Eidgenössische Technische Hochschule Zürich
Seminar für Angewandte Mathematik
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Date of Birth: November 22, 1983

Dr. Roger Käppeli

Education

November 2011	**Ph.D. in Theoretical Physics**, *Universität Basel*, Basel, 6.0 out of 6.0 (Summa Cum Laude).
	PhD thesis: *'Numerical Methods for 3D Magneto-Rotational Core-Collapse Supernova Simulation with Jet Formation'*
	Supervisors: Prof. M. Liebendörfer , Prof. F.-K. Thielemann
	External expert: Prof. S. Mishra
January 2008	**M.Sc. in Physics**, *Universität Basel*, Basel, 6.0 out of 6.0 (Summa Cum Laude).
	Master thesis: *'3D Hydrodynamics with Adaptive Mesh for Supernova Models'*
	Supervision: Prof. M. Liebendörfer
	Master exam: *'Computational Astrophysics and Computational Physics'*
	Examiners: Prof. M. Liebendörfer , Prof. S. Goedecker
Fall 2005	**B.Sc. in Physics**, *Universität Basel*, Basel, 5.6 out of 6.0.
July 2002	**Baccalauréat**, *Lycée cantonal de Porrentruy*, Porrentruy.
	Matura type C, scope: sciences

Employment

May - October 2019	**Visiting Scholar**, *Flash Center for Computational Science, Department of Astronomy and Astrophysics*, University of Chicago, Chicago, USA.
January 2016 -	**Senior assistant**, *Seminar für Angewandte Mathematik*, ETH, Zürich.
January 2012 - December 2015	**Postdoc**, *Seminar für Angewandte Mathematik*, ETH, Zürich.
December 2011	**Postdoc**, *Departement Physik*, Universität Basel, Basel.

Teaching experience

University level

Winter term 2019	**Programming Techniques for Scientific Simulations I**, *Lecturer*, ETH, Zürich.
Winter term 2019	**Statistical and Numerical Methods for Chemical Engineers**, *Lecturer for Numerical Methods part*, ETH, Zürich.
Spring term 2019	**Numerische Methoden für D-ITET und D-MATL**, *Lecturer*, ETH, Zürich.
Winter term 2018	**Programming Techniques for Scientific Simulations I**, *Lecturer*, ETH, Zürich.
Winter term 2018	**Statistical and Numerical Methods for Chemical Engineers**, *Lecturer for Numerical Methods part*, ETH, Zürich.
Spring term 2018	**Numerische Methoden für D-ITET und D-MATL**, *Lecturer*, ETH, Zürich.
Winter term 2017	**Programming Techniques for Scientific Simulations I**, *Lecturer*, ETH, Zürich.
Winter term 2017	**Statistical and Numerical Methods for Chemical Engineers**, *Lecturer for Numerical Methods part*, ETH, Zürich.

Spring term 2017	**Numerische Methoden für D-ITET und D-MATL**, *Lecturer*, ETH, Zürich.
Spring term 2017	**Case Studies Seminar für RW/CSE**, *Together with V. C. Gradinaru, K. Nipp and M. Reiher*, ETH, Zürich.
Winter term 2016	**Lineare Algebra und Numerische Mathematik für D-BAUG**, *Lecturer*, ETH, Zürich.
Winter term 2016	**Lineare Algebra für D-ITET, D-MATL und RW/CSE**, *Together with V. C. Gradinaru*, ETH, Zürich.
Winter term 2016	**Statistical and Numerical Methods for Chemical Engineers**, *Lecturer for Numerical Methods part*, ETH, Zürich.
Winter term 2015	**Statistical and Numerical Methods for Chemical Engineers**, *Lecturer for Numerical Methods part*, ETH, Zürich.
Winter term 2014	**Statistical and Numerical Methods for Chemical Engineers**, *Lecturer for Numerical Methods part*, ETH, Zürich.
Spring term 2014	**Numerische Methoden für D-ITET und D-MATL**, *Lecturer*, ETH, Zürich.
Spring term 2013	**Numerische Methoden für D-PHYS**, *Exercise coordinator and twice substitute lecturer*, ETH, Zürich.
October 29 - November 9 2012	**Numerical methods for conservation laws**, *Lecturer*, Mobility program for international professors, Tbilisi State University, Georgia.
Spring term 2012	**Numerische Methoden für D-PHYS**, *Exercise coordinator*, ETH, Zürich.
Spring term 2008	**Hydrodynamics and introduction to parallel programming in FORTRAN**, *Exercise coordinator and substitute lecturer*, Universität Basel.

Thesis supervision

2017-	**Ph.D. Thesis**, *Luc Grosheintz Laval*, Co-supervision with Prof. S. Mishra.
2018-2019	**Master Thesis**, *Samuel Maloney*, "Well-balanced methods for computation of the standing accretion shock instability (SASI)", Co-supervised with Prof. S. Mishra.
2016-2017	**Master Thesis**, *Thomas Graf*, "Runge-Kutta discontinuous Galerkin schemes for the induction equation using multidimensional Riemann solvers".
2016-2017	**Master Thesis**, *Marc Maetz*, "Central Schemes for the Induction Equation", Co-supervised with Prof. S. Mishra.
2016	**Semester Thesis**, *Thomas Graf*, "Implementation and Discussion of fundamental Methods in Magnetohydrodynamics".
2014	**Master Thesis**, *Ingmar Getzner*, "Analysis of measure valued solutions for the magnetohydrodynamic equations", Co-supervised with Prof. S. Mishra.
2013	**Bachelor Thesis**, *Alexander Lobbe*, "Constraint Preserving Schemes for the Shallow Water Equations", Co-supervised with Prof. S. Mishra.

High school level

June 4 - 8 2018	**ETH Studienwoche D-MATH: Differentialgleichungen oder wie beschreibt man Veränderung**, *Lecturer*, ETH, Zürich.
June 6 - 10 2017	**ETH Studienwoche D-MATH: Differentialgleichungen oder wie beschreibt man Veränderung**, *Lecturer*, ETH, Zürich.
June 6 - 10 2016	**ETH Studienwoche D-MATH: Differentialgleichungen oder wie beschreibt man Veränderung**, *Lecturer*, ETH, Zürich.
June 1 - 5 2015	**ETH Studienwoche D-MATH: Differentialgleichungen oder wie beschreibt man Veränderung**, *Lecturer*, ETH, Zürich.
June 2 - 6 2014	**ETH Studienwoche D-MATH: Differentialgleichungen oder wie beschreibt man Veränderung**, *Lecturer*, ETH, Zürich.

June 4 - 8 2013	**ETH Studienwoche D-MATH: Differentialgleichungen oder wie beschreibt man Veränderung**, *Lecturer*, ETH, Zürich.

Languages

German	Excellent	*Native*
French	Excellent	*Matura in French*
English	Fluent	

Computing Skills

Programming languages	FORTRAN, C and C++
Parallel programming	OpenMP (shared memory) Message Passing Interface (MPI) (distributed memory) Coarray Fortran (Partitioned Global Address Space language)
Accelerator programming	NVIDIA CUDA, OpenACC
Parallel I/O	MPI-IO, HDF5
Scripting languages	Python, Matlab, Octave, Scilab, Bash, Perl
Visualization	Matplotlib, ParaView, VisIt, VTK
Cluster administration	Operating System (Linux) Cluster Configuration and Application Deployment (Rocks Cluster Distribution) Scheduler (Sun Grid Engine, TORQUE, SLURM)

Research interests

- **Computational astrophysics** (Core-Collapse Supernovae, Neutron Star Merger, Multidimensional Stellar Evolution, Exoplanets Climate)
- **Numerical methods** (FV/FD/DG Methods for (Magneto-) Hydrodynamics and Computational Electrodynamics, Well-Balancing, Structure Preservation)
- **High Performance Computing** (Shared/Distributed Memory Parallelization, GPGPU, Hybrid Parallelization)

Funding record

- Swiss NSF grant, 177K CHF, Number 169631, 01.02.2017 - 31.01.2020, Co-applicant with Prof. S. Mishra

High Performance Computing and CPU time allocations

I have co-developed a parallel radiation-magnetohydrodynamics code for astrophysical applications such as the core-collapse of massive stars and binary neutron star mergers. The code featured a novel hybrid MPI/OpenMP parallelization scaling to $> 10'000$ cores.

I am a (principal and co-) investigator on a number of projects at the Swiss National Supercomputing Centre (CSCS) having been granted a total of $\sim$ **97.61 million CPU-hours** since 2008.

Other professional activities

Organizational

- Domain Co-Chair (Physics) of PASC20, University of Geneva, Switzerland, June 29 - July 1, 2020.
- Domain Co-Chair (Physics) of PASC19, ETH Zurich, Switzerland, June 12 - 14, 2019.
- Organizer (jointly with R. Cabezón) of minisymposia at PASC19, *Breaking the Wall in Computational Astrophysics: Current Bottlenecks and How to Address them towards the Exascale Era*, ETH Zurich, Switzerland, June 12 - 14, 2019.
- Organizer (jointly with R. Walder) of minisymposia at PASC19, *Multidimensional Stellar Evolution: Bridging the Modelling and Computational Challenges*, ETH Zurich, Switzerland, June 12 - 14, 2019.

Refereeing

I have peer reviewed for Journal of Computational Physics, Journal of Scientific Computing, SIAM Journal on Scientific Computing, Computational Astrophysics and Cosmology, Progress in Computational Fluid Dynamics, International Journal of Thermal Sciences, Zeitschrift für angewandte Mathematik und Physik, International Journal for Numerical Methods in Fluids.

List of publications

Publications

- M. V. Popov, R. Walder, D. Folini, T. Goffrey, I. Baraffe, T. Constantino, C. Geroux, J. Pratt, M. Viallet, and **R. Käppeli**. A well-balanced scheme for the simulation tool-kit A-MaZe: implementation, tests, and first applications to stellar structure. *Astronomy and Astrophysics*, 630:A129, Oct 2019.

- L. Grosheintz and **R. Käppeli**. High-order well-balanced finite volume schemes for the Euler equations with gravitation. *Journal of Computational Physics*, 378:324–343, 2019.

- D. S. Balsara and **R. Käppeli**. von Neumann stability analysis of globally constraint-preserving DGTD and PNPM schemes for the Maxwell equations using multidimensional Riemann solvers. *Journal of Computational Physics*, 376:1108–1137, 2019.

- D. S. Balsara and **R. Käppeli**. Von Neumann stability analysis of globally divergence-free RKDG schemes for the induction equation using multidimensional Riemann solvers. *Journal of Computational Physics*, 336:104 – 127, 2017.

- **R. Käppeli**. A Well-Balanced Scheme for the Euler Equations with Gravitation. In *Innovative Algorithms and Analysis*, pages 229–241. Springer International Publishing, 2017.

- U. S. Fjordholm, **R. Käppeli**, S. Mishra, and E. Tadmor. Construction of approximate entropy measure-valued solutions for hyperbolic systems of conservation laws. *Foundations of Computational Mathematics*, 17(3):763–827, Jun 2017.

- A. Perego, R. M. Cabezón, and **R. Käppeli**. An Advanced Leakage Scheme for Neutrino Treatment in Astrophysical Simulations. *Astrophysical Journal, Supplement*, 223:22, April 2016.

- **R. Käppeli** and S. Mishra. A well-balanced finite volume scheme for the Euler equations with gravitation. The exact preservation of hydrostatic equilibrium with arbitrary entropy stratification. *Astronomy and Astrophysics*, 587:A94, March 2016.

- **R. Käppeli** and S. Mishra. Well-balanced Schemes for Gravitationally Stratified Media. In N. V. Pogorelov, E. Audit, and G. P. Zank, editors, *Numerical Modeling of Space Plasma Flows ASTRONUM-2014*, volume 498 of *Astronomical Society of the Pacific Conference Series*, page 210, October 2015.

- A. Perego, S. Rosswog, R. M. Cabezón, O. Korobkin, **R. Käppeli**, A. Arcones, and M. Liebendörfer. Neutrino-driven winds from neutron star merger remnants. *Monthly Notices of the Royal Astronomical Society*, 443:3134–3156, October 2014.

- **R. Käppeli** and S. Mishra. Structure Preserving Schemes. In N. V. Pogorelov, E. Audit, and G. P. Zank, editors, *8th International Conference of Numerical Modeling of Space Plasma Flows (ASTRONUM 2013)*, volume 488 of *Astronomical Society of the Pacific Conference Series*, page 231, September 2014.

- **R. Käppeli** and S. Mishra. Well-balanced schemes for the Euler equations with gravitation. *Journal of Computational Physics*, 259:199–219, February 2014.

- C. Winteler, **R. Käppeli**, A. Perego, A. Arcones, N. Vasset, N. Nishimura, M. Liebendörfer, and F.-K. Thielemann. Magnetorotationally Driven Supernovae as the Origin of Early Galaxy r-process Elements? *Astrophysical Journal, Letters*, 750:L22, May 2012.

- N. Nishimura, T. Fischer, F.-K. Thielemann, C. Fröhlich, M. Hempel, **R. Käppeli**, G. Martínez-Pinedo, T. Rauscher, I. Sagert, and C. Winteler. Nucleosynthesis in Core-collapse Supernova Explosions Triggered by a Quark-Hadron Phase Transition. *Astrophysical Journal*, 758:9, October 2012.

- **R. Käppeli**, S. C. Whitehouse, S. Scheidegger, U.-L. Pen, and M. Liebendörfer. FISH: A Three-dimensional Parallel Magnetohydrodynamics Code for Astrophysical Applications. *Astrophysical Journal, Supplement*, 195:20, August 2011.

- T. Fischer, I. Sagert, G. Pagliara, M. Hempel, J. Schaffner-Bielich, T. Rauscher, F.-K. Thielemann, **R. Käppeli**, G. Martínez-Pinedo, and M. Liebendörfer. Core-collapse Supernova Explosions Triggered by a Quark-Hadron Phase Transition During the Early Post-bounce Phase. *Astrophysical Journal, Supplement*, 194:39, June 2011.

- F.-K. Thielemann, A. Arcones, **R. Käppeli**, M. Liebendörfer, T. Rauscher, C. Winteler, C. Fröhlich, I. Dillmann, T. Fischer, G. Martinez-Pinedo, K. Langanke, K. Farouqi, K.-L. Kratz, I. Panov, and I. K. Korneev. What are the astrophysical sites for the r-process and the production of heavy elements? *Progress in Particle and Nuclear Physics*, 66:346–353, April 2011.

- M. Liebendörfer, T. Fischer, M. Hempel, **R. Käppeli**, G. Pagliara, A. Perego, I. Sagert, J. Schaffner-Bielich, S. Scheidegger, F. Thielemann, and S. C. Whitehouse. Neutrino Radiation-Hydrodynamics: General Relativistic versus Multidimensional Supernova Simulations. *Progress of Theoretical Physics Supplement*, 186:87–92, 2010.

- S. Scheidegger, S. C. Whitehouse, **R. Käppeli**, and M. Liebendörfer. Gravitational waves from supernova matter. *Classical and Quantum Gravity*, 27(11):114101, June 2010.

- S. Scheidegger, **R. Käppeli**, S. C. Whitehouse, T. Fischer, and M. Liebendörfer. The influence of model parameters on the prediction of gravitational wave signals from stellar core collapse. *Astronomy and Astrophysics*, 514:A51, May 2010.

Talks

Invited talks

- *Computational astrophysics: The explosion mechanism of massive stars*,
  April 12 2018. Case Studies seminar in Computational Science and Engineering ETH Zürich, Switzerland.

- *Well-balanced schemes for astrophysical applications*,
  December 1 2017. Computational Science Seminar, Universität Zürich , Switzerland.

- *Well-balanced methods for computational astrophysics*,
  May 17-20 2016. Innovative Algorithms and Analysis, INdAM, Rome, Italy.

- *Well-balanced schemes for astrophysical applications*,
  January 25-26 2016. La mécanique des fluides numérique, Institut Henri Poincaré, Paris, France.

- *Advanced numerical methods for astrophysical applications*,
  November 18-20 2015. CoCoNuT Meeting 2015, University of Málaga, Spain.

- *Well-balanced schemes for astrophysical applications*,
  May 10 - 15 2015. Higher Order Numerical Methods for Evolutionary PDEs: Applied Mathematics Meets Astrophysical Applications (15w5134), Banff International Research Station, Canada.

- *Computational astrophysics: The explosion mechanism of massive stars*,
  October 9 2014. Case Studies seminar in Computational Science and Engineering ETH Zürich, Switzerland.

- *Structure preserving methods for modeling astrophysical phenomena*,
  December 3 2013. Séminaires de la Modélisation, Maison de la Simulation, CEA Saclay, France.

- *Three-dimensional simulation of magneto-rotationally driven core-collapse supernovae*,
  October 31 2013. Theorie-Seminar, Institut für Kernphysik, Darmstadt, Germany.

- *Structure preserving schemes*,
  September 15 - 21 2013. High-Resolution Mathematical and Numerical Analysis of Involution-Constrained PDEs, Oberwolfach, Germany.

- *Numerical simulation of Core-Collapse Supernovae*,
  November 1 2012. Seminar of the Department of Mathematics, Tbilisi State University, Tbilisi, Georgia.

- *Simulation of magneto-rotationally driven supernovae and some results on r-process elements production*,
  July 11 2012. Seminar for nuclear- and cosmo-chemistry, MPI für Chemie, Mainz, Germany.

- *The FISH/ELEPHANT astrophysics codes for modelling stellar explosions*,
  May 23 2012. Advanced Distributed Memory Parallel Programming: MPI-2.2, MPI 3.0 and PGAS, CSCS - Swiss National Supercomputing Centre, Lugano, Switzerland.

- *Numerical modelling of core-collapse supernovae*,
  November 8 2010. Weekly group meeting, Seminar for Applied Mathematics, ETH Zürich, Switzerland.

- *The FISH astrophysics code for modelling supernova explosions*,
  September 7 2010. 39th SPEEDUP Workshop on High-Performance Computing, ETH Zürich.

- *A Parallel 3D MHD code for core-collapse supernovae*,
  July 2 2008. Asymmetric instabilities in stellar core collapse, IHP Paris, France.

  Contributed talks

- *Well-balanced schemes for equilibrium flows*,
  June 26 - 30 2017. ASTRONUM 2017, Saint-Malo, France.

- *Well-balanced methods for computational astrophysics*,
  August 1-5 2016. HYP2016 - 16th International Conference on Hyperbolic Problems, RWTH Aachen, Germany.

- *Magnetorotational supernova explosions and their r-process nucleosynthesis*,
  September 29-30 2014. Stellar Evolution/Explosions, Nuclear/Particle Physics Input, Origin of the Elements and Evolution of Galaxies, Basel, Switzerland.

- *Jets from fast rotating MHD-driven supernova explosions and their impact on r-process.*
  September 23, 2014 2014. NewCOMPSTAR working group meeting, Barcelona, Spain.

- *Well-balanced schemes for gravitationally stratified media*,
  June 23 - 27 2014. ASTRONUM 2014, Long Beach, CA, USA.

- *Structure Preserving Schemes (for modeling astrophysical phenomena)*,
  June 2-3 2014. Platform for Advanced Scientific Computing (PASC) Conference, ETH Zürich, Switzerland.

- *Magnetars: Supernova Jets from fast rotating massive stars with high magnetic fields*,
  October 11 2013. SSAA/SGAA general assembly, Basel, Switzerland.

- *Well-balanced schemes for the Euler equations with gravitation*,
  October 7 - 9 2013. Efficient solution of large systems of non-linear PDEs in science, Lyon, France.

- *Structure preserving schemes*,
  July 1 - 5 2013. ASTRONUM 2013, Biarritz, France.

- *Well-balanced schemes for the Euler equations with gravitation*,
  March 4 2013. Swiss Numerics Colloquium, EPF Lausanne, Switzerland.

- *A Well-Balanced Multi-Dimensional Reconstruction Scheme for Hydrostatic Equilibria*,
  June 25-29 2012. HYP2012 - 14th International Conference on Hyperbolic Problems,
  University of Padua, Italy.

- *Numerical simulation of core-collapse supernovae*,
  September 21 2011. Student Science Fair 2011, Basel, Switzerland.

- *Simulation of magneto-rotational core-collapse supernovae*,
  June 17 2011. Annual Swiss Physical Society Meeting, EPF Lausanne, Switzerland.

- *Magnetorotational core-collapse simulations*,
  September 28 2010. Annual Workshop of the International Graduate School Basel-
  Graz-Tübingen, Todtmoos, Germany.

- *Numerical tools for the simulation of core-collapse supernovae*,
  April 16 2010. Swiss Numerics Colloquium, ETH Zürich, Switzerland.

- *Core-collapse Supernova with strong magnetic fields and jet formation*,
  February 14 2010. CompStar workshop, Caen, France.

- *Introduction to core-collapse supernova simulation*,
  October 1 2008. Annual Workshop of the International Graduate School Basel-Graz-
  Tübingen, Blaubeuren, Germany.

- *Computational hydrodynamics: Introduction to basic methods*,
  September 11 2007. Annual Workshop of the International Graduate School Basel-
  Graz-Tübingen, Todtmoos, Germany.