CV

Philipp Denzel
Current position(s): Junior researcher / Postdoc
Academic age: 2 year(s) 8 month(s)

Education

Degree	Organisation	Duration
PhD / Dr.: Physics Prof. Dr. Prasenjit Saha	Universität Zürich - ZH, CH Institute for Computational Science	08.2016 - 10.2020 4 year(s) 3 month(s)
Master: Computational Science Prof. Dr. Romain Teyssier	Universität Zürich - ZH, CH Institute for Computational Science	09.2015 - 07.2016 11 month(s)
Bachelor: Physics Prof. Dr. Jürg Diemand	Universität Zürich - ZH, CH Institute for Physics	09.2010 - 06.2015 4 year(s) 10 month(s)

Employment

Role	Organisation	Duration
Junior researcher / Postdoc Prof. Dr. Frank-Peter Schilling	Zürcher Hochschule f. Angew. Wissenschaften - ZHAW, CH Centre for Artificial Intelligence	07.2022 - Present 10 month(s)
-	Self-employed	12.2020 - 06.2022 1 year(s) 7 month(s)
Doctoral student / PhD student Prof. Dr. Prasenjit Saha	Universität Zürich - ZH, CH Institute for Computational Science	08.2016 - 10.2020 4 year(s) 3 month(s)

SNSF

Major achievements

Achievement 1

My research presents a new estimate of the Hubble parameter, which quantifies the expansion rate and age of the Universe, completely independent from previous methods. This is particularly relevant in light of the ongoing crisis in cosmology, where precise measurements of the Hubble parameter exhibit discrepancies beyond the 5-sigma uncertainty level. Through a comprehensive, free-form analysis of eight strongly, quadruply lensing systems, I obtained an estimate of H0=71.8+3.9-3.3 kms-1Mpc-1 with a precision of 4.97 per cent in the concordance cosmology. This study is designed to be agnostic of any inferential uncertainties which may arise from the interaction between aleatoric and epistemic uncertainties in the data and inference methods. Moreover, it demonstrates that current measurements close the 1%-precision mark might be less robust as previously thought.

[1] journal-article. Denzel, P., Coles, J. P., Saha, P., & Williams, L. L. R. (2020). The Hubble constant from eight time-delay galaxy lenses. Monthly Notices of the Royal Astronomical Society, 501(1), 784–801. https://doi.org/10.1093/mnras/staa3603. DOI.
[2] journal-article. X Ding, T Treu, S Birrer, G C-F Chen, J Coles, P Denzel, M Frigo, A Galan, P J Marshall, M Millon, A More, A J Shajib, D Sluse, H Tak, D Xu, M W Auger, V Bonvin, H Chand, F Courbin, G Despali, C D Fassnacht, D Gilman, S Hilbert, S R Kumar, J Y-Y Lin, J W Park, P Saha, S Vegetti, L Van de Vyvere, L L R Williams, (2021). Time delay lens modelling challenge, Monthly Notices of the Royal Astronomical Society. 503(1), 1096–1123. https://doi.org/10.1093/mnras/stab484. DOI.

Achievement 2

I pioneered a novel lens modelling approach, known as the lens "matching" technique, which directly connects galaxy simulations to lensing galaxies in observations.
Traditional lens modelling techniques rely on recipes which aim to efficiently reproduce shapes and slopes of galaxies, as they are usually observed. These methods therefore suppress or even completely ignore the evolutionary processes of galaxies and the physical properties which form and drive them. In contrast, cosmological hydrodynamical simulations have made significant strides in recent years, incorporating semi-analytical models which simulate star formation and feedback effects at small scales, enabling exploration of various galaxy-formation scenarios.
Through proof-of-concept, I demonstrate that enhancing the complexity and realism of the galaxy models underlying the lens models can lead to plausible matches with observations. Additionally, by embedding the lens matching technique within a Bayesian framework, it becomes feasible to infer the relative posterior probabilities of two different galaxy-formation scenarios, a task that was previously deemed nearly impossible.

[1] journal-article. Denzel, P., Mukherjee, S., & Saha, P. (2021). A new strategy for matching observed and simulated lensing galaxies. Monthly Notices of the Royal Astronomical Society. https://doi.org/10.1093/mnras/stab1716. DOI.
[2] journal-article. Barrera, B., Williams, L. L. R., Coles, J. P., & Denzel, P. (2021). Bridging the Gap Between Simply Parametrized and Free-Form Pixelated Models of Galaxy Lenses: The Case of WFI 2033-4723 Quad. The Open Journal of Astrophysics, 4(1). https://doi.org/10.21105/astro.2108.04348. DOI.

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[3] journal-article. Denzel, P., Mukherjee, S., Coles, J. P., & Saha, P. (2020). Lessons from a blind study of simulated lenses: image reconstructions do not always reproduce true convergence. Monthly Notices of the Royal Astronomical Society, 492(3), 3885–3903. https://doi.org/10.1093/mnras/staa108. DOI.
[4] journal-article. Denzel, P., Çatmabacak, O., Coles, J., Cornen, C., Feldmann, R., Ferreras, I., Palmer, X. G., KÃ¼ng, R., Leier, D., Saha, P., & Verma, A. (2021). The lens SW05 J143454.4\mathplus522850: a fossil group at redshift 0.6? Monthly Notices of the Royal Astronomical Society. https://doi.org/10.1093/mnras/stab1825. DOI.

Achievement 3

Bubble chambers and droplet detectors used in dosimetry and dark matter particle search experiments use a superheated metastable liquid in which nuclear recoils trigger bubble nucleation. This process is described by the classical heat spike model of F. Seitz [Phys. Fluids (1958-1988) 1, 2 (1958)], which uses classical nucleation theory to estimate the amount and the localization of the deposited energy required for bubble formation. Here we report on direct molecular dynamics simulations of heat-spike-induced bubble formation. They allow us to test the nanoscale process described in the classical heat spike model. 40 simulations were performed, each containing about 20 million atoms, which interact by a truncated force-shifted Lennard-Jones potential. We find that the energy per length unit needed for bubble nucleation agrees quite well with theoretical predictions, but the allowed spike length and the required total energy are about twice as large as predicted. This could be explained by the rapid energy diffusion measured in the simulation: contrary to the assumption in the classical model, we observe significantly faster heat diffusion than the bubble formation time scale. Finally we examine α-particle tracks, which are much longer than those of neutrons and potential dark matter particles. Empirically, α events were recently found to result in louder acoustic signals than neutron events. This distinction is crucial for the background rejection in dark matter searches. We show that a large number of individual bubbles can form along an α track, which explains the observed larger acoustic amplitudes.

[1] journal-article. Denzel, P., Diemand, J., & Angélil, R. (2016). Molecular dynamics simulations of bubble nucleation in dark matter detectors. Physical Review E, 93(1). https://doi.org/10.1103/physreve.93.013301.

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