Neutron sciences are accelerating at MLZ!

GNeuS – Global Neutron Scientists

NEWSLETTER JANUARY 2024

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EDITO

In the first two calls of the GNeuS program we received a large number of high-quality applications. Thanks to the exceptional commitment of our reviewers, outstanding candidates were selected for the MLZ, who produced many high-quality results. An interim evaluation by the EU officers confirmed the full success of the program.

The deadline for the third call for the GNeuS program is now upcoming and, also for this last call, we expect many exceptional proposals dedicated to performing first-class science using neutron scattering.

The richness and diversity of the scientific topics tackled within the GNeuS program is of enormous benefit to the partners at MLZ. The integration of the highly motivated fellows, the continuous support provided to them by the dedicated staff at the partner organizations, and the newly established links with several companies, strengthened through the secondments of the fellows, strongly advanced the scientific standing of the MLZ.

We highly appreciate the overall impact of the program up to now and hope for an equally successful final stage!

Karen Friese, GNeuS Coordinator

Learn about the GNeuS project through our newly video

The GNeuS Management Office and three GNeuS Postdoctoral Fellows are happy to share their views on the GNeuS project.

https://gneus.eu/video/

This project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under the Marie Skłodowska-Curie Grant Agreement N°101034266.

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GNeuS
Global Neutron Scientists

MLZ
Heinz Maier-Leibnitz Zentrum

TUM

JÜLICH
Forschungszentrum

Helmholtz-Zentrum
hereon

GNeuS Trajectory

During the past year, the GNeuS Management Team successfully implemented the planned actions that lead to the selection of 14 Fellows under call n.1 (closed on 15th January 2022) and 12 Fellows under call n.2 (closed on 18th January 2023).

Among the latest events, the project passed successfully the Mid Term Review with the MSCA EU Project Officer in October 2023, and **the call n.3 has started on November 1st, 2023, with many applications expected!**

Call 2 results

The GNeuS call n. 2 officially opened on November 1st, 2022 and closed on January 18th, 2023.

The assessment of the 23 submitted applications was carried out quickly and the results were communicated on mid April, 2023.

Among the 23 applications submitted to the Call N. 2, **12 were based upon or derived from the suggested topics while 11 applicants submitted their own research projects.** Out of the 17 applications admitted to the second step, the first 15 ones were selected for a contract. The gender balance of the selected candidates is well respected, with 5 females and 10 males, respectively.

At the moment, 8 Fellows already started in August and the remaining 4 ones are expected to start early 2024.

Fellows' presentation

In November 2022, a communication campaign was launched to introduce the Fellows selected for call n.1, their background, the ambitions of their research projects ambition and the expected impact.
The interviews are published on the GNeuS Website: https://gneus.eu/.

Interviews with the Fellows of call n.2 will be published in the coming weeks! Stay tuned

GNeuS on social media!

GNeuS has a strong presence on social media and on the web. Follow us to receive the latest news.

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CALL 3 OPEN SINCE 1st November, 2023
CALL 3 CLOSURE: 17th January, 2024

- Possession of a doctoral degree or equivalent research experience
- 1 original publication in a peer-reviewed journal
- Full application package submitted
- Background in neutron scattering techniques
- Not more than 12 months in the last 3 years in Germany
- At least one secondment in a non-academic organisation

Applicants can free choose of their research topics, hosting organizations and supervisors. Once selected, they will build the next generation of neutron scientists able to answer major scientific challenges.

Guidelines for Applicants available on www.gneus.eu

Call n.3 webinar

On November 30th, 2023, a webinar was organized to present the opportunities and conditions of the call and to answer candidates' questions. The available GNeus topics were presented.

The session was recorded and the video is available for all the registered candidates in the Documents section of the my.gneus portal (application portal).

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Science day

The 1st GNeuS Science Day took place last 24th of March 2023. It followed the 8th European Conference on Neutron Scattering (ECNS) that took place in Garching, at the Heinz Maier-Leibnitz Zentrum (MLZ), with the presence of all the GNeuS Fellows.

The day was dedicated to gather GNeuS management office and Coordinator, all GNeuS Fellows hired within Call 1 (2021), their supervisors, as well as the Directors of the GNeuS Partner organizations,the Forschungszentrum Jülich (FZJ), the Technical University of Munich (TUM) and Helmholtz Zentrum Hereon (HEREON).

Each Fellow had the opportunity to share with the whole GNeuS community the milestones of their research projects and their achievements to date. Each presentation was followed by a lively discussion that provided immediate feedback and hints for potential future developments. All the participants enjoyed the very pleasant and fruitful atmosphere.

The next GNeuS Science Day will take place in Spring - Summer 2024.

From top to down, and left to right: Thomas Brueckel, GNeuS Coordinator - Jurgen Neuhaus, TUM-FRM II Deputy Director - Aurel Radulescu, Main Supervisor - Brijitta Joseph Boniface, GNeuS Fellow - Anastasiia Fanova, GNeuS Fellow – Yixi Su, Main Supervisor - Yating Zhou, GNeuS Fellow - Monia El Barbari, GNeuS Fellow – Christopher Garvey, Main Supervisor - Junyang Chen, GNeuS Fellow – Jose Robledo, GNeuS Fellow – Ramya Koduvayur, GNeuS Fellow - Pikesh Pal, GNeuS Fellow – Flavio Carsughi, GNeuS Management Office - Debasish Saha, GNeuS Fellow – Iaroslav Meleshenkovskii, GNeuS Fellow – Mayada Abdelgalil, GNeuS Management Office – Sheetal Devi, GNeuS Fellow – Matthew Wade, GNeuS Fellow - Madhu Ghanathe, GNeuS Fellow .

Photo credit: Bernhard Ludewig, FRM II / TUM

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Neutron sciences are accelerating at MLZ!

When the *Global Neutron Scientists* generation meets the next neutron generation facility *HBS*, by Monia El Barbari, GNeuS Fellow

Neutron research plays an important role in the academic field, contributing to the development of fresh insights and the education of emerging scientists. Moreover, it serves as a catalyst for innovation by translating research findings into novel and enhanced products. Furthermore, beyond its support for the generation of knowledge in academic research, neutrons find widespread application across various industry sectors. They are frequently utilized for quality control and the enhancement of existing products and processes. In recent years, neutron facilities were actively engaged by a diverse array of companies, ranging from small and medium-sized enterprises to large global corporations in sectors such as automotive, transport, pharmacology, food, and consumer goods. This diversity proves the substantial impact of neutron facilities on not only fundamental academic science but also on innovation closely aligned with market needs.

Among the advanced neutron facilities, the High Brilliance neutron Source (HBS) project at Jülich introduces a new innovative approach as a high-current compact, accelerator-driven neutron source. The HBS project at the Jülich Centre for Neutron Science of Forschungszentrum Jülich GmbH (FZJ), collaborates with partners within FZJ, national universities, members of the Helmholtz Association, and international research centres. This endeavour brings forward innovative strategies, departing from traditional approaches. Instead of relying on conventional fission or spallation, the HBS achieves neutron release through nuclear reactions involving low-energy protons and a metal target. Recent scientific and technological advancements have made it feasible for a high-end facility, eliminating the need for a nuclear license and even reducing shielding requirements.

In contrast to the conventional pursuit of maximum source strength, the HBS prioritizes efficiency and brightness-essential parameters for most neutron beam instruments. This shift not only reduces installation and operation costs but also integrates the neutron source as an integral part of each instrument.

Rather than offering a universal solution, HBS customizes the pulse structure and neutron spectrum for individual instruments, elevating overall performance.

Furthermore, the HBS concept is characterized by adaptability and scalability, accommodating diverse sizes from a local laboratory to a full-scale user facility. HBS, with its focus on brightness, expands capacity and capabilities for neutron research, particularly benefiting fields such as life science, nanotechnology, engineering, and industrial applications like quality control and imaging of larger objects in manufacturing, raw materials, and recycling industries.

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Within the framework of the GNeuS project, we have work on the incorporation of the cryogenic systems for HBS, contributing to the development of moderators. Each team member played a distinct role, focusing on a specific facet of this intricate research. The integration of the cryogenic setup into the HBS unit represents a pivotal step in our collective efforts, showcasing the collaborative nature of our work as we strive to advance and refine moderator technologies. Our individual contributions, working in tandem, underscore the synergy required for the success of this project, as we collectively navigate the complexities of cryogenic moderator development within the broader GNeuS initiative.

Among the GNeuS fellows, Junyang Chen stands out as a contributor for the optimization of the performance of the cold moderators. Leveraging sophisticated Monte Carlo codes, Junyang meticulously refined the configuration to achieve an optimal neutron brightness of the neutron flux. On the other hand, Dalini Maharaj assumes the role of overseeing the studies on cold and very cold neutron sources.

Her primary focus is to determine a design that is not only technically sound but also tailored to specific applications. Dalini's responsibilities involve delving into the intricacies of very cold neutron sources, carefully evaluating their potential applications, and crafting designs that align with the nuanced requirements of specific use cases. Monia El Barbari, another distinguished GNeuS fellow, dedicates her efforts to the comprehensive study and development of cold neutron materials. Specifically, her focus revolves around materials currently under consideration, with notable emphasis on solid ethane, solid methane, and liquid hydrogen. Monia's role is instrumental in advancing our understanding of these materials and exploring their potential applications within the context of cold neutron research.

Significant strides were accomplished over the past year across various facets of our collaborative efforts. These achievements culminated in numerous findings, which were disseminated through participation in diverse scientific events. Additionally, a multitude of these outcomes has been submitted for publication, underscoring the depth and breadth of our research contributions.

The wealth of knowledge generated through these endeavors not only reflects our commitment to advancing scientific understanding but also positions us at the forefront of current discourse in relevant fields. We are optimistic about the prospects for further advancements and refined developments arising from this collaborative venture. The collective dedication and shared expertise within our collaboration set the stage for continued growth and success in the coming phases of our research journey.

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Neutron Insights into Quantum Spin Liquids:

Unveiling Quantum Phenomena for Future Tech, by Sheetal Davi, GNeuS Fellow

In the world of science, quantum magnetism is emerging as a captivating frontier. This field delves into the behavior of magnetic materials at the quantum level, unveiling secrets with the potential to revolutionize technology. Aspects like superconductivity and advanced data storage, arising from the realm of quantum magnetism, hold the promise of transformative applications for society.

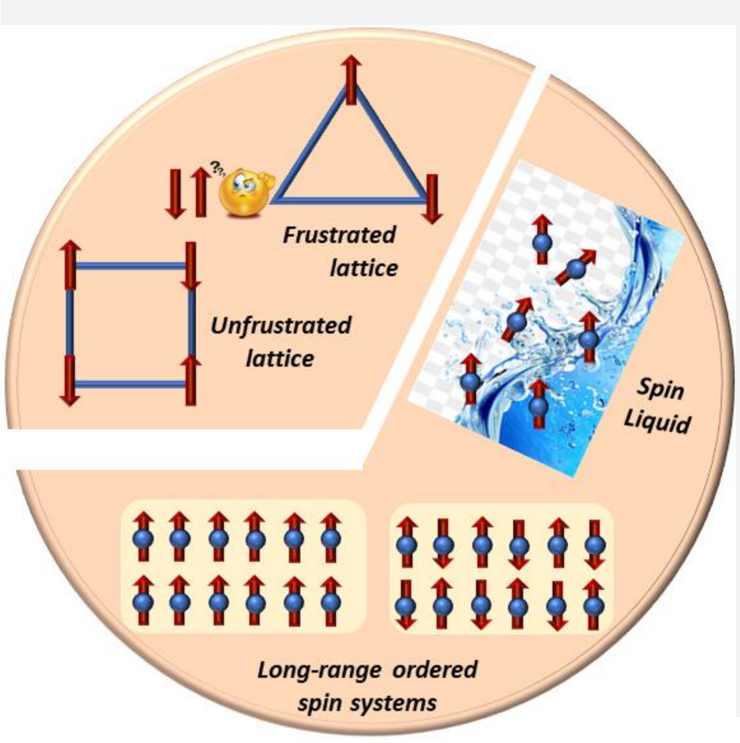
Within this quest, Quantum Spin Liquids (QSLs) stand out as mysterious phase challenging traditional magnetic norms. These materials defy the conventional behavior of magnetic materials, offering groundbreaking advancement in quantum technologies, promising a future beyond our current comprehension.

Exploring Quantum Spin Liquids

Imagine QSLs as a group of rebellious magnets or “spins”-breaking the conventional rules of magnetism. Unlike ordinary magnets where magnetic spins align in fixed patterns, QSLs, due to their quantum nature, refuse to settle into a static arrangement. But where do we find these quantum rebels?

In specific lattice structures, such as those with corner-sharing triangles or tetrahedra, the magnetic spin avoids adopting a unique state. Instead, these structures introduce disorder, giving rise to a fascinating and unpredictable unconventional magnetic state known as the Quantum Spin Liquid.

In the project entitled “Correlated disorder in spin ice and beyond” under the GNeuS COFUND program, we employ advanced neutron scattering techniques to unravel the exotic properties of emerging quantum magnets. **Dr. Sheetal Devi and Dr. Yixi Su** play pivotal roles, synthesizing chemically disordered quantum materials and exploring potential routes for realizing QSLs. This is achieved by systematically tuning the chemical disorder, enhancing their significance in quantum research.



The figure illustrates the arrangement of magnetic spins on both a square lattice and a triangular lattice. It clearly demonstrates that the triangular lattice hinders the simultaneous anti-parallel alignment of spins, leading to a state of frustration.

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Challenges in Studying Quantum Properties

As we journey into the quantum realm, exploring fundamentally new forms of correlated quantum states, traditional macroscopic techniques face limitations in comprehending the intricacies of this microscopic domain. Macroscopic methods, such as bulk magnetometry, SQUID, electrical resistivity etc., designed for the study of larger-scale phenomena, struggle to capture the nuances of quantum behavior at the microscopic level. The quantum realm, characterized by delicate superpositions, entanglement, and other quantum phenomena, poses challenges beyond the capabilities of traditional macroscopic tools.

Recognizing these constraints, there is a growing imperative to shift toward new avenues of exploration, embracing innovative techniques specifically tailored for the demands of quantum research. This shift not only broadens our understanding of quantum phenomena but also opens up new possibilities for technological advancements and applications in the burgeoning field of quantum technologies.

Neutrons: Illuminating the Quantum World

In simpler terms, neutron experiments act as powerful microscopes, enabling scientists to witness the magnetic dance of individual atoms within materials. This precision allows for a detailed examination, akin to appreciating the finer details of a painting, in contrast to the broader strokes revealed by macroscopic techniques.

These neutron techniques play a pivotal role in unravelling the mysteries of quantum phenomena, offering a direct look into the magnetic and spin structures of materials. Within the fascinating domain of Quantum Spin Liquids (QSLs), neutron experiments provide crucial insights into exotic magnetic ground states, unveiling dynamic and disordered spin arrangements. This exploration contributes not only to understanding quantum entanglement and complex spin structures but also reveals emergent phenomena, such as Majorana fermions, which are exclusive to QSLs. These particles are fascinating because they act as their own special kind of twins, existing in a unique state that combine both particle and antiparticle properties. This quality holds promises for the development of advanced technologies, especially in the exciting field of quantum computing.

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Moving beyond theory, neutron experiments shed light on the real-world implications of these discoveries. They uncover the influence of impurities and defects on the behavior of quantum spin liquids, offering insights that pave the way for the design and engineering of innovative materials. Neutron techniques, with their unique ability to probe quantum properties, have proven essential in diverse applications. For instance, they contribute to the design of advanced magnetic materials for information storage, guide the development of energy-efficient devices, and aid in the creation of novel superconductors with transformative applications. These advancements not only deepen our grasp of fundamental physics but also present opportunities for future technologies, making the quantum world accessible and impactful for a broader audience.

The Neutron Challenge: Bridging Gaps through Collaboration

In a surprising twist, we are confronted with the challenge of a lack of access to neutrons at the FRM II reactor. However, this is not a unique problem. Globally, many neutron sources are grappling with challenges and are not operating at full capacity. Yet, the European Union's Horizon 2020 Research and Innovation Programme under the Marie Skłodowska-Curie Grant Agreement N°101034266 and the dynamic neutron community at FZ-Juelich rise to the occasion. Financial support fosters collaboration across facilities at Paul Scherrer Institute (PSI) Switzerland, ISIS at STFC Rutherford Appleton Laboratory UK, Institut Laue-Langevin (ILL) France, and J-PARC, breaking geographical constraints. This collective effort empowers scientists to conduct neutron experiments and explore diverse microscopic techniques, transcending the limitations of individual facilities.

Learn more on our fellows' results in the next newsletter, website and social media.

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