Curriculum vitae

MADAY Yvon.

Date and place of birth : May 20, 1957 at Saint Brieuc (22000) France.

Nationality : French.

Maried to Annick Maday, Four children (Charlotte, Marie Cécile, Agathe, Corentin).

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Current positions : Full professor at Université Pierre et Marie CURIE since October 1989,
Professor of « classe exceptionnelle » since september 2001
Visiting Professor at Brown University since september 2003
Consultant at ONERA

Current responsabilities :
Director of the Laboratoire Jacques Louis Lions (2001 -…)

Editor at Annales de l'Institut Henri Poincaré (C) Non Linear Analysis, Calcolo, CAMCoS, Journal of Scientific Computing, Maths in Actions,
Editor in chief of MathematicS In Action

Former main responsabilities

Director of the School of Doctoral Studies (1999 - 2004)
Department Head (1994-2001)
Director of the Scientific Council of the Math Department (2001 -2004)
Director of the Federal Institute in Maths (2005)
(that regroups all the labs of maths in university of Paris 6 and 7, about 1000 mathematiciens)
President of the board of deputies of the center for high computating of the ministry of research (1999 -2005)
President Smai (june 2004 - 2006)
Initiator and director of the CEMRACS

Award : Prix Blaise Pascal (Gamni-Smai) of theFrench Academy of Sciences in 1991.
Member of the European Academy od Sciences since 2003
Section lecturer, International Congress of Mathematicians, Madrid 2006

Former students

H. Vandeven (thèse de l'Université de Paris 6, 1987, 100%) CNRS on leave
B. Pernaud Thomas (thèse de l'Université de Paris 6, 1988, 100%) (Chief scientist at EDF)
E. Ronquist (PhD au MIT, 1988, Dir. A. T. Patera, 10%) (Prof at Trondheim)
C. Mavriplis (PhD au MIT, 1989, Dir. A. T. Patera, 10%) (Ass. Prof USA)
R. Munoz (thèse de l'Université de St Jacques de Compostelle, 1989, 100%) (Ass Prof St Jacques)
G. Anagnostou (PhD au MIT, 1990, Dir. A. T. Patera, 10%)
S.M.K. Ould (thèse de l'Université de Paris 6, 1991, 80%) (Ass Prof Paris 6)
N. Débit (thèse de l'Université de Paris 6, 1991, 100%) (Ass Prof Lyon)
F. Ben Belgacem (thèse de l'Université de Paris 6, 1992, 80%) (Ass Prof Toulouse)
K. Boukir (thèse de l'Université de Paris 6, 1993, 80%) (Scientist EDF)
J. Xu (thèse de l'Université de Paris 6, 1993, 100%) (Ass Prof Chine)
F. Devuyst (thèse de l'Université de Paris 6, 1994, 50%) (Professor Ecole Centrale Paris)
D. Errate (thèse de l'Université de Paris 6, 1995, 80%) (Ingeneer)
X. Louis (thèse de l'Université de Paris 6, 1995, 10%) (Ingeneer)
C. Lacourt (thèse de l'Université de Paris 6, 1997, 70%) (Ass Prof Versailles)
A Ben Mamoun (thèse de l'Université de Paris 6, 1997)(Ingeneer)
C. Grandmont (thèse de l'Université de Paris 6, 1998, 100%, Ass Prof Paris 9)
G. Bal (thèse de l'Université de Paris 6 1997 80%) (Ass. Prof Columbiasept 97)
L. Cazabeau (thèse de l'Université de Paris 6, 1997, 80%) (Ingeneer)
L. Emmel (thèse de l'Université de Paris 6, 1998, 80%) (post doc Turin)
V. Guimet (thèse de l'Université de Paris 6, 1998, 80%) (Ingeneer)
T. Boulmezaoud (thèse de l'Université de Paris 6, 1999, 50%) (Ass Prof Versailles)
F. Magoules (thèse de l'Université de Paris 6, 2000, 70%) (Ass Prof Nancy)
F. Rapetti (thèse de l'Université de Paris 6, 2000, 100%) (Ass Prof Nice)
G. Turinici (thèse de l'Université de Paris 6, 2000, 80%) (Full Prof Paris 9)
L. Baffico (thèse de l'Université de Paris 6, 2001, 50%) (Ass Prof Chili)
F. Lagoutière (thèse de l'Université de Paris 6, 200 1, 10%) (Ass Prof Paris 7)
P. Métier (thèse de l'Université de Paris 6, 2003, 80%) (Researcher CEA)
F. Legoll (thèse de l'Université de Paris 6, 2004, 50%) (Research Ingeneer)

J. Salomon (thèse de l'Université de Paris 6, 2005) (Ass Prof Paris9)
E. Delaveau (thèse de l'IPG, 2007, 30%)
N. Poussineau (thèse de l'Université de Paris 6, 2007, 100%)
P. Guerin (thèse de l'Université de Paris 6, 2007, 100%)

J.-D. Garaud(thèse de l'Université de Paris 6, defense expected in july 2008, 100%)
A. Pages (thèse de l'Université de Paris 6, end expected 2008, 100%)
A. Franchitti(thèse de l'Université de Paris 6, end expected 2008, 100%)
B. R. Chakir(thèse de l'Université de Paris 6, in progress, 100%)
C. R. Guetat(thèse de l'Université de Paris 6, in progress, 100%)
D. N. Morcos(thèse de l'Université de Paris 6, in progress, 100%)
E. G. Suarez(thèse de l'Université de Paris 6, in progress, 100%)

Books

- B1 - C. Bernardi, Y. Maday ``Approximation spectrales de problèmes aux limite elliptiques" Mathématiques et Applications, Springe r Verlag, Paris 1994.

- B2- C. Bernardi, Y. Maday ``Spectral Methods" Handbook of Numerical Analysis, P.G. Ciarlet et J.L. Lions eds. 1997

- B3 - C. Bernardi, M. Dauge, Y. Maday : Spectral Methods for Axisymmetric Domains, Series in Applied Maths, Ciarlet Lions eds, Editions Scientifiques et Médicales Elsevier, Paris, 1999.

-B4- E. Cances, M. De Franceschi, W. Kutzelneigg, C. Le Bris, Y. Maday : Computational quantum chemistry : a primer, Handbook of Numerical Analysis, P.G. Ciarlet C. Le Bris eds. 200 3

-B5- C. Bernardi, Y. Maday, F. Rapetti : Discretisations variationnelles de problèmes aux ,limites elliptiques, Mathématiques et Applications, Springer Verlag, Paris, vol 45 (2004).

-B6- E. Cances, C. Le Bris, Y. Maday : Méthodes mathématiques en chimi e quantique - Une introduction, Mathématiques et Applications, Springer Verlag, Paris (2005) translation in progress

Publications

-1- Y.Maday: Thèse de 3eme cycle à Paris 6 « Sur quelques propriétés des approximations par des méthodes spectrales dans les espaces de Sobolev à poids. Application à la résolution de problèmes non linéaires »

-2- Y.Maday; A.Quarteroni: « Approximation de l'équation de Burgers par méthodes spectrales » C.R.Acad.Sci. Paris 293-I, pp 143-146, 1981.

-3- Y.Maday; A.Quarteroni: « Approximation of Burgers' equation by pseudospectral methods » R.A.I.R.O. An. Num. 16, pp 375-404, 1982.

-4- Y.Maday; A.Quarteroni:``Legendre and Chebyshev spectral approximation of Burgers' equations `` Numer. Math. 37, pp 321-332, 1981.

-5- Y.Maday; A.Quarteroni:``Spectral and pseudospectral approximation of Navier -Stokes' equation `` SIAM J.Numer.Anal. 19, pp 761-780, 1982.

-6- G.H.Cottet; Y.Maday:``Hydrodynamic and cell division `` actes du colloque Rythms in Biology and other fields of application , Luminy 1981. Lecture notes in Biomathematics Spinger Verlag. Berlin, Heildelberg, New York, Tokio.

-7- C.Canuto; Y.Maday;A.Quarteroni:``Analysis of the combined Finite Element and Fourier Interpolation `` Numer.Math. 39, pp 205-220, 1982.

-8- Y.Maday; B.Metivet:``Estimation d'erreur pour l'approximation des équations de Stokes par une méthode spectrale ``La Rech.Aéro.4, pp 237-244, 1983.

-9- C.Canuto; Y.Maday;A.Quarteroni:``Combined Finite Element \& Spectral approximation of the Navier-Stokes' equations ``Numer.Math.44, pp 201-217, 1984.

-10- Y.Maday:``Analysis of Spectral operators in one dimensional domains ``Math. comput.1990 55, 192, pp 537, 562.

-11- Y.Maday; B.Metivet:``Chebyshev spectral approximation of Navier-Stokes' equation in a two dimentional domain `` M2AN 21 pp 93-123, 1986.

-12- C.Bernardi; Y.Maday; B.Metivet:``Spectral approximation of the periodic/ nonperiodic Navier - Stokes equations `` Numer.Math., pp 655 -700, 51, 1987.

-13- C.Bernardi; Y.Maday; B. Metivet:``Approximation des equations de Stokes par méthodes spectrales `` C.R.Acad.Sci. Paris 302 -I n∞4, pp 163-166, 1986.

-14- C.Bernardi; Y.Maday; B.Metivet:``Calcul de la pression dans la résolution spectrale du problème de Stokes `` La Rech.Aéro.pp 1-21, 1987.

-15- Y.Maday; B.Pernaud-Thomas; H.Vandeven:``Une tentative de rehabilitation des méthodes spectrales de type Laguerre `` La Rech.Aéro.pp 353 -375, 1985.

-16- K.Dang; Y.Maday; B.Pernaud-Thomas; H.Vandeven:``Mé\-thodes d'ajustement de choc pour l'approximation de problèmes hyperboliques par méthodes spectrales `` La Rech. Aéro. 1986.

-17- C.Bernardi; Y.Maday:``A staggered grid Spectral method for the Stokes problem ``Actes du 6∞ colloque International INRIA 1986.

-18- C.Bernardi; Y.Maday:``Propriétés de quelques espaces de Sobolev avec poids et application à la collocation de Tchebycheff `` C.R.Acad.Sci. Paris 303 -I , 1986 .

-19- C.Bernardi; Y.Maday:``Properties of some weighted Sobolev spaces and application to spectral approximation ``SIAM J. of Numer. Anal., 26, (1989) pp 769-829.

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-21- C.Bernardi; C.Canuto; Y.Maday :``Approximation of Navier -Stokes \break equations by a Chebyshev Collocation method `` Icase report no 86 -61.

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-23- Y.Maday;A.Quarteroni:``Approximation of the KdV equation by Spectral and pseudospectral method ``Icase report no 87-36, M2AN, 1988.

-24- C.Bernardi; Y.Maday: `` Analysis of a staggered grid algorithm for the Stokes equation`` Int. J. for Num. Meth. in Fluid 8, pp 537-557, 1988.

-25- C.Bernardi; N. Débit; Y.Maday: ``Couplage de methodes spectrales et d'Elements fini s: Premiers resultats `` C.R.Acad.Sci. Paris 305-I, pp 353-356, 1987.

-26- C.Bernardi; N. Débit; Y.Maday: `` Coupling spectral and Finite Element methods for the Laplace equation `` ICASE report 1987 , Math. Comput. 54-189 (1990) pp 21-41.

-27- Y.Maday; A.T.Patera `` Spectral element methods for the incompressibl;e Navier Stokes Equations `` in State of the art surveys in computational mechanics. Ed. A. NOOR, A.S.M.E (1989).

-28-Y.Maday: ``Contribution a l'Analyse Numerique des Methodes Spectrale s `` Thèse de Doctorat d'Etat ès Mathématiques Juillet 1987.

-29- C. Bègue, C.Bernardi; N. Débit; Y.Maday, G. Karniadakis; C. Mavriplis; A.T. Patera:``Nonconforming spectral element-finite element approximation for partial differential equations`` actes du colloque international Computing methods in applied sciences and engeneering R. Glowinski et J.L. Lions ed. 1987.

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-32- Y.Maday; A.T.Patera; E.M.Ronquist:``A well posed optimal spectral element approximation for the Stokes problem`` . Icase report no 87-48,

-33- C. Bernardi; Y. Maday; G. Sacchi-Landriani: `` Nonconforming matching conditions for coupling spectral and finit element methods `` Applied Numerical Mathematics, 1989/1990.

-34- C. Bernardi; Y. Maday `` Non conforming spectral element methods; Analysis of some projection operators `` Applied Numerical Mathematics, 1989 /1990.

-35- Y. Maday; E.Tadmor `` Analysis of the spectral vanishing viscosity method for periodic non -linear conservation laws `` SIAM J. of Numer Anal (1989),26, pp 854 -870

-36- Y.Maday; C. Mavriplis; A.T.Patera ``Non conforming mortar element m ethods: application to spectral discretizations.``Proceedings of the second International Conference on D.D.M. for P.D.E., T. Chan Ed. SIAM,Philadelphia.

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-46- C. Bernardi; Y. Maday; A.T. Patera ``A new nonconforming approach to domain decomposition: the mortar element method`` dans Nonlinear Partial Differential Equations and Their Applications, H.BREZIS and J.L. LIONS eds Pitman. 1994

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-52- Y. Maday: `` Méthodes spectrales pour l'app roximation numérique de l'équation de Navier -Stokes. Article de synthèse pour conf. Invitée au 22 Colloque National d'Analyse Numérique, Loctudy (1990).

-53- Y. Maday; V. Perrier; J.C. Ravel `` Adaptivité dynamique sur base d'ondelettes pour l'approximation d'équations aux dérivées partielles `` Note aux Comptes rendus de l'Académie des Sciences de Paris.312, série I, 1991, pp 405 -410.

-54-Y. Maday; D. Meiron; A.T. Patera; E.M.Ronquist: `` Analysis of iterative methods for the steady and unsteady Stokes problem: Application to spectral element discretizations `` SIAM J. of Stat. Comp.1993, 14,2 pp 310,337.

-55- C. Bernardi; V. Girault; Y. Maday `` Mixed spectral element approximation of the Navier Stokes equations in the stream-function and vorticity formulation `` IMA J. Numer. Anal. 12, No.4, 565-608 (1992)

-56- C. Bernardi; G. Coppoletta; Y. Maday ``Some Spectral Approximations of Multidimensional Fourth Order Problems `` Rapport interne du Laboratoire d'Analyse Numérique 90021, version abrég ée parue dans Math. Comput. 59, No.199, 63-76 (1992)

-57- Y. Maday: ``Résultats d'approximation optimaux pour les opérateurs d'interpolation polynomiale, Comptes rendus de l'Académie desSciences de Paris.312, série I (1991), pp 705/710

-58- C.Bernardi; Y.Maday: ``Polynomial interpolation results in Sobolev Spaces" J. Comp. and Aplied Math., special issue, Monegato ed, 1993.

-59- Y. Maday; A.T. Patera : ``A general Estimate for the thermal Time-to-Steady-State for a Solid Body Suddenly Immersed in a Fluid Stream. `` Journal of Heat Transfert.1992

-60- G. Anagnostou; Y. Maday; A. T. Patera:`` A Sliding Mesh Method for Partial Differential Equations in Nonstationary Geometries: Application to the Incompressible Navier-Stokes Equations.``

-61- Y. Maday; J.C. Ravel `` Adaptivité dynamique sur base d'ondelettes pour l'approximation d'équations aux dérivées partielles `` Comptes rendus de l'Académie des Sciences de Paris.315, série I (1992), pp 85/90

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-63- C. Bernardi; M. Dauge; Y. Maday `` Relèvement de traces préservant les polynomes `` Comptes rendus de l'Académie des Sciences de Paris. 315, I, (1992) 333-338.

-64-S. Bertholuzza, Y. Maday; J.C. Ravel `` Numerical analysis of the dynamically adative wavelet method for solving partial differential equations `` Comp. Methods in Applied Mathematics and Engineering 116 (1994), 293, 299.

-65-P. Joly, Y. Maday, V. Perrier `` Towards a Method for Solving Partial Differential Equations by Using Wavelet Packet Bases. `` Comp. Methods in Applied Mathematics and Engineering 116 (1994), 301, 307

-66- F. Ben Belgacem, Y.Maday `` A Spectral Element Methodology Tuned to Parallel Implementations `` Comp. Methods Applied Mech. and Eng. 116 (1994), 59 --67.

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-69- K. Boukir, Y. Maday, B. Metivet, ``A high order characteristics method for the incompressible Navier Stokes equations `` Comp. Methods in Applied Mathematics and Engineering 116 (1994), 211 218.

-70-F. Ben Belgacem, Y.Maday:`` Non-Conforming Spectral Element Method for Second Order Elliptic Problems in 3D , Est-West journal on Applied Math.4 (1993), 235 --251.

-71-D. Errate, M. Esteban, Y. Maday ``Couplage fluide-structure. Un modèle simplifié en dimension un. Note aux Comptes rendus de l'Académie des Sciences de Paris, 318, 1994, pp 275, 281..

-72- Y. Maday; D. Pavoni `` Spectral Element Approximation of Axisymetric Stokes Flows. `` a paraitre dans M3AS

-73- K. Boukir, Y. Maday, B. Meti vet, E. Razafindrakoto: ``A high order characteristic/Finite element method for the incompressible Navier-Stokes equations. `` Internat. J. Numer. Methods Fluids (1997), 25, 12, pp 1421-1454.

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- 75 - C. Bernardi; M. Dauge; Y. Maday ``Interpolation of nullspaces for polynomial approximation of divergence-free functions in a cube`` à paraitre dans les actes du colloque Singular functions and related topics, Costabel, Dauge Nicaise Eds 1994

-76- Y.Maday; A.T.Patera; E.M.Ronquist:`` The PN*PN -2 method for the approximation of the Stokes problem. Accepté dans Numer Math

-77- C. Ghaddar, Y. Maday; A.T. Patera : `` Analysis of a Part Design Procedure Numer. Math. (1995) 71, 4, pp 465-510.

-78- Achdou, Maday, Widlund : Sous-structuration pour la méthode des éléments avec joints, C. R. Acad. Sci. Paris (1996), 322, 2, pp 185-190.

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Rapid presentation of the scientific activity

Numerical Analysis

Spectral methods

A large part of my work has been dedicated to the numerical analysis of the spectral and pseudo spectral methods. The problems I have treated are general elliptic problems, the Navier Stokes equations (stationnary and unsteady) so as pro blems coming from the hyperbolic conservation laws. This includes also the combinaison with domain decomposition methods that has led to the spectral element approximation. All this has been synthetized in the following papers and books [27 -107-B1-B2-B3]. Among the most important contributions are the optimal analysis of full set of Sobolev projectors and interpolation operator the definition and analysis of the $P_N \times P_{N-2}$ method for the Stokes problem the analysis of the spectral element method the definiti on and analysis of the spectral vanishing viscosity method for non periodic problems the definition and analysis of the high order characteristic method for Navier Stokes the polynomial extension of polynomial traces the definition of rational filters

The mortar element method

In order to be able to either to couple different variational approximations or be able to treat some moving geometries of rotor staor types, we have invented a new concept : the mortar element method, that is very flexible and provides an optimal approximation. This concept has been proposed and analysed for a wide class of problems (Navier Stokes, shells and plates, Maxwell, bilaplacian..together with the coupling of different models) and has been forouthly analysed from the t heoretical and the algorithmic point of view. This approach has received a large attention and the major breakthrough is in the treatment of rotating geometries where we have been able to propose optimal and flexible approach. One of the main contribution is the simulation in 3D of magnetomechanical problems involving sliding interfaces. The analysis and implementations have performed for spectral, finite element, finite volume, wavelets discretization methods. The major contributions in this direction are [46-48-66-70-81-99-11-112-120-122-125-145-147-159]. A book on the subject is in preparation.

A posteriori analysis of outputs

The simulations of partial differential equations leads to the generally on the whole domain. Most often, users are only interested in some outputs (values in some points or integrated values) computed from te solution. From these values, decisions are then taken. The reliability on these outputs is the subject of an intesive reasearch with the group of A.T. Patera in MIT. Th is has led to the definition of a posteriori bounds for outputs where we are able to provide a optimal [104] lower bound and an upper bound on some of the outputs for a larger class of problems and discretizations. These include the finite element

approximations (elliptic [109], parabolic[165], Navier Stokes and eigenvalue problems [113]) together with reduced basis approximations [117-119] where the number of discrete functions to approximate the problem appears so small that an answer can be obtained in r eal time. The method is extended to general nonlinear problems [105] and an application to quantum chemistry has been even proposed and experienced with success [135-144]. In addition to the reliability in the results, this approach allows to define new reduce basis concepts [149-150-155] since the a posteriori validation comes at the end to certificate the approximation.

Parallelization

Domain decomposition

Domain decomposition methods has been extensively used in the litterature, my contributio n in the field has been a side product of the mortar element method since the approach allows to limit a lot the communication required between the subdomains and the speedup is thus increased [66]. The standard Schwarz approach has been extended and analy sed in this context and most of the results that are available on standard conforming discretizations are valid on nonconforming and composite approximations [78-99-147].

Parareal algorithm

Domain decomposition has been the major approach that has b een extensively analised to get a flexible method for the parallelization. The time direction has not received much attention, certainly due to the sequential intrisic nature of this variable. In [146], we have introduced a way to get parallelism in this direction as well and this approach has been tested on many problems and also has been combined with other iterative process such as optimal control [156] and domain decomposition [178]. The parallelization speedup allow for real time simulations for comple x problems such as the one encountered in chemistry [160] or in finances [152].

Analysis of coupled problems

Fluid- structure interaction

This is the model context for the coupling of phenomenon. When I started to work in this direction, there was not so many contributions in the field and in particular there was no theory on the well posedness of the coupled problem. The main difficulty comes from the fact that the domain where the fluid is living is itself an unknown. my contribution in the fi led has been to prove that in the case of rigid motions, the problem is well posed [121-126]. In particular we have been the first to put in evidence that the coupling of Stokes and elasticity may lead to instability but the same coupling of the

nonlinear Navier-Stokes model with elasticity has the a priori energy stability that are the first step for existence. Currently the situation on the existence is not closed and we are still working on this. Besides the analysis of the model, we have also focussed o n the discretization. We have proposed and analysed discretizations techniques both in space [96] and time [128]. We are currently working on the extension to be able to treat problems were the deformation of the structure leads to changes in the topology of the domain. We have also worked on the definition of models of structure where large rigid motions plus small prturbations are involved [157-164]. In [97-127] a survey of existing results and techniques is presented.

Others

In parallel to this model coupled problem, I have been working and still work on the following topics : magneto-mechanic [116-140-142] transport-diffusion in neutronics [148], more recently I have started to work on micro-macro simulations in material sciences and on magnetostri ctive problems.

Problems in life sciences

The Heart project

This item is actually the back-bone for my interest into fluid structure interaction. The modelling for the circulation system is a very large task on which a lot of teams are worki ng. Among the very numerous phenomenon that have to be taken into account, at the macroscopic level at least, appear the electric excitation of the heart through the Fitzhug Nagumo equations, the coupling of the electric and the elastic part and finally t he coupling with the fluid simulation. Three thesis are in development under my supervision on this matter, including collaboration with cardiologist at the hospital

The Lung project

This is a new direction for the research that has been initiated t hrough a scientific project « le-poumon-vous-dis-je » and gives rise to many interesting mathematical problems such as fractal homogeneization multiphysics homogeneization model reduction

Problems in quantum chemistry

This last item corresponds to a rather recent orinetation of my work. I have get interested in the numerical analysis of the methods and approaches in the field of quantum chemistry. The purpose has been to understand in particular the reason why the LCAO discretzation is converging a nd also the rate of convergence. A paper is in progress on this difficult problem. Another aspect is in the definition of tools that allows the chemists to get certainty in their computations. We have thus proposed a posteriori error tools (error bars and estimations of the energy) both on the Hartree Fock model [144] and the nuclear Shrodinger equations [102-145]. We are also proposing new methods of discretization that may allow for more rapid algorithms and simulations [149]. One other direction is to pr opose new algorithms for the control of chemical reactions. We have proposed bothy new approaches [167] so as parallelisation of current approaches [160-166]. We have also written an extended survey paper on the models, results and discretization of the p roblems that are encountered in this domains in the handbook of numerical analysis [B4] and a book [B6]