

Network PDE, Modelling and Control

**MAJOR ACHIEVEMENTS
(1999-2009)**

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MAJOR ACHIEVEMENTS OF NETWORK
PDE MODELLING AND CONTROL FROM 1999 to 2009

A- Summary of network research activities

Network "**PDE, Modelling and Control**" were constituted in May 1999. It gathers researchers in mathematics from Senegal, Mauritania and Burkina Faso. These researchers belong to Computer Science and Numerical Analysis Laboratory (LANI) of Saint-Louis in Senegal, the Mathematical Analysis Laboratory of Equations (LAME) Ouagadougou in Burkina and the Group of Research on Differential Equations (GRED) of Nouakchott in Mauritania. Pr Adou Kablan Jerome research group on fluid mechanics of University d'Abidjan Cocody in Ivory Cost joined the Network. The network was made up in order to promote a sub-regional critical mass of active mathematics researchers, in the field of the PDE, Modelling and Control, and maintains a very good joint links with the international scientific community. It contributes to intensify the doctoral program in applied mathematics, which still exists now, in universities of Saint-Louis and Ouagadougou. It maintains a very good management of young researchers, in that area. Our aim is also to maintain in that Sub-Saharan region, very active scientists, to overcome their isolation and to fight again brain-drain, instead off to develop, a regional tradition of research in the universities part of this program, we organize fort that, schools and annual meetings (workshops). Each year we may organize workshops, regional meetings, conferences and doctoral school of researchers within the region.

We intend to train more students in doctoral program in Saint Louis du Senegal and in Ouagadougou (Burkina Faso). We are starting a new master and doctoral training in Nouakchott. For that purpose, we need to support post graduate students, and involve them in research training program in activities of the network, throughout the region. Our aim is to build research capacity in our universities in applied mathematics. The aim is also to arrange short visits of scientist's part of the network or outside it, in the laboratories members of the network and abroad. The visiting scientists will have to give doctoral course, seminar and to contribute in training of researchers.

Since his foundation in 1999, our Network had administrative assistance and local facilities from our universities, University Gaston Berger, Ouagadougou University and Nouakchott University. The high management of theses universities, Vice-Chancellors, Dean of Faculty and Head of Mathematics department give as local facilities. They are strongly involved to support activities when they are organized in their universities. We begin to have little support from the private sector in Senegal.

In 2003 we organized in Saint Louis the first International Conference on Mathematics and Applications to Development Problems in Sahel. The second International Conference on take place in Ouagadougou, Burkina Faso from 20 to 26 November 2006. Our goal is to have such type of International Conference each three years such as to give opportunity to researchers in the Network and in the region to present their own results.

The research carried in the network, mainly concern, the following area:

- nonlinear PDE (degenerate, critical power,)
- singularities (domain with corners ...)
- control of systems
- modelling advanced salted bevel and digital simulation,
- ground water pollution starting from irrigated perimeters and urban centers,
- polluted water discharge in since basins,
- mathematical models of ecology and epidemiology
- modelling human infectious with mycobacterium (tuberculosis, malaria...)
- mathematics of infectious diseases (Malaria, Rift valley fever...)
- demographic models of fish, forest and animal resources.

These subjects are very relevant for the Sub-Saharan region of Africa.

B- Doctoral programme and research training

Activity of research training within the network has been intensified. It gathers each year more students, PhD students and researchers. By taking support on the problems of development of Africa Sub-Sahara, the Network, EDP, Modeling and Control is thus spirit to patiently build capacity of an active and dynamic research.

The network support boss local PhD training and Sandwich PhD programme. From 1999 to august 2009, twenty nine (29) PhD theses have been defended: 3 habilitation , 4 local training, 22 Sandwich programme. According to publications (see details in appendix), seven (59) articles has been published in international journal, three (3) in regional journal, three (3) in national journal, that is a total of sixty five (65) publications.

From the sessions of the African Council for Tertiary Education (CAMES) , which evaluate the teachers of most African Francophone Countries, the members of the network got the following qualifications: 2 Full Professor , 8 Professor , 15 Assistant Professor. All the assistant professors and six (6) professors defended their PhD during this period within the network.

C- WORKSHOPS AND CONFERENCES

We organize each year workshop involving members of network and colleagues within the region. We also organize conferences with partners involving researchers in the continent, lectures and participants from elsewhere. We will outline in the following workshops and conferences organize the last three years, by the network with different partnerships.

Mathematical models and Data-processing of Water and Sand (MOMIES), Saint-Louis, March 20 -24, 2006: Burkina Faso, Ivory Coast, Cameroon, Benin, Mali, Mauritania, Senegal, France. Celebration of Water world day and open doors of the LANI. Wednesday March 22, 2006 in the Chambre de Commerce of Saint-Louis

Workshop in scientific computation 19-22 March 2007 with 41 participant.

Workshop digital simulation, Ouagadougou, November 22 -24, 2006.

11th Conference Mathematics and Applications to development problems in Sahel. From 27 November to 2 December 2006, , Ouagadougou, Burkina Faso.

A total of twenty-seven lectures of forty to fifty minutes were given, covering the following scientific topics: Control and stabilization, Numerical analyzes and simulation, Mathematical modelling (in biology, water resources management, environment...), Mechanical of the polyphases mediums. All these fields utilized Ordinary Differential Equations or Partial Differential Equations which constitute the central topic of the conference. Few lectures were related to mathematics finance and statistics. The talks were of a very good scientific level. They were subject of animated scientific discussions. It seems to us that the quality of scientific contents of the conferences represents the emergence of an active mathematical community in our region, particularly in the field of the PDE and their applications to the problems of development in the Sahel.

CIMPA School 11-24 July 2005, Nouadhibou (Mauritania) on Modelling and Mathematical tools for fishing regulation. (For details see full report on CIMPA website).

Workshop Mathematical Models and Data processing of Water and Sand (MOMIES), International Workshop on Scientific computation March 19-22, 2007

The lecturers and participants came from several countries: Burkina Faso (03), Ivory Coast (02), France (03), Mauritania (03) and Senegal (30). The Senegalese participation includes in particular academics of the University Sheick Anta Diop, University Gaston Berger of Saint-Louis, Thiès University of and SAED Company. The participants are PhD students, teacher, researchers and workers.

Conference in honor of Prof Claude Lobry

Université Gaston Berger de Saint Louis ; 10 - 14 September 2007

This scientific conference was in the image of scientific contributions of Claude Lobry. The mains topics approached during about forty communications, reflect the contributions of Claude Lobry which were not only multiform and on various fields , but he was often a nonconformist precursor in a number of activities:

- Control theory of control,
- Mathematics and control theory,
- Singular perturbations, in bifurcation, non standard analysis,
- Interactions between Biology, Mathematics, Computer science
- Population dynamics, Ecology and Environment,
- Modeling, Epistemology, Philosophy of Sciences;

Some talks were related to PDE, Complex analysis and financial mathematics.

More than eighty participants with a keen interest followed the conferences; Many conferences gave a description of the state of art in the concerned fields. More than fifty participants came from abroad, from Europe (Belgium, France, Poland, Portugal, Sweden, Switzerland), from Africa (Benin, Burkina, Cameroon, Congo Brazaville, Gabon, Morocco, Mauritania, Niger, Chad, Tunisia), and from Japan. The remainder was coming from host country host Senegal. That is in direct connation of excellent relationships maintained by Professor Claude Lobry

within the international scientific community, on all the continents and in all the countries, particularly in Africa.

Conference in honor of Professor Claude Lobry was at the same time a high level scientific conference and a meeting of friendship and fraternity between men.

Ith African Research Conference in Applied Mathematics, Ouagadougou 12-17 November 2007: CARMA is a biannual forum for the promotion of applied mathematics in Africa. It concerns the mathematicians working on questions of development and those interested by the promotion of use of mathematics for resolution of such problem

The inaugural conference was given by Dr. Souley Kane from Gaston Berger University of Saint Louis on "Model of porous media deformable environments ". It is noted that Notice that, the lecturer is one of the shining doctor trained within Network EDP.

A whole of twenty three lectures of thirty to forty minutes were given. These lectures covered a wide spread of scientific topics like: control and stabilization, numerical analyzes and digital simulation, mathematical modeling (in biology, management of water, environment...), dynamical systems, optimization , mechanics of the polyphazes media. Some lectures were related to operational research and complex analyses.

Six lectures were given by young researchers who have just finished their theses and got a fixed position in Africa. Eight presentations were given by PhD. The talks were of a very good scientific level. They give occasion for of scientific discussions animated and going to the bottom of the raised problems.

The conference was followed assiduously by around fifty participants, including eighteenth (18) lecturers from abroad, namely: Benin (1), Cameroun (2), Ivory Coast (1), France (2), Antilles (1), Mali (1), Morocco (3), Niger (1), Senegal (4), Togo (1) and Tunisia (1).

Workshop on Nonlinear Analysis and PDE Nouakchott 4-14 August 2008.
Nouakchott-Mauritania.

The topics covered were:

- Functional analysis by Professors Mohamed Oudadess (Morocco) and Ahmed Ould Bahya (Nouakchott)
- Theory of PDE by Professors A. Sene (Senegal) and Isselkou Ould Ahmed Izid Bih (Nouakchott)
- Morse theory and applications to PDE by Hicham Chtoui (Tunisia)
- Evolutions equations by professors S.Ouaro (Burkina) and K. Ezzinbi (Morocco),
- Scientific computing by Mohamed Ould Henoune (Nouakchott),
- Minimax method and variationnelle calculus by Mohameden Ould Ahmedou (Germany).

The workshop has been attended by 31 participants coming mainly from Burkina, Mauritania, Senegal, Morocco and Tunisia. Participants give a total of 9 shorts talk about their research result. It has been very successful. "

WEST AFRICAN TRAINING SCHOOL ECOLE DOCTORALE OUEST AFRICAINE (WATS)

WEST AFRICAN TRAINING SCHOOL has just completed its three years cycle this 30 September 2005 in Saint-Louis. Eighteenth students followed a 24 weeks training of 360 hours courses and 240 hours of tutorial, during eight weeks each year from September to August since 2003. This training was on four sets of fields: real analysis; functional analysis; ordinary differential equations (ODE); partial differential equations (PDE), optimization and digital simulation.

WATS have been set up by: Prof. F.K.A Allotey SAPAM President, Director Math Institute Ghana, Prof. Hamidou Toure Network Coordinator, Prof Charles Chidume and Prof Claude Lobry.

WATS students could reinforce their training in the wide field of analysis directed towards differential equations, associated area of control and numerical methods. The courses started on the basis of a level of master degree (master1) until it reached the level of PhD and research training the last year. Thanks to this training school formation, WATS students had a good background to hold classes at university level and to carry out their own research in view to obtain their PhD thesis.

These three years were mainly devoted to build a strong culture of analysis for young universities teachers coming from French-speaking and English-speaking countries of West Africa.

This experience enables us to consider the next steps of WATS in a more flexible form. The duration of WATS will be shorter and the training is especially completely directed on research bases. It is a question of gathering, students of Africa South of Sahara, during four weeks on the set of research subject on which they work or plan to work. The training will supplement their knowledge in theses set of research fields, bring a support and a methodological follow-up to them. It will also put them in relationships and synergy with active researchers in theses fields within Africa and outside Africa.

WATS ORGANISATION

Each year a topic is defined in the field of real analysis, functional analysis, ordinary differential equations, partial differential equations, modelling, optimization and control, mathematical economy, numerical methods, scientific computation and digital simulation, theoretical data processing and more generally of applied mathematics.

WATS will take place during four weeks, divided into two periods of two weeks each. During each period, will be given twenty (20) hours of courses, fifteen (15) hours of workshop. During the four weeks the participant will prepare and give small talk of one hour each, which make fifteen (15) hours of talks at a rate of one hour per students. Home work is evaluated eighty (80) hours per students.

Course: two specialists deliver each one a course of ten (10) hours

Workshop: Students will be divided into five small groups of three students; each group carries out a small research project with the follow-up of an African researcher specialist in the field. These small projects will be supervised by two specialists.

Small talk: Each student will have a one presentation to make on the results obtained in the projects, in each groups.

Home work: During the four weeks a detailed attention will be made with the share of personal work which each student must make.

The WATS will include twenty four (24) participants:

- fifteen (15) students with their subject of PhD thesis is in the set of fields or wishing to work in that fields ;
- five (05) African researchers having their PhD in the set of subject able to follow-up the students in the realization of a project;
- four (04) specialists in international level, which will work by binomial during each period; they will supervise the workshops, and the five young African researchers in the field.

OBJECTIVE

- To develop and reinforce capacity of research of the PhD students;
- To develop the capacities of research training;
- To develop team spirit and the aptitudes of working in groups;
- To support networking of African researchers and the constitution of research working groups in some applied mathematics subjects;
- To increase the number of African researchers publications of international level in the field.

NETWORK PDE-MODELING AND CONTROL
PhD Theses defended 1999 - August 2009

Defence 1999

1. **Abdou SENE**, Analyse Asymptotique des plaques piezo-electriques et contrôlabilité exacte. Co-direction M. T. Niane-Annie Raoult, Grenoble1 Joseph Fourier. Soutenue en janvier1999.

Defence 2001

2. **Ouaro Stanislas**, Etude de problèmes elliptique paraboliques non linéaires en une dimension d'espace. Université de Ouagadougou, 29/11/2001(Doctorat Unique). Direction H. Touré
3. **Abdoulaye Sène**, Calcul de singularité pour l'équation de la chaleur et contrôlabilité exacte de l'équation des plaques pour des données peu régulières. Université de Saint Louis, 26/07/2001(Doctorat de 3ème Cycle). Direction M. T. Niane.
4. **Mohamed Maliki**, Solutions faibles pour des problèmes paraboliques fortement dégénérés. Université de Rabat, 07/07/2001(Doctorat d'Etat).

Defence 2002

5. **Idrissa Ly**, Résultat d'existence en optimisation de forme et étude d'un problème extérieur à frontière libre: cas du p-Laplacien, Université de Saint Louis, 2002 (Doctorat de 3èmeCycle). Direction M. T. Niane.

Defence 2003

6. **Mamadou Sy**, Paramétrisation en Mécanique des fluides : Analyse Mathématiques de quelques modèles. Doctorat de Troisième Cycle de Mathématiques Appliquées. Université Gaston Berger, de Saint Louis, soutenu le 15 Décembre 2003. Co-direction M. T. Niane- Didier Bresch.
7. **Cheikh Talibouya Diop** Etude et mise en œuvre des aspects itératifs de l'extraction des règles d'association dans une base de données,. Doctorat d'Informatique de l'Université de Tours, soutenu le 8 Décembre 2003.
8. **Mamadou Abdoul Diop**, Equations aux dérivées partielles stochastiques et homogénéisation.. Docorat de Mathématiques de l'Université Aix-Marseille I, soutenu le 6 Octobre 2003. Direction M.T. Niane.
9. **Ayitchéou Judicael Deguenon** , Observateurs des systèmes anti-adjoints de dimension infinie et applications. Doctorat de l'Université de Metz, soutenu le 20 Octobre 2003. Co-direction H Touré- Cheng-Zhong Xu.

Defence 2004

10. **Abdoua Tchouso**, Etude de la stabilité asymptotique de quelques modèles de transfert de chaleur, Doctorat de l'Université Claude Bernard Lyon I, soutenu le 24 Juin 2004. Co-direction H Touré- Cheng-Zhong Xu.
11. **Ngalla Djitte**, Systèmes différentiels extérieurs et applications aux problèmes inverses. Doctorat de l'Université Paris IX-Dauphine, soutenu le 12 juillet 2004. Co-direction M. T. Niane-Ekland.

Defence 2005

12. **Mamadou Sy**, Effets des termes diffusifs sur des modèles diphasiques et un modèle géophysique, Université Blaise Pascal, Clermont-Ferrand, 2005. Codirection M.T. Niane-Didier Bresch.
13. **Soulèye Khane**, Analyse Mathématique et simulation numérique de modèles d'écoulement de fluides incompressibles en surface libre et milieux poreux déformable, 2005. Université de Neuchâtel, Codirection M.T. Niane-Olivier Besson.
14. **Abdou Khadry Dramé**, Modélisation et analyse de procédés biologiques : application à la dépollution des eaux. Théorie des systèmes asymptotiquement autonomes, 2005. Université de Montpellier II, Codirection M.T. Niane- Claude Lobry.

Defence 2006

15. **Abdoulaye Sène** (These d'Etat): Stabilization of a thermoelastic system, exact controllability of wave equations, Université de Dakar, February 18, 2006.
16. **Papa Ibrahima Ndiaye**: Modelling dynamics of mosquitos Aedes in Sahelian region. Example of Aedes vexans arabiensis example, vectors of rift valley fever, University of Metz December 2006. Codirection M.T. Niane- Dominique Bicout-Gauthier Sallet.

Defence 2007

17. **David Célestin FAYE**, *Médiation de données sémantique dans SenPeer, un système pair à partir de gestion de données*, 22 Octobre 2007, Université de Nantes.
18. **Ousmane THIARE**, *Exclusion mutuelle de groupes dans les systèmes distribués : application aux réseaux mobiles ad hoc*, 25 juin 2007, Université de Cergy Pontoise.

19. **Mariama N'DIAYE DIAKHABY**, Contrôle et Stabilisation dans les canaux d'irrigation avec ou sans prélèvements, Université Gaston Berger de Saint-Louis, 2007.
20. **Oumar Diop**, Détection de nuages de poussière dans les images Météosat à l'aide des attributs de textures et de la fusion de segmentations : application à la zone sahélienne du continent africain. Université de Rennes.
21. **Oumar Niang**, Décomposition Modale Empirique : Contribution à la modélisation et applications en traitement du signal et de l'image. Université de Paris XII. Codirection MT Niane-J. Lemoine.
22. **OKOU H.** : Analyse asymptotique des ondes inertielles d'un fluide en rotation rapide dans un tore. Thèse de Doctorat de l'Université de Cocody Abidjan soutenue le 7 Novembre 2007. Direction Adou Kablan Jérôme.
23. **KONAN N. A.** : Modélisation numérique stochastique des rebonds des particules sur parois rugueuses. Thèse de Doctorat de l'Institut National Polytechnique de Toulouse soutenue le 9 Décembre 2007.
24. **Dr Idrissa Ly** (These d'Etat): Problèmes a phases et spectraux en optimisation de forme, Université Cheick Anta Diop de Dakar, 15 décembre 2007

Defence 2008

25. **Diène Ngom** : soutenue le 15 décembre 2008 à Saint Louis « *Observation et Régulation de Certains Modèles Discrets d'Ecosystèmes* ». Codirection : Abdérahmane Iggidr, Mary Teuw Niane.
26. **Zabsonre Jean de Dieu** : PhD « Modèles visqueux en sédimentation et stratification : obtention formelle, stabilité théorique et schémas volumes finis bien équilibrés » 24 Juillet 2008 ; Université de Savoie ; Codirection D. Bresch, E. Fernandez-Nieto, H. Touré.

Defence until August 2009

27. ²² **Aboudramane GUIRO**, Sur quelques problèmes d'observateurs Applications à certains modèles d'écosystème aquatique , 12 Mars 2009, Codirection H Touré- Abderrahman IGGIDR, INRIA-Université de Metz, France.
28. **Adama OUEDRAOGO**, Solutions renormalisées pour des problèmes paraboliques fortement dégénérés : cas isotrope et non isotrope, 14 Mars 2009 Codirection H Touré-Mohamed Maliki, Université Hassan II de Mohammedia, Maroc.
29. **KAMARA Fatou épouse SANGARE** Doctorat de l'Université Gaston Berger de Saint Louis soutenue le 04 février 2009.

NETWORK PDE-MODELING AND CONTROL
List of Publications (2001 – August 2009)

Publications 2001

1. Modelling of piezo electric static thin plates; Abdou Sène, *Asymptotic Anal.* 25, n°1,1-20 (2001)
2. Etude d'un problème à frontière libre pour le p-Laplacien, Idrissa Ly, Diaraf Seck, *C. R. Acad. Sc. Paris*, t.332, Série I, p.899-902, 2001.
3. Critical Boundary Constants and Pohozaev Identity, Ould Ahmed Izid-Bih Isselkou, *Ann. Fac. Sci. Toulouse*, n°1, Vol 10 (2001).
4. Dépendance continue de solutions généralisées locales, Mohamed Maliki, Hamidou Touré, *Ann. Fac. Sci. Toulouse* ; Vol. X n°4, 2001, p.701-711.

Publications 2002

5. Sur un problème de type elliptique-parabolique non linéaire, Ouaro Stanislas, Hamidou Touré, *C.R. Acad. Sc. Paris*, t. 334, Série I, (2002) p. 27-30.
6. Mary Teuw Niane and Abdoulaye Sene, Sur la contrôlabilité exacte de l'équation des plaques vibrantes. *Revista Matematica Complutense* 15, N°2, 619-629 (2002).
7. Etude d'une équation elliptique associée à un problème de type elliptique-parabolique non linéaire, Ouaro Stanislas, Hamidou Touré, *Afrika Matematika*, Serie 3,vol 13 (2002) p13-34.
8. On Subgradients of spectral functions. Sado Traore and Marc Ciligot-Travain, *J.Convex Analysis*, V 9 (2002), n° 2,1-14.

Publications 2003

9. Convection in rotating porous media: The planetary geostrophic equations, used in geophysical fluid dynamics, revisited. Mamadou Sy and D. Bresch. *Cont. Mech. Thermodyn.*, 15 (2003)3, p 247-263.
10. Uniqueness of Entropy Solutions for Non-linear Degenerate Parabolic Problems, Mohamed Maliki, Hamidou Touré , *Journal of Evolution Equations* 3, N°4, p603-622 (2003).
11. Modelling of piezoelectric plates including magnetic's effects. Raoult Annie, Abdou Sène, *Asymptotic Anal.* 34, n°1,1-40 (2003)

Publications 2004

12. M. C. Jaeger, M. Lo, R J. Pefferly, Simulation Models and their meta-info management using RDF-based paradigms, proceedings of IEEE International Conference on e-Technology, e-Commerce, and e-Service, Mars 2004, Taiwan.
13. Mamadou Abdoul Diop, Etienne Pardoux , Averaging of a parabolic partial differential equation with random evolution in Stochastic analysis, random fields and applications IV. Progress in Probability 58, 111-128, Birkhäuser, Verlag, 2004.
14. Critical eigenvalues for a non-linear problem, Ould Ahmed Izid Bih Isselkou, Non-linear differential equ. Appl. 11 (2004) 225-236.
15. A.Heminna; S.Nicaise; A.Sène : STABILISATION D'UN SYSTEME DE THERMOELASTICITE ANISOTROPE AVEC FEEDBACKS NON LINERAIRES; C.R. Acad. Sci: Paris, Ser.I.339 (2004).
16. J. HARMAND, A. RAPAPORT, A. DRAMÉ. Optimal design of 2 interconnected enzymatic reactors, in "Journal of Process Control", vol. 14, no 7, 2004, p. 785–794.

Publications 2005

17. Kalifa Bodian, Mary Teuw Niane and Abdoulaye Sène, Exact controllability of the wave equation in fractional order spaces, C.R.Math. Rep. Acad. Sci. Can. 27, n°1, 2-7, 2005.a.
18. Daniel Le Roux, Abdou Sène, Virgile Rostand and Emmanuel Hanert, On some spurious mode issues in shallow-water models using a linear algebra approach, Ocean modelling 10 (2005) 83-94.
19. Abdou Sène and Kalifa Bodian, Modelling of viscoelastic thin plates, URED n°10, p 11-22.
20. Ouaro Stanislas, Unicité de solutions renormalisées d'un problème non linéaire de type elliptique-parabolique en une dimension d'espace, URED n°10, p 63-76.
21. Ouaro Stanislas, Hamidou Toure On some nonlinear elliptic-parabolic equations of second order; Int. J.Pure Appl. Maths. 25 (2005), n° 2, 255-265.

Publications 2006

22. Ekeland, Ngalla Djitté An inverse problem in the economic theory of Demand. Annales de l'Institut Henry Poincaré, Analyse non Linéaire, Paris, p.269-281, 2006.
23. P.I. Ndiaye, D.J. Bicout, B. Mondet, P. Sabatier, Rainfall triggered dynamics of Aedes mosquitos aggressiveness, Journal of Theoretical Biology (243), p222-229, 2006

24. M.T. Niane, Gilbert Bayili, Abdou Sène, Abdoulaye Sène, Mamadou Sy; Is it possible to cancel singularities in a domain with corners? C. R. Acad. Sci. Paris, p115 - 118, 2006
25. M. Sy, D. Bresch, F. G.-Gonzalez, J. Lemoine, M. A. R.-Bellido ; Local strong solution for the incompressible Korteweg model. C. R. Acad. Sci. Paris, p169 - 174, 2006
26. Diop, M.A.; Iftimie, B; Pardoux, E; Piatnitski, Singular homogenization with stationary in time and periodic in space coefficients. A.L, J.Funct.Anal. 231, p1-46, n°1 2006
27. A. DRAMÉ, J. HARMAND, A. RAPAPORT, C. LOBRY. Multiple steady state profiles in interconnected biological systems, in "Mathematical and Computer Modelling of Dynamical Systems", vol. 12, no 5, 2006, p. 379–393.
28. S. Ouaro. Entropy solutions of a stationary problem associated to a nonlinear parabolic strongly degenerate problem in one space dimension. Ann. Univ. Craiova. Math. Inform. **33** (2006), 108-131. (Zbl 1119.35334).
29. ADOU J., OKOU H. : The resonant behaviour of the inertial oscillations in the Ekman layer. *Advances and applications in Fluid Mechanics*. Vol. 1, issue 1, pp 91-100

Publications 2007

30. KONAN A., BADARAYANI S., SIMONIN O., SQUIRES K. : LES/DPS of horizontal Gas-Solid channel flow with Particle-Particle collision and wall roughness effects. *6th Int. Conference on multiphase flow, ICMF 2007*, Liepzig, Germany, July 9-13 (2007).
31. COULIBALY A., J-P CROUZEIX : Condition numbers and error bounds in convex programming. *Mathematical Programming Série B; Springer* (Juillet 2007).
32. A. Sène, I. NGOM, A. W. AÏDARA, F.. DIAGNE ,Influence of Orthodontic Anomalies on Masticatory Function, *American J. of Orthodontics and Dentofacial Orthopedics*, Vol. 131, Number 2, Feb. 2007.
33. A. Sène, Babacar TOUMBOU and D. Y. LE ROUX; An existence theorem for a 2-D coupled sedimentation shallow-water model, C. R. Math. Acad. Sci. Paris, Ser. I 344 (2007) 443-446 .
34. D. Bresch, E.H. Essoufi, M. Sy; Effects of density dependent viscosities on multiphase incompressible fluid models, *Journal of Mathematical and Fluid Mechanics* 9 (2007) pages 377-397 .
35. Ousmane Sall, Moussa Lo, *Intégration de données environnementales : une approche basée sur les entrepôts de documents XML et les ontologies*,

Actes des 3èmes journées francophones sur les Entrepôts de Données et l'Analyse en ligne (EDA), Revue des Nouvelles Technologies de l'Information (RNTI B-3), pp. 147-159, Editions Cepadues, Poitiers, Juin 2007.

36. Moussa Lo, Fabien Gandon, *Semantic web services in corporate memories*, Proceedings of the The Second International Conference on Internet and Web Applications and Services (ICIW), Mauritius, pp 19-26, IEEE Computer Society Press, Mai 2007.
37. Cheikh Talibouya Diop, Moussa Lo, Fatou Kamara-Sangaré, *Intégration de règles d'association pour améliorer la recherche d'informations XML*, Actes de la Quatrième conférence francophone en Recherche d'Information et Applications (CORIA), pp. 137-148, Hermès, Mars 2007.
38. Mouhamadou Thiam, Nacéra Bennacer, Nathalie Pernelle: *WebDocEnrich : enrichissement sémantique flexible de documents semi-structurés*. EGC 2007: pp. 211-212, 2007.
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WATS ORIGINAL FORMAT
West African Training School
(Saint Louis du Senegal)

1) Aim : To produce a critical mass of young mathematicians at high level in the broad area of Analysis (Nonlinear Analysis, Differential Equations, Control Theory, etc.)

2) Method : 3-years of training program (2 consecutive months every year). All training will take place at

Mathematics Department
University Gaston Berger
Saint Louis, Senegal.

3) The Program

- a. We have selected 20 young students (please see attached) registered for the PhD degree in universities in the West African Sub-region.
- b. We have competent and dedicated staff (please see attached list, not exhaustive).
- c. Same students will be invited for those 3 years. Basically the same courses will be repeated at a higher level every successive year.
- d. Starting with a modest background in the first year, lectures during the second and third years will be at the appropriate advanced levels
- e. Three (3) lectures of one and a half hours duration each will be given per day for 5 days a week. Each day, assistants will be available in designated offices to assist the students.
- f. At the end of the training, each year, examinations will be given to the students.

4) PhD thesis supervision. The current PhD theses supervisors of all the students selected are involved in this program. Consequently, joint supervision of students will be encouraged.

5) Proposed standard Courses in Analysis

- a. Real Analysis
 - Measure Theory I – Finite dimensional case;
 - Measure Theory II – Lebesgue Measure & Integration;
 - Real Analysis – Rudin's Book.

b. Functional Analysis

- Linear Functional Analysis
- Spectral Theory, Nonlinear Functional Analysis
- Degree Theory, Sobolev Spaces

c. Partial Differential Equations and Control Theory

- Linear PDE;
- Nonlinear PDE;
- Control Theory;
- Asymptotic method for ODE.

d. Ordinary Differential Equations

- Linear ODE;
- Nonlinear ODE;
- Boundary Value Problem's;
- Asymptotic method for ODE.

6) **SAMPLE SYLLABUS**. We give below a sketch of a sample of the courses proposed in Functional Analysis for the 3 years.

1st year: 2003

Linear Functional Analysis: - Hahn Banach Theorem (Analytic & Geometric Forms); Uniform Boundedness Principle; Banach Steinhaus Theorem; Open Mapping and Closed Graph Theorems; Weak Topology; Banach Alaoglu Theorem; Kakutani's Characterization of Reflexive spaces; Eberlein Smul'yan Theorem; Applications.

2nd year: 2004

Geometric Properties of Banach Spaces and Elements of Nonlinear, Functional Analysis; Spectral Theory of Operators; Introduction to Banach Algebras.

3rd year: 2005

Independent study of the following two topics as preparation for the study of differential equations (ODE and PDE): (i) Sololev Spaces; (ii) Degree Theory.

ANNEX 1. Academic Staff

Functional Analysis:

- (i) Professor C.E. Chidume (ICTP, Nigeria)
- (ii) Professor Toure Hamidou (Burkina Faso, ICTP Associate)

Real Analysis:

- (i) Dr Diaraf Seck (Senegal)

(ii) Professor C.H. Morales (Huntsville, Alabama)

Differential Equations:

(i) Professor Gauthier Sallet (Metz, France)

(ii) Professor Toure (Burkina Faso, ICTP Associate))

(iii) Professor Isselkou (Mauritania, ICTP Associate)

Control Theory:

(i) Professor C. Lobry (France)

(ii) Professor M. Niane (Senegal, ICTP Associate)

(iii) Professor Abdou Sene (Senegal)

ASSISTANTS

(ii) Dr. H. Zegeye - Ethiopian - Former DICTP(Math.)

(ii) Dr. Ouaro Stanislas - Burkina Faso

(iii) Dr. Djitte - Senegal - Former DICTP (Math.)

(iv) Dr. F.I. Njoku - Nigerian - ICTP Regular Associate.

(v) Dr Bonzi Bernard - Burkina Faso