

Oliver Zier

ITC Fellow · Computational Astrophysicist

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Academic Appointments

ITC Fellow <i>Institute for Theory and Computation, Center for Astrophysics Harvard & Smithsonian</i>	Sep 2024–present Cambridge, MA
Postdoctoral Researcher <i>Kavli Institute for Astrophysics and Space Research, Massachusetts Institute of Technology</i>	Oct 2023–Aug 2024 Cambridge, MA
Postdoctoral Researcher <i>Max Planck Institute for Astrophysics</i>	Apr 2023–Sep 2023 Garching, Germany
Doctoral Researcher <i>Max Planck Institute for Astrophysics</i>	Sep 2019–Mar 2023 Garching, Germany

Education

Ph.D. in Physics <i>LMU Munich</i> <i>Thesis: Taming rotationally supported disks using state-of-the-art numerical methods · Advisor: Volker Springel</i>	Sep 2019–Mar 2023 Munich, Germany
M.Sc. in Theoretical and Mathematical Physics <i>LMU Munich and Technical University of Munich</i> <i>Thesis: The physics of the interstellar medium · Advisor: Andreas Burkert</i>	Oct 2016–Aug 2019 Munich, Germany
B.Sc. in Computer Science <i>University of Bayreuth</i> <i>Thesis: Further development of a parallel particle-in-cell code for nonlinear models from mathematical physics · Advisor: Gerhard Rein</i>	Oct 2015–Mar 2017 Bayreuth, Germany
B.Sc. in Physics <i>University of Bayreuth</i> <i>Thesis: Convection instabilities in an inclined layer of mercury · Advisor: Werner Pesch</i>	Oct 2013–Sep 2016 Bayreuth, Germany

Research Focus

Cosmological simulations of galaxy formation; cosmic reionization and the intergalactic medium; self-interacting dark matter; star and disk formation; radiation hydrodynamics; numerical methods and high-performance computing.

Research Leadership & Software

- Principal investigator of **Lumina**, a program of large-volume radiation-hydrodynamic simulations of hydrogen and helium reionization.
- Developer of GPU-accelerated radiation transport and self-interacting dark matter methods in AREPO; contributor to GADGET-4.

Publication Record

37 papers and manuscripts: 12 first-author (10 peer-reviewed, 2 submitted/preprints) and 25 coauthored (20 peer-reviewed, 5 submitted/preprints). [Complete record on NASA ADS](#).

Awards & Fellowships

Institute for Theory and Computation Fellowship	Harvard, 2024–2027
Otto Hahn Medal	Max Planck Society, 2024
Scholarship, Hanns Seidel Foundation	Germany, 2015–2019
Max Weber Program scholarship	Bavaria, 2013–2019

Computing Allocations

Principal Investigator

Frontier · THESAN-ALT 1,000,000 node-hours · 2026

Frontier · THESAN-XL 900,000 node-hours · 2025

Co-Principal Investigator

SuperMUC-NG · THESAN-ZOOM Cluster 33,000,000 core-hours · 2025

Research Mentoring

Ph.D. students

Sonja Koehler (CfA, 2025–2026); Teodora-Elena Bulichi (MIT, 2024–present); Rongrong Liu (CfA, 2024–present); Alexander Mayer (MPA, 2022–2026).

Undergraduate and master's students

Yudou Du (University of Chicago, 2025–present); Lucas Schleuss (CfA/Heidelberg, 2025–present); Vinh Tran (MIT, 2025–present); Erkin Verbeek (MIT, 2023–2024); Valentin Thoss (LMU, 2021–2022).

Professional Service

- Referee for *Monthly Notices of the Royal Astronomical Society* (since 2024) and *The Astrophysical Journal* (since 2023).
- Lead organizer, Lumina Collaboration Meeting (2025).

Publications

* denotes a major contribution; † denotes a paper led by a student I mentored.

First-author submitted manuscripts and preprints

- [1] **O Zier**, X Shen, V Tran, M Rosenlyst, M Vogelsberger, and R Liu. “A Novel Implementation of Self-Interacting Dark Matter in AREPO”. *preprint* (2026). [arXiv:2607.05504](https://arxiv.org/abs/2607.05504).
- [2] **O Zier**, A Smith, X Shen, R Liu, R Kannan, SM Koehler, V Springel, R Pakmor, M Vogelsberger, TE Bulichi, and L Hernquist. “Introducing the Lumina project: large-volume radiation-hydrodynamic simulations of the epochs of hydrogen and helium reionization”. *submitted to MNRAS* (2026). [arXiv:2605.15310](https://arxiv.org/abs/2605.15310).

First-author peer-reviewed articles

- [3] **O Zier**, R Kannan, A Smith, E Puchwein, M Vogelsberger, J Borrow, E Garaldi, L Keating, W McClymont, X Shen, and L Hernquist. “The THESAN-ZOOM project: Population III star formation continues until the end of reionization”. *MNRAS* 544 (2025), pp. 410–429. [doi:10.1093/mnras/staf1053](https://doi.org/10.1093/mnras/staf1053).
- [4] **O Zier**, R Kannan, A Smith, E Puchwein, M Vogelsberger, J Borrow, E Garaldi, L Keating, W McClymont, X Shen, and L Hernquist. “The THESAN-ZOOM project: Long-term imprints of external reionization on galaxy evolution”. *MNRAS* 544 (2025), pp. 391–409. [doi:10.1093/mnras/staf1052](https://doi.org/10.1093/mnras/staf1052).
- [5] **O Zier**, R Kannan, A Smith, M Vogelsberger, and E Verbeek. “Adapting AREPO-RT for exascale computing: GPU acceleration and efficient communication”. *MNRAS* 533 (2024), pp. 268–286. [doi:10.1093/mnras/stae1837](https://doi.org/10.1093/mnras/stae1837).
- [6] **O Zier**, AC Mayer, and V Springel. “Non-ideal magnetohydrodynamics on a moving mesh II: Hall effect”. *MNRAS* 527 (2024), pp. 8355–8368. [doi:10.1093/mnras/stad3769](https://doi.org/10.1093/mnras/stad3769).
- [7] **O Zier**, V Springel, and AC Mayer. “Non-ideal magnetohydrodynamics on a moving mesh I: Ohmic and ambipolar diffusion”. *MNRAS* 527 (2024), pp. 1563–1579. [doi:10.1093/mnras/stad3200](https://doi.org/10.1093/mnras/stad3200).
- [8] **O Zier** and V Springel. “Gravito-turbulence in local disc simulations with an adaptive moving mesh”. *MNRAS* 520 (2023), pp. 3097–3116. [doi:10.1093/mnras/stad319](https://doi.org/10.1093/mnras/stad319).
- [9] **O Zier** and V Springel. “Simulating the magnetorotational instability on a moving mesh with the shearing box approximation”. *MNRAS* 517 (2022), pp. 2639–2658. [doi:10.1093/mnras/stac2831](https://doi.org/10.1093/mnras/stac2831).
- [10] **O Zier** and V Springel. “Simulating cold shear flows on a moving mesh”. *MNRAS* 515 (2022), pp. 525–542. [doi:10.1093/mnras/stac1783](https://doi.org/10.1093/mnras/stac1783).
- [11] **O Zier**, A Burkert, and C Alig. “On the Interaction of a Bonnor–Ebert Sphere with a Stellar Wind”. *ApJ* 915 (2021), p. 7. [doi:10.3847/1538-4357/abfdc8](https://doi.org/10.3847/1538-4357/abfdc8).
- [12] **O Zier**, W Zimmermann, and W Pesch. “On low-Prandtl-number convection in an inclined layer of liquid mercury”. *JFM* 874 (2019), pp. 76–101. [doi:10.1017/jfm.2019.432](https://doi.org/10.1017/jfm.2019.432).

Coauthored submitted manuscripts and preprints

- [13] W McClymont, V Belokurov, S Tacchella, R Kannan, A Smith, E Puchwein, E Garaldi, M Vogelsberger, S Monty, J Borrow, L Keating, X Shen, Z Wang, **O Zier**, C Cho, Y Isobe, X Ji, R Maiolino, and G Pruto. “Globular cluster abundance patterns inherited from giant molecular clouds”. *preprint* (2026). [arXiv:2607.05509](https://arxiv.org/abs/2607.05509).
- [14] A Sadain, A Smith, **O Zier**, H Park, TE Bulichi, X Shen, R Kannan, R Liu, Y Bian, V Springel, M Vogelsberger, SM Koehler, and L Hernquist. “The Lumina Project: Intergalactic Clumping and Recombination Sinks”. *preprint* (2026). [arXiv:2606.18382](https://arxiv.org/abs/2606.18382).
- [15] Z Summerfield, W McClymont, S Tacchella, A Smith, R Kannan, E Garaldi, E Puchwein, X Shen, J Borrow, AL Danhaive, L Keating, G Maheson, P Mehrotra, C Simmonds, A Stoffers, M Vogelsberger, and **O Zier**. “From THESAN-ZOOM to JWST: Predicting ionizing photon escape and the rise of UV-bright reionization sources”. *preprint* (2026). [arXiv:2606.14671](https://arxiv.org/abs/2606.14671).
- [16] X Shen, **O Zier**, A Smith, R Liu, R Kannan, TE Bulichi, SM Koehler, V Springel, M Vogelsberger, L Hernquist, RP Naidu, A de Graaff, E Pizzati, DM Alexander, LC Ho, V Kokorev, G Leung, AC Eilers, and RC Hickox. “The Lumina Project: The Demographics of Active Galactic Nuclei from Quasars to Little Red Dots at $z \geq 3$ ”. *submitted to MNRAS* (2026). [arXiv:2605.24112](https://arxiv.org/abs/2605.24112).
- [17] A Smith, **O Zier**, R Kannan, X Shen, R Liu, M Vogelsberger, V Springel, R Pakmor, SM Koehler, L Hernquist, and M Neyer. “The Lumina Project: CMB Optical Depth Fluctuations from Patchy Reionization”. *submitted to OJAp* (2026). [arXiv:2605.18939](https://arxiv.org/abs/2605.18939).

Coauthored peer-reviewed articles

- [18] X Shen, **O Zier**, M Vogelsberger, M Boylan-Kolchin, L Hernquist, S Tacchella, and RP Naidu. “The Cosmic Rush Hour: Rapid Formation of Bright, Massive, Disky, Star-Forming Galaxies as Signatures of Early-Universe Physics”. *MNRAS* 550 (2026), [stag1227](https://arxiv.org/abs/2605.12227). [doi:10.1093/mnras/stag1227](https://doi.org/10.1093/mnras/stag1227) *.
- [19] V Tran, D Gilman, MS Delos, X Shen, **O Zier**, M Vogelsberger, and D Xu. “Role of prompt cusps in driving the core collapse of self-interacting dark matter halos”. *PRD* 113 (2026), p. 083030. [doi:10.1103/3yrt-2r45](https://doi.org/10.1103/3yrt-2r45) †.

- [20] AM Garcia, P Torrey, A Bhagwat, X Shen, M Vogelsberger, W McClymont, J Nagarajan-Swenson, SG Ridolfo, P Zhu, DT Zimmerman, **O Zier**, S Biddle, A Sarkar, P Chakraborty, RJ Wright, K Grasha, T Costa, L Keating, R Kannan, A Smith, E Garaldi, E Puchwein, B Ciardi, L Hernquist, and LJ Kewley. “Metallicity Gradients in Modern Cosmological Simulations II: The Role of Bursty Versus Smooth Feedback at High Redshift”. *ApJ* 1001 (2026), p. 188. doi:10.3847/1538-4357/ae561e.
- [21] V Tran, X Shen, M Vogelsberger, D Gilman, S O’Neil, C Roche, **O Zier**, and J Gao. “Novel density profile for isothermal cores of dark matter halos”. *PRD* 113 (2026), p. 063024. doi:10.1103/t8pl-mdhc[†].
- [22] G Pruto, L Keating, R Kannan, E Puchwein, A Smith, J Borrow, E Garaldi, M Vogelsberger, **O Zier**, W McClymont, X Shen, and S Tacchella. “The THESAN-ZOOM project: The Hidden Neighbours of OI Absorbers during Reionization”. *MNRAS* 546 (2026), staf064. doi:10.1093/mnras/stag064.
- [23] W McClymont, S Tacchella, A Smith, R Kannan, E Garaldi, E Puchwein, Y Isobe, X Ji, X Shen, Z Wang, V Belokurov, J Borrow, F D’Eugenio, L Keating, R Maiolino, S Monty, M Vogelsberger, and **O Zier**. “The THESAN-ZOOM project: mystery N/O more — uncovering the origin of peculiar chemical abundances and a not-so-fundamental metallicity relation at $3 < z < 12$ ”. *MNRAS* 548 (2026), stag016. doi:10.1093/mnras/stag016.
- [24] AC Mayer, R Pakmor, T Naab, **O Zier**, AV Ivlev, T Grassi, P Caselli, and V Springel. “Formation of protostars and the launching of stellar core outflows with moving-mesh radiation non-ideal magnetohydrodynamics”. *MNRAS* 545 (2026), staf2199. doi:10.1093/mnras/staf2199[†].
- [25] X Shen, R Kannan, E Puchwein, A Smith, M Vogelsberger, J Borrow, E Garaldi, L Keating, **O Zier**, W McClymont, S Tacchella, Z Wang, and L Hernquist. “The THESAN-ZOOM project: star formation efficiencies in high-redshift galaxies”. *MNRAS* 545 (2026), staf2119. doi:10.1093/mnras/staf2119.
- [26] W McClymont, S Tacchella, X Ji, R Kannan, R Maiolino, C Simmonds, A Smith, E Puchwein, E Garaldi, M Vogelsberger, F D’Eugenio, L Keating, X Shen, B Trefoloni, and **O Zier**. “Overmassive black holes in the early Universe can be explained by gas-rich, dark matter-dominated galaxies”. *MNRAS* 545 (2026), staf2092. doi:10.1093/mnras/staf2092.
- [27] Z Wang, X Shen, M Vogelsberger, H Li, R Kannan, E Puchwein, A Smith, J Borrow, E Garaldi, L Keating, **O Zier**, W McClymont, S Tacchella, Y Ni, and L Hernquist. “The THESAN-ZOOM project: Star formation efficiency from giant molecular clouds to galactic scale in high-redshift starbursts”. *MNRAS* 544 (2025), pp. 2675–2697. doi:10.1093/mnras/staf1677.
- [28] W McClymont, S Tacchella, A Smith, R Kannan, E Puchwein, J Borrow, E Garaldi, L Keating, M Vogelsberger, **O Zier**, X Shen, and F Popovic. “The THESAN-ZOOM project: central starbursts and inside-out quenching govern galaxy sizes in the early Universe”. *MNRAS* 544 (2025), pp. 1732–1747. doi:10.1093/mnras/staf1861.
- [29] W McClymont, S Tacchella, A Smith, R Kannan, E Puchwein, J Borrow, E Garaldi, L Keating, M Vogelsberger, **O Zier**, X Shen, F Popovic, and C Simmonds. “The THESAN-ZOOM project: burst, quench, repeat — unveiling the evolution of high-redshift galaxies along the star-forming main sequence”. *MNRAS* 544 (2025), pp. 513–534. doi:10.1093/mnras/staf1660.
- [30] TE Bulichi, **O Zier**, A Smith, M Vogelsberger, AC Eilers, R Kannan, X Shen, E Puchwein, E Garaldi, and J Borrow. “High-redshift AGN population in radiation-hydrodynamics simulations”. *MNRAS* 544 (2025), pp. 355–371. doi:10.1093/mnras/staf1769^{*†}.
- [31] R Kannan, E Puchwein, A Smith, J Borrow, E Garaldi, L Keating, M Vogelsberger, **O Zier**, W McClymont, X Shen, F Popovic, S Tacchella, L Hernquist, and V Springel. “Introducing the THESAN-ZOOM project: radiation-hydrodynamic simulations of high-redshift galaxies with a multi-phase interstellar medium”. *The Open Journal of Astrophysics* 8 (2025), p. 153. doi:10.33232/001c.145804.
- [32] AC Mayer, T Naab, P Caselli, AV Ivlev, T Grassi, **O Zier**, R Pakmor, S Walch, and V Springel. “Protostellar discs in their natural habitat — the formation of protostars and their accretion discs in the turbulent and magnetized interstellar medium”. *MNRAS* 543 (2025), pp. 3321–3344. doi:10.1093/mnras/staf1404[†].
- [33] N Jamieson, A Smith, M Neyer, R Kannan, E Garaldi, M Vogelsberger, L Hernquist, **O Zier**, X Shen, and K Kakiichi. “The THESAN project: tracking the expansion and merger histories of ionized bubbles during the Epoch of Reionization”. *MNRAS* 541 (2025), pp. 1088–1105. doi:10.1093/mnras/staf996.
- [34] AC Mayer, **O Zier**, T Naab, R Pakmor, P Caselli, AV Ivlev, V Springel, and S Walch. “Moving-mesh non-ideal magnetohydrodynamical simulations of the collapse of cloud cores to protostars”. *MNRAS* 537 (2025), pp. 379–401. doi:10.1093/mnras/staf027^{*†}.
- [35] X Shen, M Vogelsberger, J Borrow, Y Hu, E Erickson, R Kannan, A Smith, E Garaldi, L Hernquist, T Morishita, S Tacchella, **O Zier**, G Sun, AC Eilers, and H Wang. “The THESAN project: galaxy sizes during the epoch of reionization”. *MNRAS* 534 (2024), pp. 1433–1458. doi:10.1093/mnras/stae2156.
- [36] C Alig, A Prieto, M Blańa, M Frischman, C Metzl, A Burkert, **O Zier**, and A Streblyanska. “The Accretion Mode in Sub-Eddington Supermassive Black Holes: Getting into the Central Parsecs of Andromeda”. *ApJ* 953 (2023), p. 109. doi:10.3847/1538-4357/ace2c3.
- [37] V Springel, R Pakmor, **O Zier**, and M Reinecke. “Simulating cosmic structure formation with the GADGET-4 code”. *MNRAS* 506 (2021), pp. 2871–2949. doi:10.1093/mnras/stab1855[†].