and subtraction of vectors, analytical presentation of vectors, multiplication of vectors by scalars, single and main vectors, internal or scalar product, external or vector product, complex products, vector classification, scalars and pseudo-scalars, radius-vector [19]. There are 63 problems in this part.

The second part of "*vector analysis*" considers: fields: general properties and types, vector derivatives with respect to a scalar variable, gradient, theorem of Gauss, flow and outflow of the field, divergence, Green's theorem, Stokes' theorem, point vector functions, curvilinear co-ordinates, particular cases of curvilinear co-ordinates [19]. Gradient, divergence, rotation, and operator of Hamilton have been introduced in this part, containing 79 problems.

The third part "*special cases of vector fields*", comprises 53 pages and 7 sections. The subjects are: surfaces of interrupting, volumetric flexion of complex function, second derivation, vector determination from volumetric derivation, potential of vectors and decomposition of unspecified vector in the potential and solenoid field, alteration of integral areas by different integrals, functions of point and time, differential - geometric properties of vector fields: a) general notes, b) surface-normal fields, c) general equations of vector fields, d) three dimensional derivation of the vector on the field e) application in Laplace field [19]. There are 110 problems in this part.

The fourth part "*main elements of tensor calculus*" has 36 pages and 7 sections. It considers theory of vector functions (tensors). Elements of tensor calculus are "reciprocal vectors and systems basis, linear vector function, symmetrical tensors; concept and geometrical idea, degeneration of the symmetric tensors" [19]. There are 67 problems in this part.

The fifth part "*analytical theory of tensors*" has 38 pages and 7 sections. The subjects of this part are: inverse vectors, tensors, properties and actions, base tensor, special tensors and invariants, parallel carrying in continuous medium, Christofel's symbols, covariant derivative of tensor, Laplace factor, divergence and rotation, Riemman tensor [19].

The method of vector calculus was developed by Grassmann and Hamilton on the base of geometrical concepts in the first half of nineteenth century.

Professor Georgi Maneff gave interpretation of scalars, vectors and tensors for three-dimensional Euclidean space. He illustrated scalar field by surface with equal potential, vectors with segment of straight line, and symmetrical tensors with surface of second order.

Analytical methods were predominantly examined by Professor Ivan Tsenoff and Christo J. Christov. "*Analytical mechanics*" is a university textbook, written by Professor Ivan Tsenoff in 1924. The preface called "*Theory of the vectors*" contains "*analytical definition of vectors*". Professor Ivan Tsenoff called mechanics rational and applied (celestial mechanics, mathematical physics and technical mechanics). Analytical presentation we find in the textbook "*Mathematical method in physics*", written by Christo J. Christov (1951). It contains analytical theory of vectors, complex analysis, harmonious analysis, theory of special functions and variation calculus.

5 Conclusions

Professor Georgi Ivanoff Maneff made significant contributions to the development of theoretical physics at the Sofia University from 1921 to 1944. He founded the Chair in Theoretical Physics at the Faculty of Physics and Mathematics and initiated lectures in theoretical physics and vector calculus. The General Course in Theoretical Physics included the traditional subjects: mechanics, elasticity, sound, heat, electricity and magnetism, theory of light. Relativity, quantum theory, statistical mechanics, and electron theory were modern special courses offered by him personally.

The first Bulgarian university textbook in theoretical physics, written by Professor Georgi Maneff, includes all of the traditional and some of the innovative subjects of modern physics: mechanics, elasticity, sound, theory of heat, electricity and magnetism, theory of light and electron theory. The language of G. Maneff's textbook "*Introduction in theoretical physics*" (1938 - 1940) is accurate and clear, although the terminology used is comparatively old. On the other hand, his textbook in vector calculus marked the connection between old and new science of the 20^{th} century.

Acknowledgments

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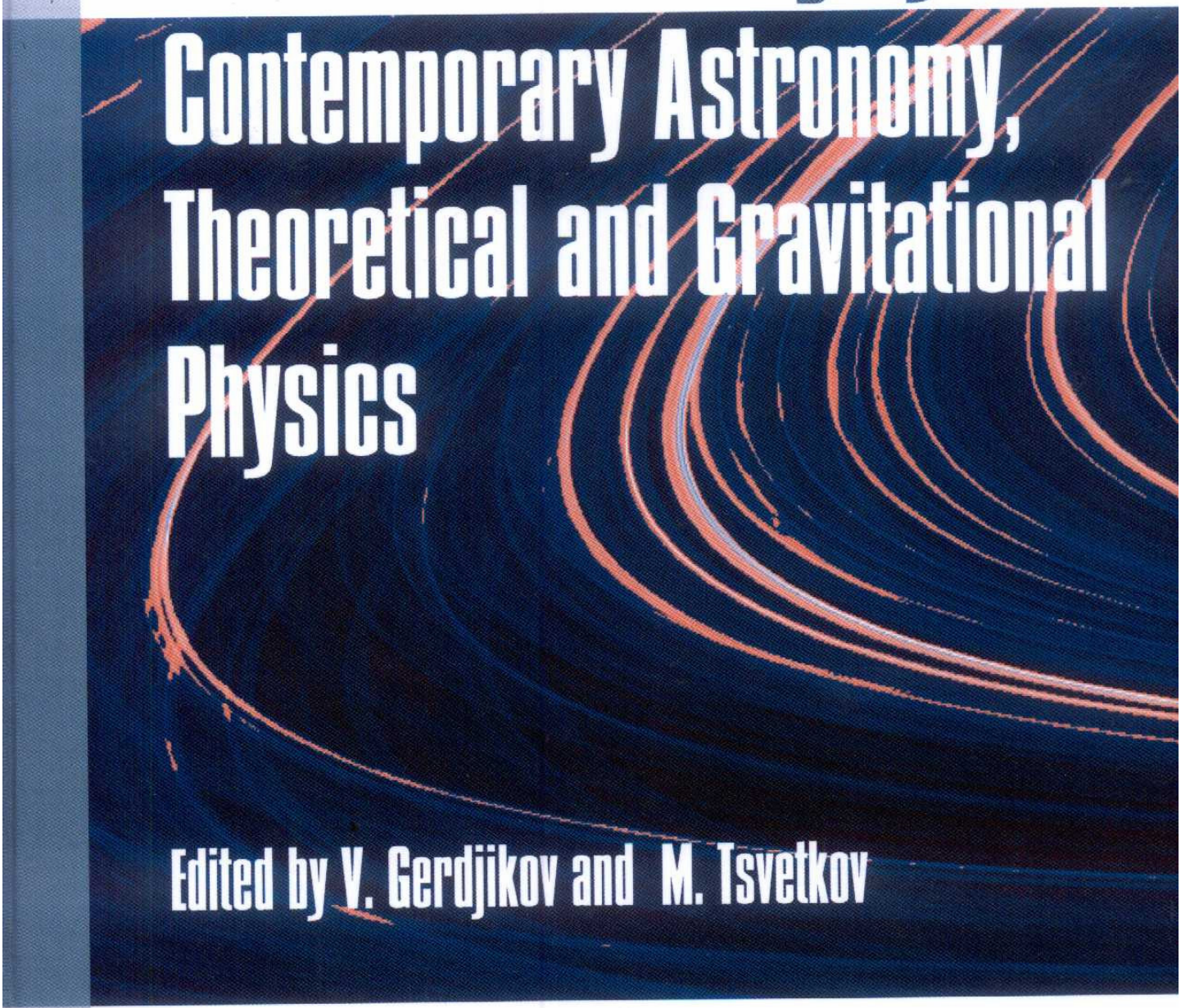

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