ROMAI J., v. 13, no. 1(2017), i–xvii

IN MEMORIAM ADRIAN CARABINEANU

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This article is dedicated to Prof. Adrian Carabineanu - the math teacher, scientific researcher, colleague and friend. We aim to analyze his activity and present some facts that made him a remarkable and exemplary person. In his scientific activity, Prof. Adrian Carabineanu tried to construct, for real problems, mathematical models that lead to mathematical problems that can be analytically solved. His favorite method was to reduce a fluid mechanics problem to a problem of conformal mappings or to a problem of solving an integral equation. It is true that not all the problems can be solved in this manner, but there are many of them that can be. His published papers include a large variety of problems that were analyzed and solved by using such a method. In this article, besides presenting Professor's Carabineanu life, we will review some of his scientific ideas as they result from his published articles.

1. SHORT CV

Born on February 25$^{\text{th}}$, 1953 in Bucharest, Adrian - the second child of Elena and Ştefan Carabineanu - was raised in an environment with many contrasts. His father, Ştefan Carabineanu - a demanding and pretty tough man - was a very passionate bibliophile and had a house full of interesting books. This has led Adrian to lecture in most diverse areas. His mother, Elena Carabineanu was a very calm and patient woman, dedicated to her boys. His older brother, Marcel Carabineanu, is an electronics engineer who initially worked at IFA Măgurele, then emigrated to Canada.

After spending two years in a high school from his neighborhood, Adrian followed his great passion for mathematics and continued his studies at *Gheorghe Lazăr* High School (National College nowadays) from Bucharest where he achieved very good results. After graduating in 1972, contrary to the will of the parents and especially of the father who wanted to see him an engineer, Adrian enrolled and attended the courses of Faculty of Mathematics from the University of Bucharest between 1972 and 1976; being a very good student, he also received during this period a scholarship to study at Lomonosov University from Moscow. Adrian obtained his "specialization" in Fluid Mechanics and Astronomy in 1977, and got his PhD in Mathematics in 1983, under the supervision of Acad. Caius Iacob, with the thesis "*Contributions to the study of fluid motions with free surface*". Ten years later, the Romanian Academy granted him the "Spiru Haret" Award for his work and contributions to the domain of fluid mechanics.

After teaching mathematics at *Dimitrie Bolintineanu* High School of Bucharest for almost a decade Prof. Adrian Carabineanu followed the advices of academicians Caius Iacob and Lazăr Dragoş and joined the Department of Mechanics and Equations from the Faculty of Mathematics, University of Bucharest in 1986 where he will carry out his didactic activity for the rest of his life. Over the years, he thought courses and seminars of Theoretical Mechanics, Gas Dynamics, Filtration Theory, Magnetohydrodynamics, Aerodynamics, Distribution Theory, Special Mathematics, Partial Differential Equations, Algorithms and Data Structures. In 1995, he joined the Institute of Applied Mathematics of Romanian Academy (known nowadays as "*Gheorghe Mihoc-Caius Iacob*" Institute of Mathematical Statistics and Applied Mathematics) as a part time Scientific Researcher. In the time period 1997 - 2003 he was a part time Associate Professor at the *Valahia* University in Târgovişte.

He left this world on May 3, 2016, after having fight against a strong illness.

2. SCIENTIFIC CONTRIBUTIONS

In this article, we do not intend to review all the papers published by Prof. Adrian Carabineanu. An almost complete list with his publications is given at References, where we tried to group them on subjects, so that one can have a clear image of his scientific activity. Instead, we review a subject that we appreciate it was his favorite, the oscillatory motion of a wing, and we summarize some results obtained in domain of aerodynamics of Savonius turbine and crack propagation.

2.1. THE LIFTING SURFACE THEORY. OSCILLATORY MOTION

The oscillatory motion is a subject very reach in aplication, especially in aeroelasticity and in the study of aquatic animal motion. It can be analized in the frame of lifting surface theory. In the lifting surface theory, the main assumption is that the wing is a thin body which can be approximated by a surface and it induces a small perturbation to the basic flow. Consequently, one can assume that the perturbed fields satisfy a linear Euler equation. In what follows, we assume that all variables are dimensionless. Let $\boldsymbol{v}$, p, thereafter all variables are dimensionless, be the perturbed field of the velocity and pressure, respectively. The linear Euler equations for a compressible fluid can be written as

$$\begin{aligned} M^2\partial p + \operatorname{div}\boldsymbol{v} &= 0 \\ \partial\boldsymbol{v} + \operatorname{grad} p &= 0 \end{aligned}, \tag{1}$$

where M is the Mach number. The expression of the derivative operator ∂ depends on the contextual problem. In the case of uniform at infinity upstream flow, ∂ is

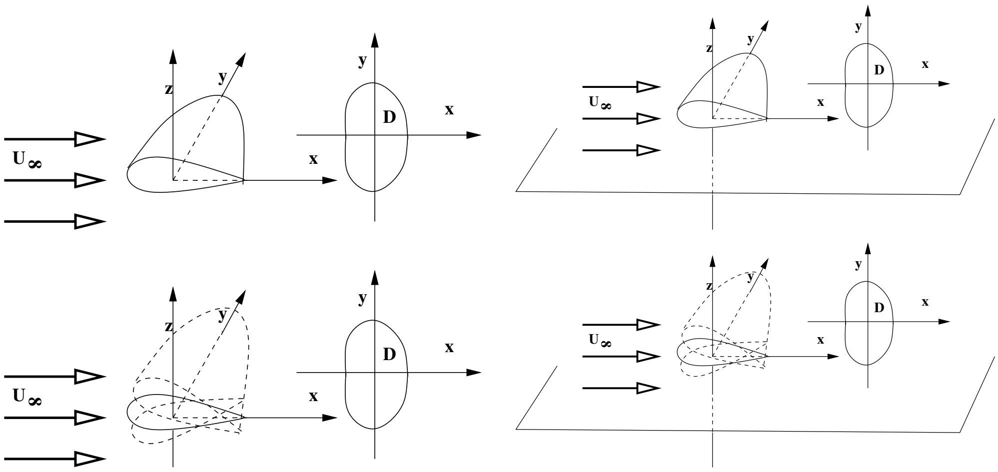


Fig. 1.: A finite span wing in a uniform flow. The first row of pictures corresponds to a fixed wing, while the second row of pictures corresponds to an oscillating one. If the wing is close to the ground surface (the right column of pictures), then the effect of ground must be taken into account.

given by

$$\partial = \frac{\partial}{\partial t} + \frac{\partial}{\partial x}$$

and in the case of steady motion, one has

$$\partial = \frac{\partial}{\partial x}.$$

The case of incompressible fluid motion can be obtained from (1) by considering $M = 0$.

Let

$$z = h(x, y, t), \qquad (x, y) \in D \tag{2}$$

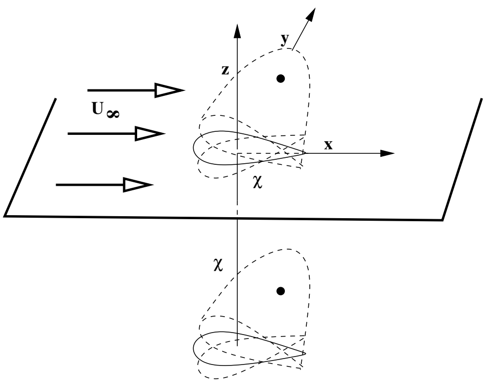
be the perturbing surface. On the surface, the fluid is slipping so that the velocity must satisfy

$$\frac{\partial h(x, y, t)}{\partial t} + \frac{\partial h(x, y, t)}{\partial x} = w(x, y, 0, t), \tag{3}$$

where w is the Oz component of the velocity field. At infinity upstream, the perturbed fields vanish

$$\lim_{x \to -\infty} (\boldsymbol{v}, p) = 0. \tag{4}$$

The entire lifting surface theory lays on the equations (1–4). Given that there are many applications, the subject was analyzed by many researchers and there is a huge



To take into account the ground effect, one considers a symmetric wing with respect to the wall. The wing is located at $z = 0$, the wall at $z = -\chi$ and the symmetric profile at $z = -2\chi$. The equation of the wing is $z = h(x, y) \exp \mathrm{i}\omega t,\ (x, y) \in D$.

Fig. 2.: An oscillatory wing in the presence of ground surface.

literature devoted to it. We refer here only to the monography *Mathematical Methods in Aerodymanics* by Lazăr Dragoş, Kluwer Academic Publishers and Publishing House of the Romanian Academy, 2003, the English translation by Prof. Adrian Carabineanu. A very elegant way to investigate several applications is to build up the fundamental solution of the mathematical model using Fourier transform. Knowing of the fundamental solutions allows one to reduce the problem of determining the unknowns fields $\boldsymbol{v}$ and p to solving an integral equation with singular kernel.

This is this domain where Prof. Adrian Carabineanu has contributed in a substantial way. He has obtained new quadrature formulas and he was able to numerical determine the velocity and pressure fields. The oscillatory motion of a lifting surface was analyzed in papers as [2], [6], [8], [10], [11], [13],[14], [19]. To accomplish the relevance and the beauty of the subject, we expose here the case of the oscillatory wing in the vicinity of the ground surface. The main ideas follow the previously cited papers. The fluid is assumed to be incompressible. One replaces the wing with a force distribution $\boldsymbol{f}^+ = (0, 0, f \exp \mathrm{i}\omega t),\ (x, y)$ defined on the wing and with a symmetric distribution $\boldsymbol{f}^- = (0, 0, -f \exp \mathrm{i}\omega t),\ (x, y)$ defined on the symmetric wing. The Euler equation (1) has the form

$$\begin{aligned} \operatorname{div} \boldsymbol{v} &= 0, \\ \left(\frac{\partial}{\partial t} + \frac{\partial}{\partial x}\right) \boldsymbol{v} + \operatorname{grad} p &= (f\delta(x - \xi^+) - f\delta(x - \xi^-)) \exp \mathrm{i}\omega t, \end{aligned} \tag{5}$$

and the slip condition

$$w(x, y, 0, t) = (\partial_x h(x, y) + \mathrm{i}\omega h) \exp \mathrm{i}\omega t.$$

On the wall $z = -\chi$

$$w(x, y, -\chi, t) = 0.$$

We search a solution of the form

$$\boldsymbol{v} = \widetilde{\boldsymbol{v}}(x, y, z) \exp \mathrm{i}\omega t, \qquad p = \widetilde{p}(x, y, z) \exp \mathrm{i}\omega t. \tag{6}$$

The steady fields (thereafter we drop the tilde) satisfy

$$\begin{aligned} \operatorname{div} \boldsymbol{v} &= 0, \\ \mathrm{i}\omega \boldsymbol{v} + \frac{\partial}{\partial x}\boldsymbol{v} + \operatorname{grad} p &= \left(f\delta(x - \xi^+) - f\delta(x - \xi^-)\right). \end{aligned} \tag{7}$$

The slip condition reads as:

$$w(x, y, 0) = \partial_x h(x, y) + \mathrm{i}\omega h.$$

By using Fourier transform, the partial differential equations are transformed into an algebraic system

$$\begin{aligned} -\mathrm{i}\boldsymbol{\alpha} \cdot \hat{\boldsymbol{v}} &= 0, \\ \mathrm{i}\omega \hat{\boldsymbol{v}} - \mathrm{i}\alpha_1 \hat{\boldsymbol{v}} - \mathrm{i}\boldsymbol{\alpha}\hat{p} &= f\mathrm{Exp}(\boldsymbol{\alpha}, \boldsymbol{\xi}^+, \boldsymbol{\xi}^-), \end{aligned} \tag{8}$$

where we use the notation

$$\mathrm{Exp}(\boldsymbol{\alpha}, \boldsymbol{\xi}^+, \boldsymbol{\xi}^-) := (\exp(\mathrm{i}\boldsymbol{\alpha} \cdot \boldsymbol{\xi}^+) - \exp(\mathrm{i}\boldsymbol{\alpha} \cdot \boldsymbol{\xi}^-)).$$

The equations can be easy solved and one obtains

$$\begin{aligned} &\hat{p} = \mathrm{i}\alpha_3 f \frac{\mathrm{Exp}(\boldsymbol{\alpha}, \boldsymbol{\xi}^+, \boldsymbol{\xi}^-)}{|\boldsymbol{\alpha}|^2}, \\ &\hat{w} = -\frac{f\mathrm{Exp}(\boldsymbol{\alpha}, \boldsymbol{\xi}^+, \boldsymbol{\xi}^-)}{\mathrm{i}\alpha_1 - \mathrm{i}\omega} - \frac{\mathrm{i}\alpha_3 \mathrm{i}\alpha_3 f}{\mathrm{i}\alpha_1 - \mathrm{i}\omega} \frac{\mathrm{Exp}(\boldsymbol{\alpha}, \boldsymbol{\xi}^+, \boldsymbol{\xi}^-)}{|\boldsymbol{\alpha}|^2}. \end{aligned} \tag{9}$$

Then, performing the inverse Fourier transform, one obtains the solutions

$$\begin{aligned} p(x, y, z) &= -\frac{1}{4\pi} \int\int_D f(\xi, \eta) \frac{\partial}{\partial z} \left(\frac{1}{R^+} - \frac{1}{R^-} \right) \mathrm{d}\xi \mathrm{d}\eta, \\ w(x, y, z) &= \int\int_D f(\xi, \eta) \mathrm{e}^{-\mathrm{i}x_0\omega} H(x_0) \left(\delta(y_0, z) - \delta(y_0, z + 2\chi)\right) \mathrm{d}\xi \mathrm{d}\eta + \\ &+ \int\int_D f(\xi, \eta) \mathrm{e}^{-\mathrm{i}x_0\omega} \mathcal{G}(x_0, y_0, z, \chi), \mathrm{d}\xi \mathrm{d}\eta \end{aligned} \tag{10}$$

where

$$\begin{aligned} &R^+ = \sqrt{x_0^2 + y_0^2 + z^2}, \qquad R^- = \sqrt{x_0^2 + y_0^2 + (z + 2\chi)^2}, \\ &\mathcal{G}(x_0, y_0, z, \chi) = \frac{1}{4\pi} \frac{\partial^2}{\partial z^2} \int_{-\infty}^{x_0} \mathrm{e}^{\mathrm{i}\omega\tau} \left[\frac{1}{\sqrt{\tau^2 + y_0^2 + z^2}} - \frac{1}{\sqrt{\tau^2 + y_0^2 + (z + 2\chi)^2}} \right] \mathrm{d}\tau, \\ &x_0 = x - \xi, \qquad y_0 = y - \eta. \end{aligned}$$

With the exception of the domain $\Sigma := D + (\tau, 0)$, $\tau > 0$, the wake of wing, the component w of the velocity is a regular distribution given by the function

$$w(x,y,z) = \int\int_D f(\xi,\eta)\mathrm{e}^{-\mathrm{i}x_0\omega}\mathcal{G}(x_0,y_0,z,\chi)\mathrm{d}\xi\mathrm{d}\eta. \tag{11}$$

To determine the unknown function $f : D \to \mathbb{R}$, one imposes w to satisfies the boundary conditions.

One can readily verify that

$$\frac{\partial p}{\partial z}|_{z=-\chi} = 0, w(x,y,-\chi) = 0.$$

To determine the unknown function $f : D \to \mathbb{R}$ one imposes to w to satisfy the slip condition. One evaluates the limit:

$$\lim_{z\to 0}\mathcal{G}(x_0,y_0,z,\chi) = -\frac{1}{4\pi}\int_{-\infty}^{x_0}\mathrm{e}^{\mathrm{i}\omega\tau}\left[\frac{1}{\sqrt{\tau^2+y_0^2}^3} + \frac{8\chi^2-\tau^2-y_0^2}{\sqrt{\tau^2+y_0^2+4\chi^2}^5}\right]\mathrm{d}\tau.$$

As the integral is not convergent for $y_0 = 0$, one must understand the integral in the sense of finite part.

The slip condition can now be written as:

$$\partial_x h(x,y) + \mathrm{i}\omega h = \int\int_D^{\circ} f(\xi,\eta)\mathcal{N}(x_0,y_0)\mathrm{d}\xi\mathrm{d}\eta, \tag{12}$$

where the kernel $\mathcal{N}(x_0,y_0)$ is given by

$$\mathcal{N}(x_0,y_0) = -\frac{1}{4\pi}\mathrm{e}^{-\mathrm{i}x_0\omega}\int_{-\infty}^{x_0}\mathrm{e}^{\mathrm{i}\omega\tau}\left[\frac{1}{\sqrt{\tau^2+y_0^2}^3} + \frac{8\chi^2-\tau^2-y_0^2}{\sqrt{\tau^2+y_0^2+4\chi^2}^5}\right]\mathrm{d}\tau$$

and $\circ$ denotes that the integral must be interpreted in the sense of the finite part.

In [2], the authors present a method to numerically solve the strong singular integral (12) and they obtained a very important result ... *if the reduced frequency surpasses a certain value, the average drag coefficient is negative, i.e. it appears a propulsive force. We also notice that the propulsive force is bigger for* $\chi = 1$ *than for* $\chi = 10$*, i.e. it is bigger when the oscillatory wing is closer to the floor.*

We note that if the wall is far away, wing in a whole space, then the kernel of the integral equation becomes

$$\mathcal{N}(x_0,y_0) = -\frac{1}{4\pi}\mathrm{e}^{-\mathrm{i}x_0\omega}\int_{-\infty}^{x_0}\mathrm{e}^{\mathrm{i}\omega\tau}\frac{1}{\sqrt{\tau^2+y_0^2}^3}\mathrm{d}\tau.$$

This case was analyzed in paper [14].

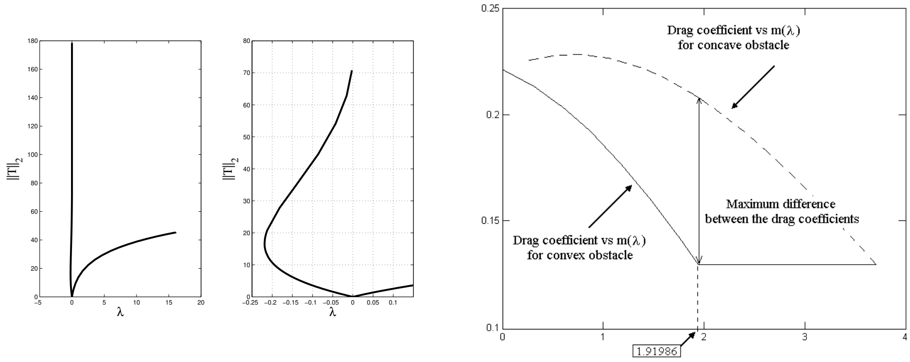


Fig. 3.: Left picture: the bifurcation diagram in $\|\cdot\|_2$ for Hammerstein equation: the figure on the right side represents a zoom near the y-axis in order to better observe the turning point. Right picture: the drag coefficients C_D for the concave and convex obstacles as functions of the measure $m(\lambda)$

2.2. THE SAVONIUS WIND TURBINE

As a short summary of [1], we recall that at the end of the XIX$^{\text{th}}$ century, Helmholtz noticed that d'Alembert's paradox (*for the case of an ideal fluid, the solutions of the motion equations indicate that the frictional force exerted by a fluid on a body moving inside the fluid is zero*) can be avoided even in the case of an ideal fluid if one considers that a wake (*a stagnation zone where the velocity vanishes and the pressure remains constant*) appears behind the obstacle. The mathematical fundamentals of the wake were developed at the beginning of the XX$^{\text{th}}$ century (Levi-Civit, H. Villat) and a special attention was payed to the Hammerstein integral equation (13) obtained for the case of Helmholtz free boundary flow past an obstacle consisting of an arc of circle, convex with respect to the direction of the uniform incoming stream

$$T(t) = \frac{\lambda}{\pi}\int_0^{\pi} \exp(-T(\sigma)) \ln \frac{\sin \dfrac{t+\sigma}{2}}{|\sin \dfrac{t-\sigma}{2}|}(1+\sin\sigma)\sin\sigma d\sigma. \tag{13}$$

For this equation, theoretical (existence and uniqueness) and numerical results have been obtained, but they are no longer valid for the case of an obstacle consisting of an arc of a circle concave with respect to the direction of the input stream because the integral operator no longer has the same properties as in the case of the convex arc of a circle and the numerical methods already employed in the convex case do not work for the concave one.

Developing an arclength numerical continuation algorithm based on a Prediction-Correction method, it was possible to successfully investigate this case, improving and generalizing previous results from literature. The existence and uniqueness of the solution were numerically confirmed, but only for positive values of the parameter λ; for negative λ, it was emphasized the existence of a small critical value $\lambda_T \approx -0.219$ of this parameter (value corresponding to a turning point T) above which the equation admits two real and distinct solutions and below which the equation has no solution. These new results found for negative values of λ also offered the opportunity to study an important technical application: the Savonius wind turbine with the vertical axis and for which the cross section of a blade is an arc of circle. It was mathematically obtained the optimal measure $m(\lambda)$ of such an arc of circle for which the difference between the friction coefficient for the concave blade and the one for the convex blade is maximal. This measure corresponds in fact to the $110°$ angle (1.91986 rad) found experimentally in the literature and indicates the optimal size of a pallet for which the moment of the aerodynamic force is maximum.

2.3. CRACK PROPAGATION

Starting from 1998, Adrian Carabineanu, together with Eduard-Marius Crăciun, published three papers in the prestigious journal Computational Material Science regarding mathematical modelling of zero thickness antiplane interface cracks in prestressed composite materials ([55], [56], [57]) and one in Journal of Optoelectronics and Advanced Materials ([59]). Using the theory of Cauchy's integral and the numerical analysis were determined the incremental stress and displacement fields in the vicinity of the crack tips. The cases of elliptical type and parabolic type of incremental antiplane shear forces were considered and were obtained the critical values of the incremental stresses which were producing crack propagation and the crack propagation direction. He delivered a very good formula for the numerical computation of the complex integrals employing Plemelj's formulas and Cauchy's integral.

We restrict our presentation to the above results. The References contain all the papers published by Professor Carabineanu. We leave to the interested reader the pleasure to study them.

3. THOUGHTS OF FAMILY AND FRIENDS

In order to present in a warmer way the personality of our colleague, we kindly asked some persons that have known him to remind his personality in a few words.

Family. *Maria, wife*: "He was a man of rarely encountered kindness and gentleness, nobility of soul, generosity, modesty. He was always trying to help the people around him, he did not want to upset or bother anyone: no one could argue something with him. As a husband, father and grandfather, Adrian was very caring and responsible. He was preoccupied how to pleasantly spend our free time, to visit exciting places. He and I often went to the mountains with our girls, and later also with our granddaughter Eva, to theater plays, museums etc... He sometimes took us with him at various conferences he attended (Plovdiv-Bulgaria, Ohrid-Macedonia, Gratz-Austria, Lviv-Ukraina, Ankara-Turcia, CAIMs and many other more in Romania). He is the one who most often took Eva to the circus, children's theater, skating, violin and piano lessons. Though in great pain due to the disease that was crushing him, his thoughts and care were still for us: he was repeatedly telling us that we ≪must keep close≫.".

Elena, eldest daughter: "It is said that every person in your life is a lesson, a gift or a punishment. For me, my dad was a gift from which I had to learn countless lessons. Maybe not all of them were at the right moment and I certainly did not finish learning from him when he passed away, but I'm grateful I had someone to learn from."

Ioana, youngest daughter: "Adrian was a very thoughtful dad. I was his ≪Little One≫" - the English translation for the Romanian appellative ≪Micşunica≫. At the age of 13, when a serious health problem arose, he was the one who took me to the hospital. At that time, I did a little ankle and knee surgery, and I asked him not to tell about it to my mother in order to protect her. He understood and got very careful and understanding with my health problem. During winters, he was the one joining me for skating in the park or hiking in the mountains. He was my most devoted friend and a loving father. I was very happy when I was hearing his voice. I will never forget his jokes. I think and pray for him every night, asking for forgiveness for all the mistakes I made. I miss him so much, I will always keep him in my soul for the rest of my life."

Friends. *Victor Ţigoiu*: "A delicate person (maybe too delicate for these times), introverted and very stable in feelings. A person disposed to listen the other, to pay an advice, to help. A person with a fine and contagious humour. These qualities made him a very good colleague, an understanding professor, close to and devoted to his students, and, last but not least, a reliable friend. Being very modest, he regarded with surprise the proposal of his colleagues from the Faculty of Mathematics of the University of Bucharest to be Head of his Department. And the times in which he had this function were quite difficult! Then we found out that he had a major problem of health. As a consequence, after a while, he asked to be replaced in that function, because his health would not allow him to continue his activity as Head of the Department in the rhythm and at the level he desired (and that were required at that time). But even after this moment, he remained a person that you could rely on, from which you could receive a wise and competent advice, that helped the students and the PhD students with much patience and (where from, we wonder?) with a great power of work. I am convinced that in this way he shows us that he accepted his faith and that he is in peace with himself.

This was our colleague Adrian Carabineanu until his last moments of life."

Andrei Halanay: "Adrian loved the mountains. He shared this passion with his family and friends. There were numerous weekends when we went in groups to discover new routes on unmarked areas or to review the wonderful landscapes of Bucegi, Baiului or Piatra Craiului. He was always ready to help if needed, picking up from the luggage of or accompanying the ones left behind. Adrian loved his teaching job. He always tried new paths, tried to make the complicated things understandable. I miss him so much!"

Zaza Andreescu: "For me, Adrian was like a brother and a real friend. Thanks to him, I roamed the mountains far and wide, I met wonderful people. He was a good dancer, knew a lot of poems, and created ad-hoc verses. He was passionate of religion, geography, history, philosophy. The excursions he "thought" to go always had a "sporting" and a "cultural" part. Stories? There are plenty... The trip to Omu Peak when he forgot up there a pair of trousers and once arrived on Bucşoiu, he proposed us to climb back to recover them. The New Year's Eves at Slănic with projections on the ad-hoc screens of fragments of famous operas chosen with great care and patience etc. I always admired the respect and love he had for his wife, Maria, who had a great admiration and amazement for the force he had it. I could write a novel about Adrian, but I'm grabbing my cry, although I remember his colossal humor and a phrase that became famous: ≪Life is complex, Zaza, real and imaginary!≫"

Adriana Totoescu: "Adrian... was the friend who was answering to your call with ≪Hey...≫ followed your name and that unforgettable joy in his voice. Adrian... was the friend who was listening to your wishes, and was calling you back - even after one year - to say, ≪Look, I now have the opportunity to fulfill your wish you have described me. Do you still want?≫. And you answer yes, impressed by his gentleness. Adrian was the person who advocated for the University Solidarity in the early 1990s and you could feel the pleasure in being in solidarity with him. Adrian had an unequaled and fine humor that never hurt anyone. His humor was a joy to everyone around."

Mihaela Constantinescu: "Adrian. He was the friend who got me out long time ago of the stalemate created by solving some arithmetic problems, total enigmas for my fourth grade daughter at that time. Since my mind was perverted of too much algebra at that time and was refusing to understand what he was trying to explain me, he had a remark that I kept it for the last 30 years: ≪Come on, Mihaela, you're not stupid!≫. He was the friend I've often sourly provoked to all sorts of talks, just to spiritually enjoy myself with his fine, elegant, exquisite reactions. He was the friend who has forever defined for me the concept of pure modesty. He was the friend who brought up too many qualities for a single man. I really wish to play one more time a bridge game together with his wife, Maria, somewhere, sometime..."

Anca Veronica Ion: "Prof. Adrian Carabineanu was a member of ROMAI (Romanian Society of Applied and Industrial Mathematics) from the beginning of the existence of this society (year 1992). In this quality I know him from the moment I myself became a member of ROMAI, in 1993. Then, we were colleagues at the former *Caius Iacob* Institute of Applied Mathematics and, since 2008, in the actual *Gh. Mihoc - C. Iacob* Institute of Mathematical Statistics and Applied Mathematics.

He participated in many of conferences organized by ROMAI, the CAIMs (Conferences of Applied and Industrial Mathematics) that are held each year, in (or close to) university towns of Romania, or at Chişinău, the capital of Republic of Moldova. At this conferences, besides his good communications, we enjoyed the quality of his spirit. Our conferences always end with an excursion, at places not only with a beautiful nature, but also with historical significance. These excursions always offer to the participants opportunities for nice conversations, for changing information and impressions. In this context we enjoyed the culture, the quality of the information and the wisdom of his thinking, as well as the qualities remarked by the other friends that wrote their opinions above: the courtesy, the simplicity in behaviour, the humour, the permanent disposition to help. In these excursions I met also a part of his family, i.e. his wife, Maria and his youngest daughter, Ioana. Together they showed to form a very harmonious family. I felt (and I still feel) deep sorrow for Maria, Elena, Ioana and Eva (grand daughter, from Elena) that he left behind and that miss him. I hope that they will find in the thoughts about him listed above some consolation.

May God give eternal rest in peace to our colleague and friend Adrian Carabineanu!"

References

Aerodynamics

[1] St. G. Cruceanu, E. Rapeanu,, Adrian Carabineanu, *Arclength numerical continuation in free-boundary flow,* Appl. Math. Comput., 230, pp.138-153, 2014.

[2] E. Rapeanu,, Adrian Carabineanu, *A Green function approach for the investigation of the incompressible flow past an oscillatory thin hydrofoil including floor effects,* Boundary Value Problems, 2014:104

[3] Adrian Carabineanu, *The flow of an incompressible electroconductive fluid past a thin airfoil. The parabolic profile,* INCAS BULLETIN, 6, Special Issue 1/2014, pp. 41-50.

[4] Adrian Carabineanu, *Steady flow of an incompressible perfectly conducting fluid past a thin airfoil,* Boundary Value Problems 2013:231.

[5] Adrian Carabineanu, R. Dumitrache *A numerical solution for the equation of the lifting surface in subsonic flow including tunnel effects,* INCAS Bulletin,3, 3, 35-44, 2011.

[6] Adrian Carabineanu, *Self-propulsion of oscillating wings in incompressible flow,* Int. J. Numer. Meth. Fluids 56, p. 1-21, Wiley InterScience, (2008).

[7] Adrian Carabineanu, L. Dragoş, R. Dumitrache, *A numerical solution for the equation of the lifting line including ground and tunnel effects,* Proceedings of Romanian Academy, Series A, Vol.9, No.3/2008, pp.1-7.

[8] Adrian Carabineanu, *Incompressible flow past an oscillatory wing. Self-propulsion effect,* in *Current topics in continuum mechanics* III, general editor Acad.L. Dragos, volume editor V. Tigoiu, Editura Academiei, 2006, ISBN 973-27-1348-8.

[9] Adrian Carabineanu, Al. Dumitrache *A numerical study of 2-D flow around a flapping airfoil,* Bulletin of the Transilvania University of Brasov, B, Supplement, tom 13(48), p. 125-142, 2006.

[10] Adrian Carabineanu, *Self-propulsion of an oscillatory wing including tunnel effects,* An. Univ. Bucureşti, Matematica, anul LV(2006), p.5-26.

[11] Adrian Carabineanu, *Self Propulsion of an Oscillatory Wing Including Ground Effects,* in *Mathematical Modelling of Environmental and Life Sciences Problems*, eds. Stelian Ion, Gabriela Marinoschi and Constantin Popa, ISBN (10)973-27-1358-5, Ed. Academiei Romane, 2006

[12] Adrian Carabineanu, *On the steady subsonic flow with circulation past the circular cylinder,* An. Univ. Bucureşti, Matematica, anul LIII(2004), p.201-208.

[13] Adrian Carabineanu, *Self-Propulsion of Aquatic Animals by Undalluatory or Oscillatory Motion,* in *Mathematical Modelling of Environmental and Life Sciences Problems*, eds. Stelian Ion, Gabriela Marinoschi and Constantin Popa, ISBN 973-27-1113-2, Ed. Academiei Romane, 2004

[14] Adrian Carabineanu, *Self-Propulsion of an Oscillatory Wing* XXI ICTAM, 15-21 August, Warsaw, Poland

[15] Adrian Carabineanu, *Supersonic flow past a grid of thin profiles,* Proc. Romanian Academy, Series A, Vol. 4, Nr. 2/2003, pp. 83-92.

[16] L. Dragoş, Adrian Carabineanu, *A numerical solution for the equation of the lifting surface in ground effects,* Comm. Numer. Meth. Engng. 18, 177-187 (2002).

[17] Adrian Carabineanu, L. Dragoş, *The supersonic flow past a thin profile including ground and tunnel- effects,* Zeit. Angew. Math. Mech. 82(2002) 9, 649-652.

[18] Adrian Carabineanu, *A class of aerodynamic profiles with cusped edges* Rev. Roum. Math. Pures Appl., 46(2001), 2-3, p. 225-233.

[19] Adrian Carabineanu, *Incompressible flow past oscillatory wings of low aspect ratio by the integral equations method,* Int. J. Numer. Meth. Engng. 45,1187-1201(1999)

[20] Adrian Carabineanu, L. Dragos *Numerical integration of the lifting line equation in ground effects,* Bul. Inst. Politehnic Iasi, Tome XLVI (L), Supplement, 2000, p. 11-14.

[21] Adrian Carabineanu, *Remarks on the solutions of the integral equation of thin profiles,* An. Univ. Bucureşti, Matematica, Anul XLIX (2000), nr. 2, pp. 117-126.

[22] Adrian Carabineanu, *An improved boundary element method for the 2d lifting airfoil problem,* Rev. d'analyse num. et de la theor. de rapproximation, Tome 28, No.1, 1999, pp. 3-14.

[23] Adrian Carabineanu, *A boundary integral equations approach for the study of the subsonic compressible flow past a cusped airfoil,* Nonlinear Anal.. 30 (1997). no. 6, 3449–3454.

[24] Adrian Carabineanu, *A boundary element approach to the study of 2d subsonic lifting flow past airfoils with sharp trailing edge,* Rev. Roum. Math. Pures. Appl.. 42(1997). 5-6, 383-400.

[25] Adrian Carabineanu, *A boundary element approach to the 2D potential flow problem around airfoils with cusped trailing edge,* Computer Meth. Appl. Mech. Engng. 129(1996) p.213-219.

[26] Adrian Carabineanu, V. Cardoş, *The application of the boundary element, method to the subsonic compressible flow past smooth profiles,* Rev. Roum. Sci. Techn. - Mec. Appl.,tome 41,nr.5-6, p.315-327, 1996.

[27] Adrian Carabineanu, *Fundamental solutions for the plane-parallel steady flow of incompressible perfectly conducting fluids past thin airfoils,* Rev. Roum. Math. Pures Appl. 40(1995), 3-4, p.279-288.

[28] Adrian Carabineanu, *Asupra mişcării plane subsonice in prezenta unei aripi subţiri in canal,* Stud. Cerc. Mat., tom 46, nr.4, p.423-440, 1994.

[29] Adrian Carabineanu, *Asupra mişcării subsonice staţionare in jurul obstacolului circular,* Stud. Cerc. Mat., tom 44, nr.3, p.205-216, 1992.

[30] Adrian Carabineanu, *Studiul mişcării subsonice in jurul unui obstacol eliptic,* Stud. Cerc. Mec. Apl., tom 51, nr.5, p.457-468, 1992.

[31] Adrian Carabineanu, L. Dragos, I. Oprea *The linearized theory for the submerged thin hydrofoil of infinite span* Arch. Mech., **43**(1990), 25.

[32] Adrian Carabineanu, L. Dragos *On steady subsonic flow past slender bodies of revolution,* Rev. Roum. Sci. Techn. - Mec. Appl.,tome 34, no.5, p.453-459, 1989.

[33] Adrian Carabineanu, *Aplicarea metodei transformărilor conforme in teoria aripii subţiri,* Stud. Cerc. Mec. Apl., tom 47, nr.l, 1988, p.25-28, 1988.

[34] Adrian Carabineanu, *The application of the hodograph method of successive approximations to the study of subsonic flow past an ellipse of small eccentricity,* Rev. Roum. Math. Pures et Appl., tome XXVII. No.4. p.437-442, 1982.

Jets and Free Boundary Problems

[35] Adrian Carabineanu, *A conformal mapping approach for investigating the free-boundary seepage from symmetric channels,* Complex Var. Elliptic Eq., Vol.60, Issue 9,1190-1204, 2015

[36] Adrian Carabineanu, *Free Boundary Seepage from Asymmetric Soil Channels,* Int. J. Math. Math. Sci., vol. 2012(2012).

[37] Adrian Carabineanu, *Water seepage through a permeable dam,* in *Mathematical Modelling of Environmental and Life Sciences Problems*, eds. Stelian Ion, Gabriela Marinoschi and Constantin Popa, ISBN 978-973-27-1903-9, Ed. Academiei Romane, 2010

[38] Adrian Carabineanu, *Free boundary seepage from open earthen channels,* Annals Univ. Bucharest (math, series), 2(LX),3-11, 2011.

[39] Adrian Carabineanu, *The free-boundary flow past an obstacle. Qualitative and numerical results,* Carpathian J. Math. (23) (2007),No. 1-2, p.53-62.

[40] Adrian Carabineanu, *Qualitative and numerical results concerning the problem of incompressible jets with curvilinear walls,* in *Current topics in continuum mechanics*, ed. Acad. L. Dragos, Editura Academiei, 2002, ISBN 973-27-0919-7.

[41] Adrian Carabineanu, Adelaida Honţuş *The Study of the Drainage of Underground Water by Means of the Complex Boundary Integrals Method,* in *Mathematical Modelling of Environmental and Life Sciences Problems*, eds. Stelian Ion, Gabriela Marinoschi and Constantin Popa, ISBN 973-27-1113-2, Ed. Academiei Romane, 2004

[42] Adrian Carabineanu, *Numerical and qualitative study of the problem of incompressible jets with curvilinear walls,* An. Univ. Bucureşti, Matematica, anul L(2001), nr. 1-2, pp, 37-44.

[43] Adrian Carabineanu, *A free boundary problem in porous media,* Rev. Roum. Math Pures Appl., 37 (1992),7, p.563-570.

[44] Adrian Carabineanu, *Asupra problem,ei jeturilor incompresibile cu pereţi curbilinii, II,* Stud. Cerc. Mat., tom 38, nr.2, p.91-106, 1986.

[45] Adrian Carabineanu, *Asupra problemei jeturilor incompresibile cu pereţi curbilinii, I,* Stud. Cerc. Mat., tom 37, nr.5, p.377-397, 1985.

[46] Adrian Carabineanu, *Contribuţii la studiul mişcarilor fluide cu suprafeţe libere,* Phd. Thesis, University of Bucharest, 1983

[47] Adrian Carabineanu, *Studiul unui jet asimetric si incompresibil,* Contribuţii ştiintifice Studenţeşti, lito, Univ. Bucuresti, 1976, p.28-33.

MHD Theory

[48] Adrian Carabineanu, *A simplified mathematical theory of MHD power generator* An. St. Univ. Ovidius Constanta, Vol. XXIII, (3), 29-40, 2015.

[49] Adrian Carabineanu, *Numerical calculation of the output power of a mhd generator,* INCAS BULLETIN, 6,4/2014, pp. 15-22.

[50] Adrian Carabineanu, E. Lungu, *Pseudospectral method for MHD pipe flow,* Int. J. Numer Meth. Engng. 68(2), p. 173-191, Wiley InterScience, (2006).

[51] Adrian Carabineanu, I. Oprea, *Boundary integrals method for the magnetohydrodynamic duct flow* Zeit. Angew. Math. Mech., 76(1996), So, p.95-96.

[52] Adrian Carabineanu, M. Gavrilescu *A new proof of the existence of weak solutions for the equations of magnetohydrodynamics,* Bul. Stiint. - Univ. Piteşti, Seria Mat. - Inf., Nr. 8(2002), pp. 31-42.

[53] Adrian Carabineanu, A. Dinu, I. Oprea, *The application of the boundary element method to the magnetohy- drodynamic duct flow,* Zeit. Angew. Math. Phys. 46, p.971-981, 1995.

[54] Adrian Carabineanu, *Mişcarea unui fluid perfect electroconductor in jurul unei aripi subţiri in prezenţa solului in câmp magnetic aliniat,* Stud. Cerc. Mec. Apl., tom 54, nr.l, p.9-20, 1995.

Crack Propragation

[55] N. Peride, Adrian Carabineanu, E.M. Craciun, *Mathematical modelling of the interface crack propagation in a pre-stressed fiber reinforced elastic composite,* Computational Materials Science, vol 45, 3(2009) p. 684-692.

[56] Adrian Carabineanu, N. Peride, E.Rapeanu, E.M. Craciun, *Mathematical modelling of the interface crack. A new improved numerical method,* Computational Materials Science, vol.46.3(2009), p.677-681.

[57] E.M. Craciun, Adrian carabineanu, N. Peride, *Antiplane interface crack in a pre-stressed fiber-reinforced elastic composite,*Computational Materials Science, 43 (2008). p.184-189.

[58] Adrian Carabineanu, E.M. Craciun, N. Peride, *Fracture analysis of an oblique crack propagation in a pre-stressed glass-epoxy composite,* Key Engng. Materials, vol. 385-387 (2008), p. 733-736.

[59] Adrian Carabineanu, E. Peride, E.M. Crăciun, L. Marsavina, *Mixed mode crack propagation in advanced materials,* J. Optoelectronics Advanced Materials. Vol. 10, No. IP 2008, p.2870-2875.

Boundary Element Method

[60] Adrian Carabineanu, *The study of the potential flow past a submerged hydrofoil by the complex boundary element method,* Engineering Analysis with Boundary Elements,39(2014) pp.23-35.

[61] Adrian Carabineanu, *A boundary element approach for the torsion of cylindrical bars,* An. St. Univ. Ovidius Constanta, Vol. 5, (1), 21-28, 1997.

[62] Adrian Carabineanu, *Boundary integral equation and its hydro dynamical interpretation,* Analele Univ. Bucureşti, Seria Matematică, Anul XLVI(1997), pp. 9-14.

[63] Adrian Carabineanu, A.Dinu, *The study of the incompressible flow past a smooth obstacle in a channel by the boundary element method,* Rev. Roum. Sci. Techn. - Mec. Appl., tome 38,no.6, p.601-616, 1993.

Miscellanea

[64] Adrian Carabineanu, N. Pop, S. Sburlan, *Probleme la limită în mecanica mecanica mediilor continue,* Valahia UniversityPress, Targoviste, 2011.

[65] Adrian Carabineanu, *A modified Seidel method for calculating the fixed points of contractive mappings,* Creat. Math. Inform., vol 17(2008) No. 3.

[66] Adrian Carabineanu, M. Iuga *Numerical solutions of some Hammerstein-type equations which appear in the theory of cavitations,* Bulletin of the Transilvania University of Brasov, B, Supplement, tom 13(48), p.203-215, 2006.

[67] Adrian Carabineanu, *Structuri de date,* Ed. Matrix Rom, Bucureşti, 2006, ISBN (10)973-755-068-4.

[68] Adrian Carabineanu, *Mecanică teoretică,* Editura Matrix Rom, Bucureşti, 2006,ISBN (10)973-755-102-8.

[69] Adrian Carabineanu, *Numerical method of drainage of underground water by narrow rectangular channels,* Bul. Stiint. - Univ. Piteşti, Seria Mat. - Inf., Nr. 9(2003).

[70] Adrian Carabineanu, *On Lagrange's equations of first kind in curvilinear coordinates,* Rev. Roum. Sci. Techn. - Mec. Appl., No.l, 2000, p. 13-21.

[71] Adrian Carabineanu, N. Markov, *Ecuaţii integrale neliniare in studiul mişcărilor fluide cu linii de discontinuitate,* Math. Reports (Stud. Cerc. Matern), tom 1(51), nr.3, p.359-377, 1999.

[72] Adrian Carabineanu, *O generalizare a teoremei lui Cetaev,* Stud. Cerc. Mec. Apl., tom 56,nr. 1-2, p.3-7,1997.

[73] Adrian Carabineanu, *Plemelj-like formulas for the integral representations of the solu tions of the steady 2D Stokes system,* Bull. Math. Soc. Sci. Math. Roum., Nouv. Ser. 41. No 2, 107-118(1997).

[74] Adrian Carabineanu, *O generalizare a distribuţiei parte finită (valoare principală in sensul lui Cauchy),* Stud. Cerc. Mat., tom 48, nr.5-6, p.295-302, 1996.

[75] Adrian Carabineanu, D. Bena, *Metoda transformărilor conforme pentru domenii vecine cu aplicaţii m mecanica fluidelor,* Ed. Academiei, 1993, ISBN 973-27-0353.

[76] Adrian Carabineanu, *Mişcarea uniformă de filtraţie in prezenţa unei cavităţi subţiri,* Stud. Cerc. Mec. Apl., tom 49, nr.l, p.19-25, 1990.

[77] Adrian Carabineanu, *Some applications of the spherical functions in the filtration theory,* Rev. Roum. Sci. Techn. -Mec. Appl., tome 31, no.l. p.53-62, 1986.

[78] Adrian Carabineanu, *Mişcarea apelor arteziene in prezenţa a doua puţuri semisferice,* Stud. Cerc. Mat., tom 34, nr.2, p.105-112,1982.

[79] Adrian Carabineanu, *Aplicarea unor teoreme variaţionale de reprezentare conformă la studiul mişcării subsonice in jurul unui cilindru circular,* Stud.Cerc.Mat. tom 33, nr.4, p.405-408, 1981.

[80] Adrian Carabineanu, *On the stability of the motion of a heavy gyroscope with a fixed point,* Supplement to volume IX, fasc.2, Analele Ştiinţifice ale Universităţii 'Ovidius', Constanta, Seria Matematica.