Dr. Ing. Ahmed Ratnani

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PROFESSIONAL EXPERIENCE

Since 10/2019	**UM6P, Ben Guerir, Morocco** Assistant Professor Program Lead CSEHS (Since 12/2019)
09/2014 - 09/2019	**Max-Planck Institut für Plasmaphysik IPP, München, Germany** PostDoc : Physics-Based Preconditioners for Non-linear MHD MHD group leader since 2016
10/2013 - 09/2014	**Université de Nice Sophia-Antipolis, Nice FRANCE** PostDoc : Taylor-Galerkin Stabilization (TG2/TG3) for Non-linear Reduced MHD. (ANR GRANT ANEMOS)
10/2011 - 10/2013	**C.E.A./DSM/IRFM/SIPP, Cadarache FRANCE** PostDoc : Study of new models and numerical improvements of the JOREK code. Simulations and study of ELMs. (ANR GRANT ANEMOS)
02/2006 - 09/2007	**FERMAT - Risk Management Software Provider FRANCE** *Intern, then Engineer (Basel II Project - Credit Risk)*

EDUCATIONAL ACHIEVEMENTS

2008/2011	**Phd** - Isogeometric Analysis in Plasma Physics and Electromagnetism. **INRIA / IRMA - Institut de Recherche en Mathématiques Avancées, Strasbourg FRANCE** Supervisors: E.Sonnendrucker and N.Crouseilles,
2007/2008	**Research Master** - Numerical Analysis and Partial Differential Equations (ANEDP), **Université Pierre et Marie Curie - Paris in France**,
2002/2006	**Engineering degree** - Applied Mathematics and Computer Science, Major in Quantitative Finance, ENSIMAG (Ecole Nationale Supérieur d'Informatique et de Mathématiques Appliquées),

RESEARCH AREAS

- Machine Learning, code verification and validation: Gaussian Processes, Neural Networks
- Numerical methods in Plasma Physics: kinetic/gyrokinetic, equilibrium, nonlinear reduced/full MHD
- Numerical methods in Electromagnetism: time/frequency domain Maxwell's equations
- Applied Linear Algebra: spectral analysis, Generalized Locally Toeplitz (GLT) theory
- Multigrid methods, Fast solvers, Physics-based Preconditioners
- Finite Elements Method, Isogeometric Analysis, Semi-Lagrangian schemes, Particle In Cell Method,
- Mesh generation: adaptive meshes and mappings
- Structure Preserving Methods
- Tomography
- Optimal Transport
- High Performance Computing (**HPC**), Parallel patterns
- Domain Specific Languages, Automatic code generation, Formal Language Theory, Symbolic Calculus

AWARDS AND FUNDS

— TUM-DI-LAB 2018 (1 semester project), *Machine Learning for PDE verification and validation*
— DAAD-MIUR German-Italian collaboration 2018-2019 (16'142 €)
— EuroFusion Engineering Grant (2018-2021 with Dr. D. Vezinet, CEA Cadarache), *Development and optimisation of a machine-independent open-source python library for synthetic tomography diagnostics and inversions*
— HLST 2017-2018 (18 months), *Parallel and Optimal Multigrid B-Splines based solver (POMS)*
— *The Bavarian Competence Network for Technical and Scientific High Performance Computing* Konwihr 2015 (25 k €), *Enhancements for efficiency and parallel scalability of non-linear MHD simulations with the JOREK*
— EFDA Fellowship 2012-2013 (66 k €)
— Visiting IPAM-UCLA (04/2012-06/2012), funded by NSF program
— Laureate of *Fondation Académia* program (2002 – 2005)

TEACHING EXPERIENCE

— Isogeometric Analysis: Theory and Practice, Summer Term 2018-2019 – Lectures and Exercises [*Master level*]
— Advanced Finite Element Methods, Winter Term 2015-2016 – Exercises. Lectures by Pr. E. Sonnendrücker [*Master level*]
— Finite Element Methods for Hyperbolic Systems, Winter Term 2014-2015 – Exercises. Lectures by Pr. E. Sonnendrücker [*Master level*]
— Analysis 1st year, 2nd semester, major *Math and Computer science*. University of Strasbourg, 2010,
— Maple, Analysis and algebra 1st year, 2nd semester, major *Math and Computer science*. University of Strasbourg, 2010,
— Diffrential Calculs, 2nd year, 1st semester, major *Science de l'environnement et l'univers*. University of Strasbourg, 2010.
— Contribution to a textbook to prepare for the mathematical olympiads, available at *Académie Agadir Ida Outanane* - 1999

STUDENTS

— Florian Holderied, (**Phd. candidate** started in *3.2019*) co-supervised with X. Wang (IPP) and S. Possaner (TUM)
— Arthur Grundner, (TUM Master Degree. since *12.2018*)
— Said Aissa Hadjout, (**Phd. candidate** started in *12.2018*)
— Margaux Bruliard, (2^{nd} year Sup-Galilée, Paris, France. *7.2018-8.2018*)
— Said Aissa Hadjout, (TUM Master Degree and Sup-Galilée. *3.2018-8.2018*)
— Florian Holderied, (TUM Master Degree *02.2018-1.2019*) co-supervised with X. Wang (IPP)
— Rémi Mattéoli, (2^{nd} year École Normale Supérieure, Cachan, France. *4.2017-6.2017*) co-supervised with X. Wang (IPP)
— Said Aissa Hadjout, (2^{nd} year Sup-Galilée - French Engineering school. *8.2017-8.2017*)
— Nacime Bouziani, (2^{nd} year Sup-Galilée - French Engineering school. *2.2017-4.2017*)
— Théotime Buchot, (2^{nd} year Sup-Galilée - French Engineering school. *6.2016-8.2016*)
— Benedikt Schenk, (TUM Master Degree Student *04.2016-12.2016*)
— Cyril Duchon-Doris, (Telecom-Paris/TUM Interdisciplinary Computer Science project. *04.2016-07.2016*)
— Nader Hadda, (ENSTA, Master Degree Student *05.2015-08.2015*)
— Mustafa Gaja, (**Phd. candidate** started in *12.2015*)

REVIEWINGS AND OTHER ACTIVITIES

— reviewing: IEEE, ESAIM, NMPDE, SISC, JCTT, COAM
— Coorganizer of the Magnetohydrodynamics Mini-Symposium in CANUM 2016
— Member and/or co-supervisor of different *Cemracs* projects (2010, 2011, 2014, 2015)
— IPP coordinator for the *Energy oriented Center of Excellence for computing applications* (EOCOE), work-package WP5.1: *Constructing flux-surface aligned mesh-grids in the poloidal plane*

UPCOMING TALKS

2020	**MPFUS-2020: Première école de la physique du plasma et de la fusion dans la région MENA, Hammamet, TUNISIA** Simulations numériques pour la physique du plasma
2020	**INdAM Workshop: Geometric Challenges in Isogeometric Analysis, Rome, ITALY** Mesh generation and challenges for Tokamaks [**Invited talk**]
2019	**Schloss Dagstuhl, Saarbrücken, GERMANY** **Invited** for the **Interactive Design and Simulation** Dagstuhl Seminar [**19512**]
2019	**COMPLAS, Barcelona, SPAIN** Automated Symbolic, HPC and Spectral study for Isogeometric Analysis using Python [**Invited talk**]

INVITED TALKS

2018	**ICOSAHOM, London, UK** Spectral studies and fast solvers for Maxwell equations using IsoGeometric Analysis
2018	**ECCM & ECFD, Glasgow, UK** Parallel Multigrid Solver for Finite Elements using B-Splines
2017	**CMO-BIRS Geometry & Computation for Interactive Simulation, Oaxaca, Mexico** Automatic computation of GLT symbols for B-Splines discretizations
2017	**CIME 2017, Cetraro, Italy** Modern Computer Science and IsoGeometric Analysis
2017	**PASC 2017, Lugano, Switzerland** HPC and GLT for IsoGeometric Applications in Computational Plasma Physics
2016	**MAFELAP, Brunel University, UK** Parallel Time Domain Maxwell solver and Hybrid Particles In Cell method
2013	**MFO, Oberwolfach, GERMANY** Adaptive IsoGeometric Mappings for complex and realistic tokamaks geometries

CONFERENCES

2019	**CAISAM, UM6P, MOROCCO** Adaptive IsoGeometric mesh generation using Optimal Transport
2018	**PyConDE, Karlsruhe, GERMANY** Pyccel, a Fortran static compiler for scientific High-Performance Computing
2018	**Numkin, Garching, GERMANY** High-Performance Computing using Python and Pyccel
2018	**EUROSCIPY, Trento, Italy** Pyccel, a Fortran static compiler for scientific High-Performance Computing
2017	**NUMKIN, Garching, GERMANY** Towards an automated mesh generation framework for Tokamaks
2016	**2nd EU JOREK Meeting - INRIA Sophia-Antipolis** Compatible B-Splines Finite Elements
2015	**CEMRACS, Marseille, FRANCE** IsoGeometric Analysis: Bézier techniques in Numerical Simulations
2015	**ESMC, Madrid, SPAIN** An IsoGeometric Analysis Hybrid Semi-Lagrangian Scheme for Kinetic Simulations in Complex Geometries
2014	**NUMKIN, Garching, GERMANY** CAID: A Python Computer AIded Design tool for Computational Plasma Physics
2014	**CEMRACS, Marseille, FRANCE** Towards complex and realistic tokamaks geometries in Computational Plasma Physics
2013	**ICNSP, Beijing, CHINA** Alignement and equidistribution meshes for complex and realistic tokamaks geometries
2012	**Computational Methods in High Energy Density Plasmas, IPAM, UCLA, USA** IsoGeometric Analysis: From CAD to Plasmas Physics
2012	**ACE, Karlsruhe, GERMANY** IsoGeometric Analysis in Plasma Physics and Electromagnetism
2011 (Poster)	**ICNSP, Long Branch, New Jersey, USA** IsoGeometric Analysis in Plasma Physics and Electromagnetism
2011 (Poster)	**HOFEIM, Cracow, Poland** IsoGeometric Analysis in Plasma Physics and Electromagnetism
2011	**1st EU JOREK Meeting - IRFM/CEA Cadarache** Simulation of 2D reduced MHD using IsoGeometric Analysis
2010	**The 10th International Workshop on Finite Elements for Microwave Engineering, Meredith, USA** Arbitrary High-Order Spline Finite Element Solver for the Time Domain Maxwell equations
2010	**CEMRACS, Marseille** Isogeometric Analysis: From C.A.D to F.E.A.
2010	**Non-Standard Numerical Methods for PDE's, Pavia, Italy** Arbitrary High-Order Spline Finite Element Solver for the Time Domain Maxwell equations
2010	**CANUM** Isogeometric Analysis: From C.A.D to F.E.A. Application to the Quasi-Neutral equation

PUBLICATIONS

Peer Reviewed Journals

AR10 Structure-preserving vs. standard particle-in-cell methods: the case of an electron hybrid model. (with F. Holderied, S. Possaner, A. Ratnani and X. Wang) *Journal of Computational Physics (2019)*.

AR9 Isogeometric analysis for 2D and 3D curl-div problems: Spectral symbols and fast iterative solvers. (with C.Manni, M. Mazza, S. Serra-Capizzano and H. Speleers) *CMAME 344, February 2019*.

AR8 Spectral analysis and spectral symbol for the 2D curl-curl (stabilized) operator with applications to the related iterative solutions. (with M. Mazza and S. Serra-Capizzano) *Mathematics of Computation 88, 2019*.

AR7 Implicit time schemes for compressible fluid models based on relaxation methods, D. Coulette, E. Franck, P. Helluy, A. Ratnani, E. Sonnendruecker) *Computer & Fluids, pages 70-85 (2019)*.

AR6 Non-linear MHD modeling of edge localized mode cycles and mitigation by resonant magnetic perturbations (with F. Orain et al.) *Plasma Physics and Controlled Fusion, 57, 2014*

AR5 Mechanism of Edge Localized Mode mitigation by Resonant Magnetic Perturbations (with M. Bécoulet et al.) *Physical Review Letters 113, September 2014*

AR4 Non-linear MHD modeling of plasma response to Resonant Magnetic Perturbations (with F. Orain et al.) *Physics of Plasmas 20, (2013)*.

AR3 Science and technology research and development in support to ITER and the Broader Approach at CEA (with A. Bécoulet et al.) *Nuclear Fusion (2013)*.

AR2 An Isogeometric Analysis Approach for the study of the gyrokinetic quasi-neutrality equation (with E. Sonnendrücker and N. Crouseilles). *Journal of Computational Physics 231, pages 373-393 (2012)*.

AR1 Arbitrary High-Order Spline Finite Element Solver for the Time Domain Maxwell equations (with E. Sonnendrücker). *Journal of Scientific Computing, pages 1-20, (2011)*.

Proceedings

AR4P Anisotropic diffusion in toroidal geometry (with B. Nkonga, E. Franck, A. Eksaeva, M. Kazakova). Proceedings of CEMRACS 2014. *ESAIM: Proc., Volume 53, pages 77-98 (2016)*.

AR3P Simulation of 2D reduced MHD using Isogeometric Analysis (with E. Sonnendrücker). *Computational Science & Discovery, (2012)*.

AR2P Solving the Vlasov equations in complex geometries. (with J. Abiteboul, G. Latu, V. Grandgirard, E. Sonnendrücker and A. Strugarek.). Proceedings of CEMRACS 2010. *ESAIM 32, pages 103-117 (2011)*.

AR1P An Axisymmetric PIC code based on Isogeometric Analysis (with A. Back, A. Crestetto, and E. Sonnendrücker). Proceedings of CEMRACS 2010. *ESAIM 32, pages 118-133 (2011)*.

Reports

AR4R Tokamesh : A software for mesh generation in Tokamaks (with H. Guillard et al.). *url: https://hal.inria.fr/hal-01948060/document*

AR3R Achieve complex and realistic Tokamak geometries and simulations using IsoGeometric Analysis. *EFDA Fellowship Report*

AR2R Non regression testing for the JOREK code (with G. Latu et al.). *INRIA report, http://hal.inria.fr/hal-00752270/*

AR1R **Πgasus**, Isogeometric Analysis simulations in *Python*. *INRIA report, http://hal.inria.fr/hal-00769225*.

In preparation

— SymPDE: a SymPy Extension for Variational Formulations in Python (*with S. Hadjout, Y. Guclü*)
— PsyDac: Automated Symbolic and HPC Isogeometric Analysis using Python (*with S.H., Y.G.*)
— GeLaTo: Automatic computation of GLT symbols in IsoGeometric Analysis. (*with C. Manni, M. Mazza, S. Serra-Capizzano and H. Speleers*).
— Pyccel, a Fortran static compiler for scientific High-Performance Computing. (*with S. Hadjout*)
— Spectral study of the Alfven operator. (*with C. Manni, M. Mazza, S. Serra-Capizzano and H. Speleers*).
— Hamiltonian and metriplectic structures of the cold-plasma model and their discretization (*with O. Maj, E. Sonnendrücker, O. Lafitte, P.J. Morrison*)
— Local projectors on Spline Finite Element spaces (*with M. Campos and E. Sonnendrücker*)
— Application of GLT symbols in Linear analysis for MHD.
— Mesh generation for Tokamaks (*with J. Lakhlili, H. Guillard*)
— Adaptive IsoGeometric Analysis using Optimal Transport and r-refinement, (*with J. Lakhlili*)
— Parallel B-Splines Finite Elements solver for the Time Domain Maxwell equations (*with J. Lakhlili*)
— POMS: Parallel and robust Multigrid solver for B-Splines Finite Elements (*with T. M. Tran, J. Lakhlili*)
— A new DeRham sequence based on Box-splines.
— Compatible B-Splines Finite Elements method for the full MagnetoHydrodynamics (*with E. Sonnendruecker, E. Franck, M. Gaja*),