

## CV – Joachim Gerhard Stadel

### 1. **Contact:**

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Date of birth: April 4, 1968

### 2. **Education:**

PhD in Astronomy, University of Washington, 1996-2000

Graduate Studies in Physics with a move to Astrophysics, University of Toronto, 1991-1993

Bachelor in Physics and Mathematics, Brandon University, 1990, 1986-1989

### 3. **Employment:**

Staff Scientist, University of Zurich, Institute for Computational Science (Institute for Theoretical Physics till 2012), 2002-Present

Postdoctoral Fellowship, University of Victoria, 2000-2002

Research Astronomer, University of Washington, NASA HPCC, 1993-1995

Research Assistant, Max Planck Institute for Extraterrestrial Physics, Garching, 1990

NSERC Summer Research in Astronomy, Brandon University, 1988

### 4. **Grants:**

SNF Project “Euclid Emulator Project” (ongoing)

NCCR PlanetS (actively involved since founding), Phase 2 Project Leader

PRACE Project awarded (2018-2019) for EUCLID Flagship v2.0 simulation (2 million node hours)

SNF R’equip funding for the zBox2 and zBox4 in house supercomputers

INCITE Computing Allocation at Oak Ridge National Labs Jaguar and Titan supercomputers

Oak Ridge National Labs Directors Discretionary Allocation on Titan supercomputer

Several CSCS Project Allocations on Monte Rosa and Piz Daint supercomputers

### 5. **Students:**

Juerg Diemand (PhD with Ben Moore), Inner structure of Dark Matter Halos.

Marcel Zemp (PhD with Marcella Carollo, ETHZ), New Dynamical Time-stepping Methods.

Doug Potter (PhD 2016) Parallel N-body Simulations for Cosmology, PKDGRAV2/3 code.

Simon Grimm (PhD 2014) GPU Accelerated Solar System Integration, GENGA code.

Christian Reinhardt (ongoing) SPH Simulations of Giant Impacts, ISPH code.

Mischa Knabenhans (ongoing) Precision Cosmology with Large Survey N-body Simulations

(I have been involved in projects with more students at the University of Zurich at the Institute for Theoretical Physics and Computational Science, but this lists those people I have worked closely with or who were my sole responsibility.)

### 6. **Teaching:**

Undergraduate course “Simulations in the Natural Sciences I & II”, 11 ECTS credits

“Computational Astrophysics Practicum” 9 ECTS credits

7. **Memberships:**

Member of EUCLID Mission and work package leader of “Large Cosmological Simulations” and member of EUCLID IST-nonlinear team.

Member of the Swiss Astronomical Society

8. **Awards:**

EUCLID Star Prize awarded, Bonn 2018

Canadian Institute for Theoretical Astrophysics National Fellow, University of Victoria, 2000-2002

Pacific Institute for Mathematical Sciences Fellow, University of Victoria, 2000-2002

Canadian NSERC 1967 Graduate Scholarship, University of Toronto, 1991-1993

Memorial Graduate Scholarship in Physics, University of Toronto, 1991-1993

Several Undergraduate Awards at Brandon University, 1986-1990

## Major Scientific Achievements (last 5 Years)

1. The EUCLID Flagship Simulation, the World’s largest cosmological simulation to-date using 2 trillion ( $2 \times 10^{12}$ ) particles on Piz Daint at CSCS. I worked both on the simulation code PKDGRAV3 with Doug Potter as well as on the analysis of the enormous data set produced by this simulation. The results are being used by EUCLID to produce the current mock galaxy catalogues.
2. Connected with the above, making PKDGRAV3 also the fastest time-to-solution and most memory efficient N-body code in the World. This was a development process with Doug Potter which was very intensive over the last 4 years. We had to make many new innovations in the computing to make simulations at the scale of trillions of particles possible.
3. Elected as a work package leader within Euclid to be responsible for large cosmological simulations and the strategy for obtaining simulation computing resources within the collaboration. Since November 2018, I am one of the members of the newly created IST-nonlinear team within EUCLID, which will deliver tools for the 3<sup>rd</sup> and last systems performance verification of the EUCLID mission (SPV3). I regard my work within the Euclid collaboration as a very engaging and rewarding experience and believe it to be, generally, my most important recent contribution.
4. Development of the GENGA GPU code with Simon Grimm which has had a major impact within the NCCR PlanetS, where it is now being used within their data analysis platform, DACE, to analyze the stability of discovered exoplanet systems and to better understand their architectures. Although not directly part of my cosmological activities, the dynamics of planets and planetary collisions continues to inspire ideas across these two very different fields of simulation. For example, the GENGA GPU code development helped to create the inner-most GPU computational kernels of PKDGRAV3. While the handling of large numbers of particles and memory saving methods of PKDGRAV3 have now begun to influence GENGA allowing it to handle more particles as well. The new time integration techniques required in planetary dynamics can bring better methods to cosmological N-body simulations as well.

## 1. Publications:

Google Scholar Link: [http://scholar.google.ch/citations?user=eCAYA\\_4AAAAJ](http://scholar.google.ch/citations?user=eCAYA_4AAAAJ)

1. Knabenhans, **Stadel**, Marelli, Potter, Teyssier, Legrand, Schneider, Sudret, Blot, Awan, Burigana, Carvalho, Kurki-Suonio, and Sirri (2019) *Euclid preparation: II. The EUCLIDEMULATOR - a tool to compute the cosmology dependence of the nonlinear matter power spectrum*. Monthly Notices of the Royal Astronomical Society. **484**: 5509
2. Schneider, Teyssier, **Stadel**, Chisari, Le Brun, Amara, and Refregier (2019) *Quantifying baryon effects on the matter power spectrum and the weak lensing shear correlation*. Journal of Cosmology and Astro-Particle Physics. **3**: 020
3. Deng, Reinhardt, Benitez, Mayer, **Stadel**, and Barr (2019) *Enhanced Mixing in Giant Impact Simulations with a New Lagrangian Method*. The Astrophysical Journal. **870**: 127
4. Chau, Reinhardt, Helled, and **Stadel** (2018) *Forming Mercury by Giant Impacts*. The Astrophysical Journal. **865**: 35
5. Tamfal, Capelo, Kazantzidis, Mayer, Potter, **Stadel**, and Widrow (2018) *Formation of LISA Black Hole Binaries in Merging Dwarf Galaxies: The Imprint of Dark Matter*. The Astrophysical Journal. **864**: L19
6. Potter, **Stadel**, and Teyssier (2017) *PKDGRAV3: beyond trillion particle cosmological simulations for the next era of galaxy surveys*. Computational Astrophysics and Cosmology. **4**: 2
7. Reinhardt and **Stadel** (2017) *Numerical aspects of giant impact simulations*. Monthly Notices of the Royal Astronomical Society. **467**: 4252
8. Hoffmann, Grimm, Moore, and **Stadel** (2017) *Stochasticity and predictability in terrestrial planet formation*. Monthly Notices of the Royal Astronomical Society. **465**: 2170
9. Fiacconi, Madau, Potter, and **Stadel** (2016) *Cold Dark Matter Substructures in Early-type Galaxy Halos*. The Astrophysical Journal. **824**: 144
10. Schneider, Teyssier, Potter, **Stadel**, Onions, Reed, Smith, Springel, Pearce, and Scoccimarro (2016) *Matter power spectrum and the challenge of percent accuracy*. Journal of Cosmology and Astro-Particle Physics. **4**: 047
11. Reed, Schneider, Smith, Potter, **Stadel**, and Moore (2015) *The same with less: The cosmic web of warm versus cold dark matter dwarf galaxies*. MNRAS: **451**:4413
12. Grimm and **Stadel** (2014) *The GENGA Code: Gravitational Encounters in N-body Simulations with GPU Acceleration*. The Astrophysical Journal. **796**: 23

## 6. Talks at International Conferences:

- Invited Colloquia
  1. May 16, 2018, University of New York, Abu Dhabi, *Giant Simulations for Giant Surveys*.
- Euclid Cosmological Simulation Working Group Meetings, Barcelona
  1. Nov. 13, 2018, *Flagship v2.0 Update*
  2. Oct. 24, 2017, *The Euclid Flagship Simulation v2.0*
  3. Nov. 10, 2016, *The Euclid Flagship Simulation*

4. Nov. 18, 2015, *Toward the Full Euclid Simulation with the pkdgrav3 Code*

• Other Euclid Conferences

1. Jun. 11, 2018, Annual Meeting, Bonn, Splinter Sessions in S20:*Flagship v2.0 N-body Simulation Plan and Status*, and in S25:*N-Body Simulation products and realistic runtimes*, **EUCLID Star prize award**.
2. Apr. 23, 2018, ESA Simulated skies for new-generation spectroscopic surveys, Madrid, *The Euclid Flagship Simulation*
3. Jun. 5, 2017, Annual Meeting, London, Theory Working Group Splinter Session, *Emulators: Oracles of Cosmology*
4. Jul. 4, 2017, Euclid Galaxy Clustering under Science Performance Review, Sesto, *The Flagship Simulation*

• Methods Related Conferences

1. Feb. 12, 2017, Carving through the Codes, Davos, *Fast Multipole, GPUs and Memory Crushing: The 2 Trillion Particle Euclid Flagship Simulation*
2. Sep. 27, 2016, Perspectives of GPU Computing in Science, Rome, *A Two Trillion Particle Dark Matter Simulation*
3. Jun. 9, 2016, PASC, Lausanne, *The MDL Library (hiding the Machine Dependent Layers from simulation codes)*
4. Oct. 18, 2016, Towards Accurate Lightcones for Cosmology, Garching *An Algorithm for Continuous Lightcone Generation*

## 7. Public Outreach Activities:

1. Oct. 22, 2018, Talk at the Zurich Informatics Info Event, *Illuminating a large dark cosmos*.
2. Aug. 24, 2018, Exhibition at Kunsthalle Zurich, *100 Ways of Thinking*, Creation of a 5m diameter ultra high resolution print of the lightcone of the universe and creation of a video display. ( 3 weeks production effort)
3. Apr. 13, 2018, Talk at Swiss Space Museum, *Die Simulation des Dunklen Universums*.
4. Apr. 12, 2018, Talk at Yuri's Night in Zurich, *Dark Kosmos*.
5. May 5, 2017, Photo Art Exhibition at the Photobastei in Zurich. *Creation and public presentation of a 10m by 2.5m ultra high resolution print of the large scale structure in the universe (> 1 Month production effort)*
6. Sep. 21, 2017, Planetarium Show at Verkehrshaus, Lucerne. *A tour through the lightcone of cosmic structure from the world's largest N-body simulation in 8k×8k dome resolution*. (roughly 1 month production effort including writing of special visualization software)
7. Sep. 11, 2017, Presentation to Kantonal High School Students, Zurich, *Etwas Über das Universum*

## 8. General Contribution to Research:

1. Euclid Cosmological Simulation Working Group, Elected workpackage leader for large scale cosmological simulation definition, planning and validation.
2. Euclid IST-nonlinear: Inter Science Team member developing non-linear emulators and tools for SPV3 (Systems Performance Verification 3).

## 9. Other Contributions:

1. **Dataset:** 2016, The Euclid Flagship Simulation. This is the world's largest dark matter simulation so far, using 2 trillion particles. It has been used to create the mock galaxy catalog for the Euclid collaboration.
2. **Software:** Potter, **Stadel** (2016) *PKDGRAV3: Parallel Gravity Code*. Astrophysics Source Code Library, **ascl:** 1609.016 y

3. **Software:** Grimm, **Stadel** (2018) *GENGA: Gravitational ENcounters with Gpu Acceleration*. Astrophysics Source Code Library. **ascl:** 1812.014
4. **arXiv:** Munshi, McEwen, Kitching, Fosalba, Teyssier, and **Stadel** (2019) *Estimating the Integrated Bispectrum from Weak Lensing Maps*. 1902.04877 (in review)
5. **arXiv:** Hands, Dehnen, Gration, **Stadel**, and Moore (2019) *The fate of planetesimal discs in young open clusters: implications for 1I/'Oumuamua, the Kuiper belt, the Oort cloud and more*. 1901.02465 (in review MNRAS)
6. **Talk:** Feb. 6, 2017, Swiss Cosmology Days, Basel, *The Euclid Flagship Simulation and Mock Galaxy Catalogs*.
7. **Talk:** Feb. 6, 2015, Swiss Cosmology Days, Geneva, *Euclid Precision Cosmology Simulations with the PKD-GRAV3 Code*.
8. **Talk:** Nov. 15, 2017, NCCR Impacts in Planetary Systems, UZH, *Giant Impacts in the Formation of Mercury, Uranus and Neptune*.