A tribute to Françoise Chatelin

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Françoise Chatelin

1941 – 2020

Tribute to Françoise Chatelin

➤ Françoise Chatelin receiced her Doctorate in 1971 (adviser: Prof. Noël Gastinel)

➤ The same year I started my doctoral studies with her as my advisor

➤ Note: Her father, Jean Laborde, along with Jean Kuntzman, Noël Gastinel, and a few others, were among the founders of IMAG. Her brother Jean-Marie Laborde is a world-renown mathematician in the area of Discrete Mathematics

➤ Context: Grenoble had a world class group in Numerical Analysis at the time.

Numerical Analysis in Grenoble in the 1970s

➤ A special mention of: Noël Gastinel, Françoise's advisor.

➤ Gastinel played a huge role in Grenoble's leadership in Numerical Linear Algebra in France and Europe

➤ A few other well-known Gastinel advisees:

Marc Atteia, François Robert, Jean-Claude Miellou, Jean-François Maitre, Claude Brezinski, ..

Noël Gastinel

[1925-1984]

➤ **Let us see what the math genealogy database says:**

https://genealogy.math.ndsu.nodak.edu/id.php?id=13701

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Francoise Chatelin

MathSciNet

Ph.D.   Université Joseph Fourier Grenoble I 1971

Dissertation: *Numerical methods for calculating eigenvalues and eigenvectors of a linear operator*

Mathematics Subject Classification: 65—Numerical analysis

Advisor 1: Noël Gastinel

Students:
Click here to see the students listed in chronological order.

Name	School	Year	Descendants
Ahues, Mario	Université Joseph Fourier Grenoble I	1983	9
d'Almeida, Maria Filomena	Universidade do Porto	1984	4
Emad, Nahid	Université Pierre-et-Marie-Curie - Paris VI	1989	1
Fraysse, Valerie	Institut National Polytechnique de Toulouse	1992	
Gratton, Serge			4
Saad, Yousef	Université Joseph Fourier Grenoble I	1983	12

According to our current on-line database, Francoise Chatelin has 6 students and 35 descendants.
We welcome any additional information.

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Noël Gastinel

[MathSciNet](#)

Ph.D.   Université Joseph Fourier Grenoble I 1960

Dissertation: *Matrices du second degré et normes générales en analyse numérique linéaire. Le théorème de Stone Weirstrass*

Mathematics Subject Classification: 65—Numerical analysis

Advisor: Jean Kuntzmann

Students:
Click here to see the students listed in chronological order.

Name	School	Year	Descendants
Attéia, Marc	Université Joseph Fourier Grenoble I	1966	46
Baranger, Jacques	Université Joseph Fourier Grenoble I	1973	18
Brezinski, Claude	Université Scientifique et Médiacale de Grenoble (University of Grenoble)	1971	30
Chatelin, Francoise	Université Joseph Fourier Grenoble I	1971	35
Coutaz, Joëlle	Université Joseph Fourier Grenoble I	1970	1
Della Dora, Jean	Université Joseph Fourier Grenoble I	1973	52
Lacolle, Bernard		1976	2
Miellou, Jean-Claude	Université Joseph Fourier Grenoble I	1970	11
Pouzet, Pierre	Université Louis Pasteur - Strasbourg I	1962	8
Robert, François	Université Joseph Fourier Grenoble I	1968	102

According to our current on-line database, Noël Gastinel has 10 students and 313 descendants.

Numerical Analysis in Grenoble in the 1970s

A few of the dominant research themes

➤ Matrix computations (broadly),

➤ Eigenvalue problems [matrices, operators], (F. Chatelin, ...)

➤ Norms, vector norms (F. Robert [vector-norms], Jean-François Maitre, Pham-Dinh Tao, ...). François Robert wins the very first Householder ('Gatlinburg') Prize awarded (1971).

➤ Finite elements (influenced by Concorde?) [Alain Poncet]

➤ Signal processing [Wolf]

➤ Iterative methods and chaotic iterations, Parallel asynchronos iterations. [Ahead of its time!] (Jean-Claude Miellou, ..)

➤ Cellular Automata, discrete iterations [F. Robert, M. Cosnard, M. Tchuente] A precursor of neural networks.. [Ahead of its time!]

➤ Approximation Theory, Splines (Marc Attéia, Pierre-Jean Laurent, ...)

➤ Theory of Algorithms, complexity [Lafon]

➤ Formal calculus (Jean Della-Dora, J.C. Lafon, ...)

➤ Acceleration methods [Claude Brezinski, J. Della-Dora, ...]

Research contributions of Françoise Chatelin

➤ Well represented by the books she published

Research contributions of Françoise Chatelin

Initial work: Linear Operators, their spectra, perturbation theory, solution of matrix eigenvalue problems.

1. Chatelin, F. Méthodes d'approximation des valeurs propres d'opérateurs linéaires dans un espace de Banach. I. Critère de stabilité. C. R. Hebd. Séances Acad. Sci. Ser. A 271, (1970)

2. Chatelin, F. II. Bornes d'erreur. C. R. Hebd. Seance. Acad. Sci. Ser. A 271, (1970)

3. Chatelin, F. Etude de la stabilité de méthodes d'approximation des éléments propres d'opérateurs linéaires. C. R. Hehd. Séances Acad. Sci. Ser. A 272, (1971).

4. Chatelin, F. Perturbation d'une matrice hermitienne ou normale.

Numer. Math. 17, (1971).

5. Chatelin, F. Etude de la continuité du spectre dun operateur lineaire. C. R. Hebd. Séances Acad. Sci. Ser. A 274, ... (1972)

6. Chatelin, F. Error bounds in QR and Jacobi algorithms applied to hermitian or normal matrices. In Information Processing 71, Vol. 2, North-Holland Publ.,Amsterdam. (1972)

7. Chatelin, F. Convergence of approximate methods to compute eigenelements of linear operators. SIAM J. Numer. Anal. 10, (1973).

8. Chatelin, F. La méthode de Galerkin. Ordre de convergence des éléments propres.C. R. Hebd. Séances Acad. Sci. Ser. A 278, (1975).

9. Chatelin, F. Numerical computation of the eigenelements of linear integral operators by iterations. SIAM J. Numer. Anal. 15,

(1978).

10. Chatelin, F. Sur les bornes d'erreur a posteriori pour les éléments propres d'opérateurs linéaires. Numer. Math. 32, (1979).

11. Chatelin, F. The spectral approximation of linear operators with applications to the computation of eigenelements of differential and integral operators. SIAM Rev. 23, (1981).

12. Chatelin, F., and Lebbar, R. The iterated projection solution for the Fredholm integral equation of second kind. J. Austral. Math. Soc. Ser. B 22, (Special issue) (1981).

13. Chatelin, F., and Lemordant, J. La méthode de Rayleigh-Ritz appliquée à des opérateurs différentiels elliptiques-ordres de convergence des éléments propres. Numer. Math. 23, (1975).

➤ **Part of this work is in her book:**

Spectral approximation of linear operators, Academic Press, 1984.

➤ **Major undertaking..**

➤ **A well known book. Reprinted as a 'SIAM classic' in 2011.**

"I am ashamed to say that when I first saw her book (...) – I think I was still a graduate student and had not heard of her — I thought the author was called François Chatelin – I guess I was blind sighted – somehow my brain could not associate a woman's name with the heavy math published in the prestigious hardback "black" series of Academic Press... what can I say.. "

Computer Science and Applied Mathematics

SPECTRAL APPROXIMATION OF LINEAR OPERATORS

Françoise Chatelin
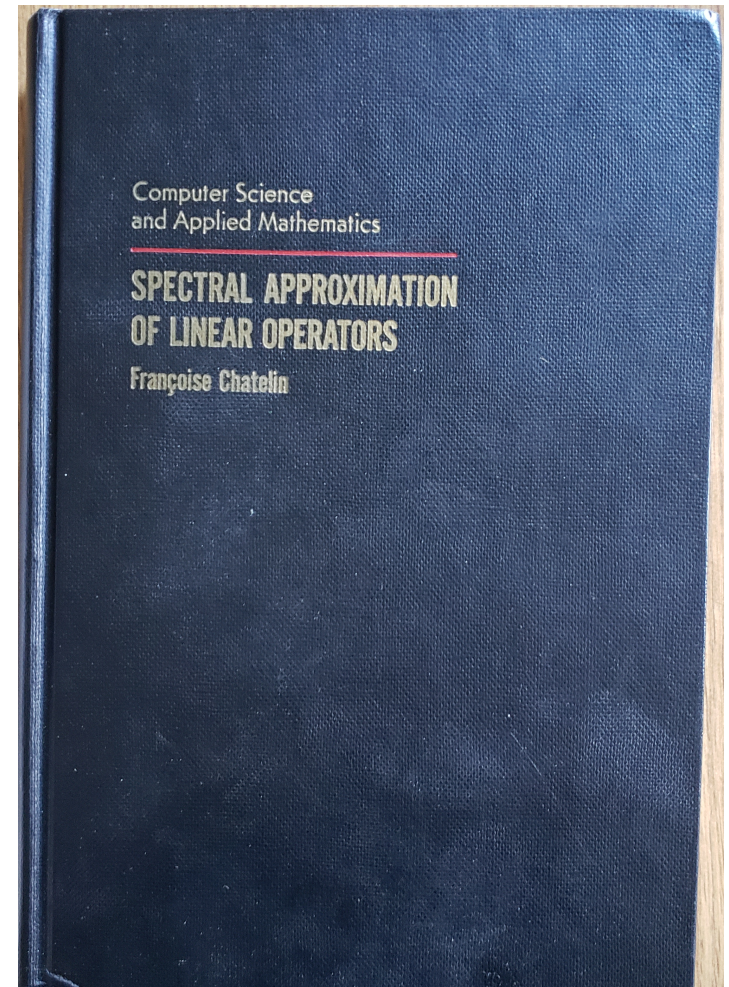
Research on Aggregation-type methods:

1. Chatelin, F. and Miranker, W. L. Acceleration by aggregation of successive approximation methods. Linear Algebra Appl. 43, 17-47.)1982).

2. Chatelin, F., and Miranker, W. L. Aggregation/disaggregation for eigenvalue problems. SIAM J. Numer. Anal., vol. 21, pp. 567-582 (1984).

Research in finite precision arithmetic:

➤ Started working on finite precision arithmetic in mid-1990s

➤ Co-authors: *Valérie Frayssé, Serge Graton, V. Toumazou, Thierry Braconnier, Marie-Christine Brunet, ...*

➤ Co-authored a (SIAM) book with Valérie Frayssé titled: "Lectures on Finite Precision Arithmetic"

Highlight: Françoise Chatelin's work on invariant subspaces

➤ Topic of great current interest

➤ Goal: Given $A \in \mathbb{R}^{n \times n}$ Compute $X \in \mathbb{R}^{n \times m}$ such that

$$AX = XB$$

where B is a certain matrix in $\mathbb{R}^{m \times m}$

➤ Columns of $X \equiv$ basis of an invariant subspace.

➤ Let $Z \in \mathbb{R}^{n \times m}$ such that

$$Z^H X = I$$

➤ Then $B = Z^H A X$. So – we need to find X, Z such that

$$\begin{cases} AX = X(Z^H A X) \\ Z^H X = I \end{cases}$$

➤ Idea: Use Newton's method

Invariant subspaces (continued)

➤ Define :

$$F(Y) : Y \to AY - Y(Z^H AY)$$

➤ Then Newton →

$$X_{k+1} = X_k - F'(X_k)^{-1} F(X_k)$$

With mapping $F' \equiv$ Frechet differential defined as:

$$F'(Y).E = (I - YZ^H)AE - E(Z^H AY)$$

➤ $\boxed{F'(X_k)E = -F(X_k)}$ is a Sylvester equation (in E)

➤ Quadratic convergence, existence of solution, ...

Article: F. Chatelin, *Simultaneous Newton's iterations for the eigenproblem*, Computing, Suppl., 5, 67-74. In Error Asymptotics and Defect Correction, Proc. Oberwolfach Conference. (1984)

➤ Several people later discovered similar schemes.

➤ Work is referenced in context of Grassmannian schemes for invariant subspaces – see, e.g.,

1. A. Edelman, T. A. Arias, and S. T. Smith, *The geometry of algorithms with orthogonality constraints*, SIAM J. Matrix Anal. Appl., 20 (1999), pp. 303–353.

2. P. A. Absil, R. Mahony and R. Sepulchre, *Riemannian Geometry of Grassmann Manifolds with a View on Algorithmic Computation*, Acta Applicandae Mathematicae, 80:199-220 (2004)

Concluding remarks

➤ Françoise Chatelin has had a strong influence by her work on

1 Approximation of linear operators

2 Finite precision arithmetic, and

3 Matrix algorithms

➤ Emerged from University of Grenoble to become a scholar with international stature

➤ Amazingly enthusiastic about new ideas & new ways of thinking. [In her final years, she touched on philosophical ideas, e.g., she authored book-chapters titled *"A computational journey into the mind"* and later: *"About the architecture of the human mind, a mathematical experiment"*]

➤ Very passionate about her work ...

➤ ... often expressed very strong opinions and this sometimes caused tensions

➤ Helped many of us with our careers. Also: A champion of women in mathematics, and in helping disadvantaged students, e.g., from under-developed countries

➤ May she rest in peace.