Department of Mathematics and Computer Science,
Viale Andrea Doria 6,
University of Catania,
CAP 95125, Catania, Italy.

(0039) 392 6311328
emanuele.macca@unict.it

Emanuele Macca

personal data

Place and Date of Birth: Vittoria (RG), Italy on November 23^{th} 1992;
Nationality: Italian; Sex: Male;
Address: Via Duca degli Abruzzi 42C, Catania (CT), CAP 95127, Italy;
Phone Number: (0039) 3926311328;
Personal email: emanuele.macca@unict.it;

appointments

2016-2017 Tutor junior in Numerical Calculus in Mathematics at University of Catania, Italy;
2017-2018 Tutor junior in Numerical Calculus in Mathematics at University of Catania, Italy;
2017-2018 Tutor junior in Mathematical 1 in Biology at University of Catania, Italy;
2019-2020 Research experience (predoctoral) for six months at the Applied Mathematic Institute of the University of Malága in the framework of the ITN ModCompShock (Marie Sklodowska-Curie grant agreement No 642768);
2020-2021 Tutor junior in Numerical Calculus in Mathematics at University of Catania, Italy;
2020-2021 Tutor junior in Mathematical Analysis 1 in Engineering at University of Catania, Italy;
2018-2022 PhD Student in Mathematics and Computer Science at University of Palermo, Catania and Messina;
2022-2023 Tutor qualified in Numerical Calculus in Mathematics at University of Catania, Italy;
2022-2023 Occasional intellectual work contract. Nomination as external expert for the project PON-POC "FARINATO'S CONTEMPORARY SKILLS" code 10.2.2A-FDRPOC-SI-2022-350 modul "MAT-STEM" Prot. n. 6818/IV-5/PON of 05/10/2022 at Liceo Scientifico P. Farinato, Enna;
2022-2023 Postdoc at University of Catania;
2023-present Research Fellow in Numerical Analysis at University of Catania

research interest

The primary objective of my research is to develop advanced numerical techniques capable of efficiently simulating and modeling a wide range of physical phenomena. These numerical methods should strike a balance between computational cost and accuracy, minimizing waste caused by excessive computational requirements and errors inherent in the numerical approximation.

My research primarily focuses on the modeling and simulation of hyperbolic systems governed by conservation and balance laws. These systems are characterized by the propagation of information at finite speeds, resulting in complex wave interactions and discontinuities. By studying and understanding these hyperbolic systems, I aim to develop numerical schemes that can accurately capture the dynamics of such phenomena while maintaining computational efficiency.

An important aspect of my research is investigating well-known benchmark problems, such as the Sod shock problem and the piston problem. These problems serve as test cases for evaluating the performance of numerical methods in capturing shock waves and other discontinuities accurately. By developing efficient and accurate numerical schemes for these benchmark problems, I can establish the reliability and robustness of the proposed techniques.

Additionally, my research extends to the modeling and simulation of environmental and geophysical phenomena. For example, I explore the shallow water model, which describes the behavior of water in areas with small depth compared to the wavelength of the propagating waves. By accurately simulating the dynamics of shallow water systems, I can contribute to the understanding and prediction of events such as coastal evolution, sedimentation processes, and the behavior of waves in estuaries.

Furthermore, my research encompasses the development of multiscale simulation techniques, which allow for the modeling of phenomena occurring at multiple spatial and temporal scales. This is particularly relevant in complex systems where phenomena on different scales interact and influence each other. By efficiently capturing the multiscale nature of these systems, my research aims to provide a more comprehensive understanding of the underlying physics and improve the accuracy of predictions.

In terms of computational efficiency, I investigate the design and implementation of efficient numerical schemes that minimize computational costs while maintaining accuracy. By improving computational efficiency, I aim to reduce the resources required for simulations, making them more accessible and cost-effective.

Overall, my research revolves around the development of numerical techniques that strike a balance between computational cost and accuracy. By focusing on hyperbolic systems of conservation and balance laws, as well as their applications in various fields, I aim to advance the field of numerical simulation and modeling while minimizing waste caused by excessive computational costs and errors.

education

2018-2022 PhD with Honor and Doctor Europeus in Mathematics and Computer Science at University of Palermo discussing a thesis titled *Shock-Capturing methods: Well-Balanced Approximate Taylor and Semi-Implicit schemes.*

2016-2018 Master degree with Honor in Mathematics at University of Catania, Italy, discussing a thesis titled *High Order Taylor-based methods and applications to conservative semi-Lagrangian schemes.*

2012-2016 Bachelor degree (106/110) in Mathematics at University of Catania, Italy, discussing a thesis titled *Calcolo delle Variazioni: dalle equazioni alle differenze al moto Browniano.*

2006-2012 Diploma at secondary high level school Stanislao Cannizzaro, Vittoria (RG), Italy.

conferences and schools

Modeling Clinic for Industrial Mathematics **MODCLIM 2016**, 15-27 February 2016 held at University of Catania;

Internation Conference in Memory of Filippo Chiarenza: A day on PDE's 14th June 2016 held at University of Catania;

Gulbenkian Summer School on Partial Differential Equation **Gulbenkiam 2016** 1-6 July 2016 held at University of Lisbon;

INdAM day 2017 7th June 2017 held at University of Messina;

The Mathematics of Mechanobiology **CIME 2018 courses** 27-31 August 2018 held at Cetraro;

frOm interacting Particle systems To Kinetic Equations: modelling, control and numerical methods **OptKe 2018** 26-30 November 2018 held at University of Verona;

International Workshop on Nonlinear Differential Problems 20th March 2019 held at University of Palermo;

Sixth Chilean Workshop on Numerical Analysis for Partial Differential Equations **WONAPDE 2019** 21-25 Jenuary 2019 held at University of Concepcion hosting a seminar titled: *"Local smoothness indicators for systems of conservation laws ";*

VII European Workshop on High Order Numerical Methods for Evolutionary PDEs and applications **HONOM 2019** 1-5 April 2019 held at University of Madrid;

XVIII Italian Meeting on Hyperbolic Equations **IperPa 2019** 15-17 May 2019 held at University of Palermo hosting a seminar: *"Adaptive Compact Approximate Taylor Methods for systems of conservation laws",* grant project INdAM: GNCS2019.

Numerical Methods for Hyperbolic Problems **NumHyp 2019** 17-21 June 2019 held at University of Malaga presenting a poster titled: *"A new family of flux limiters and its applications to different cases";*

Applied Mathematical Problems in Geophysics **Cime 2019 courses** 1-5 July 2019 held at Cetraro;

IX International Congress on Industrial and Applied Mathematics **Iciam 2019** 15-19 July 2019 held at University of Valencia;

Oberwolfach Seminar 2019 Structure-preserving Methods for Nonlinear Hyperbolic Problems 24-30 November 2019 held at the Mathematisches Forschunginstitut Oberwolfach hosting a short-seminar: *"An Order-Adaptive Compact Approximation Taylor method for systems of conservation laws"*;

Winter School and Workshop on PDEs: Modelling, Analysis and Numerical Simulation **PDE-MANS 2020** 8-16 Jenuary 2020 held at Math Institute of the University of Granada presented a poster titled: *"Minmax flux limiter function"*;

Kinetic Traffic Models and Numerical Methods (Conference on the occasion of Gabriella Puppo 60th birthday) 5th February 2020 held at University of Roma, Sapienza;

Numerical Approximation of Hyperbolic Problems and Applications 6-7 February 2020 held in Roma Tre University, hosting a seminar: *"An adaptive high-order compact approximate Taylor method for systems of conservation laws"*;

Indam 2020 National conference 11-13 February 2020 hel in Montecatini Terme, Italy;

XLV Summer School on Mathematical Physics **Ravello 2020** 31-9 September 2020 held at Villa Rufolo in Ravello, hosting a seminar: *"Adaptive high-order CAT method for systems of conservation laws"*;

XXVI Congress of Differential Equation and Applications **Cedya20-21** 14-18 June 2021 held in Gijón(Spain), hosting a seminar: *"Adaptive high-order CAT method for systems of balance law"*;

Numerical Methods for Hyperbolic Problems **NumHyp21** 26-30 July 2021 held in Trento, hosting a seminar: *"Well Balance Adaptive CAT method for systems of balance law"*;

Simai conference 2020+2021 **Simai20+21** 30-3 September 2021 held in Parma, hosting a seminar: *"High order Adaptive CAT method for systems of balance law and well-balanced property"*;

International Workshop on Efficient high-order time discretization methods for PDEs 11-13 May 2022 held in Anacapri, hosting a seminar: *"An implicit-explicit strategy for Exner model with Grass Equation for sediment evolution "*;

The XVIII International Conference on Hyperbolic Problems: Theory, Numerics, and Applications **Hyp20-22** 20-24 June 2022 held in Málaga, hosting a seminar: *"An implicit-explicit strategy for Exner model with Grass equation for sediment evolution"*;

VI Congreso de Jóvenes Investigadores de la Real Sociedad Matemática Española 6-10 February 2023, held in Léon, hosting a seminar: *"High-order Implicit-Explicit scheme for the Exner model without gravity effects"*;

Numerical Aspects of Hyperbolic Balance Laws and Related Problems **NumAsp23** 19-23 June 2023 hel in Cortona, hosting a poster: *"Semi-implicit CAT2 method for systems of balance laws with relaxation term"*;

Numerical Methods for Hyperbolic Problems **NumHyp23** 26-30 June 2023 held in Bordeaux, hosting a seminar: *"CAT scheme with good MOOD"*.

Invited speaker

LMV International Workshop 2022 Theoretical, applied, and computational aspects of hyperbolic partial differential equations 19-21 October 2022 held in Versailles hosting a talk: *Adaptive high order compact approximation Taylor method for Systems of Conservation and Balance laws"*.

visiting period

Visiting period at University of Malaga, Spain, from 1^{th} to 14^{th} December 2018;
Visiting period at University of Malaga, Spain, from 24^{th} to 31^{th} March 2019;
Visiting period at University of Malaga, Spain, from 17^{th} to 30^{th} November 2019;
Visiting period at University of Malaga, Spain, from 12^{th} to 16^{th} July 2021.
Visiting period at University of Malaga, Spain, from 26^{th} June to 2^{nd} July 2022.
Visiting period at University of Sevilla, Spain, from 07^{th} to 14^{th} November 2022.
Visiting period at University of Bordeaux, France, from 27^{th} November to 3^{rd} December 2022.

publications

Carrillo H., Macca E., Parés C., Russo G., Zorío D. *Adaptive Compact Approximate Taylor Methods for systems of conservation laws.* J. Comput. Phys. 438 (2021).

Macca E. *Shock-Capturing methods: Well-Balanced Approximate Taylor and Semi-Implicit schemes,* PhD Thesis, Università degli Studi di Palermo, Palermo2022.

Macca E., Carrillo H., Parés C., Russo G. *High-order Well-Balanced Adaptive Compact Approximate Taylor Methods for systems of balance law.* J. Comput. Phys., 478 (2023).

Loubère R., Macca E., C. Parés, G. Russo *CAT-MOOD methods for conservation laws in one space dimension.* Theory, Numerics and Applications of Hyperbolic Problems, SEMA-SIMAI Springer Series, (2023) Proceedings of HYP2022.

Macca E., Russo G. *Boundary effects on wave trains in the Exner model of sedimental transport* BUMI Bollettino Unione Matematica Italiana, Accepted.

Avgerinos S., Castro M., Macca E., Russo G. *A semi-implicit finite volume method for the Exner model of sediment transport.* J. Comp. Phys., Accepted.

Macca E., Loubère R., Parés C., Russo G. *An almost fail-safe a-posteriori limited high-order CAT scheme* J. Comp. Phys., Submitted.

grants

INdAM project 2019 National project on *Numerical approximation for hyperbolic systems and applications.*

Marie Sklodowska-Curie grant referred to the research project 8.06.UE/54.8007.

INdAM project 2023 National project on *Metodi numerici per problemi differenziali multiscala: schemi di alto ordine, ottimizzazione, controllo.*

languages

Italian as native language;
English: Writing B2; listening B2; use of English B2; reading B2.
Spanish: Writing A2; listening B1; reading B1.

Computer skill

Programming language: Matlab (5-years), Python (4-years), R (1-year), Maple (5-years), Mathematica (5-years), Octave (5-years) and C (1-year);
Platforms: Windows and Linux;

Office suits: Latex (TexStudio, Overleaf) and Microsoft (Word, Excel, PowerPoint, Power Bi, OneNote, Outlook, OneDrive).

LE INFORMAZIONI RIPORTATE NEL PRESENTE CURRICULUM VITAE SONO ESATTE E VERITIERE. AUTORIZZO IL TRATTAMENTO DEI DATI PERSONALI AI SENSI E PER GLI EFFETTI DEL DECRETO LEGISLATIVO 196/2003 PER LE FINALITA ' DI CUI AL PRESENTE AVVISO DI CANDIDATURA