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Division of Condensed Matter Physics

Association of Asia-Pacific Physical Societies

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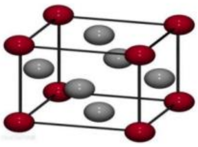

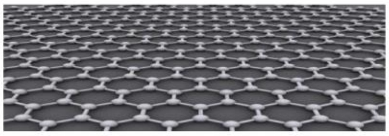

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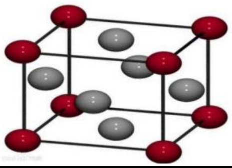
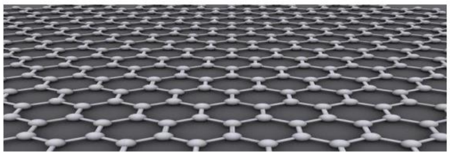




Chair message

=============== New horizon of the DCMP ===============

First of all, I would like to thank all members of the DCMP for the contributions to the AC2MP2023 in Hualien, Taiwan. We would like to express our deepest sympathies to those affected by the recent earthquake in nearby Hualien, especially to those who hosted the international conference AC2MP2023.

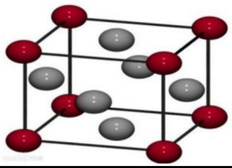
I would like to also thank the leadership of IPA to organize the AC2MP2024 in coming December. The AC2MP conference is now becoming a chain of events rather than a single occasional event like an isolated particle. In a chain, there is history and there is a direction-the development of the condensed matter physics community for future. With more mass, the activity would accelerate its speed.

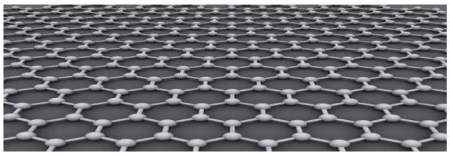
The chain of the DCMP is now coming to meet with the one from Europe. The DCMP-AAPPS and the Condensed Matter Division (CMD) of European Physical Society (EPS) has agreed to organize the joint session in the 31st EPS-CMD meeting in Portugal in September. Please visit the article in this newsletter for details. This is the first step towards the recovery of inter-continental exchange in condensed matter physics, which has been disturbed in Covid-19 era. Most notable point is that we have the DCMP as the equivalence with the CMD-EPS.

The DCMP now opens the call for the DCMP young scientist award. As you may know, we have the CN-Yang Award in AAPPS for young researchers. However, it is limited to three persons for each year. We sometimes feel a frustration in the unbalance between the limited awards and the number of excellent candidates. After more than one year of preparation, we decided to setup the DCMP young scientist award from this year. Some of you may wonder if you should apply for the DCMP award or CN-Yang Award. The answer is that you can apply for both if you wish. The DCMP award will not be given for the winner of CN-Yang Award, simply because there are so many good candidates. It may happen occasionally, the winner of the DCMP award will win the CN-Yang Award in later time. It is nothing to be avoided, but it shows the quality of the DCMP award. The specialty of the DCMP award is that it has two steps for selection. The review of the application documents and the presentation in AC2MP2024. We believe the judgement with direct hearing of your presentation will be very effective to select the good winners. So, if you want to apply for it, prepare the documents, and then register for AC2MP2024. If you are not DCMP member yet, please apply for a membership.

Finally, we are going to select a new chair and vice chairs in 2025-2026 term during the summer, 2024. In the 2025, we are going to have an on-site APPC16 conference in Hainan island, China. We hope that the DCMP will go for the new horizon with the next leadership.

Professor Hiroyuki Nojiri (Chair)
Institute for Material Research, Tohoku University





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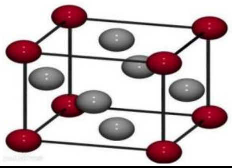

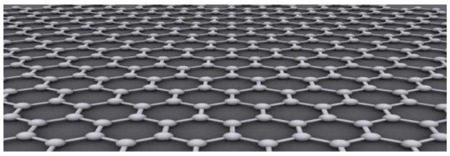

Large facilities/institute/organization reports

Report 1:

Beamlines at the ANSTO Australian Synchrotron

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Senior Scientist, ANSTO, Australia

Figure 1: Australian Synchrotron site view showing the installation in progress of a 1.4 MW solar panel array, expected to generate up to 1.8 GWh/y. Photograph: Craig Millen (ANSTO).

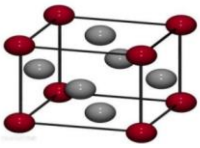
Experiments at the Australian Synchrotron (AS) (Fig. 1) started in 2007, after a long period of ‘suitcase science’ that involved Australian researchers traveling to conduct experiments at synchrotron facilities abroad. First light was achieved at AS in 2006, and nine beamlines were delivered for: imaging and medical therapy (IMBL), infrared micro-spectroscopy and terahertz far-IR Fourier transform spectroscopy (IRM, THz), powder diffraction (PD), macromolecular and microfocus-crystallography (MX1, MX2), soft X-ray spectroscopy and imaging (SXR, SXR-I), small- and wide-angle X-ray scattering (SAXS-WAXS), X-ray absorption spectroscopy (XAS), and X-ray fluorescence micro-spectroscopy (XFM).

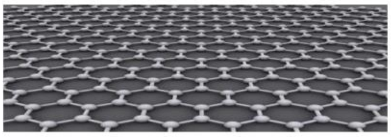
In 2017, the AS became part of the Australian Nuclear Science and Technology Organisation (ANSTO). Funding was recently obtained for the BRIGHT project which led to eight new beamlines for: micro-computed tomography (MCT), medium energy X-ray absorption spectroscopy (MEX-1, MEX-2), biological small-angle X-ray scattering (BioSAXS), advanced diffraction and scattering (ADS-1, ADS-2), high-throughput micro-crystallography (MX3), and a multimodal 100 m-long Nanoprobe housed in a dedicated isolated satellite building for ultra-high spatial resolution X-ray fluorescence microscopy and ptychography.

Diffraction

The diffraction beamlines group consists of the PD and ADS beamlines. PD makes available *ab initio* structure solution, *in situ* examination of chemical and mineralogical processes, phase identification and quantification, pair distribution function analysis, line profile analysis, and examination of stress and strain. PD uses a bending magnet source, and a Mythen strip detector covers the diffraction angle 2θ range 120°. PD science highlights include understanding of the stability of high temperature hydrogen storage materials, charge-discharge cycling of solid-state battery materials, metal-organic framework membranes for water filtration [1], and paleolithic cave art [2].

The BRIGHT ADS-1 and ADS-2 beamlines will use a superconducting wiggler source to provide high energy X-rays (fixed energies 45, 74, or 87 keV at ADS-2) and white/pink/mono beam (at 50-100 keV at ADS-1) for *in situ* powder diffraction, total scattering (PDF), diffraction from large strongly absorbing crystals, or crystals in complex sample





environments with limited angular access for the beam such as diamond anvil cells or furnaces, rapid texture analysis and 2D materials mapping, imaging, and tomography. The building extension for the ADS endstations is complete (Fig. 2). ADS will be accepting user proposals from 2024.

Figure 2 – ADS: Main Hall extension building for the Advanced Diffraction and Scattering (ADS) end stations. Source: ANSTO website.

Scattering

The scattering beamlines group consists of the SAXS-WAXS and BioSAXS beamlines. SAXS-WAXS is an undulator-based flexible X-ray scattering facility that enables transmission SAXS and anomalous SAXS, microbeam SAXS, vertical dispersion wide-angle X-ray scattering (WAXS), and a bounce-down vertical focusing mirror permits grazing-incidence (GISAXS) experiments. Changes of energy or detector distance are automated and can be readily altered during an experiment. Sample environments such as tensile stages and a high temperature silicon oil bath are available. Recent SAXS-WAXS research includes analysis of nanopore shapes in track-etched polycarbonate membranes [3], vertical slab orientation in blade-coated layered hybrid perovskite films (Fig. 3) [4], and local symmetry and centrosymmetry in glasses [5].

The BRIGHT BioSAXS beamline layout is similar, with a focus on delivering solution samples into the beam. It avoids radiation damage using a co-flow system that creates a water jacket around a stream of protein solution flowing through the synchrotron beam. BioSAXS is currently accepting proposals for user beamtime.

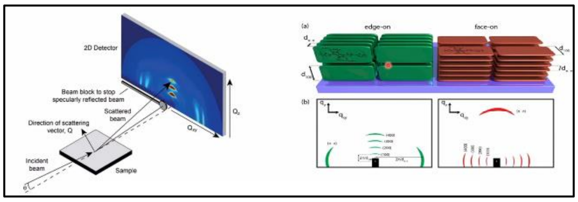


Figure 3 – SAXS/WAXS: Schematic of a GISAXS experiment discerning the structure of organic photovoltaic films. Source: Pablo Mota-Santiago (ANSTO).

Imaging

The imaging beamlines group consists of IMBL and MCT. IMBL is a long beamline whose endstation is 140 m from the superconducting wiggler source, to provide a parallel beam of high-energy white beam or monochromatic X-rays (20-120 keV) up to 500 mm by 80 mm for phase contrast radiography and tomography of up-to-human-sized samples. The IMBL satellite building has facilities to enable live animal research. The beamline can produce arrays of high intensity microbeams for radiotherapy treatment of tumors [6]. IMBL also contributes to materials science, with examples such as characterization of voids in hot isostatic pressing (Fig. 4) [7], and analysis of grain sizes affecting bursts of plasticity in Mg alloys [8]. Recently, darkfield imaging has been developed [9].

The BRIGHT MCT beamline has been in operation since 2022. It is a bending magnet beamline that provides monochromatic, pink, and white beam X-ray tomography down to 200 nm spatial resolution, for a range of samples, materials, and biological systems. Absorption and novel phase contrasts, *e.g.*, propagation-based, grating-based, speckle, are available [10].

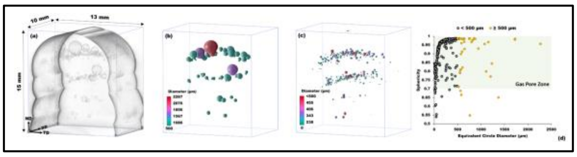


Figure 4 – IMBL: (a) CT image of hot isostatic pressed component with top 5 layers containing gas pores; (b) visualisation of ≥ 500 µm and (c) < 500 µm diameter pores; (d) relationship between sphericity and diameter in the pores. Source: [7]

Spectroscopy

The spectroscopy beamlines group covers a wide X-ray energy range, from extreme ultraviolet and soft X-rays (SXR) through to hard X-rays (XAS), with the newest additions targeting the medium energy X-rays (MEX).

The SXR spectroscopy beamline covers the photon energy range 85–2000 eV with energy resolution δE/E between 5000–10000 and adjustable polarization thanks to an APPLE-II elliptical undulator. It can distinguish the first 10 atomic layers deep into a surface from the rest of the bulk. SXR beamline has recent scientific highlights including the study of flexible inkjet-printed X-ray detectors and wearable electronics, investigating catalysts for green hydrogen [11], and surface studies of ultra-nanocrystalline diamond for biological sensing [12].

The XAS beamline covers the 5–31 keV X-ray range with a wiggler source and enables transmission and fluorescence spectroscopy measurements on bulk samples, either in a 10 K cryostat or at room temperature. Small user-supplied cells for in-situ catalysis, in-situ battery research, and capillary heating to 1000 K are supported. XAS science highlights include the catalysts for hydrogen production [13], dual-atom catalysts [14], core/shell nanocrystals [15], and high entropy oxides (Fig. 5) [16].

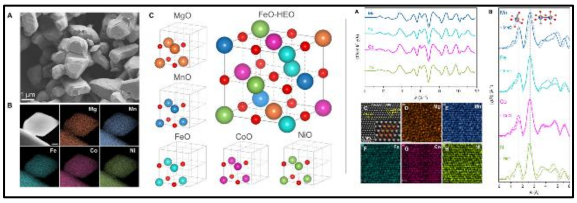


Figure 5 – XAS: (left) (A) SEM image of FeO-HEO sample; (B) DF-STEM image of the FeO-HEO and EDS maps of metal elements; (C) Binary oxides and the FeO-HEO product. Orange, blue, cyan, magenta, green, and red spheres represent Mg, Mn, Fe, Co, Ni, and O atoms, respectively. (right) (A) EXAFS spectra for Mn, Fe, Co, and Ni absorbers in the FeO-HEO; (B) Fourier transforms of k-space oscillations for absorbers of interest in the FeO-HEO; (C) HAADF image of the rocksalt structure of the FeO-HEO. (D to H) EDS mappings of Mg, Mn, Fe, Co, and Ni.

Source: [16]

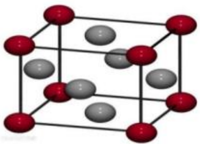
The BRIGHT MEX beamlines cover the 2–14 keV X-ray range using a bending magnet source and are now in user operation. MEX is focused on minimizing radiation damage using larger beam sizes and lower intensities, but with tunable beam size from µm to mm, for XANES and EXAFS of bulk specimens. High energy resolution fluorescence detection (HERFD) spectroscopy including non-ambient sample environments is supported at MEX-1, and micro-spectroscopy will be available at the MEX-2 microprobe. MEX facilitates chemical studies of sulfur for biological and environmental sciences, and silicon and indium phosphide for materials characterization, in nanoparticles, composites, and amorphous and microcrystalline materials.

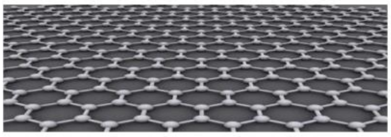
Microscopy

The microscopy beamlines group consists of the infrared/THz beamlines (IRM, THz), and the X-ray micro-spectroscopy beamlines (XFM, Nanoprobe).

IRM provides Fourier transform infrared (FTIR) microspectroscopy at a diffraction limited spatial resolution of around 3–8 microns, using a Bruker VERTEX 80v FTIR spectrometer and Hyperion 3000 microscope. The heterogeneity of surface and bulk chemistries, orientation, and structural conformation can be studied, and temporally resolved rapid scan is available permitting kinetic chemical and structural studies. Recent highlights include development of an infrared based saliva screening test for COVID-19 [17], and sustainable geopolymer concretes for Australian construction industry [18].

XFM is among the world's fastest scanning microprobes, providing hard X-ray microspectroscopy down to 2 micrometers spatial resolution with monochromatic X-rays between 4-27 keV. With typical dwell times of 1 ms per pixel,





this undulator beamline produces detailed images with several megapixels in under an hour. X-ray absorption near edge structure (XANES) and X-ray absorption fine structure (XAFS) mapping can be achieved for elements of interest. Examples of XFM studies include understanding how galvanizing protects steel from corrosion [19], and treatment of mine tailings to prevent toxic metal leaching [20]. Recently, ptychography and diffraction have been added to the beamline capabilities, providing ultrastructure morphology images down to below 100 nm spatial resolution simultaneously with XFM images, and high data rate microbeam diffraction. Scientific highlights in this space have been observation of phase changes in monoolein during high viscous injection [21], preferred orientation and its effects on intensity correlation measurements [22], and the development of high-speed ptychography imaging (Fig. 6) [23] making feasible spectroptychography experiments.

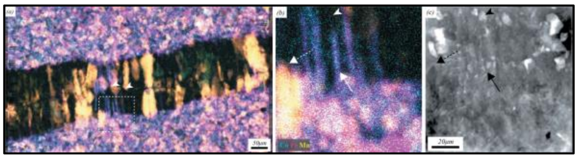


Figure 6 – XFM: A small vein in a freestanding thin section of shale with (A) a scan area 800 μm × 440 μm showing XFM data in cyan, magenta and yellow for Cu, Fe and Mn, respectively, (B) an enlargement of the 100 μm × 100 μm area indicated by the dashed square in panel (a), and (C) a ptychographic phase-contrast reconstruction in the same ROI, revealing super-resolution high-contrast structural information. The arrows point out features in the sample highlighting the complementarity of XFM and ptychography. Source: [23]

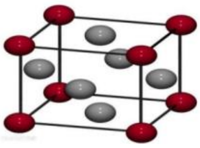
The BRIGHT Nanoprobe is a long beamline with the endstation 100 m from the cryogenic permanent magnet undulator source. The Nanoprobe satellite building, which is currently under construction, has been designed with careful attention to maximizing the thermal, vibrational, and geological stability, in order to achieve the goal of providing XFM mapping at 60 nm spatial resolution and ptychography imaging down to 10 nm. The scanning stages will permit XYZ up to 3 × 3 × 3 mm^3 total scan range with precision below 10 nm-rms, and a 360° rotation stage will facilitate 3D imaging with all the contrast methods available. An in-vacuum transmission detector will allow detector distance changes from 1–7 m, for automated changes between ptychography, differential phase contrast, and nano-beam small angle scattering measurements.

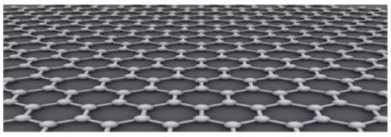
Crystallography

The MX group of beamlines comprises general purpose crystallography instruments designed for structural biology research. MX1 is a bending magnet beamline that is optimized for high-throughput and high-density screening of crystals 50-100 microns in size or greater. MX2 is an undulator beamline that provides a tightly focused beam to study crystals 3-5 microns or larger. The BRIGHT MX3 beamline is a new undulator beamline which will facilitate the study of microcrystals using a goniometer, serial crystallography, and in-tray screening. The MX beamlines provided a vital remote-access route for users during the pandemic and made important contributions to COVID-related research [24]. Recent science highlights include studies of PETase enzymes produced by plastic-digesting bacteria [25], and MX analysis of porous materials for chiral sensing [26].

Access to synchrotron beamlines

Proposals are accepted in three rounds each year, with dates announced on the ANSTO website [27]. An external review process ranks the proposals in order of scientific merit for allocation of the available beamtime. ANSTO facilities are provided free-of-charge *via* the merit system, but it is expected that results will be published in the open literature. Alternatively, IP may be protected through paid industrial or commercial use of the facilities. There is also a discretionary beam time access route which allows for particularly timely or high impact science (e.g., COVID-19 related research





during the pandemic) to be performed quickly without waiting for the next 6-monthly proposal round.

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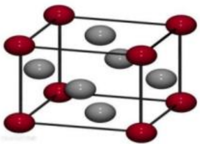

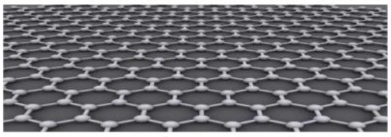

Report 2:

Shining a Light on Research: The Shanghai Synchrotron Radiation Facility

Zhentang Zhao, Renzhong Ti, Aiguo Li
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Fig.1 Aerial view of Shanghai Synchrotron Radiation Facility.

1. Introduction

Shanghai synchrotron radiation facility (SSRF), located at the Zhangjiang High-Tech Park Pudong New District of Shanghai, is one of major national science and technology infrastructures, currently operated by Shanghai Advanced Research Institute, Chinese Academy of Sciences (CAS), **Fig.1**. After 10 year’s design optimization and technology R&Ds, SSRF was constructed from December 2004 to April 2009. The first synchrotron radiation emitted from SSRF on December 24th, 2007, **[1]** The SSRF accelerator complex and its first batch of beamlines completed debugging and started operating at early 2009. **[2, 3]** Then the facility was officially opened to users on May 6th 2009. After that 8 follow-up beamlines were constructed in the following 10 years. In November 2016, the construction of the SSRF Phase II beamlines, another major national science and technology infrastructure project, began, which includes the construction of new beamlines and upgrades the facility performance of accelerator complex to provide the high-demand experimental capabilities for the research fields of energy science, public health issue, structural biology, condensed matter physics, as well as industrial applications. Accordingly, the establishment of user and technology support laboratories, construction of the data centre were also included in this Phase II beamlines project. The project construction was completed in July 2023, and at present the SSRF has 34 operational beamlines with 46 end-stations to serve user experiments.

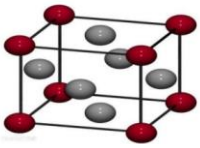
Since its operation, SSRF has served a wide range of scientific research areas and applications, including physics, chemistry, biology, environmental science, material science, life science, medicine, pharmaceuticals, archaeology, cultural heritage preservation, industrial processing and petrochemicals. With the largest number of users in China, SSRF currently serves ~10000 user visits and operates ~5000 hours each year for various experiments, supporting over 1000 yearly publications in science-journals. SSRF users obtained outstanding achievements and received many awards, for instance: 9 Awards have been selected as top 10 domestic scientific advances; 8 researches have won the first/second prizes in national natural science, science and technology progress, and national invention awards; 11 young scientists were notified and awarded the future exploration Awards. All achievements have strongly promoted the development of science and technology in related fields indeed.

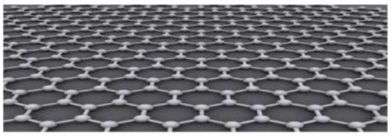
2. Accelerator complex

The SSRF accelerator system consists of a linac, a booster, a storage ring, and two beam transport lines, operation status as shown in figure 2. The linac generates an electron beam and accelerates it to 150 MeV. The electron beam is injected into the booster *via* a low-energy beam transport line. The booster synchrotron, with a circumference of 180 meters, further accelerate the electrons from the linac to 3.5 GeV. Then the electron beam is injected into the storage ring *via* a high-energy transport line and captured for circulating on the storage ring orbit to generate synchrotron radiation at its bending magnets and insertion devices. The circumference of the SSRF storage ring is 432 meters, consisting of 20 Double Bend Achromat (DBA) **[4]** The ring has four 12-meter-long straight sections and sixteen 6.5-meter-long standard straight sections. Apart from the two long straight sections occupied by the injection equipment and RF cavities, the remaining sections are used to accommodate insertion devices to provide synchrotron radiation to the beamlines. In the SSRF Phase-II beamline project, the lattice of the SSRF storage ring underwent significant upgrades, **Table.1** **[5-7]**. Since December 2012, the SSRF has been operating by top-up mode for user experiments to maintain in high performance and high stability. Approximately 7000 hours per year, it is with about 5000 hours for user and collaboration experiments, 1000 hours for machine studies, 600 hours for beamtime developments and 400 hours for warmup and maintenance, **Fig.2**. **[8]**.

Table.1 Accelerators Status Parameters summary in Phase I and Phase II project in SSRF.

Parameter	Phase I	Phase II	Units
Beam energy	3.5	3.5	GeV
Photon Energy	0.1~100	0.1~100	keV
Circumference	432	432	m
Current	200~300	200~300	mA
Natural emittance	3.89	4.23	nm·rad
Tune (H/ V)	22.220/11.290	22.222/12.153	
Momentum compaction factor	4.27×10^{-4}	4.19×10^{-4}	
Beam lifetime	>10.0	>10.0	hour
Natural chromaticity (H/V)	−55.7/−17.9	−55.3/−20.4	
Corrected chromaticity (H/V)	1.5/0.5	1.0/1.0	
Energy loss per turn	1.43	1.6983	MeV
Natural energy spread	9.83×10^{-4}	1.11×10^{-3}	
Synchrotron Tune	7.2×10^{-3}	7.56×10^{-3}	





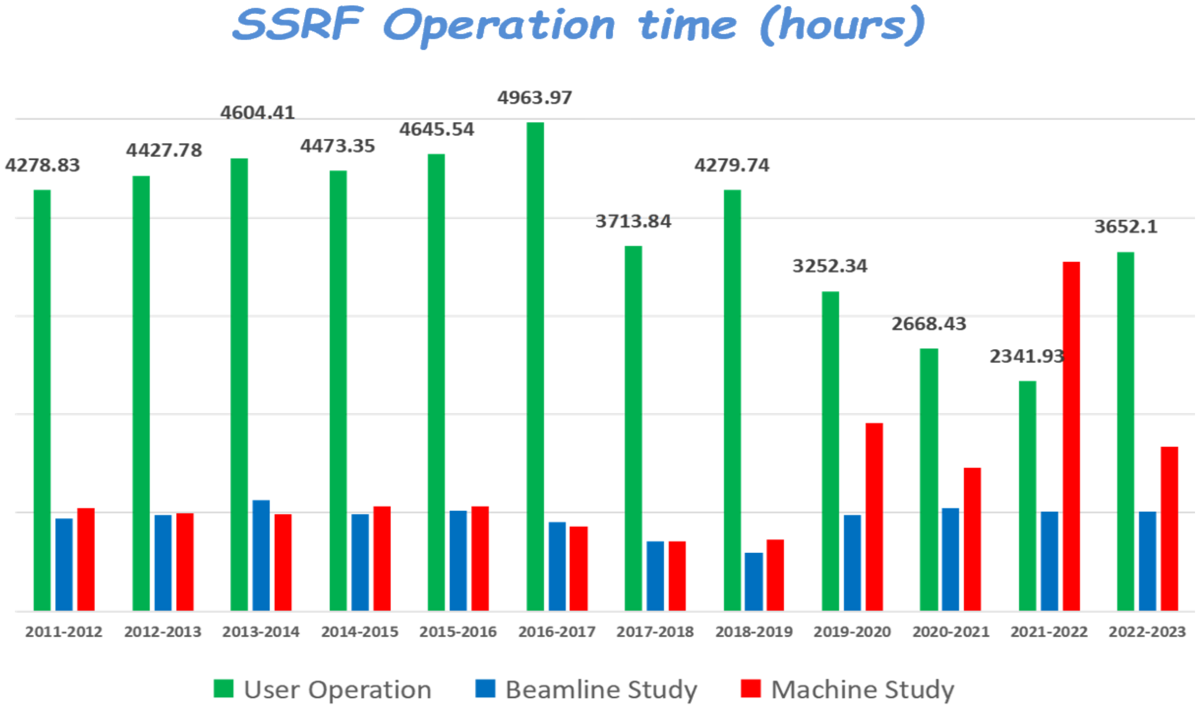
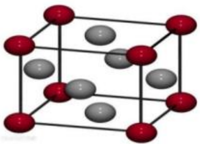


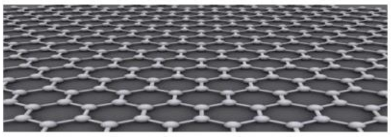
Fig.2 Summary of the SSRF operation status from 2011 to 2023

3. Beamlines Performance and features

The SSRF overall performance is at the top level of the intermediate energy third-generation light sources around the world. After Phase II project completion, the SSRF realized **Fig.3**, a full coverage of the major photon energy regions and tremendous methodologies. At present, nearly 100 synchrotron radiation experimental methods have been developed and applied to user's research, which covering imaging, scattering and spectroscopy techniques in the photon energy region from infrared to soft X-ray, hard X-ray and γ -ray, etc. User supporting facilities, such as auxiliary laboratory, big data center, and one-stop user service capabilities also have been established and operated.

A number of distinctive beamlines have been built for cutting-edge research. The Energy Materials Beamline is a soft and a hard X-ray beamlines complex (130-18000 eV) that can detect electronic structures layer by layer, and the Dynamics Beamlines complex has realized the concurrent measurements of ED-XAS and SR-IR at the same sample position in milliseconds scale. Three long beamlines, Ultra-hard X-ray Multifunctional Beamline, Time-resolved USAXS, and Hard X-ray Nano-probe are capable of providing ultrabright X-rays for industrial applications and advanced materials characterization, **Table.2**.





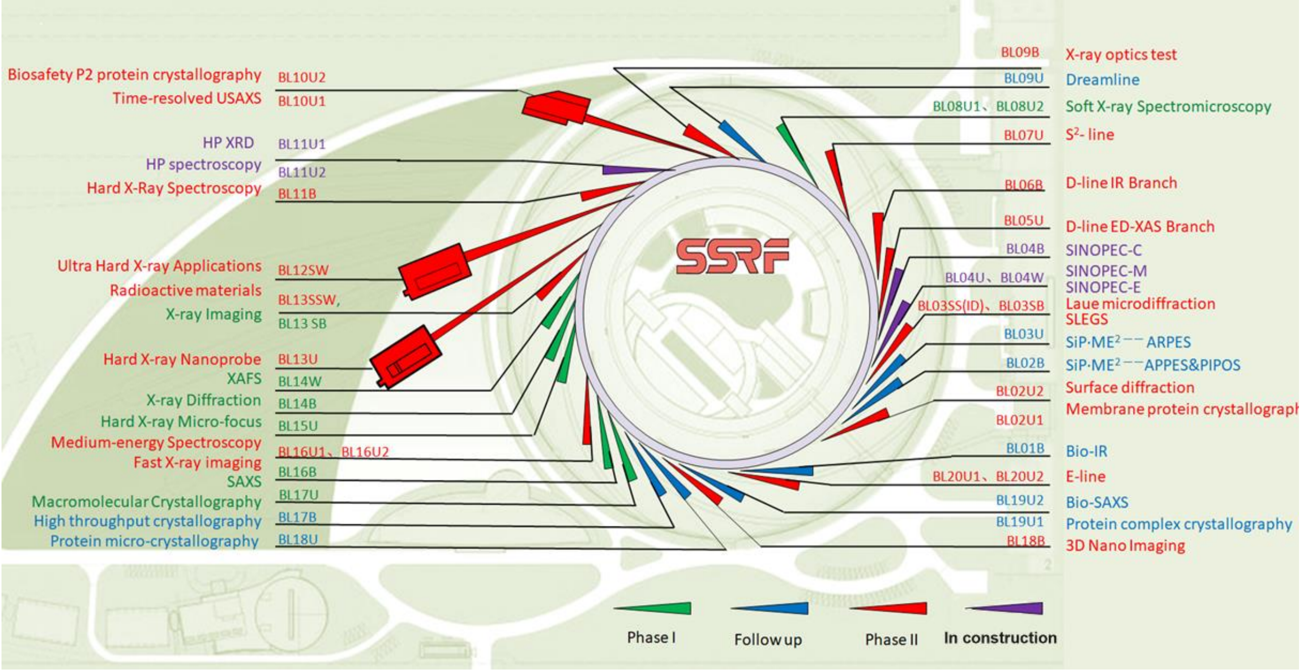
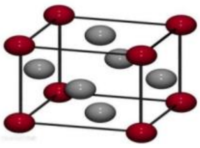
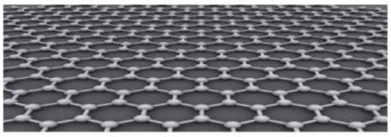


Fig.3 Schematic layout of beamlines in the SSRF.

Table.2 Summarized beamlines of SSRF

SSRF Project	Beamline	Light Source	Photon Energy	Scientific Objective
Phase I and follow-up Beamlines	Soft X-ray Spectromicroscopy and Interference Lithography	EPU	150-2000 eV	Spatial scanning in nano-scale, XIL , EUV resist evaluation
	X-ray imaging and Biomedical application	SuperB	8-40 keV, White beam	Microstructure of materials
	XAFS	Wiggler	4.5-50 keV	Energy conversion, catalysis
	High resolution X-ray Diffraction	BM	4-22 keV	Crystallography
	Hard X-ray Micro-focusing	IVU	5-20 keV	Hi-pressure science, environmental science，archaeology
	Small Angle X-ray Scattering	BM	5-20 keV	Microstructure of complex and nanostructured materials
	Macromolecular Crystallography	IVU	7-15 keV	Analysis of macromolecules and their complexes
	Dreamline: APRES & PEEM	EPU	20-2000 eV	Solid-state Physics
	High Throughput Crystallography	BM	5-20 keV	High-throughput crystal structure characterization
	Protein micro-Crystallography	IVU	5-18 keV	Structural characterization of microcrystalline proteins
	Protein complex Crystallography	IVU	7-15 keV	Large-cell crystal characterization
	BioSAXS	IVU	7-15 keV	Structural characterization of biomolecules and drugs
	IR time-resolved/micro spectroscopy	BM	10-8000 cm^{-1}	Hi-spatial resolution IR microscopy and mapping
	SiP·ME^2_NAP-XPS	BM	40-2000 eV	In-situ electronic structure
	SiP·ME^2_HR-ARPES	EPU	7-70 eV	Quantum materials electronic structures
Phase II	Surface Diffraction	IVU	4.8-2.8 keV	Low-dimensional material





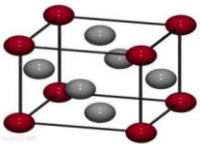
Beamlines				surface interface structure
	Laue Micro-diffraction	SpuerB	7-20 keV 7-30 keV (white beam)	Bio-protein crystallography, single crystal structure
	Shanghai Laser Electron Gamma Source	-	0.25-21.7 MeV	Photonuclear physics
	Dynamics beamline (Two-beamline complex)	IVU	5-25 keV	Dynamic process in structure of complex materials
	Spatial-resolved and Spin-resolved ARPES	EPU	50-2000 eV	In-situ electronic structure in low dimension materials；Solid-state physics
	Time-resolved USAXS	IVU	8-15 keV	Time-resolved microstructure of complex and nanostructured materials
	Hard X-ray Spectroscopy	BM	5-30 keV	In-situ energy materials researching
	Radioactive Materials	Wiggler	5-50 keV	Radioactive materials
	BSL-2 MX Beamline	CPMU	6.5-18 keV	Protein crystallography
	Ultra-hard X-ray Multifunctional Beamline	Wigger	30-160keV	Engineering materials, Earth Science
	Hard X-ray Nano-probe	IVU	5-25 keV	Material Science, Life science, Environment Science
	Tender X-ray Spectroscopy	IVU	2.1-16 keV	Environmental science, archaeology
	Fast X-ray Imaging	IVU	8.3-30 keV	High speed dynamic imaging
	Nano-CT	BM	5-14 keV	Material Science, Life science, Environment Science
	Energy Materials (Two-beamline complex)	IVU+EPU	1.5-18 keV, 130-1500 eV	Energy conversion, catalysis
	High Performance Membrane Protein Crystallography	CPMU	5-25 keV	Membrane Protein Crystallography

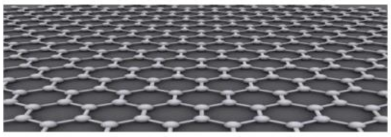
4. Research Highlights

The SSRF extensively supported the scientific research and industrial R&D, which brought fruitful outcomes with totally about 10,000 journal publications, including more than 220 were published on Science, Nature and Cell. Plenty of important breakthroughs were made, such as active species composition confirmation during transformation of CO2 to glucose, measurement of chemical reaction processes on the order of 1fs to 1ns, large plastic deformation of silicon nitride ceramics at room temperature, structure of lanthanide metal halides solid electrolyte for lithium battery applications, operando growth mechanism of perovskite photovoltaics film, medicinal chemistry of bismuth applied to the treatment of COVID-19, etc. SSRF was also intensively devoted to industrial innovation, such like supporting development of the new drug HuaTangNing for diabetes, new energy vehicles battery, large scale energy storage, new structure zeolite synthesis.

Serial Research on Solid-state Physics

In the solid-state physics, continuous studies were carried-on in the SSRF, which made a series of major breakthroughs in the electronic structure of topological materials, including “experimental discovery of Weyl Fermion **[9-10]**, Three-component Fermions **[11]**, Hourglass Fermion **[12]**,





Unconventional Chiral Fermions" **[13]**, etc., **Fig. 4**. These would initiate the discovery of new types of fermions, which indeed set off a boom in the discovery of new types of fermions. Also, those important discoveries do stem from theoretical models developed by physicists and mathematicians in the request to study the fundamental particles of the universe.

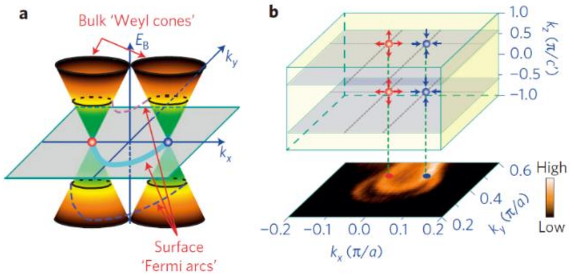


Fig.4 Observation of Weyl nodes in TaAs. Relationship between bulk Weyl nodes and surface Fermi arcs.[9]

Exotic physical properties of superconducting materials under high pressure

In situ high-pressure X-ray diffraction (XRD) is an experimental method for studying the structural changes of materials under high pressure conditions. The SSRF has set up a high-pressure microbeam XRD, which is specialized in studying the evolution of the structure and properties of materials under high-pressure conditions. Many breakthrough results were carried out on iron-based superconductivity (**Fig. 5**), high-entropy alloy superconductivity, etc.

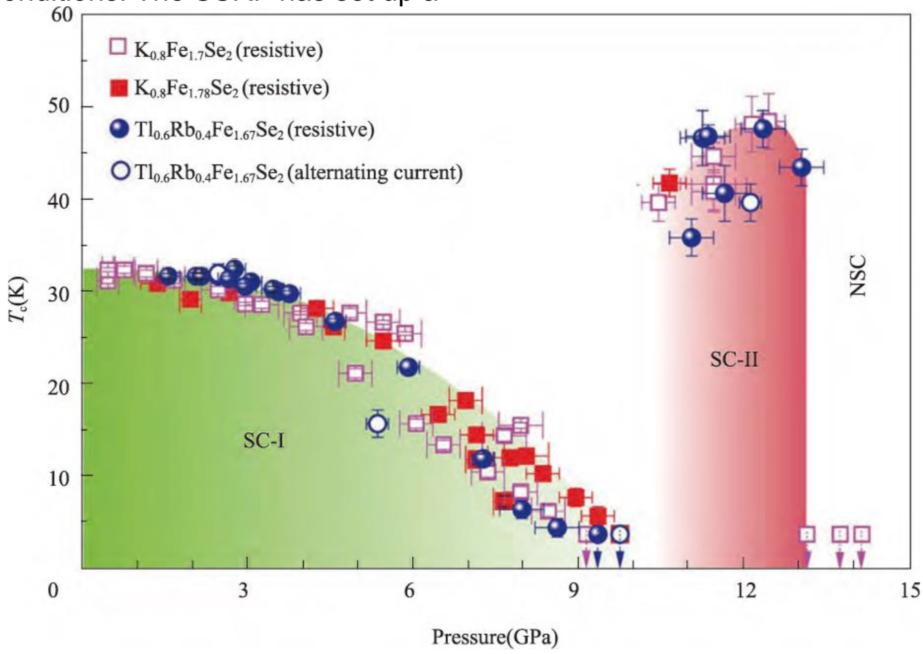
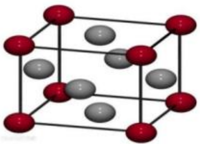
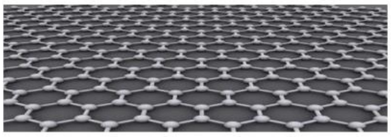


Fig. 5 First reproduction of superconductivity in iron-based sulfur compounds by high-pressure experiments.[14]

Research on Stability of Perovskite Solar Cells

The constant elimination of Pb0 and I0 simultaneously in PSCs over their life span were examined in the SSRF, which leads to exceptional stability improvement and high PCE through incorporation of the ion pair of Eu3+ (f6) ↔ Eu2+ (f7) as the redox shuttle (**Fig. 6**). **[15]**





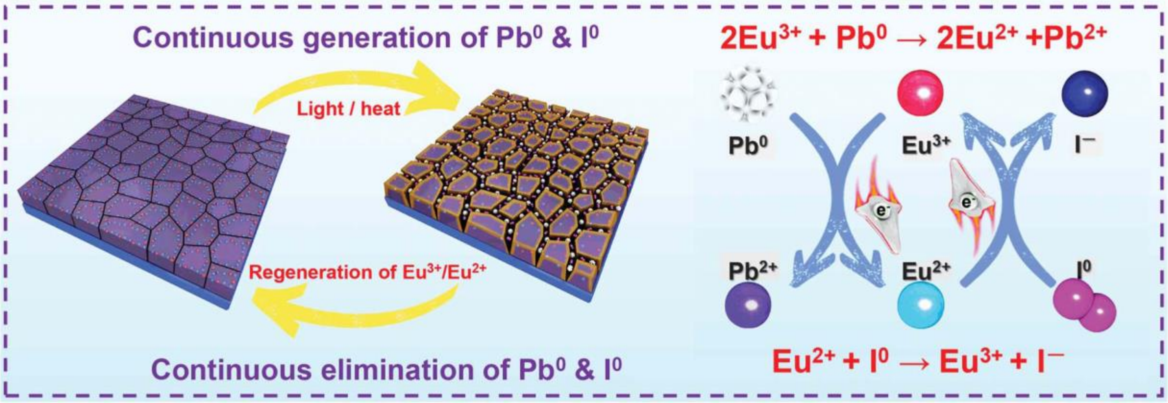


Fig. 6 Proposed mechanism diagram of cyclically elimination of Pb0 and I0 defects.

Highly Active Metal Catalysts Design

A collaboration study revealed that atomically dispersed iron hydroxide, selectively deposited on silica-supported platinum (Pt) nanoparticles, enables complete and 100 per cent selective CO removal through the PROX reaction over the broad temperature range of 198 to 380 Kelvin (**Fig 7**). **[16]**

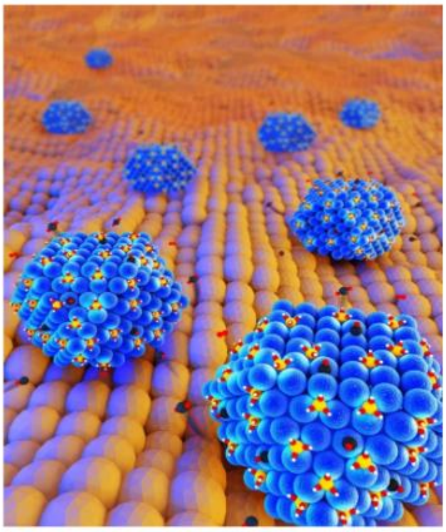


Fig. 7 Illustration of the xcFe–Pt/SiO2 catalysts.

5. Summary and outlook

During the past 15 years of operation, SSRF already served over 44,000 users from about 800 organizations all over China. It strongly supported Chinese scientists to carry out the frontier research and industrial R&Ds in various fields, which led fruitful outcomes with hi-impact achievements and plenty of important research breakthroughs. With the completion of the SSRF Phase II beamlines project, much more influential results will come out from SSRF in the near future. Furthermore, the SSRF has been dedicating itself on the new synchrotron radiation technology, through its intricate engineering, sophisticated beamline technique, and versatile methodologies, helping people to observe and understand the matter in atomic and molecular level to address the technical challenges and satisfy scientific curiosity and relentless pursuit of perception about natural world.

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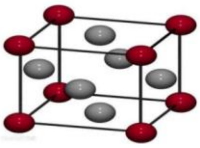
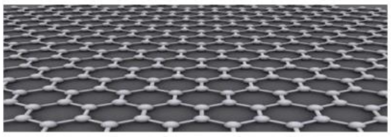
DCMP Division of Condensed Matter Physics Association of Asia Pacific Physical Societies





Selected Contributions on condensed Matter Physics in the Asian Pacific Areas

Report 1:

Title: Spin supersolid with giant magnetocaloric effect

Subtilte: *A spin supersolid with both spin solid order and spin superfluid order is identified in a triangular lattice quantum antiferromagnet* $Na_2BaCo(PO_4)_2$*, revealing a concomitant giant magnetocaloric effect.*

By Junsen Xiang and Peijie Sun
Institute of Physics, Chinese Academy of Sciences, Beijing, 100190, China

Supersolids are long-sought-after quantum materials with two seemingly contradictory features: a rigid solid structure and superfluidity [1,2]. Recently, we have found evidence for a quantum magnetic analogue of supersolid, i.e., the spin supersolid, in a triangular lattice quantum antiferromagnet $Na_2BaCo(PO_4)_2$ [3] through comprehensive thermodynamic and neutron diffraction measurements, as well as tensor network simulations. In addition, a giant magnetocaloric effect arising from the low-energy excitations of the spin supersolid phase is observed, opening up a viable and promising avenue for applications in sub-Kelvin refrigeration in the context of persistent concerns about helium shortages [4,5].

1. Pursuit of supersolid and sub-Kelvin magnetic cooling material

Can a solid – a material with a rigid, spatially ordered structure – also be a superfluid that flows with zero viscosity? Theoretical physicist Anthony Leggett posed this question in 1970 [1]. An initial observation of such “supersolid” behavior in solid helium-4, made in 2004 [6], was later revealed to be an experimental artefact [7]. But the pursuit of this exotic state of matter has become a multidisciplinary endeavour.

Recent development in the field of highly-frustrated triangular lattice antiferromagnets (TLAFs) offers a fertile playground to explore novel quantum spin states. Introducing an easy-axis spin exchange anisotropy to the TLAF was found to be able to result in spin supersolid in zero magnetic field [8,9]. Along this line, the spin-1/2 Co-based equilateral TLAF $Na_2BaCo(PO_4)_2$ (NBCP) [3] has stood out as a realistic material candidate to host such quantum spin states [10].

The simultaneous occurrence of spin solid order and spin superfluid order, if experimentally confirmed, also has practical significance in magnetic cooling. As shown in Figs. 1(a, b), compared to the conventional paramagnetic cooling which follows a straight temperature-field line with a constant slope, the temperature is expected to drop quickly at the supersolid-liquid quantum phase transition and remains at low temperature throughout the supersolid phase due to its U(1) phase fluctuations, as illustrated in Figs. 1(c, d). For details, see our recent publication [11].

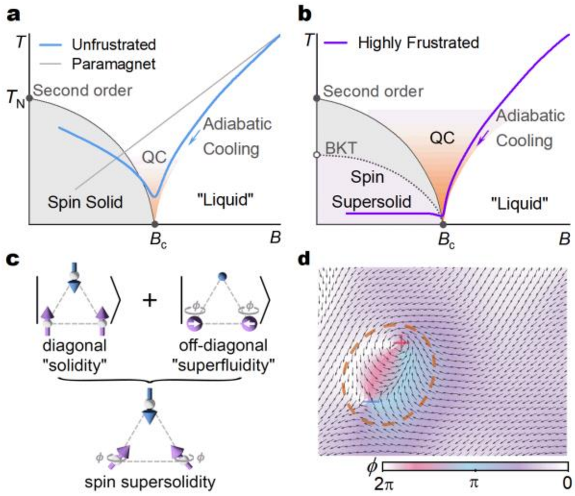
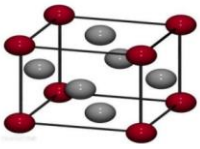
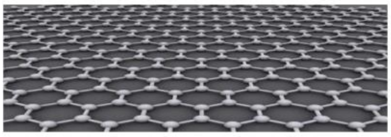


Fig. 1. Magnetic cooling effect near the conventional solid-liquid





phase transition and in paramagnetic salt (a), compared to that near a supersolid-liquid phase transition (b). Panels (c) and (d) illustrate the supersolid order and its pertinent U(1) phase fluctuations, respectively.

2. Model description of the easy-axis TLAF NBCP

NBCP, first synthesized in 2019, has hitherto garnered intensive research interest along two conflicting lines: quantum spin liquid [3,12] and a magnetically ordered state [13]. Recently, a nearly ideal easy-axis TLAF model description of this compound has been put forward, which reconciles the divergent experimental observations within a coherent picture [10]. Here, spin supersolid states under both zero and finite magnetic fields have been predicted, which raise intriguing proposals for finding this exotic quantum state in experiments, and meanwhile verifying the prominent entropy effect.

3. Giant magnetocaloric effect and the temperature-field phase diagram

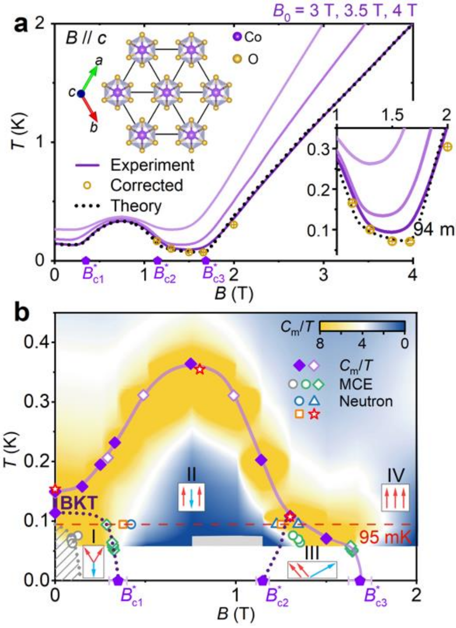


Fig. 2. Experimental results of magnetocaloric measurements (a) and temperature-field phase diagram (b) of NBCP.

The specific heat of NBCP shows very large and highly field sensitive values at very low temperatures, evidencing the strong low-energy fluctuations [11]. We have further measured the magnetocaloric effect – a phenomenon in which a changing magnetic field causes change in temperature in an adiabatic demagnetization process, see the results in Fig. 2(a). To do so, we used a specially fabricated device that provided enhanced control over weak and unavoidable leaks of heat from the instrument. These measurements allowed us to map out the material's entropy landscape, sensitively detecting its quantum spin states and transitions.

Because of the significant magnetocaloric effect, the low-temperature phase transitions of NBCP can be reached easily by demagnetizing itself. We dub this as magnetocaloric bootstrapping. As a result, the temperature-field phase diagram can be readily obtained relying on no extra cooling resources except for the magnetocaloric effect of itself, see Fig. 2(b). Specifically, the NBCP sample cools down to as low as 94 mK near B = 1.5 T, i.e., in the proposed spin supersolid phase, through a quasi-adiabatic demagnetization process from the initial conditions of T_0 = 2 K and B_0 = 4 T. In the two valley-like $T(B)$ regimes below B_{c1} and B_{c3}, the sample temperature greatly decreases and remains persistently at low values, as theoretically expected for supersolid phase. Noticeably, the aforementioned sub-Kelvin magnetocaloric response in NBCP is much larger than in many other magnetic materials [11].

4. Microscopic evidence of supersolid order and low-energy excitations

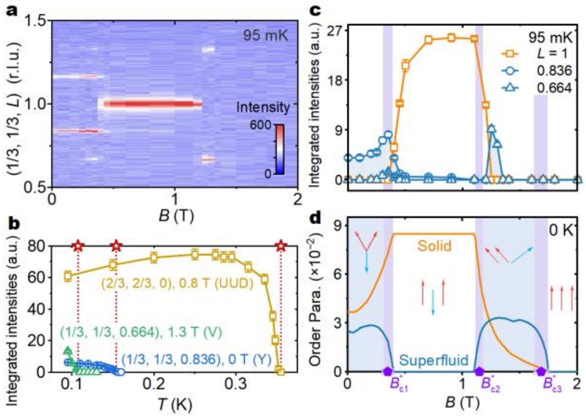
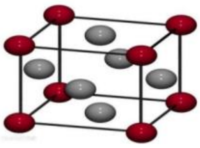
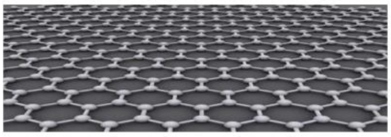


Fig. 3. (a) Reciprocal space neutron diffraction scans at 95 mK under different fields. (b, c) Temperature and field dependencies of the integrated intensities of three representative reflections. (d) Simulated spin solid and spin supersolid order parameters.

Neutron diffraction, measured down to as low as 30 mK, lends strong microscopic support to the proposed spin supersolid phases in NBCP. By comparing the neutron diffraction at 30 and 300 mK, a magnetic propagation vector of (1/3,1/3,0.183) can be observed, in which the in-plane components clearly indicates a three-sublattice solid ordering as expected for the spin supersolid state in NBCP [11]. By performing reciprocal-space scans at 95 mK along (1/3,1/3, L) under various fields, significant changes in the ordering vector at the transition fields are clearly observed, see Fig. 3(a). In particular, in





the two proposed spin supersolid phases, the ordering vector locates at (1/3,1/3,q_c) with an incommensurate out-of-plane component q_c, whereas the system shows commensurate ordering in the proposed spin solid phase. In addition, the temperature and field dependencies of the integrated intensities of three representative reflections, shown in Figs. 3(b,c), reveal good agreement with model calculation results displayed in Fig. 3(d). In support of the coexistence of magnetic solid order and strong spin fluctuations in the spin supersolid phases, the magnetic diffraction intensities in the two supersolid phases are found significantly weaker compared to that of the intermediate spin solid phase.

5. Outlook

Our observations provide thermodynamic and microscopic neutron diffraction evidences of two spin supersolid phases in a highly-frustrated triangular lattice antiferromagnet in magnetic field, in good agreement with model calculations. Intriguingly, a giant magnetocaloric effect is revealed, which has potential application in sub-Kelvin magnetic refrigeration.

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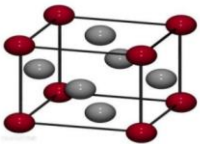
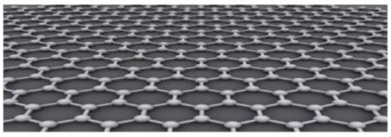




Report 2:

Title: Cubic Ice Found in Real Space

***Subtitle:** Cubic ice in it’s pure form has been grown and observed in situ at molecular resolution*

By Xuedong Bai
Institute of Physics, Chinese Academy of Sciences, Beijing 100190, China

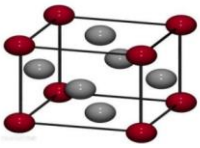
The debate about whether water can freeze to cubic ice (ice Ic)— a polymorphic phase of ice I that distinct from ordinary hexagonal ice (ice Ih)—has been a long-standing issue. The divergence arises from the experimental challenge of differentiating cubic ice from stacking disordered ice I (ice Isd), a mixture of cubic and hexagonal stacking sequences. In our recent study (1), we employed *in situ* cryogenic transmission electron microscopy (TEM) alongside low-dose imaging techniques to directly observe the nucleation and crystallization processes of water vapor deposited on substrates at 102 K. Our findings demonstrate a preferential nucleation of cubic ice at low-temperature interfaces. Moreover, we identified two types of defects within the cubic ice and elucidated the structure's evolution dynamics through molecular-resolution imaging. The direct, real-space imaging of ice formation and its dynamic behavior solves the mystery of cubic ice.

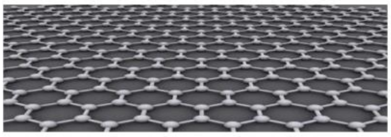
1. The Long-standing Debate on Cubic Ice:

Cubic ice (ice Ic) features a diamond cubic structure, which differs from common hexagonal ice Ih in the order its molecular layers are stacked. The existence of cubic ice was first postulated by Pauling in 1935 (2), with initial experimental reports of its structure emerging from electron diffraction studies conducted by König in 1943, following low-temperature water vapor deposition (3). Further reports of ice Ic's presence has been found in diverse experiments, such as the freezing of supercooled water, heating of vitrified water, confinement of water in mesopores, thermal treatment of high-pressure ice phases, and decomposition of gas hydrates (4). Natural manifestations of cubic ice, such as Scheiner's halo (5) and unique snowflake morphologies (6), have been recorded as well.

Despite extensive efforts, these experimental results did not convincingly demonstrate a pure cubic phase. Traditional methods of structural characterization, such as X-ray diffraction and neutron scattering, consistently identified non-cubic features within the diffraction patterns of supposed cubic ice. This has sparked discussions concerning the actual existence of cubic ice and the possibility that it may represent a distinct structure composed of randomly interlaid cubic and hexagonal sequences (7). To emphasize the lack of cubic symmetry, this mixed structure has been termed "stacking disordered ice I" (ice Isd) (8). However, recent synthesis of pure cubic ice—achieved either through the heating of ice XVII to 160 K under a vacuum or the degassing of a C_2 hydrogen hydrate at 100 K (9, 10)—have confirmed the existence and the metastability of cubic ice. These findings challenge the previously held assumption regarding the mixed-phase nature of cubic ice and suggest a reevaluation of its structural understanding.

2. Ice Nucleation and Growth Observed at molecular resolution:





Traditionally, the structural characterization of ice relies on diffraction methods, which provide spatially averaged information and thus obscure detailed structural insights. While scanning probe microscopy has enabled atomic-level structural analysis of ice, its application remains limited to surface studies. To achieve accurate microscopic investigations of ice, transmission electron microscopy (TEM) emerges as a potent tool, offering atomic-resolution imaging capabilities. However, the application of TEM to ice presents significant challenges, including difficulties in sample preparation under the low-pressure conditions in TEM columns and the damage may be caused by the electron beam to the extremely sensitive ice samples.

To enable the TEM characterization of ice, an *in situ* cryogenic stage was developed to cool monolayer graphene substrates to approximately 102 K within TEM, leading to the deposition of residual water vapor from TEM columns onto the substrate surface (Figure 1a). The extremely low vapor pressure (~10^$^{-6}$ Pa) inside TEM columns restricts the growth of ice particles to the hundreds of nanometers, thus permitting detailed TEM characterization. Concurrently, *in situ* electron energy loss spectroscopy (EELS) analyses were performed. The EELS data revealed two emerging peaks over time: one peak (peak I) at 8.8 eV, which consistent with the electronic gap of ice, and another peak at 532 eV, corresponding to the accumulating oxygen K-edge. Additionally, a gradual decrease in the carbon K-edge at 284 eV was noted, and the peak at 15.6 eV for the graphene shifted to 21 eV, indicative of the emerging bulk ice plasmon. These observations confirm the adsorption of ice (Figure 1b).

Low-dose imaging techniques were utilized to elucidate the deposition process of water vapor onto the cold substrate, with a representative heterogeneous ice nucleation event presented (Fig1c, d). Sequential high-resolution TEM (HRTEM) images reveal that water vapor adsorbed onto the cold substrate initially forms amorphous solid water (ASW). Subsequently, ice nuclei emerge and grow into particles ranging in size from tens to hundreds of nanometers. Analysis of the HRTEM images and their corresponding fast Fourier transforms revealed that the majority of these ice nuclei adopt a cubic structure, accompanying with a minor quantity of ice Ih nucleating separately. These cubic ice nuclei then grow into faceted crystals, exhibiting a lattice constant of 6.36 Å.

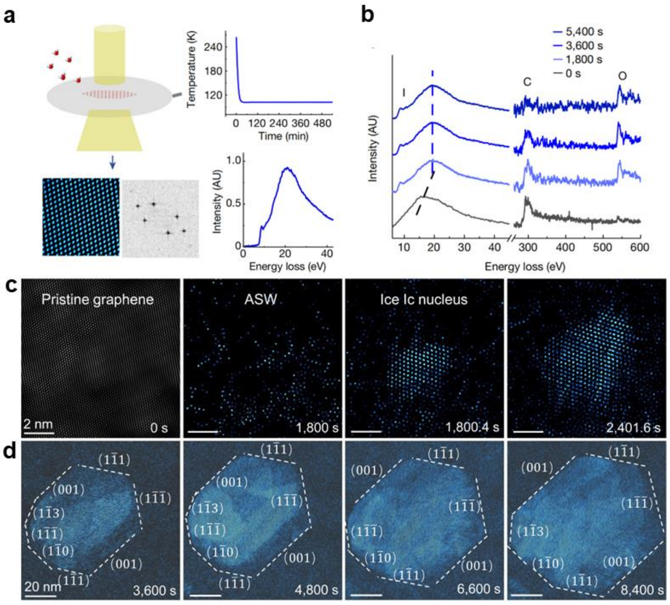


Fig.1 Direct molecular-level observation of ice Ic nucleation and growth via *in situ* low-dose cryogenic TEM.

3. *In Situ* TEM Structural Characterization of Cubic Ice:

Our investigation into ice depositions on various substrates has further illustrated that not only graphene but also other materials can facilitate the heterogeneous nucleation of ice Ic. The cryogenic process was applied to a range of substrates, including hydrophobic carbon, hydrophilic carbon, graphene, and hexagonal boron nitride (h-BN), all of which supported the formation of cubic ice. We presented four representative ice crystals, each displaying distinct and well-defined polyhedral morphologies (Fig 2a-b). High-magnification TEM images validated these crystals as single crystals devoid of significant defects (Fig 2e-f). The corresponding fast Fourier transforms corroborated the identification of these faceted crystals as ice Ic, along the <001>, <110>, <111>, and <112> crystallographic orientations (Fig. 2i-l). These observations unequivocally demonstrate the heterogeneous nucleation of pure-phase ice Ic under the low temperature and low-pressure conditions. Notably, we did not detect any phase transition from cubic to hexagonal ice, affirming the metastability of ice Ic under the current thermodynamic conditions.

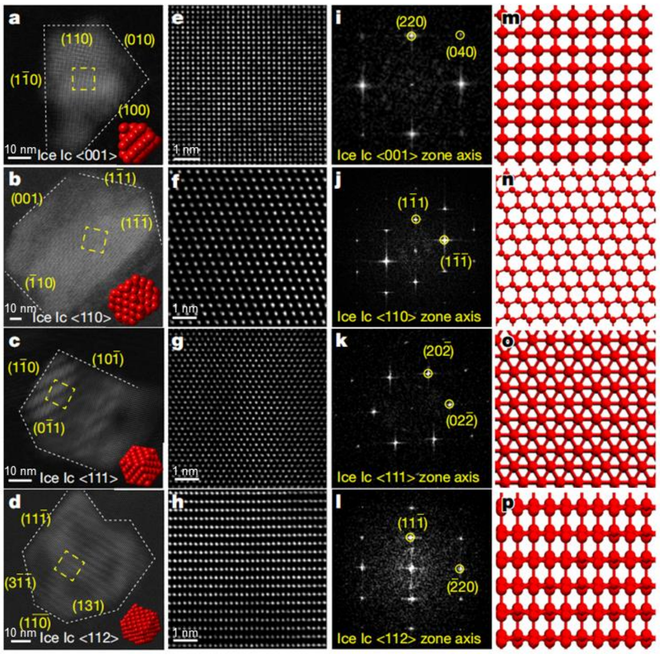


Fig.2 Single-crystalline ice Ic crystallites grown on various substrates, (a) hydrophobic carbon, (b)hydrophilic carbon, (c) graphene, (d)monolayer h-BN.

Direct high-resolution imaging at molecular resolution has facilitated a detailed examination of defects present in ice Ic. These defects are classified into two main types, depending on whether they introduce stacking-disorder domains into the ice Ic matrix. Type-I defects are identified by planar defects localized to the close-packed {111} planes, encompassing twinning, stacking faults, and their intersections. Within the Type-I faulted ice layer, the water-dimer columns exhibit a diffuse and thread-like distribution, indicating a deviation from the ideal crystal structure. Type-II defects signal domain disorders in the ice Ic matrix, such as twinning interfacing with misfit dislocations and sequences of hexagonal close packing—consistently, the Ih domain bordered by interphase boundaries. Within the TEM image, the domains of hexagonal stacking are observed to display a symmetrically stacked pattern. Despite the hexagonal domain predominantly comprising only two adjacent ice layers and its relatively minor presence within the cubic matrix, its identification underscores the existence of another ice I polytype, ice Isd. Furthermore, we investigated the evolution of defects in defective ice Ic, both through prolonged growth and under the influence of increased-dose electron beam irradiation. We observed no solid-state phase transition from ice Ic to ice Ih, further confirming the structural integrity and metastability of the ice Ic phase, despite the presence of defects.

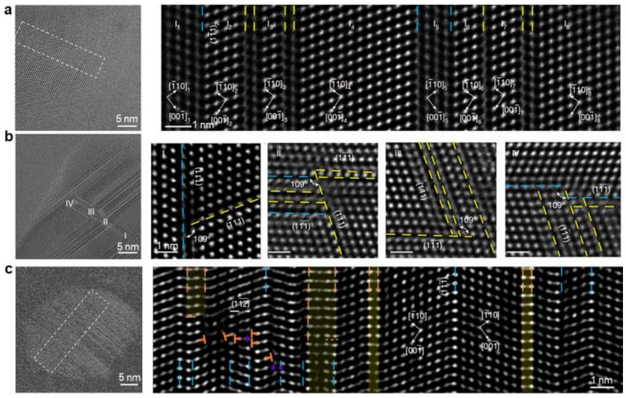
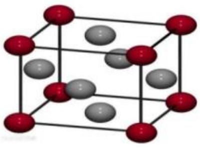
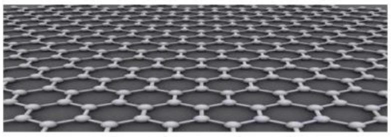


Fig.3 Defects in ice Ic crystallites. Type-I defects in ice Ic are illustrated, including twinning (blue line), stacking faults (yellow line), and their Intersecting boundaries. Type-II defects in ice Ic are shown as well, including {112} twin interfaces with dislocations (purple line), hexagonal-stacking sequences (yellow color) embedded in cubic matrix.





Outlook:

The pristine ice Ic, which emerges due to preferential nucleation at low-temperature interfaces, exhibits notable thermodynamic and kinetic stability. The slight difference in Gibbs free energy between ice Ic and ordinary ice Ih, albeit slightly more favorable for Ih, suggests that the nucleation preference for ice Ic at smaller sizes may be significantly influenced by interfacial free energy. This stability implies that heterogeneous nucleation of ice Ic could be prevalent at low temperatures, given the omnipresence of interfaces. A thorough future investigation into the formation behavior of ice Ic, especially in regard to the polymorphic competition influenced by interface effects, promises to substantially deepen our understanding of the ice Ic in nature.

Reference:

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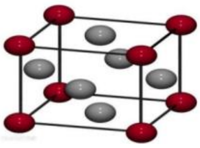
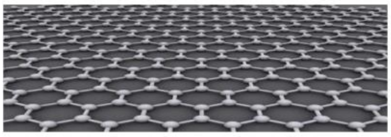




Report 3:

Title: Discovery of magnetic liquid crystal

B. J. Kim
Department of Physics, Pohang University of Science and Technology, Pohang, South Korea

Liquid crystal is a state of matter that exhibits properties of both liquid and solid. It can flow like a liquid, while its constituent molecules are aligned as in a solid. The liquid crystal is widely used nowadays, for example, as a core element of LCD devices. The magnetic analog of this kind of material is dubbed the “spin-nematic phase”, where spin moments play the role of the molecules. However, it has not yet been directly observed despite its prediction a half-century ago. The main challenge stems from the fact that most conventional experimental techniques are insensitive to *spin quadrupoles*, which are the defining features of this spin-nematic phase.

But now for the first time in the world, a team of researchers led by Professor KIM Bumjoon at the IBS Center for Artificial Low Dimensional Electronic Systems in South Korea succeeded at directly observing spin quadrupoles. This work was made possible through remarkable achievements over the last decades in synchrotron facility development.

The IBS researchers focused their study on square-lattice iridium oxide Sr_2IrO_4, a material previously recognized for its antiferromagnetic dipolar order at low temperatures. This study newly discovered the coexistence of a spin quadrupolar order, which becomes observable through its interference with the magnetic order (Figure 1). This interference signal was detected by ‘circular-dichroic resonant x-ray diffraction’, an advanced x-ray technique employing circularly polarized x-ray beam (Figures 2b and 2c).

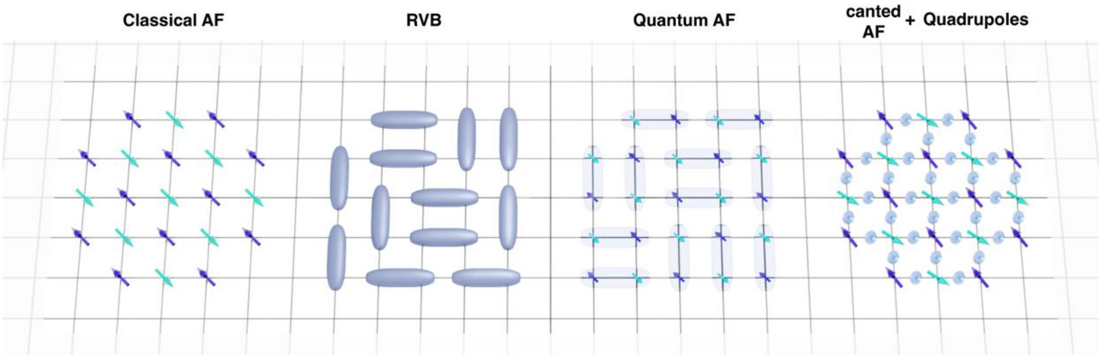


Figure 1. Spin one-half moments on a square lattice. In addition to the classical antiferromagnetic order (classical AF), the spin moments can have various magnetic ground states, such as superposition of spin-singlet configurations (resonant valence bond; RVB) or antiferromagnet with large quantum fluctuations (quantum AF). In iridium oxide Sr_2IrO_4, spin quadrupole moments coexist with a canted antiferromagnet order.

Further verification of this discovery came through ‘polarization-resolved resonant inelastic x-ray scattering’, where the magnetic excitations were revealed to significantly deviate from the behaviors anticipated for those in conventional magnets. For the completion of these experiments, the researchers in South Korea have collaborated with Argonne National Laboratory in the US to construct a resonant inelastic x-ray scattering beamline in Pohang Accelerator Laboratory over the last four years.

Last but not least, the researchers used a series of optical techniques, including Raman spectroscopy and magneto-optical Kerr effect measurement, to show that the formation of the spin quadrupole moments occurs at higher temperatures than the magnetic order. Within this temperature range, the iridium oxide has only spin quadrupole moments but no magnetic order, realizing a spin-nematic phase (Figure 2a).

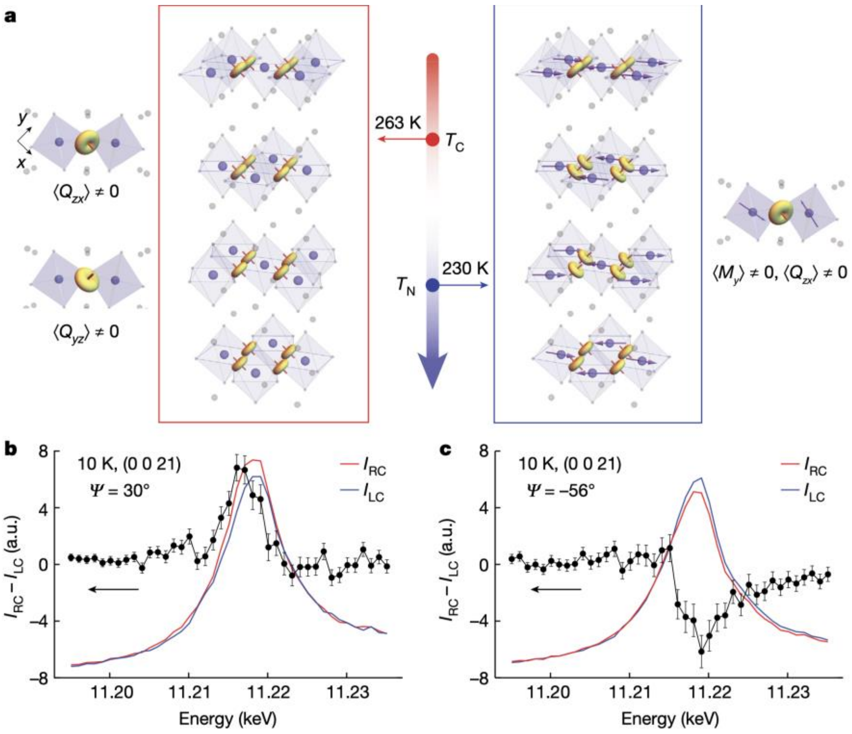
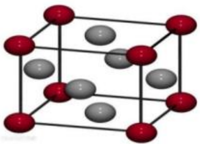


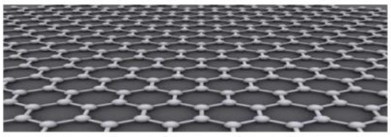
Figure 2. Dipole-quadrupole interference in circular dichroic resonant x-ray diffraction. (a) The spin quadrupole moments are formed at a higher temperature (263 K) than the magnetic moments (230 K). (b, c) At low temperatures, the interference between the spin quadrupole and the magnetic moments is manifested by circular dichroic resonant X-ray diffraction, a magnetic signal difference between left- and right-handed X-ray beams.

Taken together, this is the first direct observation of the spin quadrupole moments in a spin-nematic phase.

“This research was feasible because the infrastructure and capabilities of x-ray experiments in South Korea had reached a globally competitive level,” says Prof. KIM Bumjoon, corresponding author of this study.

“The discovery of the spin-nematic phase also holds significant implications for quantum computing and information technologies,” adds Prof. CHO Gil Young, a co-author of this study and professor at





Pohang University of Science and Technology.

Another interesting aspect of the spin-nematic phase is its potential for high-temperature superconductivity. In the spin-nematic phase, the spins are highly entangled, which was suggested by physicist P. W. Anderson as a key ingredient for high-temperature superconductivity. Furthermore, given that iridium oxide Sr_2IrO_4 has been extensively studied because of its striking similarities with the copper-oxide high-temperature superconducting system, which fuels a growing interest in this material as a potentially new high-temperature superconducting system, as well as its relation to the spin-nematic phase.

Reference:

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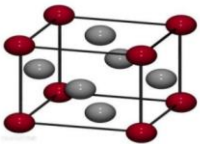
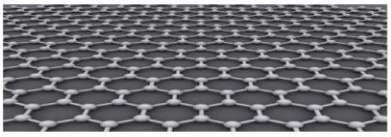




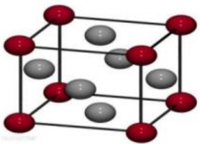
Recent Academic Exchanges and Activities in the Asian Pacific Areas

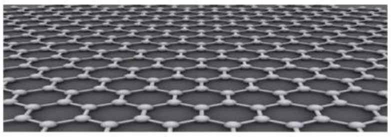
Report 1:

AC2MP 2023 in Taiwan

The Asia-Pacific Condensed Matter Physics Conference 2023 (AC2MP 2023), held from November 26 to 29, 2023, in Hualien, Taiwan, marked a significant advance in fostering innovation and international collaboration within the condensed matter physics community. As the annual meeting of the AAPPS Division of Condensed Matter Physics (DCMP), it served as a vital platform for encouraging collaboration and advancing the field of condensed matter physics across the Asia-Pacific region. This year, the DCMP, in collaboration with partners including the Physical Society located in Taipei (TPS), National Dong Hwa University (NDHU), and National Taiwan University (NTU), successfully brought together around 150 leading minds from 10 different countries, sparking an exchange of groundbreaking research and lively discussions among a diverse group of participants.

The event kicked off with motivating opening remarks from Prof. Ying-Jer Kao, Chair of the AC2MP 2023 organizing committee and President of TPS, along with Prof. Hiroyuki Nojiri, Chair of DCMP, and Prof. Minn-Tsong Lin, Deputy Minister of





NSTC, creating an optimistic atmosphere for the successful conference. Following this inspiring start, the conference featured a series of exciting talks from esteemed experts, including three world-renowned scholars who delivered plenary talks: Prof. Pablo Jarillo-Herrero from MIT, Prof. Kenji Ishida from Kyoto University, and Prof. Hai-Hu Wen from Nanjing University. These presentations spanned a wide range of cutting-edge topics in condensed matter physics, sparking vibrant discussions and fostering a rich environment for learning and collaboration among attendees. In addition to scientific sessions and discussions, a memorable excursion to Taroko National Park allowed participants to bond over breathtaking scenery, turning casual acquaintances into lasting friendships. This shared adventure highlighted how scientific collaboration is often deepened by personal connections forged in moments of exploration and wonder.

The conference concluded with an impactful speech from Prof. Hiroyuki Nojiri, the DCMP Chair, emphasizing the power of friendships and how AC2MP 2023 has significantly boosted the field of condensed matter physics across the Asia-Pacific region. This year's conference has made a lasting impact, setting the stage for further friendship and collaboration. The achievements of the event highlight a shared commitment to broadening our understanding and building networks in the ever-evolving world of condensed matter physics.

We would like to express our deepest sympathies to those affected by the recent earthquake in nearby Hualien, especially to those who hosted the international conference AC2MP2023.


Spin-Triplet Superconductivity
in U-based Superconductors
AC2MP 2023 @
Hualien, Taiwan
29. Nov. 2023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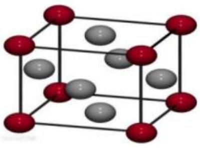
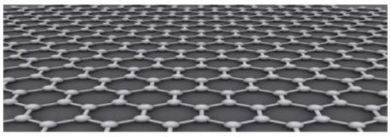




Report 2:

Call for the DCMP Young Scientist Award 2024

The DCMP announce the call of the DCMP Young Scientist Award to honor young researchers with excellent research achievements. The award is organized by the division of condensed matter physics (DCMP) of AAPPS. The DCMP encourage all young researchers working in Asia-Pacific region to apply the award.

Eligibility

1. The awardee must have obtained a PhD in physics or an equivalent degree no more than 8 years prior to the date of nomination.

2. The awardee must have done the work to be awarded when one had an affiliation to an institution in the AAPPS member country region.

3. The awardee must have an affiliation to an institution in a member country region at the time of nomination.

The awardee must be a member of the DCMP.

Channel of Nominations

1. Nomination is requested to be submitted by the recommender and no self-nomination is accepted. All regular DCMP members can recommend one candidate every year.

Selection Process

The selection will be made in two-steps processes.

1. Selection of the several final candidates by the review of the application documents

2. Presentation at the DCMP annual conference-AC2MP and the final decision (A part of the registration fee may be waived for the finalists).

3. The award consists of one gold medal and a few silver medals. The numbers may depend on number of applicants and finalists.

4. A selection committee appointed by the DCMP shall determine the recipient of the prize from the nominations taking into account 1) the overall quality and 2) significance of the contribution and 3) the creativity and originality exhibited in the contribution.

The prizes will be presented at the DCMP annual meeting.

Nomination Deadline and format

1. Nominations deadline is June 10th 2024.

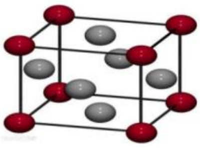
2. To reduce the workload for the nomination, we use a similar format with AAPPS CN-Yang award. Please note that there are a few important differences.

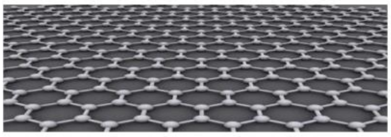
3. Nomination package should include:

a. Letter of Recommendation not more than 2 pages explaining the achievements and the activity and the potential of the nominee,

b. C. V. (including contact information and biographical information). Please show that you are eligible for this award,

c. The nominee's publication list, including the URL (DOI) information of the five of the nominee's





foremost publications can be retrieved. Listing of the citations of nominee's important publications is also preferred and

d. Description of achievements written by nominee within 2 pages. The impact, novelty, and originality of achievement as well as the independence of the nominee must be stated.

Important note

The winner of CN-Yang award is not eligible for the DCMP award. We accept the application by the applicant for CN-Yang award. i.e. One can apply for both awards in same year.

Report 3:

Joint Meeting between DCMP-AAPPS and CMD-EPS

AAPPS and European Physical Society (EPS) had organized joint meetings in a few years interval. During the COVID time, the activity had been suspended. This year, the DCMP-AAPPS and the Condensed Matter Division (CMD) of EPS has agreed to resume a joint meeting.

The CMD-EPS is going to organize the 31st CMD conference at the Altice Forum in Braga, Portugal, from September 2nd through September 6th, 2024.The DCMP and the CMD will organize a joint-mini-colloquium entitled "Europe-Asia Pacific collaboration on Condensed Matter Physics in Quantum Beam Facilities" with the following agenda.

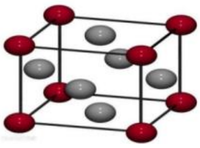
The quantum beam facilities such as synchrotron, neutron, XFEL, muon, electrons are widely used in condensed matter physics. The new facilities, new techniques and new applications are contributing for the rapid developing of the condensed matter physics. The international collaboration is the key for such development. This mini-colloquium is aiming at the sharing of the current landscape of the quantum beam facilities and the applications for condensed matter physics in Europe-Asia Pacific regions. It also picks up the existing international collaboration and stimulates the future collaborations.

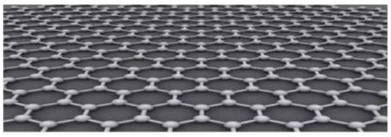
The mini-colloquium is consists of two sessions of 2.5 hours each. There will be 4 invited talks and 12 contributed talks in total and the DCMP is going to nominate two invited speakers and a few contributed presentations from the DCMP. The abstract submission will open on 11th March and the deadline is 30th April 2024. We appreciate your participation to this event.

The list of mini-colloquium can be found at the conference web site, https://cmd31.sci-meet.net/mini-colloquia. Our mini-colloquium is MC10 - Europe-Asia pacific collaboration on condensed matter physics in quantum beam facilities. There are 41 such mini-colloquiums are planned and the conference would be very useful to see the recent status of condensed matter physics in Europe and to meet old and new friends working in condensed matter physics. Moreover, Braga, Portugal is very nice place to visit.

If you are interested in participating in this event, please submit your abstract and contact us about your willingness to participate in this conference. We will consider such appeal in the process of the speaker selection.

The main target of speakers are researchers using quantum beam for condensed matter physics and thus we also encourage the researchers who is not the member of the quantum beam facilities to participate. We also encourage the scientist of such facilities to deliver the most recent status and activity of quantum beam related research in your facility in a way to include





the information of other facilities in Asia-Pacific area. This mini-colloquium is different from other meetings on specific quantum beam applications and so the presentation on the facility performance only should be avoided.

We are looking forward to seeing you in Portugal in September.

In 2025, we are going to organize a DCMP-AAPPS and CMD-EPS joint meeting at APPC16 in Hainan island.

Report 4:

Invitation to the international conference on New Frontiers in Advanced Magnetism 2024 (NFAM2024)

Co-chairs of NFAM2024: Yoshihiko IHARA and Hideaki OBUSE

In the summer of 2024, world-leading experts studying quantum spin systems will get together in Hokkaido to explore the frontier of magnetism. We would like to call your attention to join our international conference on New Frontiers in Advanced Magnetism, which will be held at Hokkaido University (Sapporo, Japan) from 5th to 9th August 2024.

Recent progress in magnetism and related fields makes this area of research the most important ever not only in the aspect of fundamental understanding but in the development of novel materials with exotic magnetic properties and further in the application of magnetic phenomena to the next- generation devices. We hope that NFAM2024 will provide a vital opportunity for both theorists and experimentalists working on the wide areas of this field to discuss together, exchange ideas, and find new open questions.

The topics of the conference cover

- Magnetic dynamics
- Low dimensional magnetism
- Quantum spin liquid
- Magnetic topological phase
- Magnetic multipole
- Magnetic dissipation
- Quantum information

These topics will be discussed in depth in the invited talks by the following researchers (as of 30th January 2024).

Gang CHEN (Peking University, China)

Benedetta FLEBUS (Boston College, USA)

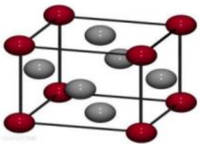
Kensuke KOBAYASHI (The University of Tokyo, Japan)
SungBin LEE (KAIST, Republic of Korea)

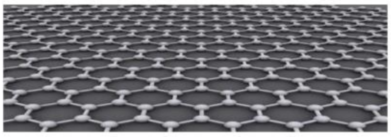
Joji NASU (Tohoku University, Japan)

Ryutaro OKUMA (The University of Tokyo, Japan)

Je-Geun PARK (Seoul National University, Republic of Korea)
Xichao ZHANG (Waseda University, Japan)

Guo-Yi ZHU (THP University of Cologne, Germany/ HKUST (GZ), China)
Oleg TCHERNYSHYOV (Johns Hopkins





University, USA)
Andrej ZORKO (Jozef Stefan Institute, Slovenia)

The deadline for abstract submission for contributed presentations is 12th April 2024.

Up-to-date information is available through the following conference website:
https://nfam.eng.hokudai.ac.jp

Summer School:

Prior to the conference, two summer schools on theory and experiments in magnetism are held at Hokkaido University. The lecturers Prof. Oleg Tchernyshyov and Prof. Andrej Zorko will give the lectures on magnetism from theoretical and experimental points of view, respectively. Graduate students and young researchers are encouraged to attend these summer schools to catch up on the latest research in quantum magnetism. The registration and the payment of the tuition fee will start from 1st March 2024 through the following website:

https://hokkaidosummerinstitute.oia.hokudai.ac.jp/

You are welcome to the city of Sapporo this summer.

Co-chairs:

Yoshihiko IHARA (Hokkaido University, Japan)

Hideaki OBUSE (Hokkaido University, Japan)

Organizers:
Satoru HAYAMI (Hokkaido University, Japan)

Hideki HIRORI (Kyoto University, Japan)

Yukitoshi MOTOME (The University of Tokyo, Japan)

Contact address: nfam@eng.hokudai.ac.jp

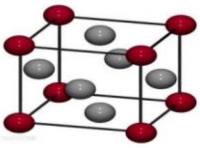
Report 5:

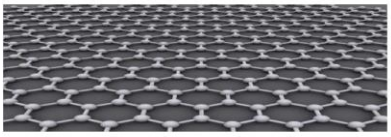
Invitation to the Conference of Condensed Matter Physics 2024 (CCMP 2024)

The Conference of Condensed Matter Physics (CCMP) evolved from the annual conference series "International Conference on Condensed Matter Theory and Computational Materials," which began in 2002. In 2015, the Organizing Committee decided to expand the conference's scope and scale to reflect the latest developments in condensed matter physics by adding new sessions that cover a broader range of topics. Consequently, the conference was renamed the Conference of Condensed Matter Physics (CCMP).

CCMP now warmly welcomes domestic and overseas participants! The conference's objectives are to stay abreast of the rapid progress in condensed matter physics, encourage academic exchanges, facilitate interdisciplinary research, and enhance the global recognition of Chinese contributions to condensed matter physics and related fields.

DCMP
Division of Condensed Matter Physics
Association of Asia Pacific Physical Societies





We are looking forward to your participation in the Conference of Condensed Matter Physics 2024, on August 4-9, 2024 at the Yangtze River Delta Physics Research Center, in Liyang, China.

Registration for the conference is now open to all scientists, postdoctoral fellows and graduate students in related fields at home and abroad, to share the excitement of new discoveries, establish new collaborations, and discuss the future direction of condensed matter physics.

http://ccmp2024.ioply.cn/

Host Institutions

·Institute of Physics, Chinese Academy of Sciences

·Shanghai Jiao Tong University

·Fudan University

·Zhejiang University

·Nanjing University

·Kavli Institute for Theoretical Sciences, University of Chinese Academy of Sciences

·Tsinghua University

·Peking University

·University of Science and Technology of China

Co-host

·Chinese Physical Society

Program

Plenary Session	New frontiers in condensed matter physics
Session 1	Superconductivity and magnetism
Session 2	Computational and material physics
Session 3	Non-equilibrium and statistical physics
Session 4	Low-dimensional systems and topological physics

Contact Us

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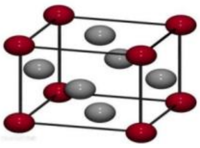
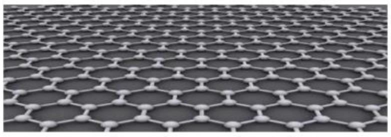




	Aug 5 (Mon)	Aug 6 (Tue)	Aug 7 (Wed)	Aug 8 (Thu)	Aug 9 (Fri)
9:00 - 10:40	Opening Remark Plenary Talk	Plenary Talk	Parallel Sessions	Plenary Talk	Parallel Sessions
10:40 - 11:00	Coffee Break	Coffee Break	Coffee Break	Coffee Break	Coffee Break
11:00 - 12:30	Plenary Talk	Parallel Sessions	Parallel Sessions	Parallel Sessions	Plenary Talk Ceremony
12:30 - 14:00	Lunch	Lunch	Lunch	Lunch	Lunch
14:00 - 15:30	Parallel Sessions	Poster Section	Parallel Sessions	Parallel Sessions	
15:30 - 15:50	Coffee Break	Coffee Break	Coffee Break	Coffee Break	
15:50 - 17:20	Parallel Sessions	Poster Section	Parallel Sessions	Parallel Sessions	
		Banquet			

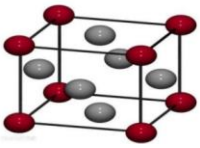
Participants	Early bird Pay Before June 15, 2024	Standard Pay Before July 15, 2024	On-site
Faculty members and postdoctoral fellows	CNY 1900	CNY 2200	CNY 2500
Students and retired Scientists	CNY 1600	CNY 1900	CNY 2500

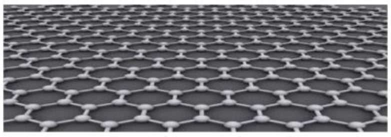
Registration fee covers:

- Conference brochure;
- Coffee/Tea break, Lunch, Dinner;
- Conference banquet;
- Shuttle bus;

Regarding refund:

- If you have paid your registration fee online and are unable to attend CCMP 2024 due to unforeseen circumstances, you may apply for a refund before July 21, 2024.
- Refund requests will no longer be accepted after July 21, 2024 due to conference costs incurred.





Report 6:

Invitation to the annual meeting of Physical Society of Japan in Sapporo

Hiroyuki Nojiri, IMR, Tohoku University, Hiroyuki.nojiri.e8@tohoku.ac.jp

The physical society of Japan (JPS) holds two meeting every year. One is the annual meeting where all members of JPS meet at one place and the other is the separate two meetings, one for condensed matter physics and the other is for particle and nuclear physics. Currently, spring meeting is online and the fall meeting is onsite.

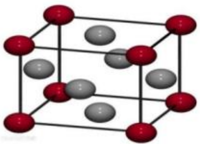
The JPS meeting use two languages-Japanese and English. If we should use English for all presentation is under the discussion for years. There are English sessions and symposiums, which you can participate and many of presentation slides are in English because it is recommended by JPS.

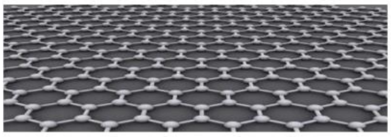
The JPS has a reciprocal agreement with many physical societies and the members of those society is eligible for presentation and participation in JPS meetings. In Asia-Pacific, Korea, Hong-Kong and Taiwan and USA are included. Moreover, invited speakers of a symposium can be non-JPS members.

This year, JPS annual meeting will be organized at Hokkaido University in Sapporo from 16th to 19th of September. The September is one of the best seasons in Hokkaido.

The DCMP members of the JPS are now preparing to organize symposium in the annual meeting. It is also planned to organize a satellite workshop before or after the JPS meeting. If you have a wish to participate as an organizer of symposium or join us as a speaker, please contact us in earlier time. The deadline of symposium proposal will be the end of April. The submission of abstract for ordinal presentation will be around the end of May. The information will be available in the following website. https://www.jps.or.jp/english/.

We believe that the annual meeting of each association can be open for the DCMP member. We want to make a good example for such open policy in the meeting of Sapporo. We hope to see you in JPS meeting in September.





Report 7:

Welcome to AC2MP2024 in Patna India, 8-11, December, 2024

It is our pleasure to announce that the 2024 AC2MP will be held at IIT Patna, Bihar India under the AAPPS Division of Condensed Matter Physics (DCMP) umbrella.

The Indian Institute of Technology Patna (IIT Patna) is a public research university in Bihta, Bihar, India. It was established in 2008 and is recognized as an Institute of National Importance by the Government of India. The institute offers undergraduate, postgraduate, and doctoral programs in various fields of engineering, science, and technology. The institute has a well-equipped library, modern laboratories, and a state-of-the-art campus that provides a conducive environment for learning and research. The institute has a strong alumni network that includes entrepreneurs, researchers, and professionals who have significantly contributed to their respective fields. IIT Patna is committed to promoting innovation, research, and entrepreneurship among its students and faculty members.

IIT Patna has been ranked 66th in the overall category by the National Institutional Ranking Framework (NIRF) in 2023. The institute has also been ranked 141st among BRICS nations by the QS World University Rankings in 2019. The institute has organized various workshops, seminars, and conferences over the years to encourage the exchange of scholarly ideas and support research and development in emerging fields of science and technology. Hence, I am sure that the 4th edition AC2MP will be a great success with the effort of IIT Patna fraternity. I am happy that the entire conference will be held in the campus of IIT Patna which is well equipped to make the conference success.

In a brief there is expected a gathering of 600-700 participants including more than 100 invited talks and more than 100 oral presentations. There are several themes have been chalked out for the parallel sessions. Conference duration will be 4 days from 8th December to 11th December -2024. Hence, I see a mesmerizing conference (AC2MP -2024) ahead. I wish all the best to the participants and organizers.

Important Information

Web site: https://www.iitp.ac.in/~ac2mp2024/

Abstract Submission
a) Deadline 31stAugust 2024
b) 30th September 2024 with a nominal fine (revised rate)
c) 31stOctober 2024 with fine (revised rate).

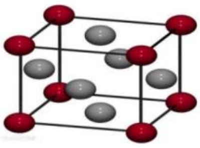
Beyond 31st is the discretion of the convener depending upon availability of accommodation and slot for presentation.

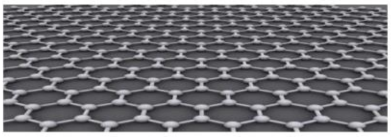
Registration fee
International:
(a) Academician/Researcher: US$500
(b) Student: US$300
Indian:
(a) Academician/Researcher: Rs. 8000
(b) Student: Rs. 5000

Access to Patna

IIT Patna's campus is located at Bihta, 35 km from Patna and 20 km from Ara, at a 501 acres (203 ha) site.

The nearest airport to reach IIT Patna campus is Jai Prakash Narayan Domestic Airport, Patna, which is located 5 kilometers southwest of Patna. More details on the local transport will appear in website.





Meeting Calendars

Date	Event	Location	URL
April 23-26	KPS Spring Meeting	Daejeon Convention Center	https://www.kps.or.kr/conference/event/
August 4-9	CCMP 2024	Liyang, China	http://ccmp2024.ioply.cn/
August 5-9	NFAM 2024	Sapporo	https://nfam.eng.hokudai.ac.jp
September 2-6	CMD meeting of EPS	Braga, Portugal	https://cmd31.sci-meet.net
September16-19	JSPS Annual Meeting 2024	Sapporo	https://www.jps.or.jp/english/meetings-and-awards/meeting.html
October 23-25	KPS Fall Meeting	Yeosu	https://www.kps.or.kr/content/conference/meeting_future.php
December 2-6	25th AIP Congress	Melbourne	https://aipcongress2024.com
December 8-11	AC2MP 2024	Patna, India	https://www.iitp.ac.in/~ac2mp2024/
January,2025	Annual Meeting	Taiwan	https://www.ps-taiwan.org/en/modules/annual/main
August,2025	APPC 16	Hainan	-