

“Science Notes” on Artificial Intelligence and Language

At HITS, artificial intelligence (AI) is not a current trend, but a long-established practice. For example, both the Astroinformatics group and the Computational Statistics group have been working with machine learning methods for many years to categorize galaxies and improve weather forecasts. SIMPLAIX is another major HITS-led research initiative dedicated to AI in the life sciences. Moreover, since 2022, HITS has also had its own Machine Learning and Artificial Intelligence research group. The group is led by **Jan Stühmer** and develops innovative algorithms and models in the field that are the ideal tools for



explaining to the general public how large language models such as ChatGPT actually work. “Artificial intelligence and language” was the topic of the “Science Notes” event on 25 January 2024 at the MAINS (Mathematics and Informatics Station) near the Heidelberg main railway station. The venue was packed with a full audience, who enjoyed sounds created by analogue synthesizers and listened to four researchers from different disciplines as well as a fiction writer shed light on various aspects of large language models. Jan Stühmer focused his presentation on the problem that ChatGPT & Co. has with ensuring the quality of the answers generated by its models. “The models often invent facts,” Stühmer said. “And what’s worse is that it’s usually impossible to tell whether the answer is incorrect or a true fact because the output of the language model sounds just as reliable when giving made-up information as it does when giving true statements.” Jan further explained how factual knowledge is stored in language models and how so-called “hallucinations” can occur. Finally, he outlined current research approaches for integrat-



ing factual knowledge into language models. The numerous questions from audience members demonstrated their tremendous interest in the processes that take place “under the hood” of large language models.

The “Science Notes” project is made possible by the Klaus Tschira Foundation. It consists of a commercially available science magazine and events at which science meets club culture. In five 15-minute sessions, researchers provide insights into their work in an entertaining way while artists frame the events with music and visuals. The “AI and Language” event was the second of such event at MAINS to focus on the topic of artificial intelligence. At the first event, **Kai Polsterer** (Astroinformatics) spoke about AI in astronomy.



Via Data

The HITS blog can be found on the “Scilogs” portal at <https://scilogs.spektrum.de/via-data/>.

HITS

Rebecca Wade editor-in-chief of the Journal of Molecular Recognition

Since January 2024, HITS group leader **Rebecca Wade** (MCM) is editor-in-chief of the Journal of Molecular Recognition. It publishes original research papers and reviews describing substantial advances in our understanding of molecular recognition phenomena in life sciences, covering all aspects from biochemistry, molecular biology, medicine, and biophysics. The focus of the journal is on recognition



phenomena involving biomolecules and their biological / biochemical partners. Molecular recognition involves non-covalent specific interactions between two or more biological

molecules, molecular aggregates, cellular modules, or organelles, as exemplified by antigen-antibody or nucleic acid-protein interactions.

New employees and visiting scientists

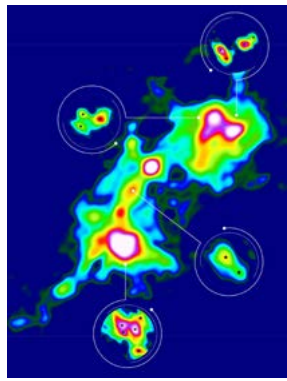
- Research associates:** Anne Elin Jegglund (SDBV), Evgeni Ulanov (CST), Qi Wu (SDBV)
PhD students: Christina Goß (MBM)
Master students: Vsevolod Viliuga (MBM)
IT Services: Martin Wendt (Systems administrator)
- Visiting scientists:** Matthias Brosz (MBM), Paul Christians (PSO, TU Darmstadt), Pascal Memmesheimer (DMQ, Heidelberg University), Fenja Schweder (AIN, Bremen University)

HITS groups (03/2024): Astroinformatics (AIN), Computational Carbon Chemistry (CCC), Computational Molecular Evolution (CME), Computational Statistics (CST), Data Mining and Uncertainty Quantification (DMQ), Machine Learning and Artificial Intelligence (MLI), Molecular Biomechanics (MBM), 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

New observations confirm computer models how massive stars are born as multiples

For massive stars, multiple birth has long thought to be the norm, shown by computer simulations which traced the collapse of giant clouds of gas and dust from the beginnings to the formation of separate stars within: a hierarchical process in which larger cloud portions contract to form denser cores, and where smaller regions within those “parent cores” collapse to form the separate stars: massive stars, but also numerous less massive stars.



Until now, however, key evidence was missing because it is very difficult to observe star formation regions in sufficient detail. This became possible once

the ALMA observatory in Chile became operational. An international group of researchers used this opportunity to observe 30 promising massive star-formation regions with ALMA. The analysis was led by Shanghuo Li (Max Planck Institute for Astronomy, MPIA, Heidelberg, Germany), and the results have now been published in Nature Astronomy. They found four binary proto-stars, one triple, one quadruple and one quintuple system – consistent with the expectations. HITS researcher **Rajika Kuruwita** contributed to this work by providing some computer models that were tested against the observation. “We found that the observed separation distribution between the stars in these young multiple-star systems is in agreement with our models of multiple-star systems forming via core fragmentation.”

Shanghuo Li et al., “Observations of high-order multiplicity in a high-mass stellar protocluster,” *Nature Astronomy*, 15 January 2024. <https://www.nature.com/articles/s41550-023-02181-9>

Publication on the computer models developed by Rajika Kuruwita: The contribution of binary star formation via core fragmentation on protostellar multiplicity. *A&A*, Volume 674, June 2023. <https://www.aanda.org/articles/aa/abs/2023/06/aa44882-22/aa44882-22.html>



EBRAINS research infrastructure secures funding for new phase of digital neuroscience

The European Commission has accepted the EBRAINS 2.0 proposal submitted in response to the INFRASERV call, granting €38 million for the further development of services of the EBRAINS research infrastructure. Over the next three years, the infrastructure will continue to develop tools and services to widely serve research communities in neurosciences, brain medicine, and brain-inspired technologies.

EBRAINS (European Brain Research Infrastructures) is an EU co-funded collaborative research platform designed to advance neuroscience and brain health. HITS is one of the partner institutions. The Molecular and Cellular Modeling group, led by **Rebecca Wade**, participates in EBRAINS 2.0, contributing to the development of modelling tools for multiscale simulation of molecular signaling cascades that are altered in brain diseases. HITS is also partner of EBRAINS Germany, the recently founded German National Node.

Research

Beyond the limits – Robert Fisher, Visiting Scientist 2023/24



Robert Fisher, Professor at the Department of Physics, University of Massachusetts Dartmouth, joined the Physics of Stellar Objects (PSO) group in October 2023 as a Visiting Scientist and will stay until July 2024. After almost half a year at HITS, he gave a video interview for the institute’s social media channels, discussing why he chose HITS for his sabbatical, and encouraging future Visiting Scientists to build and expand new collaborations.

What is your research area?

My research is primarily on the topic of exploding stars. These are stars that explode at the end of their lifetimes. A star like our sun will

eventually become a dead cinder of an object called a white dwarf. Occasionally, these white dwarfs explode when they are in a binary system and will be seen clearly across the universe by astronomers who will use them as standard candles—or benchmarks—to distances in the cosmos.

What has brought you to HITS?

I’m on sabbatical this year and HITS is a great research institution to do your sabbatical. I’m also here with my wife who is an academic in the humanities. Heidelberg, with its fantastic university, is one of the very few places in the world where a scientist and someone like my wife, who pursues research in humanities, can pursue a sabbatical jointly.

How does the work environment at HITS differ from the one at your home institution?

HITS is a particularly intensive research environment. The group leaders, who are here and are affiliated with the university, have instructional responsibilities. The balance of research and instruction is more heavily weighted towards the research side than in my home institution.

As a visiting scientist at HITS, where do you see the benefits for yourself, your home

institution and HITS/the PSO group? What can you learn from each other?

The benefits are twofold. There is the advantage of fresh ideas, coming from new collaborations, and also there is the cross-cultural benefit of learning about the German higher educational system which differs in some respects from that in the US.

Have you had the chance to travel around Germany?

We’ve travelled around Germany, but I can highly recommend a number of sites in the region. There is the Speyer cathedral, there is the artists’ colony in Darmstadt, there are the Weissenhof buildings in Stuttgart. These are phenomenal sights which are also UNESCO World Heritage Sites. I’ve also seen Aachen cathedral where Charlemagne was crowned on Christmas Day in 800, another phenomenal site.

Do you have any recommendations to future Visiting Scientists coming to HITS?

I’d say take the opportunity both to continue building your current collaborations as well as to expand on those and create new collaborations. HITS is such a great research environment with so many awesome research groups. You will find lots of opportunities to expand your network and forge new collaborations.

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Pictures: HITS, Gerhard Kopatz, S. Li, MPIA / J. Neidel, MPIA Graphics Department / Data: ALMA Observatory | www.h-hits.org

Beyond the limits



The Charts