# Ioannis Toulopoulos | Curriculum Vitae

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## Personal Data

**Birth**:  Greece, Nationality Greek

**Place of residence**: Kastoria, Greece

**military services**: completed in 2008

**web-page**: https://sites.google.com/view/ioannis-toulopoulos/home

**languages**:  English (fluently), German (A2)

## Education

**1994**-**1999**: BS Mathematics, University of Crete, Greece

**2000**-**2002**: M.Sci. in Applied and Comput. Mathem., Department of Math, Univer. of Athens, Greece, (grade excellent)

**2003**-**2009**: PhD in Applied and Comput. Mathem., Department of Math., Univer. of Athens, Greece, (grade excellent), (including military services period)

## Career history/ Research experience

**2004**-**2008,2009**: Research Assistant at the Institute of Applied and Computat. Math., (IACM), FORTH, Greece, with main research topics:

○ Design and development of high order accurate finite element methods on structured and unstructured meshes for aeroacoustic, inviscid flow problems (Euler equations), compressible Navier Stokes, Maxwell.

**2010**-**2013**: Postdoctoral researcher at Mathematisches Institut, Universität Freiburg, Germany, with main research topics:

○ Development, analysis and application of finite element methods for non-linear diffusion problems, non-Newtonian incompressible flow problems.

**2013**-**2018**: Postdoctoral researcher at J. Radon Institute for Comput. and Appl. Math., Linz, Austria, with main topics:

○ Isogeometric Analysis (IGA) for problems with low-regularity. Design, discretization error analysis and application of Discontinuous Galerkin Domain Decomposition Methods in IGA (DG-DD-IGA schemes) for second-order elliptic problems and parabolic problems. Coupling/discretization techniques on decompositions with non-matching interfaces.

○ Space-time FE/IGA methods for time dependent convection-diffusion problems and incompressible flow problems.

○ Numerical methods for nonlinear elliptic problems using multilevel meshes.

**2018**-**2020**: Senior Scientific Researcher AC2T GmbH, at Austrian Excellence Center for Tribology,

○ Math modelling for lubrication with Non-Newtonian Fluids, PDE models for solid deformations, equations for elasto-viscoplastic, investigating contact conditions, viscous type friction laws. Numerical methods for simulating contact/lubricated problems.

**2019**-**2021**: External researcher (project leader) at Institute of Computational Mathematics: Johannes Kepler University Linz, Austria.

○ Analysis and development of nonlinear IGA and FEM.

○ Efficient space-time numerical methods for time evolution problems.

○ Analysis/implementation of space-time finite element methods for Non-Newtonian Fluid flow problems.

**2021**-**today**: Assistant Professor, at University of Western Macedonia GREECE, Department of Informatics

○ Analysis and development of numerical methods for PDEs nonlinear

○ Scientific computing, and computing for engineering problems

○ Numerical methods and optimization problems

## Scholarships and awards

**2003**-**2005**: Dissertation Scholarship by IACM-FORTH, HELLAS, Crete, in the research project "AWARD"

**2006**-**2008**: Dissertation Scholarship by IACM-FORTH, HELLAS, Crete, in the research project "GOAHEAD"

## Research projects, Committee

**1**: *Geometry and Simulation*, (NFN) S117-SP03, 2016-2020, (auxiliary participation)

**2**: *Discontinuous Galerkin Isogeometric Analysis for nonlinear PDEs:Applications to fluid flow problems*, (revision of FWF.)

**3**: *Numerical simulation of incompressible Non-Newtonian problems,(stand alone project)* JKU-LIT Nbr LIT-2017-4-SEE-004, 2018

**4**: *Numerical simulation of incompressible Non-Newtonian problems,(stand alone project)* JKU-LIT Nbr LIT-2017-4-SEE-004, extension 2020-2021

**5**: *'Variational inequalities and FEM discretizations'',praktikant fur das masterprogramm* internal AC2T master/scholarship of project COMET K2 InTribology 872176

## Membership

- **Project Research Scientist**. –'' Grant GRID-APP of the General Secretariat for Research and Technology, Greece'' at IACM-FORTH, HELLAS, Crete, 2009
  –"C.2 Fluid structure interactions" of DFG/TR 71 "Geometric Partial Differential Equations" 2010-2013.
  – "Discontinuous Galerkin Domain Decomposition Methods in Isogeometric Analysis" under FWF grant NFN S 117-03 "Geometry + Simulation". 2013-2018
- **Referee in Journals.** Inter. Journal for Numerical Meth. in Fluids, Journal of Comput. Physics, Journal of Scientific Computing, Applied Math. and Computation, Journal of Comput. and Applied Math.
- Mathematical Reviews (AMS), Austrian Academy of Science

## Scientific counseling or co-supervision

**4 PhD** students, **2 M.Sci.** students,    **1 Postdoctoral**

## Numerical analysis Software, scientific programming (only main contributions)

DG-FEM for aeroacoustic, Conservation laws, compressible-incompressible Navier Stokes (personal codes-library ), nonlinear elliptic, non-Newtonian flows (FEM libraries), Isogeomtric Analysis for diffusion, space-time parabolic (G+SMO), space-time advection diffusion, Incompressible Navier Stokes (NG-SOLVE, FreeFem++), viscoplasticity with adaptivity (FreeFem++), multiphysics problems (COMSOL, MOOSE), FEM with Python (NG-SOLVE).

## Teaching Experience, (Last main courses)

Discontinuous Galerkin Methods for Elliptic and Parabolic Problems (Master course)
A-posteriory estimates and adaptivity, (Master course)
Scientific computations using FEM libraries
Discontinuous Galerkin Finite Element methods: Notes on Theory and Implementation, (Master Course)
Mathematical Modelling,
Applied mathematics (ODEs and Numerics)
Real Analysis I,
Calculus I,
Advanced subjects in Numerical Analysis,

## Research interests

Development, analysis and application of mathematical and efficient numerical methods to the solution of real world problems. Emphasis on high order continuous/discontinuous finite element, Isogeometric Analysis, for diffusion, fluid flow, viscoplastic problems. Development/analysis of stabilized space-time finite element/Isogeometric Analysis for evolutionary problems

- Discontinuous Galerkin finite elements and Isogeometric Analysis for linear/nonlinear diffusion problems in complex domains, low regularity solutions and graded mesh techniques.
- Finite element methods for wave problems, aeroacoustic, shock-capturing schemes.
- Study/analysis and application of finite element, Isogeometric Analysis, for simulating real flow problems, e.g., Navier-Stokes, non-Newtonian flows (biofluids), conservation laws, compressible flows.
- Development/analysis a of space-time DGIGA methods for initial-boundary value problems in conjunction with implementation in time-parallel integration techniques.
- Finite element discretizations for solid mechanics, viscoplastic power law models.
- Analysis/implementation of space-time finite element methods for Non-Newtonian Fluid flow problems.
- Construction of fast nonlinear iterative solvers combined with domain decomposition techniques.

# Publications

Papers under preparation and under review....................................................................

[1] I. Toulopoulos. A unified space-time finite element scheme for non-Newtonian power law models. *(2021) under review*.

Selected papers in Volumes and Refereed Articles in Collections:..............................

[2] U. Langer and A. Mantzaflaris and S. E. Moore and I. Toulopoulos. Multipatch Discontinuous Galerkin Isogeometric Analysis pag. 1–32,Vol 107,(2015) *In series: Lecture Notes in Computational Science and Engineering, Springer International Publishing, Heidelberg* Editors:Bert Jüttler and Bernd Simeon

[3] U. Langer and M. Neumüller and I. Toulopoulos. Multipatch Space-Time Isogeometric Analysis of Parabolic Diffusion Problems *In series: Lecture Notes in Computer Science, LNCS 10665, Large-scale scientific Computing', pg 21-32, 2017, Springer International Publishing, Heidelberg* Editors: I. Lirkov and S. Margenov

[4] I. Toulopoulos and J. A. Ekaterinaris Implementation of Characteristic boundary conditions to the discontinuous Galerkin Method, 44th AIAA Aerospace Science Meeting and Exhibit, 2006, AIAA paper 0108. In: Aerospace sciences meeting: a collection of technical papers, Vol 2, 1349-1359, 2006

[5] I. Toulopoulos and J. A. Ekaterinaris. Discontinuous Galerkin Discretizations for Viscous Flow Problems in Complex Domains, 43th AIAA Aerospace Science Meeting and Exhibit, 2005, AIAA paper 1264. https://arc.aiaa.org/doi/10.2514/6.2005-1264

[6] I. Toulopoulos and J. A. Ekaterinaris. High Resolution Compressible Flow Simulations with the Discontinuous Galerkin Method, 17th AIAA-CFD conference, 2005, Toronto Canada, AIAA paper 2005-5109. https://arc.aiaa.org/doi/10.2514/6.2005-5109

Papers in Journals.................................................................................................

[7] I. Toulopoulos, Numerical solutions of quasilinear parabolic problems by a continuous space-time finite element scheme. *(2022), SIAM Journal on Scientific Computing, accepted*.

[8] S. Nakov and I. Toulopoulos. Convergence Estimates of Finite Elements for a Class of Quasilinear Elliptic Problems *Computers and Mathematics with Applications, 104, (2021), pp. 87 - 112*.

[9] I. Toulopoulos, A model and numerical investigation for rolling metal process using continuous finite element discretizations. *International Journal of Computer Mathematics, 2021, https://doi.org/10.1080/00207160.2021.1928651*

[10] C. Hofer, and I. Toulopoulos. Discontinuous Galerkin Isogeometric Analysis for parametrizations with overlapping regions, *Applicable Analysis, 2019, https://doi.org/10.1080/00036811.2019.1698724* ,

[11] C. Hofer, U. Langer, and I. Toulopoulos. Discontinuous Galerkin isogeometric analysis on non-matching segmentation: error estimates and efficient solvers. Journal of Applied Mathematics and Computing, Volm 61, pp 297 - 336, 2019

[12] I. Toulopoulos. Space-time finite element methods stabilized using bubble function spaces, Applicable Analysis, 99:7, 1153-1170, 2018, doi: 10.1080/00036811.2018.1522630

[13] C. Hofer, U. Langer, M. Neumüller and I. Toulopoulos. Time Discontinuous Galerkin Space-Time Isogeometric Analysis of Parabolic Problems, Electronic Transactions on Numerical Analysis, *Volm 49, pp 126-150, 2018*.

[14] A. Mantzaflaris, F. Scholz, I. Toulopoulos Low-rank space-time decoupled isogeometric analysis for parabolic problems with varying coefficients *De-Gruyter, Comput.Methods Appl. Math. pp 1-14, Volume 19: Issue 1, 2018* .

[15] T. Malkmus, M. Růžička, S. Eckstein, I. Toulopoulos, Generalizations of SIP methods to systems with $p$-structure, (2017), IMA Journal of Numerical Analysis, 38(3):1420-1451,doi: 10.1093/imanum/drx040

[16] I. Toulopoulos and T. Wick. Numerical methods for power-law diffusion problems, *(2017) SIAM Journal on Scientific Computing,* . Vol 39, No 3, pp A681–A710

[17] C. Hofer, U. Langer, and I. Toulopoulos. Discontinuous Galerkin Isogeometric Analysis of Elliptic Diffusion Problems on Segmentations with Gaps. *SIAM Journal on Scientific Computing*, 38(6),A3430 - A3460. (2016).

[18] C. Hofer and I. Toulopoulos. Discontinuous Galerkin Isogeometric Analysis of Elliptic Problems on Segmentations with Non-matching Interfaces. *Computers and Mathematics with Applications*. 72(7): 1811–1827,2016

[19] U. Langer and I. Toulopoulos. Analysis of Multipatch Discontinuous Galerkin IgA Approximations to Elliptic Boundary Value Problems. *Computing and Visualization in Science*, 17(5):217–233, 2016.

[20] U. Langer, A. Mantzaflaris, S.E. Moore, and I. Toulopoulos. Mesh grading in isogeometric analysis. *Computers and Mathematics with Applications*, 70(7):1685–1700, 2015.

[21] D. Kröner, M. Růžička, and I. Toulopoulos. Local discontinuous Galerkin numerical solutions of non-Newtonian incompressible flows modeled by p-Navier-Stokes equations. *J. Comput. Phys.*, 270:182–202, 2014.

[22] D. Kröner, M. Růžička, and I. Toulopoulos. Numerical solutions of systems with $(p, \delta)$-structure using local discontinuous Galerkin finite element methods. *Int. J. Numer. Methods Fluids*, 76:855–874, 2014.

[23] L. Diening, D. Kröner, M. Růžička, and I. Toulopoulos. A local discontinuous Galerkin approximation for systems with $p$-structure. *IMA J. Numer. Anal.*, 34(4):1447–1488, 2013.

[24] I. Toulopoulos. An interior penalty discontinuous galerkin finite element method for quasilinear parabolic problems. *Finite Elements in Analysis and Design*, 95:42–50, 2014, doi:10.1016/j.finel.2014.11.001.

[25] I. Toulopoulos and C. Makridakis. A discontinuous galerkin scheme for the numerical solution of flow problems with discontinuities. *Internat. J. Numer. Methods in Fluids*, 68(5):582–604, 2012.

[26] Toulopoulos I. and Ekaterinaris J. A. Artificial boundary conditions for the numerical solution of the Euler equations by the discontinuous Galerkin method. *J. Comput. Phys.*, 230:5974–5995, 2011.

[27] G. Arabatzis, P. Vavilis, I. Toulopoulos, and J. Ekaterinaris. Implicit High-Order Time-Marching Schemes for the Linearized Euler Equations. *AIAA Journal*, 45(8):1819–1826, 2007. DOI: 10.2514/1.25336

[28] I. Toulopoulos and A. J. Ekaterinaris. High-Order Discontinuous Galerkin Discretizations for Computational Aeroacoustics in Complex Domains. *AIAA Journal*, 44(3):502–511, 2006. http://arc.aiaa.org/doi/abs/10.2514/1.11422

Selected papers in proceedings, Conference books, accepted after review..............................................

[29] I. Toulopoulos Discontinuous Galerkin Isogeometric Analysis of Elliptic Diffusion Problems on Segmentations with Gaps and Overlaps Computational Methods in Applied Mathematics (CMAM-7), July 31 - August 6, 2016, University of Jyväskylä,, Finland

[30] U Langer, A. Mantzaflaris, S. E. Moore, I. Toulopoulos, Devising graded meshes for solving Elliptic problems by dG IgA method Proceedings of Special Interest Conferences ECCOMAS, "Third International Conference on Isogeometric Analysis (IGA 2015), Trondheim, Norway on 1-3 June 2015

[31] T. Malkmus and I. Toulopoulos Numerical Solutions of p-Incompressible Navier Stokes Equations by the LDG Finite Element Method, European Congress on Computational Methods in Applied Sciences and Engineering (ECCOMAS 2012) Vienna, Austria, September 10-14, 2012

[32] I.Toulopoulos and J. Ekaterinaris Characteristic boundary conditions for the numerical solution of Euler Equations by the DG methods, ECCOMAS CFD 14-17 June 2010, Lisbon, Portugal.

[33] I. Toulopoulos and C. Makridakis A discontinuous Galerkin shock-capturing scheme for the numerical solution of compressible flow problems, Proceeding of Conference in Numerical Analysis (NumAn 2008), pages 195-200, 1-5 September 2008, Kalamata Greece, editors G. Akrivis,E. Gallopoulos, A. Hadjidimos, I. S. Kotsireas, D. Noutsos, M. N. Vrahatis.

[34] I. Toulopoulos and J. A. Ekaterinaris On the Application of Filters for Discontinuity Capturing with High Order Discontinuous Galerkin Discritizations, International Workshop on High-order Finite Element Methods, 17-19 May 2007, Herrsching am Ammersee (near Munich), Germany.

[35] I. Toulopoulos and J. A. Ekaterinaris High order shock capturing discontinuous Galerkin schemes, Proceedings of European Conference on Computational Fluid Dynamics, 5-8 September 2006, Egmond aan Zee, Holland, editors P. Wasseling, E. Onate, J. Periaux

[36] I. Toulopoulos and J. A. Ekaterinaris High resolution Compressible flow Simulations with the discontinuous Galerkin Method, 17th AIAA Computational Fluid Dynamics Conference, 6-9 June 2005, Toronto Canada, AIAA paper 5109.