

HITS Gears Up for Incoming Clusters of Excellence: DYNIVERSE & SynthImmune



At first glance, the Universe seems static – stars sparkle, galaxies glow, everything appears unchanging. In reality, however, the Universe is in constant motion, evolving dynamically. This

evolution is regulated by nonlinear physical processes that take place within vastly different timescales, ranging from fractions of a second to billions of years. HITS group leader **Kai Polsterer** and his research group, as part of the DYNIVERSE Cluster of Excellence – „Our Dynamic Universe,“ are attempting to understand the interconnectivity of these processes.

The work within the Cluster encompasses three approaches: In a "time-lapse of the Universe," the evolution of galaxies will be assembled into a coherent overall picture from numerous observations. In "slow motion," rapid events such as supernova explosions and their long-term effects will be analyzed. In addition, "cosmic turning points" that gave structure and light to the early Universe will be explored. DYNIVERSE brings together experts in astrophysics, mathematics, and computer science. In addition to HITS, participating institutions include the Universities of Cologne and Bonn, the German Aerospace Center (DLR), Forschungszentrum Jülich, and the Max Planck Institute for Radio Astronomy in Bonn.

SynthImmune – Synthetic Biology for Immune Functions

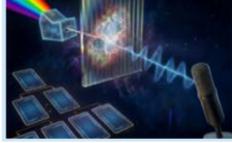
The SynthImmune Cluster of Excellence explores how synthetic biology can be used to understand and redesign immune system

functions. The goal is to enhance defenses against infections and cancer by analyzing, modeling, and reconstructing immune functions using artificial building blocks – far beyond the scope of conventional therapies. HITS group leader **Rebecca Wade** and her research group are actively contributing to the SynthImmune project. Other partners include



Heidelberg University, the German Cancer Research Center, the European Molecular Biology Laboratory (EMBL), and the Max Planck Institute for Medical Research. Together, the researchers

aim to develop new immunity modules that can detect and combat pathogens in a targeted way – paving the way for entirely new immunotherapies.



Explore Science 17–21 June 2026 at Herzogenriedpark, Mannheim

HITS booth: Sing like a Star – Sort like a Pro!
<https://www.explore-science.info/mannheim/>



HITS

HITS welcomes 2026 Journalist in Residence Monika Mondal

Indian science journalist **Monika Mondal** has started her residency as the 14th HITS Journalist in Residence this February. Mondal, an award-winning freelance reporter from Delhi, will spend six months at the institute, engaging with researchers and developing her new nonfiction project. Mondal, who holds degrees in electronics, communication engineering, and development studies, has reported on topics ranging from life sciences to astronomy for publications including Nature, Wired, The Guardian, and The Hindu. She has received accolades such as a Pulitzer Center fellow-

ship, the Alexander-von-Humboldt Chancellor's Fellowship, and the Thomson Foundation Journalist Award.

During her stay at HITS, Mondal will lead an internal workshop for the institute's researchers and give a public lecture. She will also work on a book project titled "Living in Emergence," which explores "life in all its complexity" and examines how scientific knowledge is generated. With her project, Mondal aims to shed light on the research process: "As a journalist, I find this perspective on the meta-level of the scientific method especially fascinating."

The Journalist in Residence program at HITS, established in 2012, invites experi-



enced science journalists for three- to six-month residencies to collaborate with researchers, attend conferences, and pursue independent projects.

New employees and visiting scientists

PhD Student: Peter Siu Hei Cheung (PSO)
Research Associate: Elisa Brost (SDBV)
Visiting scientist: Katrin Schrüfer (DMQ, Heidelberg University), Christoph Stelz (CME, Karlsruhe Institute of Technology)
HITS Journalist in Residence: Monika Mondal (India)

HITS groups (03/2026): *Astroinformatics (AIN), Computational Molecular Evolution (CME), Computational Statistics (CST), Data Mining and Uncertainty Quantification (DMQ), Machine Learning and Artificial Intelligence (MLI), Molecular and Cellular Modeling (MCM), Natural Language Processing (NLP), Physics of Stellar Objects (PSO), Scientific Databases and Visualization (SDBV), Stellar Evolution Theory (SET), Theory and Observations of Stars (TOS)*

HITSters

Before the Tremor: How Close Are We to Predicting the Next Earthquake?

Even today, the exact time and precise location of a potential earthquake cannot be determined reliably. What is possible, however, are short-term probabilistic forecasts. These are based on the observation that earthquakes tend to cluster in time and space, and that recent events can influence the likelihood of additional earthquakes occurring in the near future. Researchers in several countries around the world are working on such forecasting models. A key objective is to present predictions in a way that makes them directly useful for civil protection and emergency management. Italy is among these coun-



tries – particularly after the devastating L'Aquila earthquake on 6 April 2009, efforts were significantly intensified. But how can we determine

whether a forecasting model actually delivers reliable results? This question is addressed by seismologists and statisticians in a recent study published in *Seismological Research Letters*.

The statistical team was led by HITS group leader **Tilmann Gneiting** (Computational Statistics). Throughout his career, he has worked extensively on probabilistic forecasting across a wide range of fields – from economics and finance to meteorology and geosciences. Together with his research group, he contributed this expertise to the study.

Putting Models to the Test

Models integrated into operational probabilistic forecasting systems must meet the highest scientific standards. Transparent evaluation is therefore essential. In the Italian system, forecasting models are only approved after being tested by the Collaboratory for the Study of Earthquake Predictability (CSEP). The CSEP initiative was launched two decades ago by the Southern California Earthquake Center (SCEC) and now operates internationally, with partners in the United States, Europe, Japan, New Zealand, and China.

Evaluating Forecasts with a Probabilistic Scoring System

The newly published study examines models that predict the number of earthquakes in Italy above a specified magnitude for the following week. These forecasts are generated daily over a period of several years. For each day and each location, every model is assigned a probabilistic error score, which increases the more the observed events deviate from the forecast. The sum of these scores provides an overall measure of forecast quality across the entire study period.

The authors of the study also critically examined the evaluation method previously used by CSEP for probabilistic earthquake models and highlighted the advantages of the newly proposed alternatives. After all, only through careful evaluation can a model's results be considered trustworthy and communicated to decision-makers – with the ultimate goal of protecting people in earthquake-prone regions and enabling timely preventive safety measures.

Publication:
 Brehmer J et al: *Enhancing the Statistical Evaluation of Earthquake Forecasts—An Application to Italy*. *Seismological Research Letters* (2025) 96 (3): 1966–1988. <https://doi.org/10.1785/0220240209>

Research

Beyond the limits – Kai Polsterer, HITS Group Leader and Scientific Director



Researchers from astrophysics, computer science, and mathematics are collaborating closely within the DYNIVERSE Cluster of Excellence to transform vast amounts of data into a dynamic "movie" of the cosmos. Among them are HITS group leader and Scientific Director **Kai Polsterer** and his research group. In this interview, he explains what DYNIVERSE is all about and how supermassive black holes help explain the evolution of the Universe.

How does DYNIVERSE address the challenge of observing the Universe's evolution over time?

As the Universe is dynamically evolving, it's hard to see how things change over time and to observe it in real time. Therefore, within DYNIVERSE we try to stitch together individual pictures to get a movie of the evolving Universe.

Why are machine learning and AI necessary in modern astronomy?

To cope with the increasing amount of data we're facing in astronomy, not only from observation but also from simulations and laboratory work, we have to use machine learning and AI to be able to extract new knowledge.

What will be a central element of DYNIVERSE, and what is its purpose?

A central element of DYNIVERSE will be SUE – the Shared Universe Engine. It's a collaborative platform that enables researchers to work together, while integrating the general public into scientific discourse.

Supermassive black holes are spectacular phenomena. What can they tell us about the history of the Universe?

Even though their name indicates that they are dark, supermassive black holes are some of the brightest objects in the Universe and thereby allow us to be observed over very long distances. This, in turn, allows us to understand the evolution of the Universe.

What will HITS contribute to the DYNIVERSE cluster?

The Universities of Cologne and Bonn, together with their partners, offer a unique environment to do research at the thrilling intersection between Astrophysics, machine learning and AI. HITS is proud to contribute its expertise in Astroinformatics.

What goals have you and your group set for your work within the cluster?

Besides building the next generation of research infrastructure my group and I are heavily interested in getting simulations and observations closer together.

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Beyond the limits



The Charts