PIETRO ASINARI, PhD

PERSONAL DATA

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ACADEMIC

Dr. Asinari received his B.S. and M.S. (cum laude) in Mechanical Engineering in 2001 and his Ph.D. in Energetics in 2005. He is **Associate Professor** of Applied Physics (since January 2012) at the Energy Department (formerly Department of Energetics) of Politecnico di Torino, Italy. He is a member of the Faculty Board of the PhD in Energetics.

He has the direct responsibility of a research group formed by a post-doc fellow, two PhD students and a graduated fellow (4 members), who form the **Multi-scale Modeling LAB**.

RESEARCH

He is author or co-author of **41 articles (24 as first/last author) in international journals** with peer-review (2004-2011) and in total of more than 60 international publications, including **1 book chapter**. He has more than 190 citations (fast growing) and **H-index equal to 9**. He provided **11 invited talks (2 keynote lectures)** in international conferences and seminars and **4 invited courses** on mesoscopic numerical methods.

According to the annual internal assessments of Politecnico di Torino ("Action for supporting Young Faculty Members", editions 2007, 2008 and 2009), he was **the best researcher in the Department of Energetics** for scientific production and he is currently still first in the rankings. According to another internal assessment ("Action for Career Acceleration", 2008, only edition so far) he was among the top 30 researchers throughout the Politecnico **(top 10% of the researchers**).

He won the prestigious award for the best doctoral thesis **ENI Award** (http://www.eni.com/eni-award) and also the **UIT Award** of the Italian Union of Thermal Fluid Dynamics (www.uitonline.it) for thesis "Multi-Scale Analysis of Heat and Mass Transfer in Mini/Micro Structures" (in English), where he discussed the theoretical background and consequent applications of **heat transfer within mini/micro-devices**.

Research interests:

- Primary fields:
    - Transport theory at different scales (macro, micro, nano)
    - Pseudo-kinetic / kinetic modeling of gasses (single species and mixtures) and complex fluids
    - Classical Molecular Dynamics
    - Irreversible and Equilibrium Thermodynamics
    - Numerical modelling including HPC
- Other fields:
    - Heat and Mass Transfer
    - Compact Heat Exchangers
    - Mechanical Refrigeration (by natural fluids)

His main research interest focuses on **numerical modeling of heat transfer phenomena at different scales**: atomistic scale (molecular dynamics by GROMACS), intermediate scale (mesoscopic modeling by LABORA, numerical code based on the Lattice Boltzmann Method which was developed entirely in-house) and macroscopic scale (computational thermo-fluid dynamics by OPENFOAM).

He developed from scratch a numerical parallel code for computational fluid dynamics, based on the new mesoscopic Lattice Boltzmann Method (LBM), for simulating the fluid flow through complex geometries. The code is called **LABORA (LAttice BOltzmann for Raster Applications)** and it can take advantage of large computational facilities by means of the open-source library MPICH. The code is currently used at **Virginia Tech** (www.tcf.vt.edu) to optimize the fluid flow in porous media involved in the next-generation fuel

cells and at **Old Dominion University** (occs.odu.edu/research/hpc) to investigate the decay of homogeneous isotropic turbulence in reactive mixtures.

RESEARCH PROJECTS (AS PRINCIPAL INVESTIGATOR)

*** **European Research Projects**

- THERMONANO, Low-Temperature Heat Exchangers Based on Thermally-Conductive Polymer Nanocomposites (2009-2012), website: http://www.thermonano.org/

The THERMONANO project aims at developing **nanofilled-polymer-based heat exchangers** enabling: i) effective heat conductivity due to the percolation network of **carbon or metal fillers**; ii) cost reduction compared to metal materials (stainless steel, Cu-alloys,…); iii) design flexibility for an intensive volume exploitation; iv) superior corrosion resistance; v) promotion of the highly effective drop condensation with hydrophobic polymers.

*** **FIRB "Futuro in Ricerca"**

- THERMALSKIN, Revolutionary surface coatings by carbon nanotubes for high heat transfer efficiency (2012-2014)

"Futuro in Ricerca" is a funding initiative sponsored by the Italian Ministry of Education, University and Research with the goal of supporting young researchers in carrying out scientific research **projects of excellence**. In this project, we introduce a breakthrough in the **heat transfer** mechanism between a solid wall and a fluid, by means of **nanotechnology** applied to macroscopic surfaces. Towards this purpose, we introduce the concept of thermal **nano-fin**, with an entirely different meaning with respect to standard terminology. By nano-fins we mean slender nano-structures, sparse enough not to interfere with the thermal boundary layer, but sufficiently rigid and conductive to allow direct energy transfer between the wall and the bulk fluid, thus acting as thermal bridges.

*** **PRIN - Projects with Strategic National Interest**

- Microscopic modeling and degradation analysis of the membrane electrode assembly (MEA) in high temperature PEM fuel cells (2010-2012)

*** **Regional Research Projects**

- ENERGRID, Design and Development of a Grid Infrastructure for High Performance Computing in Modeling Energy Networks Based on Widespread Sources of Heat and Power Generation (2007-2011)

*** **Consulting and Industrial Research Contracts**
- Design and construction of an experimental apparatus for fire resistance testing of industrial pipes (2009-2010), COES COMPANY (MI)
- Computational thermo-fluid dynamics of industrial heat exchangers (2010-2011), ASTRA REFRIGERATION SPA (AL)

INTERNATIONAL COLLABORATION

Visiting stays (in the last 6 years):

- Department of Aeronautics and Astronautics at the Graduate School of Engineering of Kyoto University (**Japan**, Kyoto) in September 2009.
- National Laboratory of Coal Combustion, Huazhong University of Science and Technology (**China**, Wuhan) in March 2008.
- Regionales Rechenzentrum Erlangen (RRZE) at the University Erlangen-Nuremberg (**Germany**, Erlangen) in November 2007.
- Department of Aeronautics and Astronautics at the Graduate School of Engineering of Kyoto University (**Japan**, Kyoto) in September 2006.
- Department of Mathematics & Statistics at the Old Dominion University (**USA**, VA, Norfolk) in April-May 2005 and July 2006.
- Center for Energy Systems Research at the Mechanical Engineering Department of Virginia Tech (**USA**, VA, Blacksburg) in June-September 2004.

In particular, it is worth mentioning the fruitful collaboration with **Prof. Taku Ohwada**, Department of Department of Aeronautics and Astronautics, Graduate School of Engineering, **Kyoto University** (Japan). This collaboration leaded to proposing the **revisited Artificial Compressibility Method (ACM)** for low-Mach number fluid dynamics. Dr. Asinari is currently Research Associate of the Kyoto University.

As a member of the International Scientific Committee, he helped in managing conferences of the **American Society of Mechanical Engineering (ASME)**. He has been **Track Chairman** and **Chairman** of international conferences. He served as peer-to-peer reviewer for the following international journals:

- Physics Journals
    - Physical Review E
    - Journal of Statistical Physics
    - Computers & Mathematics with Applications
    - International Journal of Modern Physics C
    - Communications in Computational Physics

- Heat Transfer Journals
    - International Journal of Heat and Mass Transfer
    - Numerical Heat Transfer
    - International Journal of Thermodynamics
    - International Journal for Numerical Methods in Fluids
    - International Journal of Thermal Sciences
    - Journal of Fuel Cell Science and Technology

TEACHING

- ***"Mesoscopic Numerical Methods"* (in English)**, PhD course, 2008-present. This course aims to introduce the essential issues for the understanding and the utilization of the mesoscopic numerical methods, starting from a basic knowledge of traditional numerical methods. Moreover, some insights are reported concerning practical details of implementation and promising applications.
- ***"Advanced Topics in Applied Physics"* (in English)**, under-graduate Master course, 2004-present. This course introduces the basic concepts of thermo-fluid-dynamic equations (in particular the Navier-Stokes-Fourier system of equations) and some modeling approaches to the irreversible processes. Moreover it provides some advanced topics in conduction, convection and radiation heat transfer.
- **"Numerical Heat Transfer" (in English)**, under-graduate Master course in collaboration with the University of Chicago (UIC), 2006-present. The course provides a general overview on specific numerical modeling issues, including turbulence, radiation heat transfer, multi-component mass transfer (both non-reactive flows and combustion) and multi-phase flows.
- ***"Engineering Thermodynamics"***, under-graduate Batchelor course, 2008-present. This course introduces the principles, concepts, and laws/postulates of classical thermodynamics and how they can be applied to engineering applications. It covers basic postulates of classical thermodynamics and their application to transient open and closed systems.

SELECTED PUBLICATIONS in the last 6 years

1. In press, BENNETT S., ASINARI P., DELLAR P.J., A lattice Boltzmann model for diffusion of binary gas mixtures that includes diffusion slip, INT. J. FOR NUMERICAL METHODS IN FLUIDS, pp. 20.

2. 2012, Proment D., Onorato M., Asinari P., Nazarenko S., Warm cascade states in a forced-dissipated Boltzmann gas of hard spheres, Physica D: Nonlinear Phenomena, Vol. 241, pp. 600-615, DOI: 10.1016/j.physd.2011.11.019.

3. 2011, CHIAVAZZO E., ASINARI P., Enhancing surface heat transfer by carbon nanofins: towards an alternative to nanofluids?, NANOSCALE RESEARCH LETTERS, pp. 30, v. 6, DOI: 10.1186/1556-276X-6-249, LINK: http://www.nanoscalereslett.com/content/6/1/249/abstract

4. 2011 T. OHWADA, P. ASINARI, D. YABUSAKI, Artificial Compressibility Method and Lattice Boltzmann Method: Similarities and Differences, COMPUTERS & MATHEMATICS WITH APPLICATIONS, Vol. 61, pp. 3461-3474, DOI:10.1016/j.camwa.2010.08.032

5. 2011, BERGAMASCO L, ASINARI P, Scalable methodology for the photovoltaic solar energy potential assessment based on available roof surface area: application to Piedmont Region (Italy), SOLAR ENERGY, Vol. 85, pp. 1041-1055, DOI: 10.1016/j.solener.2011.02.022

6. 2011, CHIAVAZZO E., VISCONTI F., ASINARI P., Fast computation of multi-scale combustion systems, PHILOSOPHICAL TRANSACTIONS - ROYAL SOCIETY, Vol. 369, pp. 2396-2404, DOI:10.1098/rsta.2011.0026

7. 2011, KARLIN I., ASINARI P., SUCCI S., Matrix lattice Boltzmann reloaded, PHILOSOPHICAL TRANSACTIONS - ROYAL SOCIETY. MATHEMATICAL, PHYSICAL AND ENGINEERING SCIENCES, Vol. 369, pp. 2202-2210, ISSN: 1471-2962, DOI: 10.1098/rsta.2011.0061

8. 2011, DI RIENZO A.F., ASINARI P., BORCHIELLINI R., MISHRA S. C., Improved angular discretization and error analysis of the lattice Boltzmann method for solving radiative heat transfer in a participating medium, INT. J. OF NUMERICAL METHODS FOR HEAT & FLUID FLOW, Vol. 21, pp. 640-662, DOI: 10.1108/09615531111135873

9. 2010, T. OHWADA, ASINARI P., Artificial Compressibility Method Revisited: Asymptotic Numerical Method for Incompressible Navier-Stokes Equations, J. OF COMP. PHYSICS, v. 229, pp. 1698-1723, DOI: 10.1016/j.jcp.2009.11.003

10. 2010, CHIAVAZZO E., ASINARI P., Reconstruction and modeling of 3D percolation networks of carbon fillers in a polymer matrix, INT. J. OF THERMAL SCIENCES, pp. 10, v. 49, pp. 2272-2281, DOI: 10.1016/j.ijthermalsci.2010.07.019

11. 2010, ASINARI P., Nonlinear Boltzmann equation for the homogeneous isotropic case: Minimal deterministic Matlab program, COMPUTER PHYSICS COMMUNICATIONS, pp. 13, v. 181, pp. 1776-1788, DOI: 10.1016/j.cpc.2010.06.041

12. 2010, ASINARI P., S. C. MISHRA, R. BORCHIELLINI, A lattice Boltzmann formulation to the analysis of radiative heat transfer problems in a participating medium, NUMERICAL HEAT TRANSFER PART B-FUNDAMENTALS, v. 57, pp. 1-21, DOI: 10.1080/10407791003613769

13. 2010, ILYA V. KARLIN, ASINARI P., Factorization symmetry in the lattice Boltzmann method, PHYSICA A, 2010, V. 389, pp. 389-1548, DOI: 10.1016/j.physa.2009.12.032

14. 2010, S. UBERTINI, ASINARI P., AND S. SUCCI, Three ways to lattice Boltzmann: A unified time-marching picture, PHYSICAL REVIEW E, v. 81, pp. 016311-1-11, DOI: 10.1103/PhysRevE.81.016311

15. 2010, IZQUIERDO S., VALDÉS J.R., MARTINEZ M., ACCOLTI M., WOUDBERG S., ASINARI P., MIANA M., DU PLESSIS J.P., Porous-layer model for laminar liquid flow in rough microchannels, MICROFLUIDICS AND NANOFLUIDICS, pp. 13, DOI: 10.1007/s10404-010-0625-0

16. 2010, ASINARI P., I.V. KARLIN, Quasiequilibrium lattice Boltzmann models with tunable bulk viscosity for enhancing stability, PHYSICAL REVIEW E, v. 81, pp. 016702-1-15, DOI: 10.1103/PhysRevE.81.016702

17. 2009, ASINARI P., Lattice Boltzmann scheme for mixture modeling: analysis of the continuum diffusion regimes recovering Maxwell-Stefan model and incompressible Navier-Stokes equations, PHYSICAL REVIEW E, v. 80, DOI: 10.1103/PhysRevE.80.056701

18. 2009, A. MUSSA, ASINARI P., L.-S. LUO, Lattice Boltzmann Simulations of 2D Laminar Flows past Two Tandem Cylinders, J. OF COMP. PHYSICS, v. 228, pp. 983-999, DOI: 10.1016/j.jcp.2008.10.010

19. 2009, ASINARI P., OHWADA T, Connection between kinetic methods for fluid-dynamic equations and macroscopic finite-difference schemes, COMPUTERS & MATHEMATICS WITH APPLICATIONS, v. 58, pp. 841-861, DOI: 10.1016/j.camwa.2009.02.009

20. 2009, ASINARI P., I.V. KARLIN, Generalized Maxwell state and H theorem for computing fluid flows using the lattice Boltzmann method, PHYSICAL REVIEW E, v. 73, pp. 036703-1-5, DOI: 10.1103/PhysRevE.79.036703

21. 2009, ZHAOLI GUO, ASINARI P., AND CHUGUANG ZHENG, Lattice-Boltzmann equation for microscale gas flows of binary mixture, PHYSICAL REVIEW E, v. 79, pp. 026702-1-9, DOI: 10.1103/PhysRevE.79.026702

22. 2009, A. LANZINI, P. LEONE, M. SANTARELLI, P. ASINARI, M. CALÌ, R. BORCHIELLINI, Performances and Degradation Phenomena of Solid Oxide Anode Supported Cells With LSM and LSCF Cathodes: An

Experimental Assessment, J. OF FUEL CELL SCIENCE AND TECHNOLOGY, pp. 5, v. 6, DOI: 10.1115/1.2971128

23. 2009, LANZINI A., LEONE P, ASINARI P, Microstructural characterization of solid oxide fuel cell electrodes by image analysis technique, J. OF POWER SOURCES, pp. 15, v. 194 Issue 1, pp. 408-422, DOI: 10.1016/j.jpowsour.2009.04.062

24. 2008, P. LEONE, A. LANZINI, P. SQUILLARI, ASINARI P., M. SANTARELLI, R. BORCHIELLINI, M. CALI', Experimental evaluation of the operating temperature impact on solid oxide anode-supported fuel cells, INT. J. OF HYDROGEN ENERGY, v. 33, pp. 3167-3172, DOI: 10.1016/j.ijhydene.2008.03.042

25. 2008, LANZINI A, LEONE P, SANTARELLI M, ASINARI P., CALI' M, Polarization analysis and microstructural characterization of SOFC anode and electrolyte supported cells, ECS TRANSACTIONS, pp. 11, v. 12, pp. 343-353, DOI: 10.1149/1.2921560

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27. 2008, ASINARI P., Multiple-relaxation-time lattice Boltzmann scheme for homogeneous mixture flows with external force, PHYSICAL REVIEW E, v. 77, pp. 056706-1-13, DOI: 10.1103/PhysRevE.77.056706

28. 2008, ASINARI P., Generalized local equilibrium in the cascaded lattice Boltzmann method, PHYSICAL REVIEW E, v. 78, pp. 016701-1-5, DOI: 10.1103/PhysRevE.78.016701

29. 2008, ASINARI P., Asymptotic analysis of multiple-relaxation-time lattice Boltzmann schemes for mixture modeling, COMPUTERS & MATHEMATICS WITH APPLICATIONS, v. 55, pp. 1392-1407, DOI: 10.1016/j.camwa.2007.08.006

30. 2008, MONDAL BITTAGOPAL, MISHRA SUBHASH C, ASINARI P., BORCHIELLINI ROMANO, Analysis of a localized fire in a 3-D tunnel using a hybrid solver: Lattice Boltzmann Method, finite-volume method, and fully explicit upwind scheme, NUMERICAL HEAT TRANSFER PART A-APPLICATIONS, v. 53, pp. 392-417, DOI: 10.1080/10407780701634052

31. 2008, P. LEONE, M. SANTARELLI, P. ASINARI, M. CAL, BORCHIELLINI R., Experimental investigations of the microscopic features and polarization limiting factors of planar SOFCs with LSM and LSCF cathodes, J. OF POWER SOURCES, pp. 12, v. 117, pp. 111-122, DOI: 10.1016/j.jpowsour.2007.11.021

32. 2008, ASINARI P., LUO LI-SHI, A Consistent Lattice Boltzmann Equation with Baroclinic Coupling for Mixtures, J. OF COMP. PHYSICS, v. 227, pp. 3878-3895, DOI: 10.1016/j.jcp.2007.12.001

33. 2008, SMEACETTO F, SALVO M, FERRARIS M, CASALEGNO V, ASINARI P., Glass and composite seals for the joining of YSZ to metallic interconnect in solid oxide fuel cells, J. OF THE EUROPEAN CERAMIC SOCIETY, pp. 6, v. 28, pp. 611-616, DOI: 10.1016/j.jeurceramsoc.2007.07.008

34. 2007, ASINARI P., VON SPAKOVSKY MICHAEL ROBERT, CALI' QUAGLIA MICHELE, KASULA BHAVANI VIKRAM, Direct numerical calculation of the kinematic tortuosity of reactive mixture flow in the anode layer of solid oxide fuel cells by the Lattice Boltzmann Method, J. OF POWER SOURCES, v. 170, pp. 359-375

35. 2006, ASINARI P., Semi-implicit-linearized multiple-relaxation-time formulation of lattice Boltzmann schemes for mixture modeling, PHYSICAL REVIEW E, v. 73, pp. 056705-1-24

36. 2005, ASINARI P., Viscous coupling based lattice Boltzmann model for binary mixtures, PHYSICS OF FLUIDS, v. 17, pp. 067102-1-22

37. 2005, ASINARI P., Numerical Prediction of Turbulent Convective Heat Transfer in Mini/Micro Channels for Carbon Dioxide at Supercritical Pressure, INT. J. OF HEAT AND MASS TRANSFER, v. 48, pp. 3864-3879