

# Ioannis Touloupoulos | Curriculum Vitae

project researcher at the Institute of Computational Mathematics: Johannes Kepler University Linz, Austria.

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## Personal Data

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**Birth:** Greece, Nationality Greek

**Place of residence:** Linz, Austria

**military services:** completed in 2008

**web-page:** <https://sites.google.com/view/ioannis-touloupoulos/home>

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

## Education

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**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

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**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,

**today:** Research collaborator of Institute of Computational Mathematics: Johannes Kepler University Linz, Austria.

- Math modelling for lubrication with Non-Newtonian Fluids, PDE models for solid deformations, equations for elasto-viscoplastic, investigating contact conditions, viscous type friction laws,
- Analysis and development of nonlinear IGA and FEM.
- Efficient space-time numerical methods for time evolution problems.

## Scholarships and awards

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**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

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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 für das Masterprogramm internal AC2T master/scholarship of project COMET K2 InTribology 872176

## Membership

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- **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 to Master-PhD thesis

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

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

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

## Teaching Experience, Last main courses

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Discontinuous Galerkin Methods for Elliptic and Parabolic Problems  
Implementing FEM using FreeFem++, applications to simple models (Lab)  
A-posteriori estimates and adaptivity,  
Applications of viscoplastic models in hot-metal forming (interior project talks)  
Scientific computations using FEM libraries ( next SS: 2020-2021)  
Discontinuous Galerkin Finite Element methods: Notes on Theory and Implementation, (next SS: 2020-2021)

## Research interests

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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.
- Construction of fast nonlinear iterative solvers combined with domain decomposition techniques.

## Publications

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Papers under preparation and under review.....

[1] I. Touloupoulos. Space-Time Finite element schemes for nonlinear parabolic problems. *under preparation.*

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

[2] U. Langer and A. Mantzaflaris and S. E. Moore and I. Touloupoulos. 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. Touloupoulos. Multipatch Space-Time Isogeometric Analysis of Parabolic Diffusion

- [4] I. Touloupoulos 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. Touloupoulos 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. Touloupoulos 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] S. Nakov and I. Touloupoulos. Convergence Estimates of Finite Elements for a Class of Quasilinear Elliptic Problems *under review, 2020, Pre-print as NUMA-JKU report* :<https://www.numa.uni-linz.ac.at/publications/List/2020/2020-03.pdf>.
- [8] I. Touloupoulos, Viscoplastic Models and Finite Element Schemes for the Hot Rolling Metal Process, *under review, 2020 preprint as NUMA-JKU report at* <https://www.numa.uni-linz.ac.at/publications/List/2020/2020-01.pdf> .
- [9] C. Hofer, and I. Touloupoulos. Discontinuous Galerkin Isogeometric Analysis for parametrizations with overlapping regions, *Applicable Analysis, 2019, https://doi.org/10.1080/00036811.2019.1698724* ,
- [10] C. Hofer, U. Langer, and I. Touloupoulos. 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*
- [11] I. Touloupoulos. Space-time finite element methods stabilized using bubble function spaces, *Applicable Analysis, 99:7, 1153-1170, 2018, doi: 10.1080/00036811.2018.1522630*
- [12] C. Hofer, U. Langer, M. Neumüller and I. Touloupoulos. Time Discontinuous Galerkin Space-Time Isogeometric Analysis of Parabolic Problems, *Electronic Transactions on Numerical Analysis, Volm 49, pp 126-150, 2018.*
- [13] A. Mantzaflaris, F. Scholz, I. Touloupoulos 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* .
- [14] T. Malkmus, M. Růžička, S. Eckstein, I. Touloupoulos, Generalizations of SIP methods to systems with  $p$ -structure, (2017), *IMA Journal of Numerical Analysis, 38(3):1420-1451,doi: 10.1093/imanum/drx040*
- [15] I. Touloupoulos and T. Wick. Numerical methods for power-law diffusion problems, (2017) *SIAM Journal on Scientific Computing, . Vol 39, No 3, pp A681–A710*
- [16] C. Hofer, U. Langer, and I. Touloupoulos. Discontinuous Galerkin Isogeometric Analysis of Elliptic Diffusion Problems on Segmentations with Gaps. *SIAM Journal on Scientific Computing, 38(6),A3430 - A3460. (2016).*
- [17] C. Hofer and I. Touloupoulos. Discontinuous Galerkin Isogeometric Analysis of Elliptic Problems on Segmentations with Non-matching Interfaces. *Computers and Mathematics with Applications. 72(7): 1811–1827,2016*
- [18] U. Langer and I. Touloupoulos. Analysis of Multipatch Discontinuous Galerkin IgA Approximations to Elliptic Boundary Value Problems. *Computing and Visualization in Science, 17(5):217–233, 2016.*
- [19] U. Langer, A. Mantzaflaris, S.E. Moore, and I. Touloupoulos. Mesh grading in isogeometric analysis. *Computers and Mathematics with Applications, 70(7):1685–1700, 2015.*
- [20] D. Kröner, M. Růžička, and I. Touloupoulos. Local discontinuous Galerkin numerical solutions of non-Newtonian incompressible flows modeled by  $p$ -Navier-Stokes equations. *J. Comput. Phys., 270:182–202, 2014.*
- [21] D. Kröner, M. Růžička, and I. Touloupoulos. Numerical solutions of systems with  $(p, \delta)$ -structure using local discontinuous Galerkin finite element methods. *Int. J. Numer. Methods Fluids, 76:855–874, 2014.*
- [22] L. Dienes, D. Kröner, M. Růžička, and I. Touloupoulos. A local discontinuous Galerkin approximation for systems with  $p$ -structure. *IMA J. Numer. Anal., 34(4):1447–1488, 2013.*

- [23] I. Touloupoulos. 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.
- [24] I. Touloupoulos 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.
- [25] Touloupoulos 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.
- [26] G. Arabatzis, P. Vavilis, I. Touloupoulos, 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
- [27] I. Touloupoulos 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.....](#)
- [28] I. Touloupoulos 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
- [29] U Langer, A. Mantzaflaris, S. E. Moore, I. Touloupoulos, 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
- [30] T. Malkmus and I. Touloupoulos 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
- [31] I.Touloupoulos 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.
- [32] I. Touloupoulos 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.
- [33] I. Touloupoulos and J. A. Ekaterinaris On the Application of Filters for Discontinuity Capturing with High Order Discontinuous Galerkin Discretizations, International Workshop on High-order Finite Element Methods, 17-19 May 2007, Herrsching am Ammersee (near Munich), Germany.
- [34] I. Touloupoulos 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
- [35] I. Touloupoulos 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.