Polarized Neutrons for Condensed Matter Investigations (15th PNCMI 2025)

INSTITUTE OF HIGH ENERGY PHYSICS
&
CHINA SPALLATION NEUTRON SOURCE

Feb. 24th-28th, 2025 | Dongguan Exhibition International Hotel | Dongguan, China

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Purpose

The Polarized Neutrons for Condensed-Matter Investigations (15th PNCMI 2025) will be hosted by the **China Spallation Neutron Source (CSNS)** from Feb. 24th – 28th, 2025 in Dongguan, China, where topics related to polarization methods, instrumentation, and technical challenges will be presented. This conference will involve the latest condensed matter investigations using polarized neutrons and state-of-the-art methodologies and techniques of polarized-neutron production and utilization for novel instrumentation and experiments, with emphasis on prospects for new science and instrument concepts as well as combining neutrons with complementary techniques and in-situ secondary measurements. In addition, this conference will stimulate scientific experts in the polarized neutrons community and provide an opportunity to promote the utilization of polarized neutron related techniques among international research facilities.

ORGANIZED BY

Institute of High Energy Physics (IHEP) - Chinese Academy of Sciences (CAS)
Municipal government of Dongguan Spallation Neutron Source Science Center
Guangdong Provincial Key Laboratory of Extreme Conditions

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Venue

Name: Dongguan Exhibition International Hotel

Address: North Exhibition Road, New City Centre, Dongguan, Guangdong Province, China

Tel: +86 76922889999

Cell: 13712120376 1392682982 Mrs. Yang

Website: www.eihotel.com

E-mail: info@eihotel.com

Check-In Time: After 14:00

Check-Out Time: 12:00 Noon (Contact the reception for special needs)

Including: Free WIFI, Swimming Pool, Gymnasium, Business Center, Restaurant, Wake-up Service, Laundry Service, Room Service, Car Rental Services, Foreign Currency Exchange, Coffee Shop.

Useful Apps and Services

1) Please consider downloading the following apps on your mobile phone to help with navigation and communication while staying in China.

WeChat | Amap | DiDi | Google Translate | Dear Translate

If you have WeChat, please feel free to add the organizing committee members by scanning their respective QR codes:

Xin Tong (Tony) | Junpei Zhang (Jupiter)

2) Phone numbers of emergency services

Police Dept.
Phone: 110

Fire Dept.
Phone: 119

Medical
Phone: 120

Tours and Attractions

中国散裂中子源 - China Spallation Neutron Source (CSNS)

The CSNS, located south of Dongguan City, is one of the largest sciences and technology infrastructure projects in China.

中国沉香文化博物馆 - China Agarwood Culture Museum

The China Agarwood Culture Museum is a multi-function educational site that serves as an important institution for promoting the fragrance culture in China.

东莞可园 - Dongguan Keyuan Garden

Keyuan Garden, built in 1850, is one of the four famous gardens of the Qing Dynasty (1644-1911) in Guangdong Province.

Transportation

Transportation from Airport to Hotel

1. High-Speed Train from Hong Kong

Take the airport express or a taxi from Hong Kong International Airport to Hong Kong West Kowloon Station. Then take the high-speed train from "HK West Kowloon (香港西九龙)" to "Dongguan (东莞)" Railway Station. For high-speed train ticket purchasing, please go to the following website: https://www.12306.cn/en/index.html.

After you arrive at the Dongguan train station, you will find our volunteers to guide you to the shuttle bus to the hotel (venue). You can also take a taxi from Dongguan to the Dongguan Exhibition International Hotel (东莞会展国际大酒店), which takes 1 hour and roughly 100 CNY.

Other ticketing channels:

- 12306 mobile app
- Designated Ticket Agents
- Ticketing Counters and Ticket Machines in stations

2. Ferry Transfer from Hong Kong International Airport

SkyPier at Hong Kong International Airport (HKIA) provides speedy ferry services for transfer passengers to Dongguan Humen Port. After you arrive at the Humen Port, you can call a taxi to the local hotel. This will charge you no more than 80 CNY. For the latest ferry schedule and ticketing arrangement, please check with the ferry operator (https://www.hongkongairport.com/en/transport/to-from-airport/).

3. From the Shenzhen Baoan Airport/Guangzhou Baiyun Airport

From Shenzhen Baoan, you can take the bus from the airport to South City station, Dongguan. It charges you about 50 CNY. After you arrive at the bus station, you can call a taxi to the local hotel. This will charge you no more than 30 CNY. From Guangdong Baiyun, you can take the bus of Dongguan line from the airport to South City station, Dongguan. It charges you about 76 CNY. After you arrive at the station, you can call a taxi to the hotel. This will charge you no more than 30 CNY.

Taxis can be paid using cash, WechatPay, or AliPay. Please display **"东莞会展国际酒店 (广东省东莞市会展北路 1 号) "** to your taxi driver to show the intended destination. Please also show the driver **"请帮我开发票，谢谢"** to let the driver know that you would like to have a receipt for taxi. Alternatively, we are currently planning for shuttle buses from the Baoan and Baiyun Airport directly to the hotel. Please check later for the schedule of the shuttle bus.

For more information about the **Hong Kong International Airport**, please visit: HONG KONG INTERNATIONAL AIRPORT (https://www.hongkongairport.com/).

For more information about the traffic from **Shenzhen Baoan airport** to Dongguan, please go to the following website: SHENZHEN BAOAN INTERNATIONAL AIRPORT (https://www.szairport.com/szairport/index.shtml).

For more information about the traffic from **Guangzhou Baiyun airport** to Dongguan, please go to the following website: GUANGZHOU BAIYUN INTERNATIONAL AIRPORT (https://www.baiyunairport.com/).

Meals

23rd Feb.	**Reception Dinner (17:30-21:00)**	**2nd-floor Jixiang Hall**
24th Feb.	**Lunch and Dinner**	**2nd-floor Jixiang Hall**
25th Feb.	**Lunch**	**2nd-floor Jixiang Hall**
25th Feb.	**Dinner**	**Plymouth Mountain Villa**
26th Feb.	**Lunch and Dinner**	**2nd-floor Jixiang Hall**
27th Feb.	**Lunch and Dinner**	**2nd-floor Jixiang Hall**
28th Feb.	**Lunch and Dinner**	**2nd-floor Jixiang Hall**

Special food requirements

- To ensure we accommodate all dietary needs during the conference, please inform the conference committee (email address: zhangjunpei@ihep.ac.cn) of any special food requirements (e.g., vegetarian, vegan, gluten-free, halal, kosher, allergies, etc.) before Feb. 20th, 2025.

Program of the PNCMI-2025

Dates	February 23rd - 28th, 2025
Location	**Ruyi Hall (如意厅) at 3rd floor (AM, 24th Feb.)** **V6 Hall at 4th floor (PM, 24th Feb. - AM, 28th Feb.)**

Feb. 23rd

Date	Time	Topic
Feb. 23rd	**08:00-17:30**	Reception and registration
	17:30-21:00	Welcome Reception

Feb. 24th at Ruyi Hall (如意厅) 3rd Floor (AM) and V6 4th Floor (PM)

Date	Time	Topic	Speaker
Feb. 24th	***08:00-09:00: Breakfast at 1st-floor cafeteria***		
	Session 1: Opening		**Chair: Xin Tong (Tony)**
	09:00-09:30	Opening Remarks	TBD
	09:30-10:00	The Status of CSNS	Sheng Wang
	10:00-10:30	Study of the Centrosymmetric Skyrmion using polarized neutron scattering technique	Taro Nakajima
	10:30-11:00: Coffee/Tea Break/Photo		
	Session 2		**Chair: Taro Nakajima**
	11:00-11:30	Polarised neutrons for European Spallation Source users	Wai Tung (Hal) LEE
	11:30-12:00	Advancing Applied Magnetics: The Role of Neutron Transmission Spectroscopy	Hiroaki Mamiya
	12:00-13:30: Lunch at 2nd-floor Jixiang Hall		
	Session 3		**Chair: Wai Tung (Hal) LEE**
	14:00-14:30	Advanced magnetic systems for neutron instrumentation	Earl Babcock
	14:30-15:00	First Measurement of Neutron Birefringence in Polarized ^{129}Xe and ^{131}Xe Nuclei	Earl Babcock
	15:00-15:30	New diffraction instrumentation at the second target station at ISIS: the polarisation upgrade on the WISH beamline and WSH-II	Pascal Manuel
	15:30-16:00: Coffee/Tea Break		
	Session 4		**Chair: Earl Babcock**
	16:00-16:30	Spin-contrast-variation SANS study of nano-ice crystals in frozen sugar solutions	Takayuki Kumada
	16:30-17:00	Measuring the angular momentum of a neutron using Earth's rotation	Niels Geerits
	17:00-17:30	Polarized neutron reflectometry at CSNS and its application to the study of the magnetic thin films	Tao Zhu
	17:30-20:00: Dinner at 2nd-floor Jixiang Hall/Poster (V6 Hallway 4th-Floor)		

Feb. 25th at V6 4th Floor

Date	Time	Topic	Speaker
Feb. 25th	***08:00-09:00: Breakfast at 1st-floor cafeteria***		
	Session 5		**Chair: Niels Geerits**
	09:00-09:30	Spin-depth profile studies in Co/Pt multilayers with All-Optical Switching by Polarized Neutron Reflectometry	José María Porro Azpiazu
	09:30-10:00	The Application of Polarized Neutron Imaging in Materials Sciences	Nikolay Kardjilov
	10:00-10:30	Hydrated protein dynamics using polarised neutrons	Agathe Nidriche
	10:30-11:00: Coffee/Tea Break		
	Session 6		**Chair: Nikolay Kardjilov**
	11:00-11:30	Polarized neutron reflectometry for investigation of low-dimensional 2D magnetic & superconducting periodic and quasiperiodic heterostructures	Vladimir Zhaketov
	11:30-12:00	Field induced structures in colloidal solution of hexaferrite nanoparticles	Natalia Grigoryeva /Sergey Grigoryev
	12:00-13:30: Lunch at 2nd-floor Jixiang Hall		
	13:55: Gather at the hotel entrance and board the bus ***14:00-15:00: Take the bus to CSNS*** ***15:00-17:00: Tour in CSNS*** ***17:00-18:00: Take the bus to Plymouth Mountain Villa*** ***18:00-20:00: Banquet (Room 106/105)***		

Feb. 26th at V6 4th Floor

Date	Time	Topic	Speaker
Feb. 26th	***08:00-09:00: Breakfast at 1st-floor cafeteria***		
	Session 7		**Chair: Sergey Grigoryev**
	09:00-09:30	Spin-polarized neutron scattering study of unusual magnetic states in candidate Kitaev magnet $Na_3Co_2SbO_6$	Yuan Li
	09:30-10:00	Magnon polarons and chiral phonons in multiferroic $Fe_{2-x}Zn_xMo_3O_8$ systems	Song Bao
	10:00-10:30	Diffuse small-angle neutron scattering signatures of the Dzyaloshinkii-Moriya interaction	Andreas Michels

Feb. 26th at V6 4th Floor

Date	Time	Topic	Speaker
Feb. 26th		***10:30-11:00: Coffee/Tea Break***	
	Session 8		**Chair: Pascal Manuel**
	11:00-11:30	Spin waves in full-polarized state of Dzyaloshinskii-Moriya helimagnets: polarized SANS study	Sergey Grigoryev
	11:30-12:00	KWS-3 Very Small Angle Neutron Scattering Diffractometer: Current Status with a Focus on Polarization and Analysis Options	Vitaliy Pipich
		12:00-13:30: Lunch at 2nd-floor Jixiang Hall	
	Session 9		**Chair: Takayuki Kumada**
	14:00-14:30	Wide-range wavelength-tunable laser for studies of ^{3}He neutron spin filter cells	Takashi Ino
	14:30-15:00	Development and performance evaluation of ^{3}He neutron spin filters at J-PARC	Ryuju Kobayashi
	15:00-15:30	Separation of coherent and incoherent scattering from ^{1}H-containing samples using polarized neutrons with ex-situ ^{3}He spin filters	Shusuke Takada
		15:30-16:00: Coffee/Tea Break	
	Session 10		**Chair: Yuan Li**
	16:00-16:30	The Status of Sample Environment at CSNS	Haitao Hu
	16:30-17:00	Probing Zigzag Magnetism in α-$RuCl_3$ via Spherical Neutron Polarimetry	Xiao Wang
	17:00-17:30	Towards the development of polarization analysis with high energy resolution for SPHERES	Chuyi Huang
		17:30-20:00: Dinner at 2nd-floor Jixiang Hall ***Posters (V6 Hallway 4th-Floor)***	

Feb. 27th at V6 4th Floor

Date	Time	Topic	Speaker
Feb. 27th	***08:00-09:00: Breakfast at 1st-floor cafeteria***		
	Session 11	**Chair: Takashi Ino**	
	09:00-09:30	Trimer formation in the purely organic multiferroic magnet TNN·CH_3CN	Javier Campo
	09:30-10:00	Nuclear and magnetic structure of ferrofluids for power transformers by SANS	Viktor Petrenko
	10:00-10:30	Large uniform-volume field coil designs for polarised ^3He neutron spin filters	Wai Tung (Hal) LEE
	10:30-11:00: Coffee/Tea Break		
	Session 12	**Chair: Tianhao Wang**	
	11:00-11:30	Development of Polarized ^3He at CSNS	Junpei Zhang
	11:30-12:00	Progress in MEOP based ^3He Polarization System	Liangyong Wu
	12:00-12:50: Lunch at 2nd-floor Jixiang Hall		
	12:55: Gather at the hotel entrance and board the bus 13:00-13:50: Take the bus to China Agarwood Culture Museum 13:50-17:30: Tour in Dongguan 17:30-18:00: Take the bus back to hotel 18:00-20:00: Dinner at 2nd-floor Jixiang Hall Posters (V6 Hallway 4th-Floor)		

Feb. 28th at V6 4th Floor

Date	Time	Topic	Speaker
Feb. 28th	***08:00-09:00: Breakfast at 1st-floor cafeteria***		
	Session 13	**Chair: Tao Zhu**	
	09:00-09:30	Polarized neutron Imaging development at the CSNS	Tianhao Wang
	09:30-10:00	Polarized Neutron Observation and Modeling of Pinned Magnetic Fields in Superconductors	Siqin Meng
	10:00-10:30	Recent progress of polarized neutron imaging technique at China Advanced Research Reactor	Zhengyao Li
	Session 14: Closing	**Chair:** Javier Campo	
	10:30-11:00	**Excellent Poster Award**	
	12:00-13:30: Lunch at 2nd-floor Jixiang Hall		
	13:30-17:00: Departure		

List of Participants

BABCOCK, Earl	JCNS-MLZ
BAI, He	CSNS
BAO, Song	Nanjing University
CAMPO, Javier	INMA
CHENG, Sheng	CSNS
DENG, Sihao	CSNS
DONG, Yuchen	CSNS
FANG, Xiuhua	CSNS
FENG, Erxi	CSNS
GAO, Han	DGUT
GEERITS, Niels	TU Wien
GRIGORYEV, Sergey	PNPI
GRIGORYEVA, Natalia	PNPI
Gu, Boyang	CSNS
HAO, lijie	CARR
HE, Linfeng	CARR
HU, Haitao	CSNS
HU, Ke	CSNS
HUANG, Chuyi	JCNS-MLZ
INO, Takashi	KEK/J-PARC
IOFFE, Alexander	JCNS
JIANG, Fan	CSNS
JIANG, Qisheng	SYSU/CSNS
KARDJILOV, Nikolay	HZB
KOBAYASHI, Ryuju	J-PARC/JAEA
KUMADA, Takayuki	JAEA
LEE, Wai Tung (Hal)	ESS
LI, Xiao	CSNS
LI, Yanjie	CSNS
LI, Yuan	IOP/CAS
LI, Yunfei	CSNS
LI, Zhengyao	CARR
LIANG, Tianjiao	CSNS
LIU, Hua Chang	CSNS
LIU, Yujia	CSNS
MAMIYA, Hiroaki	National Institute for Materials Science
MANUEL, Pascal	ISIS

MENG, Siqin	CARR
MIAO, Ping	CSNS
MICHELS, Andreas	PNPI
MUSGRAVE, Matthew	CSNS
NAWASHIROBASHI,Otochika	Institute for Materials Research, Tohoku University
NAKAJIMA, Taro	Tokyo/RIKEN
NIDRICHE, Agathe	ILL
PETRENKO, Viktor	BCMaterials
PIPICH, Vitaliy	JCNS-MLZ
PORRO AZPIAZU, José María	BCMaterials
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QIN, Xu	CSNS
QIN, Zecong	CSNS
REN, Fei	CSNS
SUN, Zhijia	CSNS
SYROMYATNIKOV, Vladislav	PNPI
TAKADA, Shusuke	Tohoku University
TANG, Jian	CSNS
TIAN, Long	CSNS
TONG, Xin	CSNS
WANG, Bin	SYSU/CSNS
WANG, Li	CSNS
WANG, Jing	CSNS
WANG, Qiangwei	CSNS
WANG, Sheng	CSNS
WANG, Shilin	CSNS
WANG, Tianhao	CSNS
WANG, Xiao	CSNS
WANG, Ziyu	CSNS
WEN, Jinsheng	Nanjing University
WHITE, Jonathan	PSI
WU, Liangyong	Fudan University/CMRR
XIE, Wu	CSNS
XIONG, Yiming	CSNS
XU, Xiaoying	CSNS
YAN, Haiyang	Ningbo University
YAO, Yuan	CSNS
YE, Fan	CSNS
YIN, Wen	CSNS
ZHAKETOV, Vladimir	JINR
ZHANG, Junpei	CSNS

ZHANG, Junrong	CSNS
ZHANG, Wei	CSNS
ZHAO, Nan	CSNS
ZHAO, Guodong	CSNS
ZHENG, Qingbo	CSNS
ZHU, Fengfeng	SH-IMIT
ZHU, Tao	IOP/CSNS
ZUO, Taisen	CSNS

Welcome to Dongguan!

List of Abstracts

(Arbitrary Order)

Diffuse small-angle neutron scattering signatures of the Dzyaloshinkii-Moriya interaction

Andreas Michels[1]

[1]University of Luxembourg, Diekirch, Luxembourg

The antisymmetric Dzyaloshinkii-Moriya interaction (DMI) arises in systems with broken inversion symmetry and strong spin-orbit coupling. In conjunction with the isotropic and symmetric exchange interaction, magnetic anisotropy, the dipolar interaction, and an externally applied magnetic field, the DMI supports and stabilizes the formation of various kinds of complex mesoscale magnetization configurations, such as helices, spin spirals, skyrmions, or hopfions. A question of importance in this context addresses the neutron scattering signature of the DMI, in particular in polycrystalline bulk materials and random nanoparticle assemblies, where the related magnetic neutron scattering signal is diffuse in character and not of the single-crystal diffraction-peak type, as it is e.g. seen for a skyrmion lattice in the B20 compounds. In this talk we discuss (i) the effect of the DMI in spherical FeGe nanoparticles on the randomly averaged magnetic neutron scattering observables, more specifically on the spin-flip small-angle neutron scattering cross section, the related chiral function, and the pair-distance distribution function. Additionally, (ii) recent theoretical results regarding the diffuse scattering signatures of two types of stable hopfions in the SANS observables are presented, and (iii) experimental data for the less well studied microstructural defect-induced DMI are discussed.

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Spin-depth profile studies in Co/Pt multilayers with All-Optical Switching by Polarized Neutron Reflectometry

Aritz VILLAR[1], Daniel DOMENECH[1], Raul MONTERO[2], Anton DEVISHVILI[3], Natalia A. RIO-LOPEZ[1], Rafael MORALES[1,4,5], Paolo VAVASSORI[6], **Jose M. PORRO[1,5]**

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[3] Institut Laue-Langevin, 71 avenue des Martyrs, CS 20156, 38042 Grenoble cedex 9, France

[4] Chemical-Physics dept., Science and Technology Faculty, UPV/EHU, 48940 Leioa, Spain.

[5] IKERBASQUE, Basque Foundation for Science, 48009 Bilbao, Spain

[6] CIC nanoGUNE BRTA, 20018 Donostia-San Sebastián, Spain.

All-Optical Switching (AOS) is a phenomenon which is currently attracting significant attention due to its potential applications in magnetic memory storage technologies. The grand advantages against other storage solutions are its high energy efficiency and ultrafast magnetic dynamics [1]. The AOS consists in deterministic reversal processes of magnetic domains induced by femtosecond laser pulses. This phenomenon allows for ultrafast and photon-helicity dependent magnetization switching [2-5] (Fig. 1a) to occur in magnetic thin films and multilayers. AOS occurs in magnetic metamaterials consisting on a wide variety of magnetic thin film materials, including rare- earth alloy thin films and/or transition metal-ferromagnetic material multilayers. In the latter case, a full magnetic characterization of the magnetic behaviour of the multilayer system (FIG. 1b) is crucial to reveal the true mechanism of AOS, as allowing us to tune the material parameters to improve the AOS induction mechanism and phenomena. In this work we show a polarized neutron reflectometry study (Fig. 1c-d) of Co/Pt ferromagnetic multilayer thin films where AOS has been observed, with the objective to relate the quality of the interfaces, possible interlayer diffusion events and the magnetic spin-depth profile onto the observed AOS mechanism and the magnetic properties of the multilayers.

[1] A. Kimel. and M. Li, Nat. Rev. **4**, 189, (2019)

[2] C. D. Stanciu et al., Phys. Rev. Lett. **99**, 047601, (2007)

[3] Y. Quessab et al. Phys. Rev. B. 97 (2018)

[4] Y. Liu et al. Appl. Phys. Lett., 122 (2023)

[5] G. Kichin et al. Phys. Rev. Appl., 12 (2019)

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Polarized neutron reflectometry at CSNS and its application to the study of the magnetic thin films

Tao Zhu[1]

[1]Institute of Physics, Chinese Academy of Sciences, Beijing 100190, China

As one of the three instruments in Phase I of the Chinese Spallation Neutron Sources (CSNS), the Multipurpose Reflectometer (MR) has the highest beam flux and has been open to users since 2018. The instrument can provide both polarized and unpolarized reflectivity measurements, which are used to study the structure inside the thin film. In this talk I will first briefly introduce the polarized neutron reflectometry (PNR) at CSNS. Benefiting from the high-quality polarized supermirror setup, the PNR at CSNS has been used to study the magnetic thin films for spintronics.

Spin-orbit torque (SOT) induced magnetization switching in an energy-efficient and fast way has exhibited great application potential in next generation magnetic memories. Here, we report a significant field-free magnetization switching through large out-of-plane SOT in the Co_xPt_{100-x} single layers within a Co composition range from 40 to 70. The largest out-of-plane SOT efficiency is found at its equiatomic concentration ($Co_{50}Pt_{50}$), where the in-plane SOT efficiency also reaches the maximum value. The PNR result shows a small composition gradient of about 0.5% per nm in the single CoPt layer. Meanwhile, the magnetization (Ms) also shows a gradient distribution, which is about 20 emu/cm^3 per nm, which is responsible for the formation of SOT in the CoPt single layer[1,2].

In addition to probing the gradient magnetization in the ferromagnetic alloy films[3], the PNR can accurately determine the weak magnetization of the ferromagnetic insulators (FMIs), such as HoIG and YIG[4,5]. Then the accurate spin Hall angle can be calculated from the FMI/Pt bilayers.

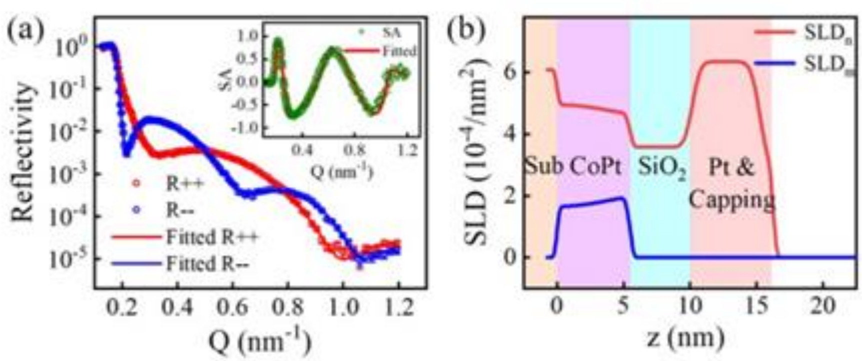

Fig. 1 (a) PNR curves of the $Co_{50}Pt_{50}/SiO_2/Pt$ multilayer measured at the external magnetic field of 1.9 T at room temperature. The inset shows the related spin asymmetry (SA). The symbols are the experimental data. The solid lines are the fitting results. (b) The fitted nuclear and magnetic SLD (SLDn and SLDm) profiles.

[1] J. L. Li *et al.*, Appl. Phys. Lett., **124** (2024) 212407.

[2] J. L. Li *et al*., Adv. Funct. Mater., **34** (2024) 2401018.

[3] Q. H. Zhang *et al.*, Phys. Rev. Lett. **128** (2022) 167202.

[4] H. Bai *et al.*, Appl. Phys. Lett. **119** (2021) 212406.

[5] H. Bai *et al.*, Adv. Electron. Mater. **10** (2024) 202300785.

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Spin-contrast-variation SANS study of nano-ice crystals in frozen sugar solutions

Takayuki Kumada[1,2]

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[2]J-PARC Center, Japan Atomic Energy Agency, Tokai 319-1195, Japan

When analyzing the structure of soft composite materials, the structure of each component (partial structure) and its entanglement with others can be determined by partial deuteration. However, for composite materials with three or more components, it is necessary to prepare many combinations of deuterium-substituted samples to determine the substructure. as material science advances, the samples brought to neutron facilities become more complex, and the preparation of multiple deuterium-substituted samples is laborious and difficult, making it unrealistic for many sample systems.

The spin-contrast variation (SCV), which utilizes the property that the scattering power of neutrons against protons varies greatly depending on their spin directions, is also a technique for determining the structure of composite materials. By combining deuterium labelling and SCV, we can determine detailed structure that cannot be addressed by the conventional technique alone. The SCV has been considered as a non-versatile technique due to the difficulty of proton polarization. However, by adopting the latest nuclear polarization technology, we have lowered the barriers for SCV experiments and have been able to study the structure of a variety of materials.

In this talk, we will present recent study on SCV small-angle neutron scattering of nano-ice crystals formed in rapidly frozen sugar solutions [1]. As shown in Figure 1, SCV enabled us to separate the scatterings from nano-ice crystals and other components, and then found that the nano-ice crystals in high concentration sugar solution form planer structure with a 2-3 nm thickness, which is close to the critical nucleation size of ice crystals nucleated in supercooled solution. This result indicates that the sugar molecules strongly disturb the crystalline growth in a specific direction.

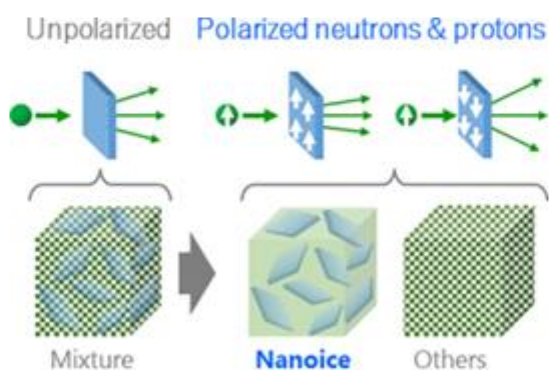

Figure 1: Separation of scattering components using proton-polarization dependent polarized neutron scattering.

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Advances in design simulation of supermirror polariser

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Neutron polariser and analyser based on polarising supermirror technology [1-3] have been enabling the widespread use of polarised neutrons in the past decades. Polarising supermirror operates on polarised neutron reflectometry principles and is highly sensitive to incident neutron's wavelength and incident angle. Modern neutron beamline often uses neutron optical elements such as a combination of curved and elliptical neutron guides to get out of the line of sight to the moderator, increase the transport of selected neutrons and focus the beam onto a sample. A polariser is placed either inline in a section of the neutron guides or at the guide exit in the experimental enclosure. At those locations, the beam characteristics are complex, making it necessary to use simulation for the design evaluation of the polariser. At present, the leading simulation software are McStas [4,5] and Vitess [6]. While many polarising devices have been incorporated, the complexity of the interaction between neutron and polarising supermirror and the increasing sophistication of beamline design demand further development of the simulation code to include physical processes that could previously be omitted [7]. We report here a development that, in addition to polarisation-dependent reflection and transmission at the supermirror coating, also includes transmission and absorption in substrate, refraction at the substrate interface, and multiple internal reflection in double-side coated supermirror. At the device level, multiple reflection between supermirrors has also been included in, e.g. v-cavity polariser. The results revealed internal reflections in a substrate and cross-talk between supermirrors can significantly affect the performance. Consequently, mitigations have been incorporated in our polariser designs to archive, for instance, 95% polarisation and 42% transmission at 2 Å for a v-cavity polariser. We will present our findings and the results of polariser design for ESS instruments using the new code.

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Advancing Applied Magnetics: The Role of Neutron Transmission Spectroscopy

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Neutron scattering has long been recognized as an indispensable tool in the study of basic magnetism, particularly to characterize magnetic structures. However, its application within the realm of applied magnetics has remained limited. This can primarily be attributed to the fact that only ferromagnetic materials with uniformly magnetized interiors have been used in practical applications from compasses to hard disk drive media, where the simplicity of the interior obviates the need for detailed internal structural observation.

Considering future carbon-neutral society, it is imperative that we fully leverage the diverse array of magnetic materials possessing intricate internal architectures. For instance, in the domain of magnetic refrigeration for hydrogen liquefaction, it has become evident that systems eliciting substantial entropy changes extend beyond traditional ferromagnets. Even within power conversion devices that employ conventional ferromagnets, the complexity of magnetic circuits has increased, negating the presumption of uniform flux flow. Consequently, the time is approaching when neutron scattering will assume a pivotal role in applied magnetics.

When neutrons are incident on a periodic magnetic structure, diffraction occurs at wavelengths satisfying the Bragg condition, resulting in a reduction of transmission intensity. This phenomenon parallels the relationship between dark-field and bright-field imaging in microscopy. Thus, information pertaining to magnetic structures is obtainable through both diffractometry and transmission spectroscopy. Historically, in the field of basic magnetism where accuracy is paramount, diffractometry has been favored over transmission spectroscopy, which lacks detailed diffraction angle information. However, as accessibility, throughput, and in-operando evaluation are critical in materials and device development, the supremacy of diffractometry over spectroscopy remains uncertain as a tool for applied magnetics.

In this talk, we shall examine the potential of neutron transmission spectroscopy within the field of applied magnetics, drawing upon the results from our model experiments [1,2]. We will commence by elucidating the principles of Bragg edge analysis within transmission spectra, followed by an overview of its current applications, such as the assessment of cultural heritage artifacts. Subsequently, we will explore the promise of laboratory-based neutron instruments employing transmission spectroscopy, capitalizing on the unimpeded use of convergent optics. Moreover, we will showcase the results wherein 25 magnetic refrigerant candidates were simultaneously measured at cryogenic temperatures, utilizing the straight-line characteristic of transmitted neutrons [2], thereby contemplating the feasibility of high-throughput magnetic structure analysis. Additionally, findings from Bragg edge imaging of a magnetic core under current using polarized neutrons [1] will be discussed, examining the potential to evaluate the magnetization state distribution within an operational magnetic circuit.

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Construction of a Neutron Spin Filter System for Polarized Neutron Scattering Experiments at JRR-3

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Polarized neutron experiments are among the most effective methods in materials science, as they can distinguish between nuclear and magnetic scatterings and extract chiral terms. Polarized neutron scattering experiments using a Heusler monochromator have been conducted at JRR-3 in Tokai. However, the neutron energy bandwidth and the accessible wavenumber range are limited, especially in the low energy and Q regions. We plan to introduce a ^{3}He neutron spin filter (NSF) option at the 6G-TOPAN triple-axis spectrometer, utilizing the in- situ spin-exchange optical pumping (SEOP) method. In FY2023, we successfully introduced an in-situ polarization device for incident neutrons and confirmed that a high neutron polarization rate (~99.9%) can be achieved under typical experimental conditions for thermal neutrons [1]. Currently, a ^{3}He-NSF similar to the one for incident neutrons is being installed for post-scattered neutrons. We prepared components, including the fabrication of amplification circuits needed to flip the ^{3}He nuclear spin state and measure the polarization rate. This presentation will report on the current status of the system's introduction and the instrument's development. In addition, this presentation will include recent achievements from 6G-TOPAN [2-5].

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Development and performance evaluation of ^{3}He neutron spin filters at J-PARC

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The ^{3}He neutron spin filter (^{3}He NSF) is a neutron polarization device that uses polarized ^{3}He nuclei. It can polarize a wide range of neutron energies, including the epithermal neutron, making it a suitable polarization device for spallation neutron sources. The polarization of ^{3}He nuclei is achieved through the Spin-Exchange Optical Pumping (SEOP) method. The SEOP method, using a high-intensity laser, slight heating (200 ℃), and a small magnetic field (2 mT), enables the achievement of a very high ^{3}He polarization with compact setup. Our group is developing and operating a ^{3}He NSF at J-PARC. Since the first user experiment in 2017[1], we have conducted more than 80 days of operational use per year. Recently, we developed compact in-situ SEOP systems for the ^{3}He NSF, specifically designed to fit within the limited installation space at J-PARC's neutron beamlines. This advancement is expected to increase experimental applications. On the other hand, there is an unanswered puzzle about the ^{3}He NSF. It concerns the relaxation mechanism of ^{3}He nuclei. The complex behavior of ^{3}He atoms contained in glass cells creates a barrier to the fabrication of high-performance ^{3}He cell for the ^{3}He NSF. We are investigating the relationship between the fabrication method and performance of the ^{3}He cell, aiming to contribute to the understanding of the relaxation mechanism.

We have developed an evaluation system for the ^{3}He cell. This system features the ability to directly and precisely measure magnetic fields, which are an environmental factor included in conventional evaluation methods using NMR. This capability allows for quantitative evaluation independent of the ^{3}He cell's shape. Using this method, we evaluated multiple ^{3}He cells and obtained consistent results.

In this presentation, we will describe an overview of the ^{3}He NSF development at J-PARC and discuss the results of the performance evaluation of the ^{3}He cells.

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KWS-3 very small angle neutron scattering diffractometer: current status with a focus on polarization and analysis options

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KWS-3 "VerySANS" is a very-small-angle-neutron-scattering diffractometer operated by Jülich Centre for Neutron Science JCNS at Heinz Maier-Leibnitz Zentrum MLZ in Garching, Germany. The principle of this instrument is one-to-one imaging of an entrance aperture onto a 2D position sensitive detector by neutron reflection from a double-focusing toroidal mirror to achieve a high Q-resolution $3\cdot10^{-5}$ Å. In "standard mode" with Q-range between 10^{-4} and $2.5\cdot10^{-3}$ Å, KWS-3 demonstrates worldwide best performance: intensity much higher than any pinhole SANS instrument and measurement time much shorter than any Bonse-Hart camera. Recently, we have finalized a multi-sample-position instrument concept: we have been able to propose optimal configurations with high flux and low background covering three decades within Q-range $3\cdot10^{-5}$ and $3\cdot10^{-2}$ Å. We can also offer a "SANS" configuration for strongly scattering samples with sample-to-detector distance between 5 and 40 cm covering the Q-range of a classical SANS instrument between $2.5\cdot10^{-3}$ and 0.35 Å. Tilt stages/rotation table for the sample environment (SE) up to 500 kg have been commissioned as a mobile device and could be used across the whole instrument Q-range. Polarized neutrons and a supermirror analyzer represent a novel option now available.

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Field induced structures in colloidal solution of hexaferrite nanoparticles

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Plate-like strontium hexaferrite particles $SrFe_{12}O_{19}$ have an average size of 50 nm× 5 nm and coercive force of about 5000 Oe. When dissolved in water, these particles disperse in space with random orientations, but cause of anisotropic steric interactions readily turn and align in magnetic fields demonstrating a phase transition of isotropic-nematic liquid. We use the small angle polarized neutron scattering (P-SANS) technique to study the effect of a magnetic field on the structural ordering of the ferrofluid. The P-SANS experiments were performed at the VSANS facility of the China Spallation Neutron Source (CSNS). The beam of neutrons polarized up to $P_0 = 0.95$ within a wavelength range from 0.22 to 0.67 nm was used. SANS patterns were taken for the sample having no magnetic prehistory and then exposed to the external magnetic field from 0.0005 to 0.9 T. The two dimensional maps of the SANS intensity reveal a diffuse isotropic scattering at small fields $H < H_c = 0.001$ T and a series of diffraction reflections appeared along the field axis ($H \gg H_c$) at q_b, $2q_b$, $3q_b$, where $q_b = 0.3$ nm^{-1}, which corresponds to the particle ordering at a distance of 21 nm, approximately. The nuclear-magnetic interference scattering obtained from the difference of intensities with a neutron spins parallel and antiparallel to magnetic field reveals two additional peaks in the direction perpendicular to the field at $q_\perp = 0.06$ nm^{-1}. It implies appearance of nematic ordering with the period of 100 nm. Thus, we conclude that upon magnetization process three structural states of the ferrofluid can be identified in different magnetic field regions. Long-range but disordered magnetic chains of hexaferrite particles are formed in a nonmagnetized sample at low fields $H < H_c$. These chains are transformed into structurally curved (spiral-like) structures oriented along the magnetic field at $H > H_c$. These spirals are broken into short strait columns of the 10-12 particles directed rigidly along the magnetic field at $H >> H_c$. The columns are organized in the nematic structure and its period decreases with increase of magnetic field. These findings are supported by the numerical simulations of the colloidal solution in magnetic field.

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Large uniform-volume field coil designs for polarised ^{3}He neutron spin filters

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Polarised ^{3}He based neutron spin filter (n.s.f.) technology has significantly broadened the use of polarised neutrons in the past decades. A crucial requirement in the application is the angular uniformity of the magnetic field at the spin filter [1] as inhomogeneity shortens the polarisation lifetime. A benchmark for sustaining a long lifetime is the maximum angular inhomogeneity. It should be less than 2×10^{-4} rad/cm in any location and direction within a cell of polarised ^{3}He gas.

A typical n.s.f. cylindrical cell would be Ø15 cm×10 cm length. A typical wide-angle analyser cell would have 7 cm ID, 20 cm OD, 12 cm tall and 120° angular span. The spatial constraint of scattering instrument usually limits the device diameter to below 80 cm. Field coils based on multiple 4-coil arrangements or a combination of coil and mu-metal [2,3], and magnetostatic cavity [4,5] have been realised for polarised neutron scattering applications. Yet there are still grounds for further development. We report here a design for longitudinal beam application, that provides uniform-field volume larger than coils found in the literature [6]. We also report a design for wide-angle scattering, that matches the uniform-field volume to a wide-angle cell and provides ±18° vertical and 340° horizontal scattering angles. Both the coil designs and their design incorporation to ESS instruments will be presented.

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Measuring the Angular Momentum of a Neutron Using Earth's Rotation

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The Angular Momentum (AM) of a quantum particle is defined as the sum of an intrinsic part, called spin and an extrinsic or structural part known as Orbital Angular Momentum (OAM). For neutrons OAM is a unique quantum mechanical degree of freedom, as OAM is discrete and can take on any integer value. This means OAM could be used as a qudit, which is thought to have a far wider range of application than standard qubits in quantum information [1]. In addition, various authors suggest that twisted waves have different scattering properties, suggesting that twisted neutrons may be useful for nuclear physics [2,3].

Up until the last decade OAM was mostly neglected in neutron optics. In 2015 a first attempt was made to generate neutron OAM in a perfect crystal interferometer [4]. However, only in 2022 were the first helical neutron waves produced on the tail end of the cold spectrum [5]. Nonetheless, many challenges remain, such as efficiently generating OAM on the thermal/cold peak and efficient detection of OAM.

In this talk we discuss our work which attempts to address the latter issue [6]. It is well known that the laws of nature appear to work differently in non-inertial frames. An example of such is the apparent coupling between the AM of a test particle and the rotation rate of the frame of reference in which it is observed. This is known as the Sagnac effect [7]. We present and discuss an experiment where the Sagnac effect, arising due to Earths rotation, is used to detect the OAM difference between two path states in a Spin-Echo interferometer. Finally, we argue, that the discrete/quantum Sagnac effect may be detected in our setup by speeding up the rate of rotation, by means of a neutron optical dove prism.

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Polarised neutrons for European Spallation Sourceusers

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Polarised neutrons have long been used in reflectometry, diffraction and inelastic scattering to study magnetic structures and dynamics in nano- to meso-scales [1]. Polarisation analysis also provide a complementary tool to deuteration in the determination of coherent and single-particle motions in soft matter studies [2,3], in imaging to quantitatively studying magnetic domain evolution in microscopic scale [4,5]. In fundamental physics, the search for the neutron electric dipole moment and the study of symmetry violation are two of the many examples that use polarised neutrons. Owing to the persistent push to advance the technology, polarised neutron has changed from a scarce resource that often requires an instrumentation expert to carry out measurements, to becoming a commonly available resource that can benefit a considerably wider research community. To date, 40% of instruments are providing polarised neutron capability.

To meet the coming user demand, twelve of the fifteen ESS instruments [6] under construction aim to offer polarised neutrons for user experiments. They include an imaging instrument (ODIN), a SANS instrument (SKADI), two reflectometers (ESTIA, FREIA), three diffractometers (DREAM, HEIMDAL, MAGiC), and four spectrometers (BIFROST, CSPEC, MIRACLES, T-REX). In conjunction with in-kind contributions and instru- ment grants, the ESS Polarisation Project will support eight of the eleven instruments to incorporate polarisation analysis capabilities [7]. Neutron spin filters based on polarised ^{3}He technologies - Metastable Optical Pumping and Spin Exchange Optical Pumping, and polarising supermirror devices are selected according to the different neutronic requirements and constraints on each instrument. An update of the project will be pre- sented with highlights on some of the instrumentation innovations and improvements, alongside examples on the use of polarised neutrons in material studies.

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Polarized neutron reflectometry for investigation of low-dimensional 2D magnetic & superconducting periodic and quasiperiodic heterostructures

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Low-dimensional magnetic and superconducting heterostructures, due to the presence of a large number of interesting phenomena, are currently being actively studied. One of the effective methods for studying magnetism is polarized neutron reflectometry, which makes it possible to obtain isotopic and magnetic depth profiles with nanometer resolution. Low-temperature studies of proximity effects in superconducting-ferromagnetic systems [1] and rare-earth films with nontrivial magnetic ordering [2] were carried out using the REMUR reflectometer of the IBR-2 reactor (Dubna).

Proximity effects at the interface between two media are currently being actively studied. Of particular interest are layered low-dimensional structures with superconducting (S) and ferromagnetic (F) properties, in which the interaction of two antagonistic order parameters is realized. Promising systems for studying proximity effects are S/F heterostructures made of niobium and rare earth (RE) metals [3]. As example for the layered heterostructure Al_2O_3//Nb(40 nm)/[Dy(6 nm)/Ho(6 nm)]34/Nb(10 nm) it was found that at a temperature below the superconducting transition, the magnetic state of the helimagnet was affected by superconductivity, namely the fan-shaped magnetic state the ordering was rearranged into helimagnetic ordering [4].

The described periodic layered systems are artificial layered crystals. When neutrons are reflected from a periodic layered structure, Bragg peaks are observed. Layered artificial quasicrystals are also of particular interest. It is possible to create artificial layered systems with quasicrystallinity in the direction perpendicular to the plane of the structure. The possibility of creating layered quasicrystals from alternating superconducting and ferromagnetic layers is considered. These model systems are simple to manufacture and research, but will make it possible to study non-trivial phenomena, such as fractal superconductivity and long-range magnetic order in a quasiperiodic system, as well as their coexistence. The creation of Fibonacci structures using magnets with helical magnetic order is of particular interest.

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Polarized neutron reflectometry plus (PNR+)

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Specularly reflected polarized neutrons bear rich and unique information about the structure and magnetism of the layers. Polarized neutron reflectometry (PNR) was established more than 40 years ago [1]. It implies the standard scheme with a polarizer, 2 flippers, and an analyzer for measuring the moduli of the complex reflection matrix elements. PNR extended by the methods of extracting the phase differences of the reflection matrix elements (difference phasometry) is defined as PNR+. The aspects related to difference phasometry, methods of obtaining the phase information and experimental schemes are discussed. Elaboration of the elements of neutron spin manipulation optics [2] will contribute to the development of PNR+. Calculations with a model structure show that the experimental data obtained with the standard scheme of PNR and with the difference phasometry schemes of PNR+ may have different sensitivity to structural and magnetic parameters. Thus, the complementarity of the data obtained with the experimental schemes of difference phasometry is demonstrated. Difference phasometry may also be regarded as an important step towards extracting the absolute phases for direct, model-free reconstruction of the depth profiles of the nuclear potential and magnetization components.

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Probing Zigzag Magnetism in α-$RuCl_3$ via Spherical Neutron Polarimetry

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Honeycomb-lattice materials such as α-$RuCl_3$ have drawn significant attention for their bond-directional, Kitaev-like exchange interactions, which can stabilize unconventional magnetic ground states [1]. Despite these strong Kitaev couplings, α-$RuCl_3$ displays a long-range zigzag antiferromagnetic order at low temper- atures. A persistent challenge in characterizing this order is the small ordered moment of Ru^{3+}, which complicates precise determination of the magnetic structure. In particular, whether the moments are strictly collinear or exhibit a small in-plane tilt remains an open question.

Here, we demonstrate how spherical neutron polarimetry (SPN) can overcome this challenge. By performing SPN measurements on a cold-neutron three-axis spectrometer equipped with a zero-field polarimeter, we collected the full polarization matrices at magnetic Bragg positions (±0.5, 0, ℓ). This method allows a direct, model-independent separation of nuclear and magnetic scattering signals, providing high sensitivity to the ordered moment direction in spite of its small magnitude. Through comparative analysis of the data, we show that a slightly tilted moment arrangement with a small (~10°) in-plane component can account for all elements of the measured polarization matrices more convincingly than a strictly collinear zigzag.

These results highlight the subtle nature of the magnetic order in α-$RuCl_3$ and underscore the efficacy of spherical neutron polarimetry for resolving small moment canting in quantum magnets.

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Properties of a compact neutron supermirror transmission polarizer of new type

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In paper [1], a new neutron transmission supermirror kink polarizer was proposed and briefly reviewed. In paper [2], a proposal was considered to increase the luminous intensity of this polarizer by adding a second element, a direct polarizing neutron guide. At the same time, the angular range of the outgoing beam with high polarization has increased significantly, several times. This polarizer is designed to operate in small magnetic fields, in which the remanent properties of polarizing supermirrors can be used. In paper [3], a polarizer was considered in which its elements (kink and direct polarizing neutron guide) were in saturating magnetic fields. In addition, a spin-flipper has been added between these elements. It is shown that the basic parameters of this polarizer are high and it can be used for a number of neutron physics facilities of the new PIK research reactor (PNPI NRC "Kurchatov Institute"). In this report, the polarizer under consideration with a new magnetic system is discussed. The use of this magnetic system makes it possible to optimize the polarizer design and reduce its length. The main parameters of the polarizer are obtained and discussed depending on the characteristics of the elements of this polarizer. The polarizer under consideration is compared with known neutron transmission polarizers.

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Separation of coherent and incoherent scattering from ^{1}H-containing samples using polarized neutrons with *ex-situ* ^{3}He spin filters

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Polarized neutron beams, generated using ^{3}He spin filters, provide a valuable approach for separating coherent and incoherent scattering, nuclear and magnetic scattering, and for observing symmetry violations in nuclear reactions. The ^{3}He spin filter is suitable for polarizing neutrons with energies ranging from meV to eV, making effective use of J-PARC's high-intensity pulsed neutron beams that cover a wide energy range. The number of user experiments with a ^{3}He spin filter in J-PARC has increased annually [1], reaching about 10 experiments per year in recent years.

This presentation focuses on the application of the ^{3}He spin filter for measurements of coherent scattering from hydrogen-containing samples. Hydrogen is a fundamental constituent of biomolecules, yet the underlying mechanisms of hydrogen bond formation remain an open question. However, incoherent scattering from hydrogen often affects significantly to background noise, complicating accurate structural analyses of samples in neutron experiments. The experiment was conducted at the BL21 NOVA beamline at J-PARC, which can perform measurements in the high-Q region with high-intensity neutron beams, facilitating precise pair distribution function (PDF) analyses. Integrating NOVA with ^{3}He spin filters allows for separation of coherent and incoherent scattering components and high-precision PDF analysis. As part of our efforts to establish a method for separating the components of coherent and incoherent scattering by neutron spin analysis using the ^{3}He spin filters, we have started to analyze the data in combination with Monte Carlo simulations. Incoherent scattering of neutrons in a sample is known to flip the neutron spin direction with a probability of 2/3. However, in cases of multiple scattering, the probability of spin flips may vary, which reduces the accuracy of the separation between coherent and incoherent scattering components. We have used Geant4, which is a toolkit for the simulation of the passage of particles through matter, to estimate the spin-flip probability due to multiple scattering. This presentation will report on the details of the polarized neutron spin analysis experiments carried out with the ^{3}He spin filter in NOVA and the current status of the data analysis.

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Spin waves in full-polarized state of Dzyaloshinskii-Moriya helimagnets: polarized SANS study

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The cubic noncentrosymmetric structure of the B20 compounds causes the formation of a spin spiral with a wave vector $k_s = D/J$ balanced by the competition of antisymmetric Dzyaloshinskii-Moriya (DM) interac- tion and the ferromagnetic exchange interaction (Back-Jensen model) [1,2]. The application of a magnetic field H transforms the helix into a conical structure, which collapses into a field-induced ferromagnet at point H_{C2}.

This field is defined by the interaction hierarchy through $g_B H_{C2} = Ak_s^2$, where $A = J/S$ is the spin-wave stiffness. This ratio between H_{C2}, A and k_S was experimentally tested for a large number of B20 compounds: MnSi [3], $Mn_{1-x}Fe_xSi$ [4], FeGe [5], $Mn_{1-x}Fe_xGe$ [6], $Fe_{1-x}Co_xSi$ [7,8], Cu_2OSeO_3 [9]. The above ratio was proven to be valid for all the above mentioned compounds within the whole temperature range from 0 to T_C. To order to perform these experimental tests, we develop a technique to study the spin wave dynamics of the full-polarized state of the Dzyaloshinskii-Moriya helimagnets by polarized small-angle neutron scattering. We have experimentally proven that the spin waves dispersion in this state has the anisotropic form given by M.Kataoka in [10]: $\epsilon_q = A(\mathbf{q}-\mathbf{k}_s)^2 + g\mu B(H-H_{C2})$. We show that the neutron scattering image displays a circle with a certain radius, which is centered at the momentum transfer corresponding to the helix wave vector in helimagnetic phase ks, which is oriented along the applied magnetic field H. The radius of this circle is directly related to the spin-wave stiffness A of this system. This scattering depends on the neutron polarization showing the one-handed nature of the spin waves in Dzyaloshinskii-Moriya helimagnets in the full-polarized phase. Thus the spin wave stiffness A can be measured in the fast mode in the wide temperature range and for a large variety of samples. We have found that the spin-wave stiffness A change weakly with temperature for each individual compound but remarkable is a change of A with the concentration x for the $Mn_{1-x}Fe_xSi$ compounds [4] and for the $Fe_{1-x}Co_xSi$ compounds [8]. A detailed picture of these changes and their interpretations will be reported.

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Trimer formation in the purely organic multiferroic magnet TNN·CH_3CN

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Equilateral spin triangles have long been a topic of interest in quantum magnetism, offering a fertile ground to explore phenomena such as frustration [1], spin-electric coupling [2], and multiferroic ordering [3]. Despite substantial progress, realizing ideal triangular spin networks remains a challenge, often hindered by structural distortions. The organic compound TNN·CH_3CN overcomes these limitations with its isotropic organic radical spins, free from Jahn-Teller effects, allowing uniform exchange interactions. This makes TNN·CH_3CN an ideal candidate for investigating the novel multiferroic phases predicted by Kamiya and Batista [3].

In this work, we focus on the 1/3 magnetization plateau ($1.25 < B < 8.49$ T), where TNN·CH_3CN exhibits a twofold-degenerate $S=1/2$, $S_z=1/2$ ground state [4]. This intriguing phase exhibits ferroelectric order below 0.35 K without a conventional spin-ordering transition, offering a unique window into the interplay between spin and electric properties in triangular spin systems. By employing polarized neutron diffraction (PND) and muon spin relaxation (μSR) techniques, we investigate the emergence of collective spin behavior within the plateau [5].

The results align well with theoretical predictions and highlight the trimer formation at low temperatures, where the initially independent paramagnetic spins couple below 5.5 K.

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Advanced magnetic systems for neutron instrumentation

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Polarized neutron experiments are an important of the scientific motivation for large scale neutron sources. These experiments often involve the use both the highest available fields and at other times techniques or instrumentation that are highly sensitive to changing magnetic fields or field gradients. This can lead to reduced polarized neutron instrument performance and undesired cross talk between instruments. ^{3}He spinfilter systems at times need to be compatible with operation in the vicinity of high field magnets, such at the 8T magnet for POLI. Hot polarized neutrons must be adiabatically transported for both high field applications and 0-field cryopol applications. Neutron spin-echo should be stable and independent of interference from nearby instruments. Wide angle polarization analysis should be robust, i.e. in the case wide angle ^{3}He spin-filters, or for large area guide fields. This presentation will focus on the developments and concepts for magnetic systems at the JCNS to enable robust polarized neutron instrumentation.

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Studies of the centrosymmetric skyrmion materialsusing polarized neutron scattering

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Topologically nontrivial magnetic orders have attracted remarkable attention since the discovery of magnetic skyrmions in MnSi [1]. The term “magnetic skyrmion” originally refers to a particle-like swirling spin object in a magnetic material. However, it often appears in a form of periodic lattice, which is regarded as a long- range magnetic order described by multiple magnetic modulation wave vectors (q-vectors), namely, a multi-q magnetic order. Neutron diffraction is one of the most powerful techniques to study the periodically modulated magnetic structures including the skyrmion lattices (SkLs). In this talk, we will introduce our neutron scattering studies on the centrosymmetric skyrmion-host materials, Gd_2PdSi_3[2], $EuAl_4$ [3].

In the early studies of magnetic skyrmions, ferromagnets with non-centrosymmetric crystal structure were considered to be the most promising candidates for skyrmion-host materials since competitions between Dzyaloshinskii-Moriya (DM) and ferromagnetic interactions can induce long-period modulated magnetic structures. However, subsequent studies demonstrated that SkLs can also be realized in centrosymmetric magnets, in which long-range interactions arising from couplings between conduction electrons and localized magnetic moments play essential roles. Gd2PdSi3 is one of the centrosymmetric skyrmion hosts and exhibits a large topological Hall effect in the first-field-induced phase [4]. The magnetic structures of this system were first studied by resonant x-ray magnetic scattering [4]. We further investigated the temperature dependence of the magnetic structure by polarized neutron scattering at PONTA spectrometer in JRR-3 [2]. Another example is $EuAl_4$, which shows a variety of magnetic orders depending on temperature and magnetic field. To identify these magnetic phases, we performed polarized neutron scattering at PONTA and TAIKAN(BL15) in Materials and Life-science experimental Facility of J-PARC, revealing two distinct SkL phases in in this compound [3].

In this talk, we also briefly introduce our recent attempt to combine the polarized neutron scattering technique with pulsed high magnetic fields.

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Wide-range wavelength-tunable laser for studies of ^{3}He neutron spin filter cells

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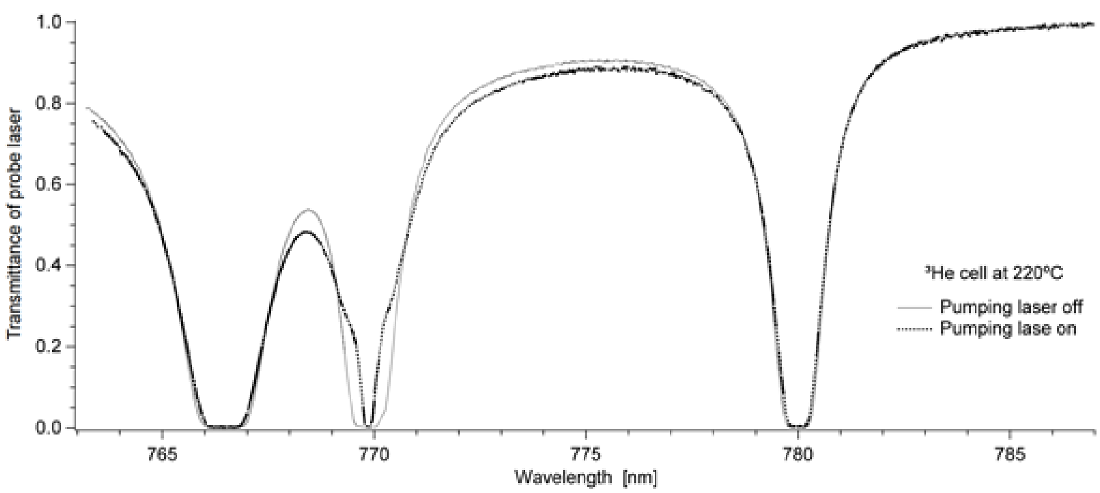
We have developed a wavelength-tunable laser for studying alkali metal atoms in ^{3}He neutron spin filter cells. Alkali metals, Rb and K, play a key role in alkali-hybrid spin-exchange optical pumping of ^{3}He as the number densities, mixture ratio, and spin polarizations of Rb and K are directly coupled to the achievable ^{3}He polarization [1, 2]. These alkali metal states can be evaluated by spectroscopic measurement with a tunable laser. Our newly developed tunable laser covers a wavelength range from 762 nm to 790 nm that includes the K D_2 line (766.701 nm), K D_1 line (770.108 nm), and Rb D_2 line (780.241 nm) so that their absorption spectra and other properties can be studied at the same time and in the same condition. The tunable laser is a type of external-cavity diode laser [3] with a two-stage thermoelectric cooler that enables a wideband tuning range. The design and performance of the tunable laser will be presented as well as some demonstration measurements for ^{3}He neutron spin filter cells.



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Towards the development of polarization analysis with high energy resolution for SPHERES

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Neutron polarization analysis provides profound additions of knowledge to the field of soft condensed matter research. The ability to separate the coherent and incoherent scattering contributions gives information on spatial correlations and collective motion, and information from single particles, respectively.

In this study, we focus on upgrading the SPHERES (SPectrometer for High Energy RESolution) backscattering instrument at JCNS [1,2] to meet the demands for high energy resolution and polarization analysis. Because of geometry constraints the polarization analyzer would need to be located between the sample and the Si111 analyzers. Based on this design, we explore transmission wide angle polarizer supermirror analyzer option through Monte-Carlo simulations [3]. At this conference, we will present our work towards performing polarization analysis with the high-resolution capabilities at the SPHERES instrument.

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Polarized neutron Imaging development at the CSNS

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We present the recent progress on the development of Polarized Neutron Imaging (PNI) at the China Spallation Neutron Source (CSNS). The Polarized Neutron Imaging method serves as an unique tool to visualize otherwise invisible magnetic field distribution within the sample. Due to its unique capability of detecting eternal magnetic field in real space, developments of such technique are made across the neutron sources internationally. At CSNS, development focuses on using time-of-flight neutron for acquiring additional information from the conventional single-wavelength based PNI measurement.[1] In addition, efforts are made to establish a standalone data processing method, which establish an initial Finite-Element-Method (FEM) magnetic field model, coupled with Bloch equation solving to create a comparable result with the PNI measurement. [2]

In this presentation, we shall demonstrate the established Polarized Neutron Imaging experiment capability at the CSNS, as well as several results from the demonstration measurement. Results on the application on electrical motors and solving superconductor surface and pined fluxed will be introduced in detail. We also briefly discuss the limitation of PNI resolution and an alternative solution to break the conventional resolution cap.

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Development of Polarized ^{3}He at CSNS

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The development of polarized neutron technology is pivotal for advancing studies in material science and fundamental physics, particularly in probing magnetic structures and symmetry violations. At the China Spallation Neutron Source (CSNS), significant progress has been made in the design and implementation of polarized ^{3}He neutron spin filters (NSFs) based on spin-exchange optical pumping (SEOP) [1-5]. An off-situ system demonstrated exceptional performance with 77.4% ^{3}He polarization and a polarization lifetime exceeding 200 hours, making it highly suitable for long-duration experiments [2]. The in-situ NSFs also achieve significant progress, building on the first-generation (70 cm × 70 cm × 60 cm, 74.4% ^{3}He polarization) [3], a compact in-situ system (55 cm × 56 cm × 48 cm) was developed [4], integrating a uniform magnetic field ($<1.74\times10^{-4}$/cm), dual-laser optical pumping, and precise thermal control (±0.15°C) with low-noise NMR monitoring. Validated on the BL-20 beamline, this system achieved 75.66%±0.09% ^{3}He polarization and 96.30% neutron polarization at 2 Å. These advancements have enabled versatile deployment across multiple CSNS beamlines. For instance, the Back-n white neutron source utilizes the in-situ NSF for time-reversal violation studies [5], while a specially designed in-situ NSF for the Very Small Angle Neutron Scattering (VSANS) instrument successfully implemented China's first polarization-analyzed small-angle neutron scattering (PASANS) technique [6].

As an underdevelopment polarized neutron facility, our group poised to enhance system stability and expand the applications in complex magnetic materials with polarized neutron, such as investigations of magnetic skyrmions and beyond-Standard Model physics. Future efforts will focus on optimizing performance for advanced experiments in nuclear weak interactions and exotic symmetry-breaking phenomena.

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