UDK 510 (092) (=161.2)

## MYKHAILO OSTROHRADSKYI: LIFE DEVOTED TO SCIENCE

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**Purpose.** To analyze the way of life and the career of the outstanding mathematician of the XIX century Mykhailo Ostrohradskyi, to highlight his achievements and their significance for the up-to-date science. **Methodology.** We have applied the biographical method of research using the evidence of Ostrohradskyi's contemporaries, interviews, letters, diaries and memoirs. **Results.** We have gathered and analyzed a lot of events of Mykhailo Ostrohradskyi's life and proved the high value of his contribution into the science. **Originality.** For the first time we present the complete information about the scientist and his attainments in one paper. **Practical value.** The information will be useful for the students of our university as well as for everybody who is interested in science and the life of famous people.

**Key words:** anniversary, memoirs, mathematics, wave propagation, algebraic function, Ostrohradskyi's mechanics, Ostrohradskyi's quantum field theory, Ostrohradskyi's variations principles.

## МИХАЙЛО ОСТРОГРАДСЬКИЙ: ЖИТТЯ, ПРИСВЯЧЕНЕ НАУЦІ

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Виконано аналіз життєвого шляху видатного математика XIX століття Михайла Васильовича Остроградського. Описано його досягнення і їх значення для сучасної науки. Для дослідження було обрано біографічний метод і використовувалися свідчення сучасників Остроградського, інтерв'ю, листи, щоденники і спогади про вченого. Зібрані та проаналізовані різні події з життя Михайла Остроградського та доведено високу цінність його вкладу в науку. Вперше представлені найбільш повні дані про вченого і його досягнення в одній статті. Інформація буде корисна студентам і абітурієнтам нашого університету, а також всім, хто цікавиться наукою і життям відомих людей.

**Ключові слова:** річниця, мемуари, математика, поширення хвиль, алгебраїчна функція, механіка Остроградського, квантова теорія поля Остроградського, принципи варіацій Остроградського.

INTRODUCTION.This year we celebrate the 10th anniversary since, by the decree of the Cabinet of Ministers of Ukraine, our University was awarded the name of the outstanding mathematician of the XIX century Mykhailo Ostrohradskyi. It is a high appraisal and a great responsibility for us to be worthy of his name.Who is he – this scientist whose talent won the European scientific community of that time? He is a great Ukrainian and we are proud that our Ukrainian land presented this man of genius to the world.

THE BEGINNING OF THE WAY. Mykhailo Ostrohradskyi was born on September 24, 1801 in Poltava province not far from our city in the family of impoverished nobles originated from the senior Cossacks [1].

Figure 1 – M. Ostrohradskyi in youth

From the early childhood the boy was interested in everything: how horses were harnessed, how the land was plowed, how the windmill and the watermill operated. He was especially interested in things that could be measured. He always had a piece of string and measured the depth ofwells, the dimensions of buildings, the size of land plots. Later this children's arithmetic was embodied in brilliant calculations [2].

At the age of eight he was sent to a boarding school for impoverished nobles, attached to the Poltava gymnasium. The study did not interest him, his academic results were unsatisfactory, he mainly got grades 6-7, when the highest grade was 10, in history and geography he got 2 and in Latin and French – 0.

Later all his papers were written in French and leading universities and academies considered it an honor to work with him.

Mother's brother insisted on sending Mykhailo to Kharkiv University. Ostrohradskyi studied there at the Department of Physics and Mathematics and when he was a second year student (Fig. 1) his capability for mathematics was manifested and realized under the influence of the talented teacher Andrii Pavlovskyi (Fig. 2) and, later, of the rector, the famous mathematician Tymofii Osypovskyi (Fig. 3) [3].

Figure 2 – Pavlovskyi Andrii Fedorovych

Figure 3 – Osypovskyi Tymofii Fedorovych

Mykhailo brilliantly completed the three-year course, obtained the certificate and got ready to take examinations to acquire the candidate's degree. He passed them satisfactorily apart from the exam in phi-

losophy that included theological sciences. The professor who taught this discipline refused to take the exam because Ostrohradskyi did not attend his lectures. He wrote a slanderous memorandum to the University Council and accused Ostrohradslyi and Osypovskyi of atheism. The Ministry of Education and Theology decided to dismiss rector Osypovskyi from the position and proposed Ostrohradskyi to take the examinations for the third time. Ostrohradskyi was indignant at such outrage and refused to do it. He returned the Certificate and came back to his native village without any document confirming his education.

However, soon the love for mathematics won, he asked his father for money and went to Paris where such outstanding mathematicians as Laplace, Cauchy, Poisson, Ampere, Fourier and others were working at that time.

In Paris Ostrohradskyi listened to lectures at the university at College de France and at the same time he attended the meetings at the Paris Academy of Sciences.

The trip to France and life in Paris were verydifficult for the young man, he was very poor, he was burgled during his travelling, by some memories he even worked as a part-time servant for Laplace (Fig. 4), he got into the debtors' prison and was bought out by Cauchy (Fig. 5) [4, 5].

But he worked hard and quickly gained authority with famous mathematicians.

In 1825 Cauchy wrote in his memoirs that his student was a talented young man with great insight especially in the calculation of infinitely small quantities.

Figure 4 - Pierre-Simon de Laplace

Figure 5 - Augustin-LouisCauchy

In November 1826 Ostrohradskyi presented his paper «Memoir concerning wave propagation in a cylindrical pool» to Paris Academy. This paper was published in the Academy Transactions in 1832.

In 1826 Ostrohradskyi presented to the Academy one more paper devoted to another field of mathematical physics – the theory of heat propagation in solid bodies and liquid – «Notes concerning the theory of heat». The paper contained the derivation of the formula that got into the treasury of the scientific thought and now the Ostrohradskyi-Gauss formula can be found in all the textbooks on mathematical analysis and mathematical physics.

In 1824 - 1827 he presented some more memoirs, which supported his reputation of a young scientist. For some time he even was the head of the Mathematics Department at Henry IV College, which certified his high authority.

His mother died in 1828 and he had to return to his native land.

WORK IN ST. PETERSBURG. Mykhailo was unknown in Russia, did not have a certificate of education but he presented his three papers to Petersburg Academy. The members of the Academy were so greatly impressed that he was proposed a position in the Academy and the possibility to teach mathematics at educational establishments.

He was chosen an associate of applied mathematics, in 1830 – an extraordinary and in 1832 – an ordinary member of the Russian Academy of Sciences.

In 1830 Osrohradskyi went to Paris again on business to present his paper «The course of celestial mechanics» that was highly appreciated by the famous French scientists Arago and Poisson.

Figure 6 - M. Ostrohradskyi

Another unpleasant incident occurred when the young man (Fig. 6) was in Paris. By some memories of his contemporaries it was at that time that he lost his eye, perhaps, when he attended fights at barricades that were taking place in France.

During all his life Mykhailo Ostrohradskyi published over 100 papers, over 60 scientific rewires. All the researchers classify his papers as those that refer to mathematical physics, mechanics and pure mathematical analysis though this division is rather relative [11].

Mathematical physics occupies a special place in the scientist's research. In this field he also continued the research of Lagrange and Laplace, the work of Poisson in the theory of gravitation, he proposed a new method of derivation of Poisson's equation.

A number of fundamental results and ideas in the field of mathematical analysis belong to Ostrrohradskyi. They are: the priority in the formulation and proving of the theorem of Liouville, the substantiation of the principle of the trigonometric series localization, the development of the theory of approximate calculations and numerical methods, the theory of series called «the series of Ostrohradskyi-Serpinskyi-Peirce» [9]. He was the author of five papers on algebraic functions, six papers on the theory of probability, the notes on linear differential equations, etc.

The Ostrohradskyi-Gauss formula:

$$\iint\limits_S (P\cos\alpha + Q\cos\beta + R\cos\gamma)ds =$$
$$= \iiint\limits_V (\frac{\partial P}{\partial x} + \frac{\partial Q}{\partial y} + \frac{\partial R}{\partial z})dv \quad .$$

The series ofOstrohradskyi-Serpinskyi-Peirce

$$\frac{1}{q_1} - \frac{1}{q_1 q_2} + \ldots + \frac{(-1)^{n-1}}{q_1 q_2 \ldots q_n},$$

where $q_n \in N$ and $q_{n+1} > q_n$ for any $n \in N$,

and

$$\frac{1}{q_1}-\frac{1}{q_2}+\ldots+\frac{(-1)^{n-1}}{q_n},$$

where $q_n \in N$ and $q_{n+1} > q_n(q_n+1)$ for any $n \in N$.

There are few outstanding mathematicians whose name was used in mathematics and mechanics as often as the name of Ostrohradskyi [10].

Ostrohradskyi's scientific achievements were highly appreciated by his contemporaries. At the age of 29 the scientist became an academician of Petersburg Academy of Sciences, at the age of 33 – the member of American Academy, at 44 – of Turin Academy, at 55 – of Paris Academy.

MykhailoOstrohradskyi contributed a lot of time to pedagogical activity. He delivered lectures at such leading higher educational establishments in Petersburg as Marine Cadet Corps, the Institute of Railway Engineers, Main Pedagogical Institute, Main Engineering and Mykhailivskyi Artillery School.

From 1847 during almost 15 years Ostrohradskyi worked at the headquarters of military educational institutions as a supervisor of teaching mathematics.

Ostrohradskyi wrote several textbooks for secondary school, his lectures for higher educational establishments were published in typographic or lithographic way, unfortunately, a lot of them were lost.

Later his lectures were renewed and published by his students.

We can say it with confidence that Ostrohradskyi was at the background of the generation of Russian scientific and engineering intelligentsia in the XIX century. No wonder that he educated a great number of talented students including the founder of the theory of automatic control I.O. Vyshniehradskyi (Fig. 7), the creator of the hydrodynamic theory of friction M.P. Petrov (Fig. 8), a scientist and engineer, the founder of the theory of calculation in bridge construction D.I. Zhuravskyi (Fig. 9), engineer-fortifier Ts.A. Kiuii (Fig. 10), well-known Russian composer) etc.

Figure 7 - I. O. Vyshniehradskyi

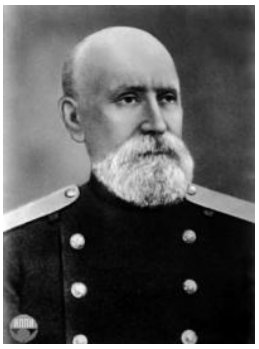

Figure 8 - M. P. Petrov

Figure 9 - D. I. Zhuravskyi

Figure 10 - Ts. A. Kiuii

M. V. Ostrohradskyi's authority and popularity were so high that his name became a synonym of a scientist. Parents, sending their children to universities wished them «to become a second Ostrohradskyi».

Ostrogradskyi was always a person of generous nature, witty and sociable. Mykhailo was tall and stately. His contemporaries told a lot of funny stories about him. He was highly appreciated not only for his great intellect but also for modesty, generosity, simplicity, for his respect to working people, for human dignity and adherence to his principles. His memory was wonderful, he knew a lot of historical and fiction stories and often quoted them.

RELATION TO UKRAINE. Working in Petersburg Mykhailo never lost his ties with the native land. He was fond of Ukrainian songs, the poetry of folk holidays, respected the folk language. Most of all he liked Taras Shevchenko (Fig. 11).

Mykhailo Ostrohradskyi was on friendly terms with many Ukrainian outstanding persons of that time: with composer Hulak-Artemovskyi (Fig. 12), with Holovko – master of mathematics at Kharkiv University, who shared Shevchenko's ideas, Ostrohradskyi had a family relationship with the families of composer Lysenko and playwright Starytskyi.

Mykhailo loved his native land and mother tongue all his life.

Even during the lectures he sometimes used a witty Ukrainian word.

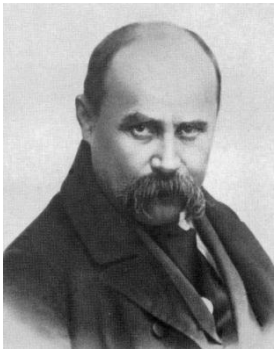

Figure 11 – Shevchenko Taras Hryhorovych

Figure 12 - Hulak-Artemovskyi Semen Stepanovych

Almost every year he came to Ukraine in summer.

Ostrohradskyi stayed in Poltava during the last months of his life. Here he celebrated his sixtieth anniversary. The entire world congratulated the great scientist on his anniversary. «Your life cannot be fitted into the 3D space; it requires a fourth coordinate – time. Everything that you have done can be measured only in time. Your school will live for centuries, history will always be grateful to You for the young team of the

national science that You have cherished and are cherishing» - said his friends scientists.

Ostrohradskyi still had a lot of plans in science, mathematics, but it was not fated. When he lived in Dovhyi village he fell seriously ill: a big abscess appeared on his back. He was operated on. Recovered.

He wanted to leave for Petersburg but some weeks later he felt worse, he suffered from severe fever and on January 1, 1862 Mykhailo Ostrohradskyi died of the paralysis of lungs in Poltava in the House of the Starytskyis.

He was buried at the family cemetery in the village of Pashenivka.

In 1981 a metal obelisk was set there, and in 1986 a granite gravestone with a scientist's bronze bas-relief was placed.

In 1959 - 1961 a complete set of works of the great scientist was published.

MEMORY ABOUT THE GREAT SCIENTIST. In 1983 Khorishkivska secondary school, situated not far from his native village Pashenivka, was awarded the name of Mykhailo Ostrohradskyi by the decree of the Cabinet of Ministers. In 1998 his name was awarded to the Poltava Institute of Postgraduate Education and in 2007 – to our University (Fig. 13).

Figure 13 - M. Ostrohradskyi

In 2001 UNESCO entered Ostrohradskyi in the listof outstanding mathematicians of the world.

CONCLUSION. Mykhailo Ostrohradskyi occupies one of the most honorable places in the history of the world mathematics. Outstanding talent, brave and acute mind, high mathematical erudition, the knowledge of the contemporary natural sciences enabled Mykhailo Ostrohradskyi to make paramount discoveries in many branches of mathematics and mechanics.

His achievements do not become out of date but acquire new significance nowadays. So, new terms have appeared in modern scientific journals on mathematical physics: Ostrohradskyi's mechanics, Ostrohradskyi's quantum field theory, Ostrohradskyi's variations principles. It turned out that Ostrohradskyi's ideas make it possible to correctly describe the motion of an electron in magnetic fields or spin effects in the quantum field theory.

Looking mentally at the way of life of the great scientist, we again respect his memory with gratitude, as there is a great share of his work in our contemporary achievements.

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## МИХАИЛ ОСТРОГРАДСКИЙ: ЖИЗНЬ, ПОСВЯЩЕННАЯ НАУКЕ

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Выполнен анализ жизненного пути выдающегося математика XIXстолетия Михаила Васильевича Остроградского. Описаны его достижения и их значение для современной науки. Для исследования был выбран биографический метод и использовались свидетельства современников Остроградского, интервью, письма, дневники и воспоминания об ученом. Собраны и проанализированы различные события из жизни Михаила Остроградского и доказана высокая ценность его вклада в науку. Впервые представлены наиболее полные данные об ученом и его достижениях в одной статье. Информация будет полезна студентам и абитуриентам нашего университета, а также всем, кто интересуется наукой и жизнью известных людей.

**Ключевые слова:** годовщина, мемуары, математика, распространение волн, алгебраическая функция, механика Остроградского, теория квантовых полей Остроградского, принципы вариаций Остроградского.

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Стаття надійшла 01.11.2017.