IN MEMORY OF HAIM BREZIS (1944–2024), A BRILLIANT MATHEMATICIAN WITH ROOTS IN ROMANIA

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1 Biographical sketch

Haim Brezis was born on June 1, 1944, in Riom–ès–Montagnes, a small town in Auvergne (France), and passed away on July 7, 2024, in Jerusalem. He was the son of a Romanian father, who had come to France in 1930, and a Jewish mother who had fled the Netherlands.

Note that Haim is a Hebrew name that means *life* or *living*, being associated with the idea of *vitality* and *energy*, and is often given as a wish for a long and healthy life. His last name, Brezis, is an abbreviation of a Hebrew sentence. He also signed some of his publications with the names Haïm Brezis or Haïm Brézis, but we will only use Haim Brezis here (as in his functional analysis book published by Springer in 2010, see below).

Haim Brezis earned his doctoral degree (doctorat d'état) in 1972 from Université de Paris, with two different theses, as was usual at that time in France, namely *Problèmes unilatéraux* (under the guidance of Gustave Choquet) and *Groupes de difféomorphismes et mouvement d'un fluide incompressible* (under the guidance of Jacques-Louis Lions). The subject of the first thesis belongs to pure mathematics, while the second thesis was oriented towards an applied topic.

In the following years, Haim Brezis dedicated his extraordinary talent especially to Nonlinear Analysis and to its applications in the study of Partial Differential Equations that govern processes that appear in modern science. He was and remains a prominent personality of the international mathematical community, renowned for deepening existent research directions, opening new important research directions, showing impeccable rigor, and involving

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his colleagues and students in outstanding research projects. For an idea about the scientific achievements of Haim Brezis, I recommend his page at mathscinet.ams.org

Haim Brezis was a professor at the Université *Pierre et Marie Curie* (Paris VI) from 1972 to 2008, when he became Professor Emeritus, and at the École Polytechnique in Paris from 1973 to 1985; he was also a Distinguished Visiting Professor at Rutgers University from 1987 to 2022, and a frequent visitor at the Technion – Israel Institute of Technology in Haifa from 2008 to 2022.

According to the *Mathematics Genealogy Project*, Professor Brezis had 58 PhD students, including 4 Romanian PhD students.

Brezis' scientific influence was strongly felt within the mathematical community in Paris, and beyond, due to his eminent role in the Brezis-Lions seminar on *Nonlinear Partial Differential Equations and Their Applications*, which was held on Friday afternoons at Collège de France from 1977 to 1990.

Aware of the importance of his scientific discoveries, Professor Brezis felt it was his sacred duty to share his mathematical knowledge with students and scientists everywhere through his lectures and communications. He had a special gift of presenting his significant results in a very engaging manner. He was also always open to cooperation with colleagues and students from around the world. In other words, he was a citizen of the whole mathematical world.

Haim Brezis' extraordinary achievements in mathematics have been recognized by numerous **awards and honors**, including:

Membership in academies

- 1988 Member, Académie des Sciences Paris
- 1989 Member, Academia Europaea
- 1993 Foreign member, Romanian Academy
- 1994 Foreign member, American Academy of Arts and Sciences
- 2000 Foreign member, Royal Academy of Sciences, Madrid
- 2002 Foreign member, Royal Academy of Sciences, Belgium
- 2003 Foreign member, National Academy of Sciences, USA
- 2010 Foreign member, Accademia dei Lincei, Rome
- 2019 Foreign member, Società Nazionale di Scienze, Lettre e Arti, Napoli

Honorary degrees

- 1996 Doctor Honoris Causa, Catholic University of Louvain-la Neuve
- 1998 Doctor Honoris Causa, Technion, Haifa
- 1999 Honorary Professor, Academia Sinica, Beijing
- 1999 Honorary Professor, Fudan University, Shanghai

• 2000 Doctor Honoris Causa, University of Bucharest
• 2001 Doctor Honoris Causa, Universidad Autonoma de Madrid
• 2002 Doctor Honoris Causa, University of Leiden
• 2005 Honorary Professor, Beijing Normal University
• 2006 Doctor Honoris Causa, SISSA (Scuola Intern. Sup. Studi Avanzati), Trieste
• 2010 Doctor Honoris Causa, University of Iași, Romania
• 2012 Honorary Member of the Royal Spanish Mathematical Society
• 2016 Doctor Honoris Causa, National Technical University, Athens

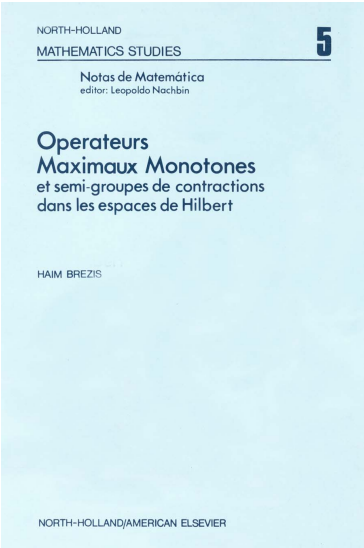
Prizes

• 1974 Prix Peccot, Collège de France
• 1976 Prix Carrière, Académie des Sciences Paris
• 1985 Prix Ampère, Grand Prix de l'Académie des Sciences Paris
• 1990 Prix Eugène Catalan, Académie Royale de Belgique
• 2001 Ky Fan Award of the American Mathematical Society
• 2024 AMS Leroy P. Steele Prize for Lifetime Achievement

2010 ***Chevalier de la Légion d'honneur***

2 My encounters with Professor Haim Brezis

I learned about Haim Brezis when I started working on my doctoral thesis (defended on January 16, 1981 at the *Alexandru Ioan Cuza* University in Iași, Romania). In those times, access to Western books and journals was very limited in Romania. However I managed to obtain a photocopy of Brezis' famous book titled *Opérateurs maximaux monotones et semi-groupes de contractions dans les éspaces de Hilbert*, North Holland, Amsterdam, 1973, which helped me progress and finish my PhD thesis quickly. Let me explain what the situation was like.



My formal advisor was Adolf Haimovici (1912–1993), Professor Emeritus at the *Alexandru Ioan Cuza* University in Iași, Romania, a renowned expert in the theory of differential equations. I remember that he appreciated my first manuscript and recommended it to Beniamino Segre

(1903–1977) for the journal *Atti Accad. Naz. Lincei Rend. Cl. Sci. Phys. Mat. Nat.* (see vol. 61 (1977), 565–570). That article was the first modest contribution to my upcoming PhD thesis. Unfortunately, Professor Haimovici advised me to continue my doctoral research under the guidance of an associate advisor, Professor Viorel Barbu from the *Alexandru Ioan Cuza* University. But Professor Barbu was only marginally involved, and we often disagreed on some mathematical matters (see, for example, my wikipedia page and my article in this volume issue).

Under those circumstances, Professor Brezis' book mentioned above provided me invaluable help, as it aligned well with my thesis topic, and so I was able to complete my PhD thesis quickly. I also had as sources of inspiration some articles authored or co-authored by Professor Brezis. So I can say that Professor Brezis was unknowingly a great remote advisor to me.

Before meeting Professor Haim Brezis in person, I exchanged several messages with him. In 1988 I sent him a copy of my book entitled *Nonlinear Evolution Equations and Applications*, D. Reidel, Dordrecht–Boston–Lancaster–Tokyo, 1988, and I received from him a letter expressing his appreciation for my book. That letter meant a lot to me, as I had heard how demanding Professor Brezis was.

The first time I met Professor Brezis in person was in 1994 at a conference held at the École Normale Supérieure in Paris. I was overwhelmed with emotion and barely managed to introduce myself to him. But Professor Brezis was very friendly with me and then we had a long conversation. Later that day, I gave him a manuscript, a joint Note with Professor Adrian Corduneanu from Iași (Romania), entitled *Une équation integro-différentielle de la theorie de la capillarité*, for possible publication in *Comptes Rendus Acad. Sci. Paris*. He read the paper the same day and accepted it.

Then, sometime in the following year (1995), I was unexpectedly informed by the French Cultural Center in Iași, Romania, of Professor Brezis' intention to visit our university, i.e., *Alexandru Ioan Cuza* University in Iași. I was very excited about the news and, in my capacity as Head of the Department of Differential Equations, I organized Brezis' presentation in the University Senate Hall. After his presentation and subsequent discussions, Professor Brezis proposed we go together the next day to Botoșani, a city in the Northern Romania, about 100 km from Iași, where his father had been born. It was only then that I found out that Botoșani was his father's hometown (it is close to my own hometown, Darabani). Professor Brezis knew the address of the house where his father had grown up, somewhere near the *Uspenia* Orthodox Church in the old center of Botoşani. So the next day we drove together to Botoșani. We reached his father's house, a

two-story building where we found a clothing store. I asked the owner to let Professor Brezis see the house. Later that day he said: "I don't have such a nice house in Paris!" On the same day, Professor Brezis visited a synagogue in Botoșani and two cemeteries in the city, where he spent a lot of time and discovered close relatives who had been buried there. He took many photos to show his father when he got home to Paris.

Later, in 2006, when I was Head of the Mathematics Department at Central European University (CEU) in Budapest, I proposed to Rector Yehuda Elkana (1934-2012) to appoint Haim Brezis as Distinguished Visiting Professor of CEU. So, in May 2006, Professor Brezis came on my invitation to CEU to deliver a lecture series on *Mathematical models occurring in liquid crystals and superconductors*.

I was introducing Prof. Haim Brezis to the audience

Prof. Haim Brezis starting his first lecture

I am attaching below the draft of Professor Brezis' report on his visit.

My first visit at CEU
by Haim Brezis

I spent the week May 1 - 7 2006 at CEU as Visiting Distinguished Professor at the invitation of the Head of the Mathematics Dept., Prof. G. Morosanu
I gave a series of lectures — every day two hours — on the topic of mathematical models occuring in liquid crystals and superconductors ~~This field~~ This subject has been an amazing source of new ideas. It has stimulated the development of new tools and has raised many new open problems. I explained the connections with numerous areas in mathematics: partial differential equations, calculus of variations, nonlinear functional analysis, singularities, degree theory, topology, Fourier

– 2 –

analysis, ~~etc...~~ graph theory, combinatorics, etc... The audience consisted of about 25 people: PhD students from CEU + (BME, Rényi Inst. in Budapest + Visitors at CEU (.....) Faculty and students from other ~~Dep~~ Universities. The atmosphere was very warm and friendly. There were plenty of questions and discussions, both from the faculty and the students. I also attended the Workshop ~~and~~ consisting of 5 lectures. I enjoyed the mathematical discussions with Professor Morosanu. I am impressed by the seriousness of the students and the ~~helpful~~ efficient staff. I look forward to future visits.

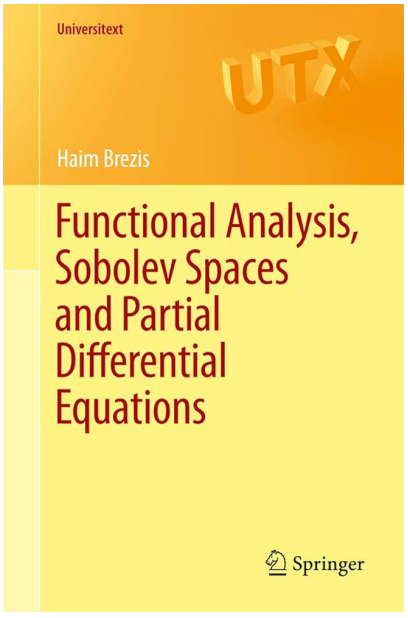
Haim Brezis

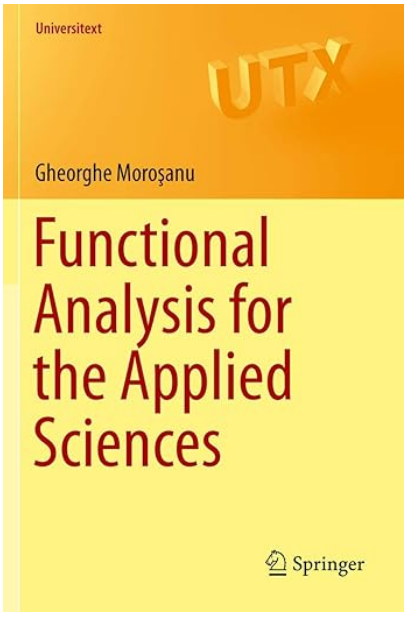
During that visit we discussed various topics, including mathematical ones. For example, I told him that I had learned about his appetite for solving open problems, including problems that seem trivial but actually aren't. He really liked my remark and told me a story about how he solved a seemingly trivial problem in cooperation with one of his collegues in Paris. Initially, that colleague thought he could solve the problem on the spot. He did not succeed, but promised he would fax Haim the solution the same day. The colleague was not able to solve the problem that day, nor in a week, nor in a month. Only later did they manage to solve the problem together!

Unfortunately, Professor Brezis could not come back to CEU Budapest in the following years.

I met Professor Brezis again later at Rutgers University while I was visiting my daughter Alina who studied there.

I would like to conclude this commemorative article by emphasizing that all of Brezis' writings have greatly influenced my work. However, I was particularly impressed by his book entitled *Functional Analysis, Sobolev Spaces and Partial Differential Equations*, Springer, 2010 (see below), an exceptional legacy left to the mathematical community. I was so impressed by this book that I decided to publish in the same *Universitext* series of Springer my own functional analysis lectures delivered during several years at Central European University in Budapest, in the form of a book titled *Functional Analysis for the Applied Sciences*, Springer, 2019 (see below).





The contents of the two books are different, even if their intersection is nonempty. Anyway, I would not risk a comparison!

Finally, I would like to say that I was very fortunate to have had the chance to meet Professor Haim Brezis, a great mathematician of modern times, with roots in my country.

The authors who have contributed to the present journal issue are pleased and honored to dedicate their papers to the memory of Professor Haim Brezis, in recognition and appreciation of his remarkable achievements in the field of mathematics.

Gheorghe Moroșanu