Barbara Re

Curriculum Vitae

Personal details

Address	Universität Zürich, Institut für Mathematik
	Winterthurerstr. 190, CH-8057 Zürich
Email	barbara.re@math.uzh.ch
Nationality	Italian
Date of birth	10 July 1988
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Research experience

01/01/2018– present

Post-Doc Research Fellow, University of Zürich, Switzerland
Institute of Mathematics

Supervisor: prof. Rémi Abgrall

Activities:
- Mathematical modeling of weakly compressible flows with a non-equilibrium, Baer and Nunziato like method.
- Robust discretization of non-conservative terms on staggered grids.
- Defect-Correction time integration including relaxation source terms.
- Simulations of pipe-flows of CO_2-rich mixtures.

Supported by: Norwegian CCS Research Centre (NCCS)

16/12/2015– 15/12/2017

Post-Doc Research Fellow, Politecnico di Milano, Italy
Department of Aerospace Science and Technology

Supervisor: prof. Alberto Guardone

Activities:
- Solution-based mesh adaptation for unsteady CFD simulations in the non-ideal regime using cubic equations of state (EoSs).
- Study of the feasibility of a fast and consistent thermodynamic evaluation of reference EoSs by means of genetic algorithms and adaptation techniques. (in collaboration with: P. Congedo, INRIA Bordeaux Sud-Ouest).
- Preliminary design of a new test rig for the experimental investigation of supercritical carbon dioxide. (in collaboration with: A. Spinelli, Energy Dept., Politecnico di Milano).

Education

Jan 2013 – 03/03/2016

PhD in Aerospace Engineering, Politecnico di Milano, Italy

Topics: Numerical methods for fluid flows around moving bodies, mesh adaptation, finite volume methods in ALE framework, unsteady Euler equations

Supervisor: A. Guardone (Politecnico di Milano, Italy)

Co-supervisor: C. Dobrzynski (INRIA Bordeaux, France)

Sept 2010 – 20/12/2012

Master in Aeronautical Engineering, Politecnico di Milano, Italy

Topics: Aerodynamics, numerical methods, thermodynamics

Sept 2007 – 22/09/2010

Bachelor in Aerospace Engineering, Politecnico di Milano, Italy

Publications

Peer-reviewed journal papers

2019
Shock Waves

B. Re & A. Guardone. An adaptive ALE scheme for non-ideal compressible fluid dynamics over dynamic unstructured meshes. *Shock Waves* 29 (2019) 73–99. (doi).

2018
Appl Math Comput

B. Re, C. Dobrzynski & A. Guardone. Assessment of grid adaptation criteria for steady, two-dimensional, inviscid flows in non-ideal compressible fluids. *Applied Mathematics and Computations.* 319 (2018) 337–354. (doi).

2017
J Comput Phys

B. Re, C. Dobrzynski & A. Guardone. An interpolation-free ALE scheme for unsteady inviscid flow computations with large boundary displacements over three-dimensional adaptive grids. *Journal of Computational Physics.* 340 (2017) 26–54. (doi).

2015
J Comput Appl Math

B. Re, R. Armellin, N.R. Nannan & A. Guardone. Efficient evaluation of vapour—liquid equilibria from multi-parameter thermodynamic models using differential algebra. *Journal of Computational and Applied Mathematics.* 273 (2015) 404–413. (doi)

2017
IOPscience

B. Re, A. Rurale, A. Spinelli & A. Guardone. Preliminary design of a supercritical CO_2 wind tunnel. *Journal of Physics: Conference Series*, 821:012027 (2017). (doi).

Conference proceedings

2018 IUTAM

B. Re & A. Guardone. Fluid-Structure simulation of a piston shock-tube using an adaptive ALE scheme in the non-ideal compressible-fluid regime. *Proceedings of IUTAM Symposium Santorini 2018*, under publication.

2018 ECCM-ECFD

L. Cirrottola, G. Quaranta, **B. Re**, C. Dobrzynski & A. Guardone. Numerical simulation of nonclassical aileron buzz over 3D unstructured adaptive meshes. In *Proceedings of the ECCM6–ECFD7*, ed. R. Owen, R. de Borst, J. Reese, C. Pearce, CIMNE, 2018. (pdf)

2017 COUPLED

B. Re, C. Dobrzynski, & A. Guardone. Numerical simulation of shock-tube piston problems with adaptive, anisotropic meshes. In *Proceedings of COUPLED PROBLEMS 2017*, ed. M. Papadrakakis, E.Onate, B.Schrefler, CIMNE, 2017. (pdf)

2017 AIAA SciTech

B. Re, A. Guardone & C. Dobrzynski. An Adaptive Conservative ALE Approach to Deal with Large Boundary Displacements in Three-Dimensional Inviscid Simulations. In *55th AIAA Aerospace Sciences Meeting*, 2017. (doi)

2015 YIC GACM

B. Re, A. Guardone & C. Dobrzynski. Preliminary results from an adaptive conservative scheme for three-dimensional Euler equations on dynamic meshes. In *Conference Proceedings of the YIC GACM 2015*, ed. S. Elgeti and J.-W. Simon, RWTH Aachen University, 2015. (pdf)

Theses

03 Mar 2016

B. Re, **PhD Thesis**. *An adaptive interpolation-free conservative scheme for the three-dimensional Euler equations on dynamic meshes for aeronautical applications.*

An innovative adaptive scheme for unsteady, inviscid flow simulations of three-dimensional moving-body problems is proposed. Grid connectivity changes due to mesh adaptation are described as series of continuous deformations of the finite volumes that compose the domain, so that the solution on the new grid is recovered within the arbitrary Lagrangian-Eulerian framework without any explicit interpolation, and the Geometric Conservation Law is fulfilled by an appropriate computation of the grid velocity. Node insertion, deletion, relocation, and edge swap are used both to capture flow features as shock waves and shear layers, and to preserve mesh quality when dealing with moving boundaries. The proposed conservative adaptive strategy has been implemented in the CFD software *Flowmesh* and underwent a thorough validation including reference and complex unsteady tests.

External referee: V. Dolejsi (Charles University Prague, Czech Republic)

20 Dec 2012

B. Re, **Master Thesis**. *Taylor expansions of the Vapor–Liquid Equilibrium curve* (Espansioni in serie di Taylor della curva di saturazione liquido–vapore)

Differential algebra techniques are used to obtain approximations of the vapor-liquid equilibrium curve that provide a good accuracy but a low computational cost. Fourth–order Taylor expansions are derived from the Span–Wagner EoS for carbon dioxide, butane, methane, and propane. The proposed technique guarantees the thermodynamic consistency with the underlying EoS and it can be applied to different thermodynamic models, both technical and reference ones.

Supervisor: A. Guardone (Politecnico di Milano)
Co-supervisors: N.R. Nannan (Anton de Kom University, Suriname)
                          R. Armellin (Politecnico di Milano)

Research visits

Sept 2013 – Dec 2013
Feb 2015 – Apr 2015

Visiting Phd student, INRIA Bordeaux Sud-Ouest, France.
BACCHUS, CARDAMOM Research teams

Supervisor: C. Dobrzynski
Activities: ○ Development of suitable series of fictitious continuous deformations to describe mesh adaptation operations performed by the re-mesher library *Mmg*.
                 ○ Implementation of inter-operable (C-Fortran) data-structures, ad-hoc API interfaces, and callbacks to link *Mmg* to the flow solver *Flowmesh*.

May 2019 – June 2019

NCCS Mobility Program, SINTEF Energy Research, Norway.

Collaborators: M. Hammer and S.T. Munkejord
Activities: ○ Implementation of accurate, engineering-relevant equation of states into the prototype solver for multiphase flows at low Mach.
                 ○ Validation against existing modeling tools and experimental data.

Teaching experience

Sept 2018 – Jan 2019 (Sept 2019– Jan 2020)	**Lecturer**, University of Zürich, Switzerland. *Numerical Methods in Informatics (L + E)*, Bachelor's level.
Feb 2018 – May 2018	**Teaching assistant**, University of Zürich, Switzerland. *Numerics seminars*, Students seminars. (Original: Seminar in Numerik) Tasks: Supervision of students during the preparation of their seminar.
Mar 2017 – Sept 2017 Jun 2016 – Dec 2016	**Teaching assistant**, Politecnico di Milano, Italy. *Compressible Fluid Dynamics*, Master's level. Tasks: Weekly tutorials, preparation for the exam; written and oral examinations.
Mar 2016 – Jul 2016 Mar 2014 – Jul 2014	**Teaching assistant**, Politecnico di Milano, Italy. *Introduction to aerospace engineering*, Bachelor's level. (Original: Istituzioni di ingegneria aerospaziale) Tasks: Weekly tutorials and written examinations.

Supervising and mentoring experience

Jul 2015 – Oct 2018	**Co-supervision of one PhD student**, Politecnico di Milano, Italy. Degree: PhD in Aerospace Engineering Thesis title: Conservative interpolation-free mesh adaptation for three-dimensional aeroelastic simulations in unsteady compressible flows Defense: 08/10/2018
May 2015 – Apr 2016	**Co-supervision of one Master student**, Politecnico di Milano, Italy. Degree: Master in Energy Engineering Thesis title: Preliminary design of a facility for experimental investigation of supercritical carbon dioxide flows Defense: 27/04/2016

Presentations

Talks at international conferences

9 – 13 Sept 2019	A diffuse interface method for weakly compressible multiphase flows based on the Baer and Nunziato model. *MULTIMAT 2019*. Trento, Italy (accepted).
25 Feb – 1 Mar 2019	An Interpolation-free Adaptive ALE Approach with Multi-step Time Schemes. *SIAM-CSE 2019*. Spokane, USA.
4–5 Oct 2018	A non-equilibrium model for weakly compressible multi-component flows. *NICFD 2018*. Bochum, Germany.
26–28 Jun 2017	An interpolation-free approach to exploit mesh adaptation within the ALE framework. *ADMOS 2017*. Verbania, Italy.
5–7 Apr 2017	An interpolation-free mesh adaptation approach for unsteady inviscid flows in aeronautical applications. *FEF 2017*. Rome, Italy.
9–13 Jan 2017	An Adaptive Conservative ALE Approach to Deal with Large Boundary Displacements in Three-Dimensional Inviscid Simulations. *AIAA SciTech 2017*. Grapevine, USA.
20–21 Oct 2016	Preliminary design of a supercritical CO2 wind tunnel. *NICFD 2016*. Varenna, Italy.
5–10 Jun 2016	An Innovative CFD Tool to Solve the Euler Equations Within the Finite Volume ALE Framework Over Adaptive Grids. *ESCO 2016*. Pilsen, Czech Republic.
20–23 Jul 2015	An adaptive conservative scheme for three-dimensional Euler equations on dynamic meshes. *YIC GACM 2015*. Aachen, Germany.
15–20 Jun 2014	Numerical Simulation of Under-expanded Jets of Dense Gases With an Adaptive Finite Volume Method. *ESCO 2014*. Pilsen, Czech Republic.
19–24 May 2013	Evaluation of the Vapor-liquid Equilibrium of Multi-parameter Thermo-dynamics Models Using Differential Algebra. *FEMTEC 2013*. Las Vegas, USA.

Invited talks

6 Dec 2018	Simulation of weakly compressible flows with a Baer and Nunziato-like method: application to CO_2. At *NCCS Consortium Days 2018*, Trondheim, Norway.
12 May 2017	An adaptive interpolation-free ALE scheme for inviscid flows around moving bodies. At *MOX, Politecnico di Milano*, Italy.
25 Jan 2016	An adaptive conservative scheme for three-dimensional Euler equations on dynamic meshes for aeronautical applications. During the course *Computational Fluid Dynamics*, prof. Quartapelle, Politecnico di Milano, Italy.
10 Apr 2015	Arbitrary Lagrangian Eulerian formulation for adaptive grids with variable connectivity. At *INRIA Bordeaux Sud-Ouest*, France.