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Contents

1. New Space for STRUCTURES
2. Our Researchers and Their Coordinates
3. We Are STRUCTURES
4. EP Report: EP A.1: Characterising Stars with Invertible Neural Networks
5. STRUCTURES asks: Annalisa Pillepich

Upcoming

Next Jour Fixe Talks

- July 9: Robert Scheichl & Eike Müller
- July 16: Lutz Hofmann

Special Talks / Workshops

- July 12 - 16: Workshop on Low Dimensional Quantum Many Body Systems

General Assembly

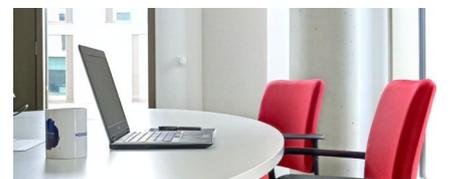
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More information on the [STRUCTURES web page](#).

New Space for STRUCTURES

In this issue, we would like to draw your attention to our research sites in Heidelberg. You certainly know the Philosophenweg villas for theoretical physics, the Neuenheimer Feld for experimental research, computer science and mathematics, and Heidelberg's hot spots for astronomy. Now, STRUCTURES has opened a new hub for networking and interdisciplinary research for all our members.

Perfectly in time for the return to on-site office work from July 1st, we have new office space available. These offices are located on the third floor of Mathematikon, Berliner Straße 47. After weeks of preparation by the STRUCTURES office and colleagues of the central administration, the new rooms are now ready for STRUCTURES to move in. They provide space for comprehensive and exploratory projects as well as guests and fellows of the STRUCTURES college. In addition, there are two offices with a children's play corner, a seminar room, space for the Young Researchers Convent (YRC) and a tea kitchen. The STRUCTURES office has already moved in part-time and is happy to welcome you there (you still find us in



A glance at the new STRUCTURES office rooms in the Mathematikon, which are ready for moving in.

Philosophenweg 12 as well). The rooms in Mathematikon have been rented by the University for STRUCTURES. The building for the EINC (European Institute for Neuromorphic Computing), which will host the "Oberstübchen", is still under construction.

Our Researchers and Their Coordinates

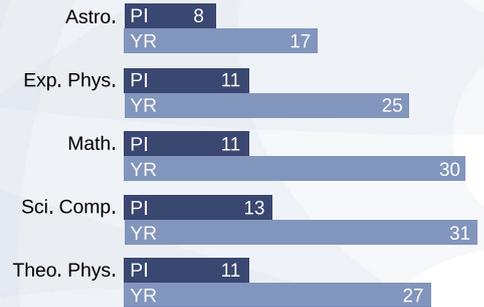
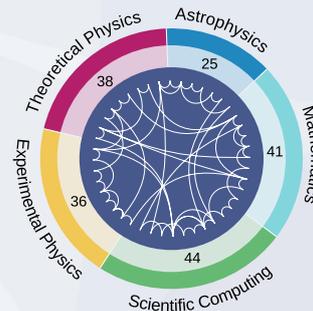
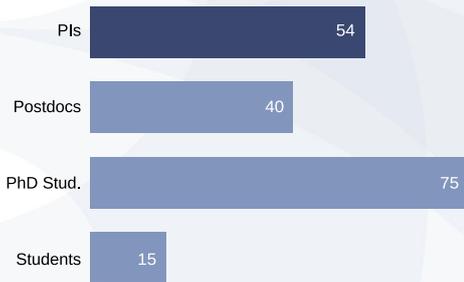
Did you know that STRUCTURES researchers can be found all over Heidelberg and even beyond? While most of our researchers are located in the Neuenheimer Feld, Campus Philosophenweg or the Königsstuhl area, we also have researchers at the ZI (Central Institute of Mental Health) in Mannheim and one external member at ETH Zürich.

As of June 18, STRUCTURES counts 184 researchers, of which 54 are senior members (PIs) and 130 young researchers (YR: postdocs, PhD students, Master and Bachelor students). The largest group are the PhD students who make up 41%. Nearly half of our re-



The map shows where most of our researchers are located in Heidelberg.

searchers (46%) are mathematicians or physicists, as shown in the figures below:



From left to right: STRUCTURES members in absolute numbers subdivided by positions, disciplines, and comparing the fractions of YRs and PIs for each field. The association of people to specific fields was made according to their institute / group affiliations.

STRUCTURES COMMUNITY

We Are STRUCTURES

In each newsletter, we introduce three members of our young researchers convent (YRC) to you.



Marta Magnani
PhD Student, Differential Geometry Group, Math. Institut

What is your connection to STRUCTURES? I am part of the YRC. The comprehensive projects of STRUCTURES that interest me the most are CP6 and CP7 (Networks & Machine Learning, Quantum Geometry & Topological Methods in Physics, editor's note).

What are you working on? I work on Hyperbolic Geometry, Symmetric Spaces and Higher Teichmüller Theory, more precisely I am

working on maximal representations of the fundamental group of hyperbolic surfaces.

What was your greatest scientific success up to now? Having the opportunity to be part of this excellent and international research group is for me already a success, I hope even more are to come!

How does one recognize you? In the department I am the one who dresses very sporty and always smiles (unfortunately you can't see it under the mask).

What are you an expert for? Difficult to answer that question. As a PhD student I would say I am doing my best to become an expert in my domain.



Alexander Zeilmann
PhD Student, Image and Pattern Analysis Group, IWR

What are you working on? My research focuses on the Linear Assignment Flow, which is a linear dynamical system for labeling metric data on graphs.

What are you an expert for? Numerics of large-scale linear dynamical systems.

How does one recognize you? You can recognize me by my large telephoto camera (not the one in the picture) I carry while hiking in my free time.

What was your greatest scientific success up to know? I worked out novel nu-

merical schemes for efficient parameter learning from data using linear dynamical systems.

What is your connection to STRUCTURES?

I'm a member of the YRC since the launch of STRUCTURES and a regular attendee of the STRUCTURES Jour Fixe.



Celia Viernann,
PhD Student,
Oberthaler Group, KIP

What are you working on?

My main project is to engineer an analog of a curved spacetime in a two-dimensional Bose-Einstein condensate (BEC). We use an analogy, where the condensate and its phononic excitations play

the roles of spacetime and excitations of a quantum field. We are especially interested to see particle production caused by the expansion of the metric.

What was your greatest scientific success up to now? Personally, I am most proud of the three-year-long construction and stabilization of the experimental setup that produces and probes a BEC every twenty seconds. And just this week, we managed to show that our condensate corresponds to a metric with hyperbolic geometry.

What are you an expert for? As an experimental cold atom physicist, I am an expert in using laser light and magnetic fields to

manipulate and probe atoms and I am learning about the properties of BECs and the theory behind it. During my master's studies, I specialized in classical kinetic field theory and cosmology and can use some of that knowledge in my current project.

In which STRUCTURES activities were you involved and which positions did you have?

I entered STRUCTURES in its final application phase and joined in its funding presentation. For two years, I was the representative for the young scientists and a member of the steering board. In addition to the Jour Fixe, I especially enjoyed the Schöntal Discussion Workshop on entanglement.

EP REPORT

EP A.1: Characterising Stars with Invertible Neural Networks

In this Exploratory Project, we develop a deep learning approach to characterise stars based on photometric observations. In particular, we aim to recover the fundamental stellar parameters (e.g. age and mass) that can provide crucial insights for many disciplines of astronomical research, such as star formation or the importance of stellar feedback on the galactic gas. Photometric surveys are one of the main tools to study large ensembles of stars, but recovering the stellar parameters of the observed sources from photometry alone is a challenging task. Owing to intrinsic effects in stellar evolution, the inherent information loss of photometry, and other observational effects (e.g. extinction, which is the attenuation and frequency shift of radiation as it travels through the galaxy), this problem is subject to considerable degeneracy. For example, in photometric observations, a very old star that has already ended its main hydrogen-burning phase may be confused with a young source that is still in the formation process.

In this project we adapt the invertible neural network (INN) architecture, developed by STRUCTURES members at the Vis-

ual Learning Lab Heidelberg, to tackle the stellar characterisation problem using data generated from stellar evolution models coupled with synthetic photometry. The INN is well-suited for solving degenerate regression tasks as it allows the prediction of full posterior distributions for the target parameters. So far, we have achieved a



Large photometric surveys of active star-forming complexes such as N44 in the Large Magellanic Cloud are important tools to gain new insights into the complex process of star formation and its environments. Image source & copyright: MYSST survey.

successful proof-of-concept of the INN-based stellar characterisation method, where we demonstrate an excellent predictive performance on synthetic test data and show an application to real photometry of the well-studied young cluster Westerlund 2. In the latter test, we correctly recover previous results on the cluster's age,

initial mass function and mass segregation profile. As a next step, we plan to extend our method's predictive capabilities to include e.g. extinction and metallicity (so far required as an input) and to take measurement uncertainties into account. Additionally, we are working on an application of our approach to data from large photometric surveys of two of the most active star-forming regions, 30 Doradus and N44, in the Large Magellanic Cloud, which is the largest satellite galaxy to our Milky Way.

In the long term we are pursuing two central goals. First, we aim to recover the star formation histories of these prominent star-forming regions in order to gain new insights into the process of stellar birth in different galactic environments. Second, we want to turn our approach into a comprehensive tool for the astronomical community that allows for efficient and thorough analysis of data from current and upcoming photometric surveys.



About the Author:

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MEMBER INTERVIEWS

STRUCTURES asks: Annalisa Pillepich

To give you the opportunity to better get to know the senior members of STRUCTURES, we will regularly present interviews with them. In this edition, we interview Annalisa Pillepich. She leads the group "Galaxies and Cosmology Theory" at the Max Planck Institute for Astronomy (MPIA) in Heidelberg. She is involved in CP1 "Cosmic Structures Formation" and EP 3.4 "From fine-structure features of stellar haloes to the assembly histories of their galaxies".



Annalisa Pillepich
Image source:
Fakultät f. Physik u.
Astronomie

What are you working on?

Currently, my team and I work on various aspects of galaxy formation and evolution. We do galaxy simulations on supercomputers and try to learn from them and from the comparison of their outcome with astronomical observations. We are similar to experimentalists, but our laboratories and tools are computer models. Recently, my focus is on understanding the interaction between supermassive black holes and the galaxies that host them.

Would you like to share any advice for young researchers about choosing their ca-

reer path? My only suggestion is to try to always keep an open mind and to keep ready for unexpected or unpredicted opportunities – both in terms of research topics and in relation to the career direction. In fact, in both, it is often not possible to pre-

What do you like best about your job? The variety, flexibility and freedom it allows, both in the practical daily life and in the research directions to tackle. I like to think that the researcher's job is not too dissimilar to that of self-employed artisans and

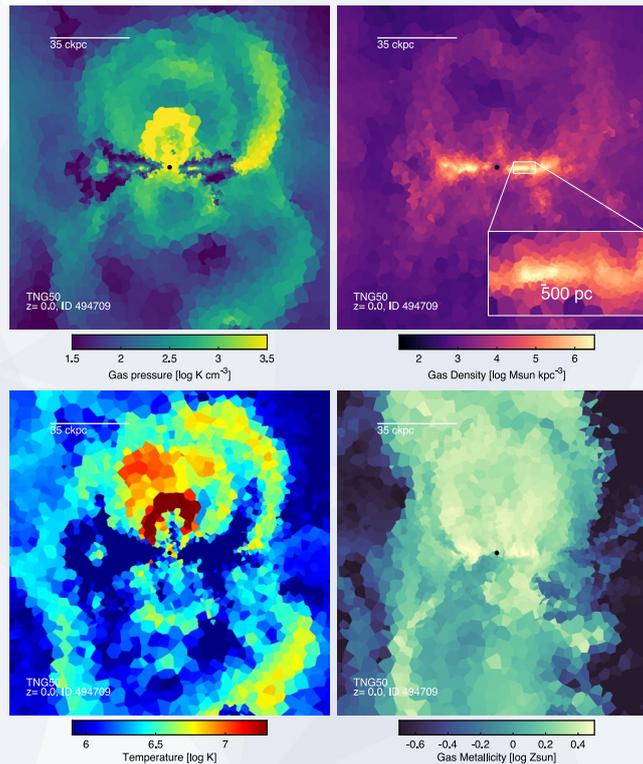
artists: in both cases, we need to procure the resources (in our case, via frequent job applications or grant proposals) and to craft, often from scratch, the tools of our activity. And once we achieve a position, even if for a finite time, we have the freedom and security to pursue our scientific interests and to be creative.

Coffee or Tea? White- or Blackboard? Linux, Mac or Windows?

- Both coffee and tea, just at different moments of the day.
- Blackboard (despite the dust).
- Mac on my desks, Linux/Unix on the supercomputers :)

Imagine you get 48 hours of extra time as a present. What would you do with it? I am assuming that this gift also comes with unbound resources? Doesn't matter, just joking: I would look for a quaint monastery on top of

a hill and would spend time there in quiet isolation and meditation.



An outflow-driven "bubble" produced by supermassive black hole feedback, around a disk galaxy similar to our own Milky Way at redshift zero, found within the TNG50 simulation. This structure is similar to those observed in gamma-rays by the Fermi telescope, and in X-rays by the eROSITA mission, in our own Galaxy. Image reproduced from IllustrisTNG / Pillepich et al. (2021).

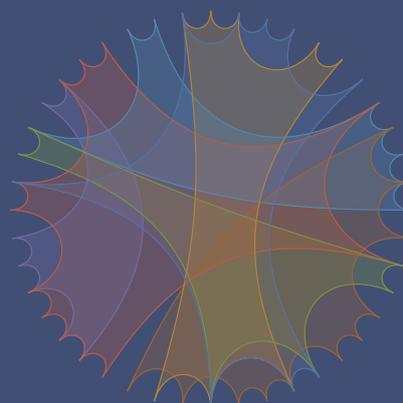
dict a priori what the best path will be, and sharp turns in a person's life or work trajectories may be extremely fruitful and fulfilling.

STRUCTURES ON THE WEB

<https://structures.uni-heidelberg.de>

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Each person depicted in the images has provided consent to the use of their pictures.



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