Nonlinear Dynamics and Systems Theory, 8(3) (2008) 217–220

PERSONAGE IN SCIENCE

Professor Myron K. Grammatikopoulos

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We dedicate this article to the memory of our friend and colleague Professor M. K. Grammatikopoulos, in recognition of his outstanding contributions to mathematics. Myron's research and teaching contributions spanned qualitative theory of ordinary, functional and partial differential equations with deviating arguments.

M.K. GRAMMATIKOPOULOS was born on November 14, 1938 (after World War II his official documents passport gives his birthday as November 8, 1935) in the village of Grebeshok of the Gagra District of Abkhasian ASSR of the Georgian SSSR. He was a son of the farmhand Kyriakos Grammatikopoulos, a Greek citizen who had fled his native Pontus sometime between 1918 and 1923.

In 1946, Myron entered elementary school in the city of Gudauta in Abkhasia, and in 1949, his family, as well as all refugees from Pontus, were forcibly relocated in Central Asia. There, under strict police surveillance, he continued his education in the village of Tamerlanovka in the Arys' area of the District of Chimkent in Southern Kazakhstan.

In 1956, Myron graduated from the 10-grade Amangeldy Imanov High School with a Silver medal. He received a scholarship and matriculated in the Physics Department of the N. Krupskaya Pedagogical Institute of Chimkent. In 1959, the Administration of this Institution discovered that due to his Greek citizenship, he was barred from entering higher education, and he was expelled. As a result of his protest letters that he addressed to the Greek Embassy in Moscow and the Ministers of Education and Exterior Affairs of the former USSR, he was allowed to continue his studies only in the Literature Department or the Mathematics Department of Chimkent Pedagogical Institute. Myron opted for Mathematics, and after being successfully examined in seventeen mathematics courses in forty days (these courses were not included in the first three years of the Physics Department's curriculum), he continued his studies in mathematics graduating finally "with distinction" in 1961. Despite the fact that he had no Graduate Studies, Mr. Jangildin, Chairman of the State Committee and Undersecretary of Education of Kazakhstan, made the unusual proposal for Myron to stay on at the Institute as an Assistant under the condition that he relinquish his Greek citizenship and become a Soviet citizen. He refused the offer and accepted a position as a teacher of Physics, Mathematics and Design at his *alma mater*, the Amangeldy Imanov High School of Tamerlanovka. In 1966, after working there for six years, Myron left and took up permanent residence in Greece.

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Myron received his Diploma in Mathematics from the Pedagogical Institute of Chimkent (a branch of the University of Kazakhstan) in 1961, and the University Thessaloniki in 1967. The Ph.D. in Mathematics (first dissertation) was awarded from the University of Ioannina 1975 and the Docent in Mathematics (second dissertation) from the University of Ioannina in 1981. In 1986, Myron was made a full Professor of Mathematics at the University of Ioannina.

In 1978, Myron was awarded a NATO Research Grant and he contacted J. R. Graef at Mississippi State University (MSU) to arrange a three month visit. In the afternoon of Wednesday, November 1, of that year, Myron arrived at MSU - small in stature, big in heart, and giant in intellect. The collaboration with Graef and P. W. Spikes at Mississippi State was fruitful and lasted long after that initial visit. Shortly before he left Ioannina for Mississippi, Myron's last son, Petros, was born. Unfortunately, the child had a serious birth defect and eventually only lived to be ten years old. Over the Christmas holidays in 1978, Myron returned to Greece only to immediately bring his son to New York in hopes of learning of some new medical technique that might have reversed the inevitable. But it was not to be. Because Myron essentially spent a month of his scheduled time in the US trying to help his son, he requested and immediately received a month extension to his visit.

Myron returned to Greece on April 15, 1979. In those four months, results for several different papers were outlined, some with more details than others. The collaboration continued over the next several years, and in 1985, Myron again visited MSU this time for only one week. The collaboration continued with the last of the more than twenty joint publications finally appearing in 1993.

Myron also held a Visiting Assistant Professor position in the Department of Mathematics at the University of Rhode Island in 1984-1985, and he was a Visiting Professor at the Center of Mathematics of the University of Rousse, Bulgaria, in 1990, 1991, and 1996.

Myron was the author or coauthor of more than 70 research papers. Monographs in which some of his research is described will be listed below. He received Distinguished Teaching Awards, Silver Medal in Secondary School USSR in 1956, and the Award in Higher Education USSR in 1961. He was awarded a Doctor Honoris Causa from the University of Rousse, Bulgaria, in 1995.

We will now give a brief outline of his results in the area of oscillation theory of ordinary and functional differential equations with deviating arguments, that is to say, equations of the form

$$x^{(n)}(t) = F(t; x^{(m_1)}(t-\tau_1), \dots, x^{(m_s)}(t-\tau_s)), \quad t \geq t_0, \tag{1}$$

where n and m_i are nonnegative integers, $\tau_i \in R$, $i = 1, 2, \dots, s$, and x, F may be vectors. Set $m = \max\{m_i\colon\ i = 1, 2, \dots, s\}$. Then equation (1) is said to be of the:

— retarded (delay) type, if $m < n$;

— advanced type, if $m > n$, and

— neutral type, if $m = n$.

Moreover, equation (1) has:

— retarded (delay) arguments, if $\tau_i \geq 0$, $i = 1, 2, \dots, s$;

— advanced arguments, if $\tau_i \leq 0$, $i = 1, 2, \dots, s$, and

— mixed arguments, if there is $s_1 \in \{1, 2, \dots, s-1\}$ such that $\tau_i \geq 0$ for $i = 1, 2, \dots, s_1$ and $\tau_i \leq 0$ for $i = s_1 + 1, s_1 + 2, \dots, s$.

The deviating arguments may depend on time t or may even depend on the solution of the equation. The type of deviation of the arguments may change depending on time or on the solution itself. It should be pointed out that deviating arguments, in some cases, do not affect the oscillatory character of the solutions of differential equations under consideration, while in some other cases, they can either generate oscillations or stop them. Consequently, it is interesting to investigate phenomena of this kind in order to choose the appropriate mathematical model of real world systems whose oscillatory character depends on differential equations with deviating arguments.

In a number of papers, Myron studied retarded type differential equations, that is, equations in which the unknown function depends on a continuous function r defined on an interval $[t_r, \infty)$. The presence of the function r is justified by the fact that these equations constitute generalizations of the well known Emden-Fowler and Thomas-Fermi equations that often arise in applications and contain functions of the type r. Such an occurrence of the function r, for example, could be a cause for the existence of oscillatory behavior of the solutions of the differential equations under consideration. The results obtained are interesting not only from the theoretical aspect, but also from the point of view of applications. Indeed, the role of these equations, for example, in relativistic electrodynamics and other natural sciences, is very important.

Another important topic is the problem of oscillatory and asymptotic behavior of the solutions of neutral differential equations with deviating arguments. This problem is interesting both from the theoretical and practical aspect. In fact, neutral differential equations have applications in electric networks containing lossless transmission lines. Such networks arise, for example, in high speed computers, where the lossless transmission lines are used to interconnect switching circuits. Second order neutral differential equations appear in the study of vibrating masses attached to an elastic bar, and they also appear as the Euler equations for the minimization of functionals involving a time delay.

In general, the study of neutral differential equations presents complications that are not present in non-neutral type equations. Indeed, it has been proved that even though the characteristic roots of a neutral differential equation may all have negative real parts, it is still possible for this equation to have unbounded solutions. Furthermore, the oscillatory character of the solutions of a neutral differential equation is determined by the roots of the corresponding characteristic equation, which is in contrast to the fact that the stability character is not determined by those characteristic roots.

Myron developed techniques and methods that have been adopted by a number of other researchers in this area. Also, it should be pointed out that results obtained for neutral differential equations with constant coefficients and constant deviations are crucial with respect to drawing conclusions concerning neutral differential equations of the same form where the coefficients and deviations are not constants but are functions of time. For this reason, the large number of important references to his work is not a surprise. Beyond the above areas, Professor Grammatikopoulos was interested in applications of partial differential equations. The results he obtained in this direction concern boundary value problems for some special types of partial differential equations (for example, wave equations); he was interested in the problem of existence and uniqueness of solutions of this type of equation and the possibility to treat practical problems appearing in technology, etc.

As a result of an analysis of Myron's research work, we see that some of the main topics treated are the following:

— Establishing criteria (necessary and sufficient conditions) for oscillation (non-oscillations) of all solutions of differential equations under consideration.

— Establishing criteria for existence of oscillatory (non-oscillatory) solutions of differential equations with some asymptotic property.

— Obtaining sufficient conditions for oscillation (non-oscillation) of all solutions of equations in question.

— Finding the relation between oscillation and other qualitative properties such as boundedness, convergence to zero, etc.

— Investigating the oscillatory and asymptotic properties of the non-oscillatory solutions of differential equations with forcing or discontinuous terms.

— Investigating the oscillatory phenomena caused by deviating arguments.

— Classification of all solutions of differential equations under consideration with respect to their behavior at infinity.

— Other topics: boundary value problems for partial differential equations, etc.

Myron made many significant contributions in all of these areas.

MONOGRAPHS in which of M.K. Grammatikopoulos research work is cited:

[1] Koplatadze, R.G. and Chanturia, T.A. *On The Oscillatory Properties of Differential Equations with a Deviating Argument.* State University of Tbilisi, Tbilisi, 1977. [Russian].

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[4] Kiguradze, I.G. and Chanturia, T.A. *Asymptotic Properties of Solutions of Non-Autonomous Ordinary Differential Equations.* Nauka, Moscow, 1990. [Russian].

[5] Bainov, D.D. and Mishev, D.P. *Oscillation Theory for Neutral Differential Equations with Delay.* Adam Hilger, Bristol, 1991.

[6] Gyori, I. and Ladas, G. *Oscillation Theory of Delay Differential Equations.* Clarendon Press, Oxford, New York, 1991.

[7] Koplatadze, R. *On Oscillatory Properties of Solutions of Functional Differential Equations. Memoirs on Differential Equations and Mathematical Physics*, Vol. 3, A. Razmadze Mathematical Institute of Georgian Academy of Sciences, Tbilisi, 1994.

[8] Erbe, L.H., Qingkai Kong and Zhang, B.G. *Oscillation Theory for Functional Differential Equations.* Marcel Dekker, New York, 1995.

[9] Agarwal, R.P., Grace, S.R. and O'Regan, D. *Oscillation Theory for Difference and Functional Differential Equations.* Kluwer Academic Publishers, Dordrecht–Boston–London, 2000.

Besides doing an incredible amount of mathematical work, Myron took time to enjoy being with his family, his wife Alla, his children (Andreas, Dimitrios, Kyriakos), and his grandchildren (Eugenia, Ioanna-Hypatia, Philarete). He also enjoyed classical ballet and history. In particular, he was a connoisseur of dramatic and humorous facts in Greek and World History. He was like his garden on Corfu, where according to description of "the island of the Phaeacians" in the Odyssey, Odysseus' last stop before arriving in his beloved Ithaca. Myron was always available for discussions concerning teaching or research problems with anyone who wished to meet with him.

The mathematics community is saddened to announce the unexpected passing of Myron Grammatikopoulos in Bulgaria on June 21, 2007. He was interred at Kastanoussa, Serres.

Sto kalo — we will miss you our friend.