

Mathematical genius Mihailo Petrović – Mika Alas (1868 – 1943)

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It has been 150 years since the birth of a great Serbian mathematician, academician Mihailo Petrović – Mika Alas. He upgraded his inborn talent for natural sciences at the Belgrade's Grand School (Grande école) where he graduated in mathematics in 1889. In France, at Sorbonne, as the best student of generation in 1892, he obtained a graduate degree in mathematical sciences, and subsequently a graduate degree in physics in 1893. He defended his doctoral dissertation in 1894 in front of the commission made of then most famous world mathematicians Emile Picard, Charles Hermite and Paul Painlevé. Upon acquiring the title of Doctor of Philosophy in Mathematical Sciences, he returned to Serbia and became a professor at the Belgrade's University.

With a bunch of published scientific papers that referred to differential equations, numerical analysis, geometry of polynomials and mathematical phenomenology, Mihailo Petrović was the owner of numerous patents. Some of the most significant patents that have found the outstanding practical application around the world are: artillery depth measurer, device for launching the missiles, automatic automobile gear, eternal calendar, etc.

The academician Petrović was not only a mathematician and scientist, yet he was a cryptographer, world traveler, travel writer, musician, ichthyologist and above all a fisherman. His passion for fishing brought him a recognizable nickname Mika Alas – river fisherman.

THE Scientific Technical Review journal and Military Technical Institute as a publisher dedicate this publishing year to 150 years since the birth of the great Serbian mathematician, academician Mihailo Petrović. Mihailo Petrović, together with Nikola Tesla, Milutin Milanković and Mihajlo Pupin, belongs to a foursome of Serbian scientists who, since the middle of the 19th to the middle of the 20th century, gave an immense contribution to natural science, i.e. technical science and thus enabled progress of entire humanity. Tesla and Pupin worked and created in America, while Milanković and Petrović were in Serbia.



Figure 1. Mihailo Petrović – Mika Alas (academician, 1899.)

Mihailo Petrović was born on May 6th, 1868 in Belgrade in the Principality of Serbia. His parents had five children, four sons and one daughter. Mihailo was the oldest one. Father Nikodim, doctor of theology, was a professor at Bogoslovija (Faculty of Orthodox Theology) and editor of "Orthodoxy" journal. Nikodim had his origins in a trade family, and mother Milica originated from an orthodox family of a priest and her father Novica Lazarević was an archpriest in the Cathedral Church of St. Michael the Archangel in Belgrade.

At the time of learning the first letters and numbers in an elementary school, when he was seven years old, Mihailo's father Nikodim died. His mother's father, grandfather Novica, took care of his upbringing and education. He made Mihailo grow love toward books since early youth. Grandfather Novica, with his noticeable appearance, his dignity and responses to all the answers inspired great trust and feeling of safety to Mihailo. [1]

To be a pupil or a student in eighties of the nineteenth century meant lot even for the European notions, let alone Belgrade, i.e. Serbian environment where the pressure and tension of five centuries of Turkish occupation were still felt. While in elementary school, Mihailo did not stand out, but since gymnasium and afterwards regarding his education he progressed with the speed of genius who acquires outstanding results at each moment. He was the best mathematician in gymnasium, but his interests were not related only to mathematics. He was also exceptionally successful in literature and philosophy, so with his literary-philosophical paper "To express and critically consider various theories of will" he called the attention of the Serbian scientific public of that time. He graduated from Gymnasium as one of four best pupils of his generation.

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Figure 2. Mihailo Petrović with his mother Milica

Nonetheless, mathematics prevailed in Mihailo's scientific life and after the Gymnasium, in 1885, he enrolled the Department of Mathematics and Natural Sciences at the Faculty of Philosophy at the Grand School (later the University of Belgrade). At the very beginning of his studies he expressed his outstanding talent for mathematics so in the end of his first year of studies, with his seminar paper "On a modification of Graeffe's method for solving equations of higher order", where he introduced the exponential function and expressed new methods of algebraic equations for it, he fascinated his professors with his mathematical genius.

Upon graduating from the Grand School, Mihailo's grandfather, archpriest Novica, sent him to Paris in 1889 for further improvement and studying of mathematics. Upon coming to Paris, for a year he learnt French and prepared for the entrance examination to *l'Ecole Normale Supérieure*. He passed the entrance examination with the highest grades and became the first foreign student enrolling the leading European schools of mathematics at Sorbonne at the time. [1,2]

Together with all the beauty, charm and challenges of Paris, in which young Mihailo remained for four years, he directed and focused his intellectual capacities to lectures held by the most famous mathematicians, but also chemists and physicists of the time such as: *Juleus Henri Poincaré*, *Charles Emile Picard*, *Paul Painlevé*, *Gabriel Lippman* and other. He obtained a degree in mathematics in 1892, and then in 1893 he obtained a degree in physics. As the best student of his generation, twice in a row, he attended receptions given by the President of the French Republic, Marie François Sadi Carnot (1837-1894), whose uncle was a famous French physicist Nicolas Léonard Sadi Carnot (*II law of thermodynamics – Carnot principle*).

At Sorbonne, on June 21st, 1894, Mihailo Petrović defended his doctoral dissertation named "On Zeroes and Infinities of the Integrals of Algebraic Differential Equations"

("Sur les zéros et les infinis des intégrales des équations différentielles algébriques") in front of the commission made of the professors: Charles Hermite, Emile Picard and Paul Painlevé. His paper got the highest grades as an original contribution in that area of mathematics by which he acquired the title of the Doctor of Philosophy in Mathematical Sciences (*Docteur ès sciences mathématiques*). Maybe the greatest recognition given to him was by a professor Picard, who in his voluminous paper regarding mathematical analysis quoted his results from the doctoral dissertation. In that period, Petrović wrote one more paper related to differential equations, published in a magazine of the French Academy of Sciences. [2-5]



Figure 3. l'Ecole Normale Supérieure

With the exceptional recommendations, in the end of summer 1894, at the age of 26, he returned to Serbia where King Aleksandar Obrenović, with his Decree from October 22nd, placed him as a full professor of mathematics at the Grand School, the school from which he left to the world. After his return to the country, in only five years to the beginning of the 20th century, he published around thirty papers in the most famous world magazines in the area of mathematics of which maybe the most significant are: *Sur l'intégration hydraulique des équations différentielles* (from 1898) and *Appareil a liquide pour l'intégration graphique de certains types d'équations différentielles* (from 1900). [6,7]

He was one of the first eight full professors of the University of Belgrade, which was established in 1905 at the foundations of the Grand School. He lectured theory of mathematics. As an outstanding expert in French, he held lectures on universities in Paris and Brussels with ease. At the age of 27, in 1897, he became a corresponding member of the Serbian Royal Academy, and two years later, in 1899, he became a full member. He was a member of numerous foreign academies of sciences (Prague, Warsaw, Krakow, Bucharest) as well as of a great number of scientific societies and organizer and presiding officer of a significant number of international symposiums whose subject matter was mathematics and its application.



Figure 4. The first eight professors of the University of Belgrade. On the left, sitting: Jovan Žujović, Sima Lozanić, Jovan Cvijić, Mihailo Petrović. On the left, standing: Andra Stevanović, Dragoljub Pavlović, Milan Radovanović and Ljubomir Jovanović

In his scientific career, Mihailo Petrović published 393 papers, out of which 328 are related to mathematics. He was an extreme individualist so his papers have no co-authors, and out of ten verified patents only two included a co-author. He is considered a founder of new scientific disciplines such as mathematical phenomenology and theory of mathematical specters. Together with the support of Milutin Milanković, in 1932 he run a scientific magazine of the University of Belgrade in mathematics (*Publications de l'Institut Mathématique Université de Belgrade*) in which, beside in Serbian, the papers were published in French, Russian, English and German. [1]



Figure 5. Professors of the Belgrade School of Mathematics: Mihailo Petrović (the second on the left, sitting), Milutin Milanković (the first on the right, sitting)

Professor Petrović patented nine inventions in France, and one in Great Britain. Almost all his patents had a direct military application. In Table 1 a list of his patents on application time schedule is shown. [8]

Table 1. Patents of Mihailo Petrović – Mika Alas

No	Patent number	Patent original title	Application date	Patent verification date	Patent joint owner	Patent application country
1	FR 413.730	<i>Télémetre a sextant</i>	11.02.1910	17.08.1910	Milorad Terzić	France
2	FR 447.861	<i>Chagement de vitesse avec pignons étagés recordés par des engrenages en hélice conique</i>	31.08.1912	17.01.1919	Svetolik Popović	France

3	FR 463.082	<i>Chagement de vitesse</i>	29.09.1913	13.02.1914		France
4	FR 476.320	<i>Automatique chagement de vitesse</i>	17.10.1914	27.07.1915		France
5	FR 480.788	<i>Cadran calendrier pour objets d'horlogerie, de bijouterie et autres</i>	27.01.1916	21.09.1916		France
6	FR 515.072	<i>Dispositif pour assurer la flottabilité des navires en danger</i>	24.11.1917	24.03.1921		France
7	FR 493.774	<i>Appareil pour la détermination rapide des éléments de tir sur aéronefs</i>	07.12.1917	21.08.1919		France
8	FR 495.040	<i>Moteur</i>	15.02.1918	26.09.1919		France
9	FR 503.321	<i>Appareil imprimant un mouvement rapide aux bombes, mines aériennes et torpilles aériennes lancées par un canin lisse</i>	22.02.1918	08.06.1920		France
10	GB 121.279.	<i>Means for Assuring the Buoyancy of Ships</i>	23.10.1918			Great Britain

The first Petrović's patent, for which he received a certificate in 1910 from the French Institute for Patents, was related to the artillery depth measurer. He made the depth measurer upon the request from the military technical institution from Kragujevac together with General Milorad Terzić (one of the world most famous military geographers of that time). Right before the Balkan wars (1912 and 1913) and WW I (1914), the depth measurer was introduced into the official equipment of the Serbian and Russian armies. In a good part, thanks to the application of this depth measurer in the land artillery units, the Serbian army achieved the first allied victories in 1914 (Cer, Kolubara). The superiority of the Austria-Hungary army in number and caliber of artillery weapons was nullified with the use of this depth measurer with faster and more precise occupying of the fire elements.



Figure 6. Artillery depth measurer for the Land artillery units

Several of Petrović's inventions were related to cogwheel transmitters of revolutions per minute. The most significant was the one patented together with Svetolik Popović, a mechanical nautical engineer from the Serbian Nautical Society, and it was related to multiple compression ration cogwheel transmitter with bending conical cogwheels. According to general opinion, this patent presents a precursor of the automatic automobile gears.

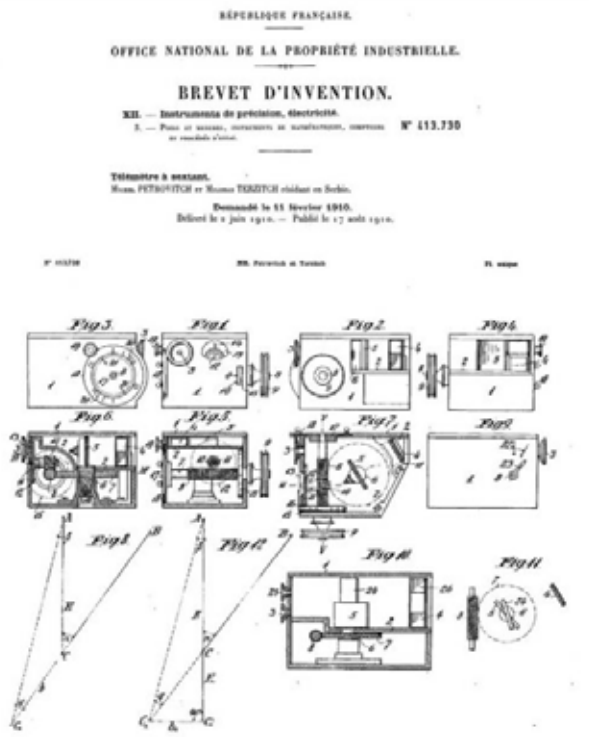


Figure 7. Patent sheet of the French Institute for Patents for the artillery depth measurer, registered under number 413.730 in 1910.

The patent that primarily found its application in Navy was related to a device that provided further buoyancy of ships following damage made by crash, mine, torpedo or stranding. This device consists of a large number of bodies in the form of a balloon with appropriate sources of gases under pressure for inflation, that can be handled manually, remotely or automatically with the help of an appropriate electromagnetic device. The application of this device was preventing or significantly slowing down the sinking of a floating vessel.

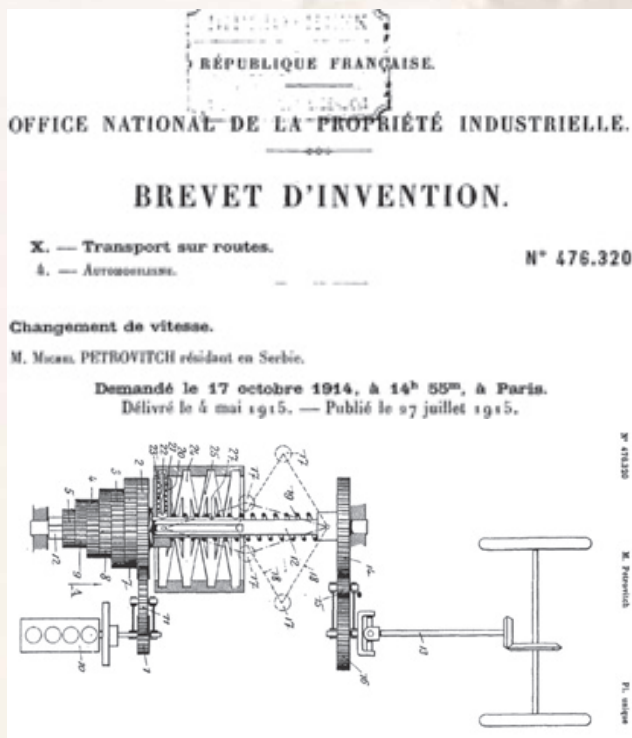


Figure 8. Patent sheet of the French Institute for Patents for automatic gear, registered under number 476.320 in 1914.

Beside the patents that were primarily intended for the Land Forces or Navy, Petrović also had the patents related to

the Air Defense. In the period 1917 -1920, the French Institute for Patents recognized two of his patents that were related to devices for rapid determination of elements of fire, i.e. firing the aircraft as well as for a device which was related to mechanisms for feeding and firing missiles from anti-aircraft guns which significantly increased their cadence. [1,8]

In a prime of the WW I, upon a request of the British Admiralty headed by Winston Churchill, and having in mind it was about the allied country of Serbia, Mihailo Petrović solved the problem of buoyancy of ships and submarines that the British fleet had with his depth measurer. As a result of this successfully realized work, in 1918, the British Institute for Patents acknowledged Mihailo's patent named "Means for Assuring the Buoyancy of Ships". In a good part, thanks to this patent of Mihailo which provided its safe buoyancy, especially in shallow seas, the British Navy governed sovereignly the seas and oceans in that period of time.

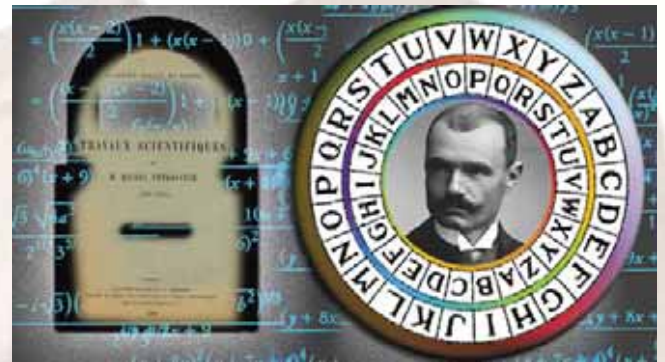


Figure 9. Eternal calendar

A small step forward from, conditionally speaking, "strict technique" presented the Petrović's patent related to the eternal calendar. After obtaining the certificate from the French Institute for Patents, the eternal calendar was made in several thousands of samples.

Together with the listed inventions that he patented, Mihailo Petrović realized some more outstanding inventions but he did not patent them. One of his most significant inventions that was not patented is a *hydrointegrator*. Petrović's hydro-integrator actually presents the first analog computer machine that operates on the principle of movement of fluid. The work on hydro-integrator may be considered a result of the research that Petrović named materialization of mathematics originated from studying mathematical phenomenology.

During 1896, Mihailo Petrović started a work on this device. He published the first scientific paper regarding the topic of hydraulic integration in 1897 in *Comptes rendus de l'Académie des Sciences de Paris* and the translation of that paper with additional explanations was also published in 1898, in Serbian, in *Serbian Technical Journal*, a scientific journal of the Serbian association of engineers and architects. He published on this topic again, related to improved version of hydro-integrator, in French, in *American Journal of Mathematics*. [5,6]

The operation principle of the Petrović's hydrointegrator was based on the analogy between the features of solutions of certain classes of differential equations and behaviour of fluids when a body is dipped into a vessel filled with fluid. His integrator was officially presented at the World's exhibition of achievements in Paris in 1900, and in a scope of the Serbian pavilion. It is considered to be the first device for solving differential equations on the principle of hydraulics. At this exhibition the hydrointegrator was awarded a gold medal for scientific achievements. This invention also

conquered other international recognitions later and in 1907 Petrović was awarded a honorary diploma of the London mathematical society for his invention.



Figure 10. Hydrointegrator drawing

The academician Mihailo Petrović dealt with one more interesting area, cryptography. On his work and results in the area of ciphering there are no publicly published papers which is not surprising having the subject matter in mind. During the WW I, in 1917, he made a new ciphering device which was used by the Serbian army and diplomacy. After the war he improved the ciphering system and named it "The three cardboards". This new ciphering system was continued to be used by the Kingdom of Yugoslavia (made on the foundations of Serbia as a winning country of war) up to the WW II (1941), when the fascist Germany occupied Yugoslavia. It is unknown whether the Germans succeeded in deciphering the "The three cardboards", having in mind that professor Petrović, being captivated and taken to prisoners camp near Nuremberg, was not cooperative. [1,2]



Figure 11. Mihailo Petrović, 1914, as the first lieutenant in WW I (the second one on the left, sitting)

It is not an accident that several of Petrović's patents and inventions had military application. Beside being a university professor of mathematics he also had enviable military career. He was promoted into a rank of reserve second lieutenant in 1898. He participated the Balkan wars as the first lieutenant. When Serbia defended its right of existence in the WW I he

was an adjutant to the Prince Đorđe Karađorđević, with a rank of captain. After Prince Đorđe Karađorđević was severely wounded in the Battle of Cer in Mačkov Kamen in August 1914, upon a decision of General staff he retreated from the military units and devoted himself to cryptography. After the end of the war he was promoted to the rank of major, and in 1925 he was promoted into a rank of reserve engineering lieutenant colonel. When Yugoslavia was attacked on April 6th, 1941 by fascist Germany, Italy, Bulgaria and Hungary he was activated again at the age of 73. However, he was captivated soon in central Bosnia (Sarajevo) and taken into a prisoners camp. Upon the intervention of Prince Đorđe Karađorđević, Jelena, wife to Italian king Emanuel, and few of German mathematicians, due to being completely uncooperative, he was liberated after three months. He returned to Belgrade, into his house, where he died in 1943.

Quite modest Mihailo Petrović was not only a man of science, mathematician, inventor, yet he was a person that loved and enjoyed life of a usual man. He enjoyed fishing, music and travels. He was a very friendly person and when someone saw him in a tavern enthusiastically playing a violin or passionately fishing in a boat on Sava or Danube, no one could even imagine that behind such a man there was a mathematical genius.

It is unknown if had more passion toward mathematics or fishing. He himself once said that in case he did not become a university professor he would be a fisherman. Hence his recognizable nickname Mika Alas (Alas = fisherman).



Figure 12. Mika Alas and Prince Đorđe Karađorđević with caught catfish, Belgrade, 1906.

He was born in Belgrade, and from his house on a small hill, the confluence of Sava into Danube might be seen and he spent time on the river from the earliest childhood. In 1882, he became a fishing apprentice, in 1888 a journeyman, and in 1895 he passed the exam for a master fisherman and acquired the right to establish his fishing company. He had his own apprentices and journeymen, and introduced new methods of river fishing with driftnets of up to 80 m length. He had his record catch in 1912 when he caught a catfish of 120 kg. He used to spend several days fishing, and his frequent companion on the river was Prince Đorđe to whom he also was a professor of mathematics. Their unbreakable friendship even strengthened on the river. Due to the friction within

dynasties, this friendship cost Mika Alas the title of the president of the *Serbian Academy of Sciences and Arts* of which King Aleksandar Karađorđević made decisions. At no cost, he wanted to abandon his student, war friend and fisherman Đorđe.

In 1898, Mika Alas participated passing the first law on fishing in Serbia. In 1900, he also participated negotiations on concluding the convention on fishing with Romania, as well as negotiations on the protection of fishing on Sava, Danube and Drina with Austro-Hungary. At the international exhibition on fishing in 1911 in Torino (Italy), he got a gold medal for displayed fishing exhibits. He also participated in establishing the first Yugoslav Oceanographic Institute in Split.

He published several expert papers on fishing. His expert papers on ichthyofauna of the lakes of Balkan, especially Skadar Lake and Ohrid Lake, were of outstanding significance. Mika Alas was the first one to point out the justification of using the statistical method in conducting an economic analysis of fishing on the Ohrid Lake. Using his knowledge of mathematics, he was the first person on the Balkans to merge two sciences— mathematics and fishing – to build statistical methods with the aim to calculate the possibilities of sustainable use of the resources of fish fund. Eels fascinated him. He studied their life, spawning in the Sargasso Sea, migration. He wrote a novel “The eel”.

Together with fishing, his great pleasure was playing the violin. He was self-taught. Since he loved taverns, he learnt the greatest number of songs, as well as the playing technique, from tavern players when he was very young. During his stay in France, he knew how to bring the atmosphere in bistros up to the climax with his music. In January 1896, he formed his orchestra of twelve members “Suz”. Mika's repertoire comprised over 700 melodies, mostly folk songs of the old city. When he played *Meljak Matraljez* (or “gypsied” Marzellez) whether in a Serbian tavern or in a French bistro, it would be a real pandemonium. In autumn of 1940 with his ensemble “Suz” he recorded a record for Radio Belgrade.



Figure 13. Mika Alas in a tavern playing the violin (he is the one with a hat)

Mika Alas was a world traveler. Many times, he was a member of numerous scientific missions. He stayed in the North Pole, Svalbard, Greenland, Iceland, Newfoundland and Labrador. He visited the South Pole where he studied the methods for removal of iceberg danger. He travelled to the Antilles where he had close connection with female pirates. [9]

Travels led him to Bermuda and Magdalena Island, too. He was one of rare Europeans who visited Napoleon's tomb on Saint Helena. He was a friend with Eskimos. During his travel to the Indian Ocean, he sailed through the Suez Canal. He transformed many of his travels into travel books and newspaper stories. [10]

This quite rich social and scientific life ceased on June 8th, 1943. Mihailo Petrović – Mika Alas died in his house in Belgrade, 22nd Kosančićev venac Street. His coffin was taken to the Cathedral Church on the hands of the fishermen. At his funeral, the posthumous speech was held by the orthodox bishop Veniamin and one more Serbian outstanding person of science, Milutin Milanković.

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Matematički genije Mihailo Petrović – Mika Alas (1868. – 1943.)

Prošlo je 150. godina od rođenja velikog srpskog matematičara, akademika Mihaila Petrovića – Mike Alasa. Svoj prirodni talenat za prirodne nauke nadogrudio je na beogradskoj Velikoj školi gde je 1889. godine diplomirao matematiku. U Francuskoj, na Sorboni, kao najbolji student generacije 1892. godine diplomira matematiku, a 1893. godine i fiziku. Pred komisijom koju čine tada najčuveniji svetski matematičari Emil Pikar, Šarl Ermit i Pol Penleve, 1894. godine brani doktorsku disertaciju. Po sticanju doktorskog zvanja iz oblasti matematike vraća se u Srbiju i postaje profesor na Beogradskom univerzitetu.

Uz pregršt objavljenih naučnih radova koji su se odnosili na diferencijalne jednačine, numeričku analizu, geometriju polinoma i matematičku fenomenologiju, Mihailo Petrović je i vlasnik više patenata. Neki od najznačajnijih patenata koji su našli izuzetnu praktičnu primenu u svetskim okvirima su: artiljerijski daljinar, uređaj za izbacivanje i lansiranje projektila, automatski automobilski menjač, večiti kalendar itd.

Akademik Petrović nije bio samo matematičar i naučnik već je bio i kriptograf, svetski putnik, književnik-putopisac, muzičar, ihtiolog i nadasve ribolovac. Njegova strast za ribolovom mu je i donela prepoznatljivi nadimak Mika Alas.

Михаил Петрович - Мика Алас (1868. – 1943. гг.)

Прошло 150 лет со дня рождения великого сербского математика, академика Михаила Петровича - Мики Аласа. Он повысил свой естественный талант к естественным наукам в высокой школе Белграда, где он в 1889 году получил диплом по математике. Во Франции в Сорбонне, как лучший ученик поколения в 1892 году, он получил диплом по математике, а в 1893 году – и по физике. Перед экзаменационной комиссией состоящей из самых известных мировых математиков Эмиля Пикара, Шарла Эрмитта и Пола Пенлева в 1894 году защитил докторскую диссертацию. Получив докторскую степень по математике, он возвращается в Сербию и работает профессором в Белградском университете.

С многими опубликованными научными работами, связанными с дифференциальными уравнениями, численным анализом, полиномиальной геометрией и математической феноменологией, Михаил Петрович является владельцем нескольких патентов. Некоторые из наиболее важных патентов, которые нашли замечательное практическое применение в мире, включают: артиллерийский дальномер, дистанционную пусковую установку, ракетную пусковую установку, автоматическую коробку передач автомобиля, вечный календарь и т. д.

Академик Петрович был не только математиком и учёным, но и криптографом, мировым путешественником, писателем-путешественником, музыкантом, ихтиологом и, прежде и более всего, рыбаком. Его страсть к рыбалке принесла ему узнаваемое прозвище Мика Алас.

Mihailo Petrović – Mika Alas (1868 – 1943)

Il y a 150 ans depuis la naissance de grand mathématicien et académicien serbe Mihailo Petrović Alas. Il a complété son talent pour les sciences naturelles à la Haute école de Belgrade où il a eu sa licence en mathématiques. En France, à la Sorbonne il a fini ses études en mathématique comme le meilleur étudiant de la génération de 1892 et ensuite il a fini les études en physique en 1893. Devant le jury composé par les plus célèbres mathématiciens de l'époque Emile Picard, Charles Hermite et Paul Painlevé il a soutenu sa thèse de doctorat en 1894. Après avoir obtenu le titre du docteur ès sciences mathématiques il rentre en Serbie et devient professeur à l'Université de Belgrade.

En outre de nombreux travaux scientifiques se rapportant aux équations différentielles, à l'analyse numérique de la géométrie des polynômes et à la phénoménologie mathématique Mihailo Petrović est auteur de plusieurs patentes. Certains parmi eux ont trouvé une application remarquable au niveau mondial tels que : télémètre d'artillerie, dispositif pour l'éjection des missiles, boîte à vitesse automatique chez automobile, le calendrier éternel, etc .

Mihailo Petrović n'était pas seulement mathématicien et savant mais aussi cryptographe, globe-trotter, auteur de récits de voyages, musicien, ichtyologue et avant tout pêcheur. Sa passion pour la pêche lui a valu la surnom connu « Mika Alas » (en serbe alas signifie pêcheur).