World Premier International Research Center Initiative (WPI)
FY2024 WPI Project Progress Report

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Research Center	International Inst. for Sustainability with Knotted Chiral Meta Matter (SKCM²)		
Center Director	Ivan I. Smalyukh	Administrative Director	Shin-ichi Tate

Common instructions:
* Unless otherwise specified, prepare this report based on the current (31 March 2025) situation of your WPI center.
* So as to execute this fiscal year's follow-up review on the "last" center project plan, prepare this report based on it.
* Use yen (¥) when writing monetary amounts in the report. If an exchange rate is used to calculate the yen amount, give the rate.
- Prepare this report within 10-20 pages (excluding the appendices, and including Summary of State of WPI Center Project Progress (within 2 pages)).

Summary of State of WPI Center Project Progress (write within **2 pages**)

WPI-SKCM^2 is maturing as a globally-visible hub of research introducing the new paradigm of knotted chiral meta matter, as well as World's the only center where pure math & fundamental research are fused with diverse disciplines to contribute to resilient sustainability. A common misperception of lay public is that pure math is all about complicated mathematical notations and abstract notions that few individuals benefit from. Our WPI is erasing this stereotype by showing vividly how pure math's knot theory can become a language of the fusion research that prioritizes development of unique values for the better, secure future. Our WPI's research breakthroughs within the last fiscal year will have transformative impact on multiple disciplines and, even more importantly, will become the role-model demonstrations of how, in the words of Nobel Laureate Noyori sensei, "*Researchers must … contribute toward constructing the sustainable society in the 21st century*." Among the specific examples of embodiment of this vision is, led by Director Smalyukh, the development of a brick-scale analogue of Earth's Greenhouse Effect based on knot-theory-modeled mesoporous meta-material that may revolutionize building envelopes of the future by changing them from inefficient consumers of heating and cooling energy to energy-generating plants (the breakthrough emerged from combining expertise in pure math, soft condensed matter physics, planetary and material sciences & building engineering). Another vivid example, led by HU PI Sato, is the development of micro-porous metamaterials with knotted molecules that efficiently capture gases like CO_2 by design, once again enabled by multi-disciplinary fusion cascade from pure-math-inspired design all the way through chemical synthesis & computational modeling enhanced by AI. In yet another example, led by SKCM^2 PI Dunkel of MIT, a notion of combinatorial vortex lattices is introduced that builds on pure math's dimer cover model to develop arrays of vortices as quasi-atom-like building blocks of meta matter to demonstrate the potential new means of sustainable data storage and classical analogues of topological quantum phases at the same time. Differently from the old-system's norm that professors initiate and direct research, our WPI also exemplifies how young researchers can be empowered to lead initiatives, including in ground breaking research. For example, internKNOTshiper Takano initiated new directions in research collaborations on photonic chips with on-chip chiral liquid crystal based distributed feedback lasers & chiral knits in textiles at the same time, all with potential transformative impacts for sustainable society in forms of brain-computer interfaces in the former & textile recycling in the latter cases. These are just few examples out of many, & we cannot wait to showcase all the ground-breaking accomplishments during the Site Visit.

Guided by the Working Group's visionary feedback to further promote collaborations that lead to fusion of research fields, the Director initiated a series of Flagship Projects. These projects organize and centralize our integration of knot topology and chirality on many length and time scales, across the natural hierarchy, from elementary particles to biological and cosmic systems, as well as in pure math, in planetary sciences, cosmology & so on. We believe that this brings clarity to the institute's key research goals, which are to develop knotted chiral meta matter as materials with properties not occurring in nature in addition to providing deep insights into physical phenomena on subatomic-to-cosmic scales by recreating them in table-top material systems accessible to direct experimentation. Anticipated future technological applications enabled by our fundamental research range from sustainable energy-efficient building technologies to materials for extraterrestrial habitats to biomedical detection, to selective capture of greenhouse gasses, to treatment of diseases & to spintronics & storage devices. WPI researchers

produced discipline-fusing research works, often co-authored by multiple PIs (~25% of our WPI-enabled research output now constitutes publications co-authored by multiple senior investigators of the center, & we intend soon achieving over 50%). A total of 21 countries and 102 international institutions are co-affiliating our publications together with WP-SKCM^2 & Hiroshima University just within the calendar year 2024 alone.

The institute has also made strides towards missions related to values for future, creating an internationalized research center, etc. PIs from international institutions are expanding their research group footprints at HU (some already hired co-PIs at HU, some just identified them) & direct collaborative research by mentoring & co-mentoring postdocs & students at HU, & sending internKNOTshipers to HU. The director also implemented procedures (now being enforced) that require all WPI-supported students & postdocs have at least three co-mentors each (a primary mentor & 2 co-mentors), where co-mentors have to represent different disciplines & at least one of them has to be from a WPI node outside Japan. Weekly seminar series that we organize feature world-renowned speakers often particularly famous for their interdisciplinary research scope, & are designed to inspire & initiate cross-disciplinary international collaborations. Students and postdocs are exposed to, and can connect with, the world's top minds in our interdisciplinary domain through symposia, conferences, & schools we organize.

To further establish a global hub at HU, we strive to model the functioning of our administrative office while building on the best practices of other WPIs & top research centers around the world, including other WPIs. Three Deputy Directors & the Admin Director support the Director to ensure smooth operation & swift decision-making, along with a standing Steering Committee that embodies collegial leadership. Further, External Advisory Board Meetings with WPI leadership, monthly Director's meetings with President Ochi & Faculty/PI meetings are regularly held to discuss the WPI functioning. We also now have a full-time Admin Director Iwata, who dedicates himself to pressing issues related to completing the processes like formal hiring of international PIs at HU (to be finalized before the Site Visit), establishing arrangements with institutions of our international PIs so that the recruitment of doctoral students can be boosted, etc. We also have bilingual support staff (~20% international origin) & established infrastructure to, as an example, receive international scholars and effectively exchange research samples. These staff members help with the community-building and development of family-like WPI-SKCM^2 network at HU and globally, which is a top priority promoted by efforts like international exchanges, collaboration-building hiking, summer/winter schools, etc. We have also formally introduced SKCM^2 as an institute at HU, with its regulations and bylaws suitable to serve its very important reform-enabling role. HU is committed to providing full-fledged support, treating WPI as an important permanent institute. We are excited about our new building on HU campus, scheduled to be completed by the end of 2025. The building has been carefully planned with fusion research being the very top priority, featuring ample room for shared facilities & collaboration-enabling space for discussions & idea exchanges, vividly different from the typical research buildings in Japan. To boost engagement & global circulation of talent, like doctoral students, our WPI is establishing a North-America Satellite on the campus of CU-Boulder.

Our WPI is unique in that it connects people with knot-&-chirality-related backgrounds from different disciplines, from top institutions around the world, as well as in that it demonstrates global leadership in efforts related to fundamental research for resilient sustainability. For example, we co-organized a 2024 Winter School and a Workshop focused on pure math and sustainability jointly with WPI-I^{2}CNER of Kyushu U, and are co-organizing a Workshop on sustainable textiles based on knot theory models jointly with Tohoku WPI & the Energy & Resilient Sustainability workshop & planning future sustainability summer schools with the US National Renewable Energy Laboratory (NREL) & CU-Boulder. The sustainability-related young researcher training efforts also help to emphasize and coordinate the sustainability focus as a key mission in our research activities.

Our WPI successfully engaged over 150 dedicated members, including PIs & faculty-level Affiliate members and visitors from all over the world, creating the global SKCM^2 partnership. They pursue collaborations while jointly co-mentoring postdoctoral fellows & Ph.D. students, working on highly interdisciplinary projects within the WPI's scope. Within the last year, the WPI-SKCM^2's affiliation appeared on well over 200 research articles/reviews, including in premier journals like Nature. In terms of publications co-authored by multiple senior members of our WPI, we went from under 10 at the time of last year's site visit to over hundred as of the end of the fiscal year (March 31, 2025). Our researchers effectively disseminate the outcomes via publications in top high-impact journals as well as via plenary, keynote & invited presentations at the top-level scientific meetings. They also effectively share the excitement of our research paradigm with the public and school children via outreach. Our work attracted a great deal of excitement & media coverage.

* Describe clearly and concisely the progress being made by the WPI center project from the following viewpoints.

1. World-Leading Scientific Excellence and Recognition

1-1. Advancing Research of the Highest Global Level

* Among the research results achieved by the center, concretely describe those that are at the world's highest level. In Appendix 1, list the center's research papers published in 2024.
* Regarding the criteria used when evaluating the world level of the center, note any updated results using your previous evaluation criteria and methods or any improvements you have made to those criteria and methods.

An example of the world's highest level of research is a Nature article published by the youngest PI of our WPI center, Dr. Claire Donnelly, where she introduced X-ray linear dichroic tomography of crystallographic and topological defects [*Nature* **636**, 354–360 (2024)]. As is well known, the functionality of materials is determined by their composition & microstructure, especially the distribution and orientation of crystalline grains, grain boundaries and the defects within them. Until Claire's work, characterization techniques that map the distribution of grains, their orientation and the presence of defects have been limited to surface investigations, to spatial resolutions of a few hundred nanometres or to systems of thickness around 100 nm, thus requiring destructive sample preparation for measurements and preventing the study of system-representative volumes or the investigation of materials under operational conditions. Claire and her collaborative team presented X-ray linear dichroic orientation tomography (XL-DOT), a quantitative, non-invasive technique that allows for an intragranular and intergranular characterization of extended polycrystalline and non-crystalline materials in 3D. They determine the nanoscale composition, microstructure and crystal orientation throughout the polycrystalline sample with 73 nm spatial resolution, as well as identify and characterize grains, as well as twist, tilt and twin grain boundaries. The non-destructive and spectroscopic nature of the method opens the door to operando combined chemical and microstructural investigations of functional materials.

PNAS article co-authored by former HU-based WPI-SKCM^2 PI Senyuk & Director Smalyukh [*PROC. NATL. ACAD. SCI. U.S.A.* **121**, e2322710121 (2024)] is another example of high-impact work. Researchers showed emergent chiral symmetry-breaking topological defect transformations in the chiral nematic host medium that lead to directional locomotion driven by an external oscillating electric field. The findings revealed dynamic reconfiguration of the elasticity-mediated out-of-equilibrium colloidal interactions, showing how inter-colloidal repulsion can be converted into tunable attractive interactions in the out-of-equilibrium settings. Furthermore, such nematic colloids in dense dispersions exhibited a striking emergent effect of coherent motion collectively selecting the direction of their copropulsion, potentially enabling electro-optic effects and various technological uses, like the new breeds of displays.

In her recent high-impact work [*Nature Comm.* **15**, 6780 (2024)], PI Dijkstra did extensive particle-based simulations to demonstrate that non-chiral hard banana-shaped particles, governed solely by excluded-volume interactions, spontaneously stabilize skyrmion structures through the bend-flexoelectric effect. Under thin confinement, she observed the formation of quasi-2D layers of isolated skyrmions or dense skyrmion lattices. These structures, comprising a racemic mixture of left- & right-handed skyrmions, show resilience against thermal fluctuations while remaining responsive to external fields, offering intriguing possibilities for manipulation. Furthermore, they highlight the remarkable capacity of these complex fluids in designing advanced functional materials and knotted chiral meta matter with diverse applications in photonics and memory devices. Another example of high-level research is an invited special-issue article (DOI: 10.1039/D5SM00014A) in *Soft Matter* fully based on experiments at shared facilities of SKCM^2 & co-authored by 2 WPI postdocs & 3 profess-r-level researchers, in which hybridization of colloidal handlebodies with singular defects and topological solitons in chiral liquid crystals was first discovered. The work of our WPI senior members Nozaki, Kálmán, Teragaito & Koda [*Procs. Royal Soc. A*, **480**, 20240148 (2024)] stands out in the context of developing mathematical homotopy classification of knotted defects in ordered media, which can now be studied experimentally in biaxial chiral liquid crystal media introduced by Director Smalyukh at about the same time [*Nature Comm*. **15**, 9941 (2024)], where the study of nonabelian vortices can be now experimentally accessible for the first time in 3D for all physical systems. SKCM^2 students and PI Haino published on latent porosity of planar tris (phenylisoxazolyl) benzene, with the findings appearing in premier journal [*Nature Comm* **15**, 8314 (2024)] and attracting significan interest. PI Matsumoto and her team reported on a breakthrough in

programming mechanics in knitted materials, stitch by stitch, with the study appearing in the same research journal as Haino's [*Nature Comm*. 15, 2622 (2024)].

Our PI Katsuya Inoue, in collaboration with Affiliate Member Prof. Dominique Luneau, along with students, have published "Electron diffraction unveils the 2D metal-radical framework of two molecule-based magnets" [https://pubs.rsc.org/en/content/articlelanding/2025/qi/d4qi02257b] in Inorganic Chemistry Frontiers. This paper has been selected as a French National Centre for Scientific Research (CNRS) Topic and featured on their homepage for its significant breakthrough. Luneau & his student Lecourt were hosted at WPI-SKCM^2 through the JSPS Summer Program and WPI Program, respectively, which enabled this collaborative research highlighted by CNRS. Our Affiliate Member Jie Shen published in *Nature* [doi.org/10.1038/s41586-024-08384-y] on topological skyrmion structures in water waves. On the other hand, PI Hsu reported on rapid simulation of glycoprotein structures by grafting and steric exclusion of glycan conformer libraries, publishing in another premier journal [*Cell* **187**, 1296-1311 (2024)]. The above papers, in addition to being published in top research journals, were identified as major research breakthroughs by our WPI-SKCM^2 External Advisory Board members. In these instances of already published works, among the criteria and metrics of visibility that we use are many of the standard ones, like journal impact factor, interest attracted by organizers of major international conferences and international awards and citations by peers, as well as the assessment by our experts on the External Advisory Board and other top experts. The works of our members attracted very significant interest as evidenced by immediate waves of citations by peers, many highlight articles, and followings by press and social media. At this moment, all PIs as well as many visiting professors and affiliate members already published with our WPI institute's affiliation that we instructed our members to be "International institute for sustainability with knotted chiral meta matter (WPI-SKCM^2), Hiroshima Univ." Many high-impact articles come from the newly recruited members who were not affiliated with HU before the establishment of the center but now share our WPI-SKCM^2 affiliation with other top international research centers, like Max Planck Institute, Univ. Utrecht, Cambridge Univ., etc.

Many more significant breakthroughs by our PIs are being published already in 2025 and are now emerging as preprints. WPI-SKCM^2 as an institute is ~2.5 years old, and most of its researchers were hired within less than 2 years, but the institute is already gaining high visibility & reputation globally. Within the ongoing research efforts on liquid crystals, polymers colloids & gels, the scientists recently develop new forms of knotted soft matter. Additionally, liquid crystals with designable high-dimensional order parameter spaces are modeled & co-implemented by Dijkstra, Smalyukh, Haino & Tasinkevych. New chiral supramolecular & nano-colloidal systems are synthesized by PI Haino and his team. Sato synthesizes new breeds of knotting-enabled high-porosity gels & collaborates with Smalyukh to control & understand properties like infrared reflectivity, visible-range transparency and thermal conductivity. The research thrust of quantum matter chirality and topology, where we added a new PI Prof. Murakami, explores multi-dimensional topology in both real and momentum spaces in spin systems. Inoue leads synthesis of new magnetic materials designed to host topological solitons. These efforts are guided by modeling of stability diagrams by Leonov & culminate in direct 3D experimental visualizations/mapping by Donnelly. Sasaki & Inoue collaborate to explore fundamental synergies between the phase diagrams in spin systems and QCD. PIs Murakami, Kuroda & WPI Project Professor Kimura study the momentum-space multi-dimensional topology, once again developing synergies with particle physics related to Weyl and Dirac semimetals in the solid state, working closely with PIs Sasaki & Shigaki. Within the (bio)polymer thrust, Hsu studies the role of knotting & solitonic configurations in biopolymers like RNA & DNA & in defining protein structures in contexts ranging from fundamental properties of biopolymer knotting & linking to Alzheimer's disease. Sato synthesizes molecules "programmed" for knotting & linking in controlled ways, as well as for the self-assembly into materials with unusual mesoscale structures enabled by chirality-controlled spontaneous knotting/linking. Vignolini demonstrates how topological defects of various kinds and knot solitons can emerge in natural photonic structures (like in cuticles of beetles), in bacterial active nematic and other systems and also in hierarchically self-assembled cellulose nanocrystal based chiral LCs. While the World-level of research of the ongoing efforts cannot be judged based on visibility of publications as the studies are still under review or even under preparation, they received very high evaluation by our External Advisory Board members (e.g. during the recent Annual Symposium in Hiroshima, in the end of last fiscal year); this assessment by these top experts in our field makes us confident that they will also gain global visibility once published.

We work to address many fundamental, inter-disciplinary questions on relations between chirality and the different knots (& their crystals) in vortices, colloids, LCs, proteins & so on. This study of various knots & solitons in diverse physical, chemical & biological systems is integrated through the deep connections with mathematical knot theory modeling by Kotorii, Sasaki, Dunkel & Matsumoto. Among examples of very recent breakthroughs, SKCM^2 researchers discovered a new topological field configuration that is a hybrid structure of a soliton & an unknot of twist disclination, explained Pulsar glitches while considering quantum vortex networks, uncovered the light-steering powers of nematic vortices in guiding solitonic laser light with potential technological utility. Other specific examples include the study of monopoles and skyrmion dynamics in colloidal ferromagnets [*Science Advances* 2024, DOI: 10.1126/sciadv.adj9373], uncovering of the role of nematodyamics in mesoscale motions [*Nature Communications* **15**, 1220 (2024)], applying knot theory to better understand knitted materials [*Nature Communications* **15**, 2622 (2024)], probing structure-function relationships of highly glycosylated coronavirus spike proteins and presenting a user-friendly and computationally efficient tool, GlycoSHIELD, to generate fully glycosylated protein models [*Cell*, **187**, 1296-1311. e26, (2024)], and so on. Our works attracted a great deal of excitement already. PI Danny Hsu reported the crystal and NMR structures of the smallest and most complex topologically knotted protein, Q9PR55, with a 7_1 knot (JBC, 2024), and the use of enzymatic ligation to generate a truly knotted protein without open ends (BBRC, 2024). He wrote a review on the current progress in knotted protein research in a prestigious journal, as well as his team integrated experimental and computational tools to investigate the structure-function relationships of highly glycosylated coronavirus spike proteins and presented a user-friendly and computationally efficient tool, GlycoSHIELD, to generate fully glycosylated protein models [*Cell*, **187**, 1296-1311. e26, (2024)]. The above projects are just examples of many activities that are now pursued. However, while being diverse, they are all inter-knotted & inter-linked by the topology, chirality & knot theory foundations on which the progress builds via cross-pollination. The unique contribution to sustainability that our WPI pursues is that we develop metamaterials with properties that are needed to address sustainability-related challenges but do not exist in nature or in demonstrations of other researchers outside our center. The fusion-focused research allows pure mathematicians to contribute to sustainability through mathematical designs of such materials with desired properties.

1-2. Generating Fused Disciplines

* Describe the content of measures taken by the center to advance research by fusing disciplines. For example, measures that facilitate doing joint research by researchers in differing fields. If any, describe the interdisciplinary research/fused discipline that have resulted from your efforts to generate fused disciplines. You may refer to the research results described concretely in "1-1. Advancing Research of the Highest Global Level."

The Director has established multi-disciplinary Flagship Projects to better organize and showcase fusion research, which is truly the very top priority for our center. These projects will allow us to be effective in recruiting young talent to work on fusion projects as well as to be more effective in articulating our accomplishments and demonstrating outcomes of our fusion research. The director also implemented procedures (now being enforced by administrators) that require all WPI-supported students & postdocs have at least three co-mentors each (a primary mentor & 2 co-mentors), where co-mentors have to represent different disciplines & at least one of the co-mentors has to be from a WPI node outside Japan. Weekly seminar series that we organize feature world-renowned speakers often particularly famous for their interdisciplinary research scope, & are designed to inspire & initiate cross-disciplinary international collaborations. We organize a series of Symposia, conferences and schools that feature knot/chirality focused talks given by representatives of different fields who are fusing interdisciplinary knowledge in their research, inspiring our students, postdocs & PIs to collaborate. Our WPI members are very excited about the construction of the new building, scheduled to be completed by the end of 2025, with meticulous planning of making it our under-one-roof home of future fusion-research discoveries and breakthroughs. With fusion research being the very top priority, it will be featuring ample room for multi-disciplinary fusion research and shared facilities, as well as shared offices of doctoral students and postdocs representing different research fields, in addition to collaboration-enabling space for discussions & idea exchanges. Our WPI leadership is making efforts to both seed and stimulate collaborations that truly can be perceived as stemming from the center's fusion research activities across disciplinary areas of our Center. For example, we organized a day-long brainstorming session in December and will hold one more in May, Director held individual meetings with many PIs. Among many other things, to

stimulate collaborative research and publications and idea exchanges, the director instituted new rules for travel subsidy for PIs and faculty of SKCM2, where publication of articles co-authored by multiple PIs and representing WPI's fusion research is a pre-requisite. In future, performance evaluations and resource distribution will take this important factor into account in a similar way. To communicate our collaborative research outcomes more clearly, in preparation for the upcoming Site Visit, PIs will be asked to provide a slide with an example of collaborative fusion research within the WPI & focus presentations on such multi-PI fusion research. Pursued by our highly interdisciplinary international team of PIs, the fusion of topology & chirality research in this paradigm-changing context allows for new concepts and material/structural design strategies that may otherwise seem impossible. For example, our combined experimental and theoretical studies reveal what types of topological knot solitons can be stabilized by chirality in material systems, providing insights into topologically similar objects in other, experimentally less accessible systems, like particle physics and cosmology. While the bulk of our research focuses on experimentally highly accessible systems, like colloids, magnets and biopolymers, our findings will have immediate impacts for the study of objects and phenomena on less accessible scales, like the still elusive types of elementary particles and cosmic strings, for which even their very existence remains unknown. Conversely, theories of particle physics and cosmology inspire us to develop a deeper understanding and practical utility of related phenomena based on these highly accessible condensed matter and biological systems. Thus, our research efforts have the potential to lead to breakthroughs in many fields of science, in addition to the research paradigm that we strive to create.

Our WPI center integrates knot topology and chirality while dealing with a hierarchy of length and time scales, in diverse systems & disciplines, so that we are harnessing the highly multi-disciplinary chirality & topology knowledge to, on one hand, develop knotted chiral meta matter as materials with properties not occurring in nature and, on the other hand, to provide deep insights into physical phenomena on subatomic-to-cosmic scales by recreating them in table-top material systems accessible to experimentation. This already greatly helps us bringing together researchers representing different fields but sharing common knots/chirality interests to create a new interdisciplinary knotted chiral meta matter research domain. While the bulk of our research is on experimentally accessible systems, like liquid crystals, colloids, magnets & biopolymers, our findings have immediate impacts on studies of phenomena on less accessible scales, like cosmology & elementary particles. Conversely, theories of particle physics & cosmology inspire us to develop deeper understanding & utility of phenomena based on these accessible systems. While we are a metamaterials developing center, the main goal of our engagement with fields like particle physics, pure math, cosmology and planetary science is not related to an ambition of becoming a globally visible Center in these areas (WPIs QUP and Kavli-IPMU have these missions/goals), but rather to enhance the development of knotted chiral meta matter by building on synergies with theories/models from these fields and ones in materials and condensed matter physics, thus creating an entirely new research field. Also, we strive to provide unique in-laboratory tests and model system realizations for phenomena and concepts from these fields, which has the potential of making positive impact on many diverse fields, as well as contributing to sustainability. This is consistent with our center's position on the science map of WPI projects that JSPS developed. The current perceived state that you describe in the feedback is because of so far insufficient fusion of these subfields with the other core focus areas of WPI-SKCM^2, but we are working hard to better integrate these areas with meta matter and metamaterial development efforts. The director is working to stimulate fusion research among representatives of these diverse fields. For example, now enforced procedure of hiring postdocs requires that at least one (out of minimum 3) co-mentor is from a different research field than that of the primary mentor, as represented on the knot diagram of our Center. Center resources will be allocated to support fusion research in-between fields that form core foci of our center. As an example, efforts in pure math, particle physics and cosmology are supported if they are linked to materials-focused efforts and meta matter development. HU provided laboratory and office space in the VBL building that is now available for the use by international PIs, even before the new building construction is completed. New experimental outcomes from these facilities already resulted in a series of published articles, with the number of publications jointly co-authored by multiple PIs and other senior investigators growing fast to now become over 100.

Among other stimuli for efforts towards fusing different fields in specific research efforts are travel subsidy procedures that encourage PI-level co-authorship within the WPI, procedures for international exchanges of students/postdocs that all have interdisciplinary collaboration expectations, the winter and summer schools with series of tutorials that introduce key concepts essential for interdisciplinary collaborations in our field, the required attendance of seminars and coffee/tea-time meetings that promote interdisciplinary communications, the community-building activities like hiking and poster sessions promote fusion studies through more informal interactions, etc. Specific other efforts include bringing world-renowned fusion-research scientists as seminar and symposium speakers, and attending major global multidisciplinary meetings. The director noted that interdisciplinary collaborations are typically rather unusual for pure math members of the center, where research often focuses on rather abstract concepts and constructs. Taking into account the Site Visit Committee's feedback, he therefore spent many long hours introducing suitable collaborative opportunities to the mathematicians as a group and on an individual basis. He attracted a prominent pure math researcher, Lou Kauffman (our WPI's affiliate member), to spend over 2 months at Hiroshima University in 2024 to help our mathematicians appreciate the fusion research opportunities through his own example. Prof. Lou Kauffman's dedication to fusing pure math (knot theory specifically) with diverse disciplines to achieve sustainability impact became so prominent that it now results in the huge following within mathematics community within and well beyond our center, as evidenced by even dedicated symposia being organized starting from this year (see the image), where many our members will present. Even though more progress is still needed, the current research efforts of mathematicians already involve the systems at the focus of our WPI's activates, like knotted vortices in nematic liquid crystals (see papers published by our mathematicians Nozaki, Kálmán, Teragaito & Koda [*Procs. Royal Soc. A*, 480, 20240148 (2024)]) and knotted proteins. Even though more work is needed, the collaborative links between PI-level researchers have already emerged. Among specific fusion-research examples that recently emerged, PIs Matsumoto and Inoue collaborate on developing and experimentally realizing chiral knits based on knot theory based ideas. Some Professor-level researchers work together with students and postdocs to further boost the interdisciplinary research through collaboration among the members. Among the examples, PI Prof. Shigaki, PI Prof. Sasaki, and Prof. Nonaka (all in high-energy physics) have been working together since the project started. Sasaki and Nonaka contribute theoretically to analyze the data Shigaki collected in high-energy physics facilities such as CERN. PI Kotorii (math) and PI Matsumoto (condensed matter theory) also actively collaborate. Kotorii has also collaborated with Tate to classify the protein entanglement in protein condensates, in which affiliate member Prof. Panagiotou (math) also engages. The other collaboration between our members Hsu (biochemistry), Tate (biophysics) and Haino (chemistry and polymer science) focuses on the Amyloid b proteins that contain one or two D-amino acids. In this work, as an example, Haino's Ph.D. student collected AFM data needed to determine the chirality-defected Amyloid β structures. Former postdoc Ziga Kos of PU Dunkel (Ziga is now an affiliate member and an Assistant Professor at Ljubljana U in Slovenia) collaborated with Director Smalyukh to introduce combinatorial vortex lattices that allow for obtaining topological order in a classical liquid crystal system. Smalyukh collaborates with Affiliate Member Bowick to develop networks of nonabelian vortex lines (in theory, experiments and numerical simulations [Phys. Rev. X 15, 021036]), similar also to ones studied pure-mathematically in our WPI [Procs. Royal Soc. A **480**, 20240148 (2024)].

A highly effective environment with optimal conditions for collaborations and young researcher exchanges is being established. We have established regular research seminars & other meetings every week online to share progress with WPI members both at HU & abroad. The close communication among the members is the top priority in this WPI management. The frequent exchange of ideas at various organized occasions will ensure productive inter-disciplinary research in a cross-pollinating way. We also pursue efforts to foster young researchers in order to contribute to advancing their career paths while taking advantage of our global and interdisciplinary network. We have formed an External Advisory Board to advise the Director and Center leadership on the

best practices related to realizing a welcoming Interdisciplinary International Research Environment, with the very helpful feedback provided at the most recent Board Meeting in March.

2. Global Research Environment and System Reform

2-1. Realizing an International Research Environment

* Describe what's been accomplished in the efforts to raise the center's recognition as a genuine globally visible research institute, along with innovative efforts proactively being taken in accordance with the development stage of the center, including the following points, for example:
- Efforts being developed based on the analysis of number and state of world-leading, frontline researchers (in Appendix 2); exchanges with overseas entities (in Appendix 4); number and state of visiting researchers (in Appendix 5)
- Proactive efforts to raise the level of the center's international recognition and to obtain diversity within the center.
- Efforts to make the center into one that attracts excellent young researchers from around the world (such as efforts fostering young researchers and contributing to advancing their career paths)

Following the feedback from the Site Visit's working group (WG) and Program Committee, the director is implementing the WG's proposal of hiring coPIs at HU who would represent foreign PIs. The implementation of this plan has been somewhat slow. With the new Admin Director Iwata already engaged, we anticipate that these plans will be implemented expeditiously. As also communicated above, following this and related remarks, we have re-defined the roles of coPIs to be consistent with other WPIs in Japan (our initial use of the term was based on its use in the USA). The former coPIs become visiting professors who visit HU to collaborate with PIs. As originally intended, the visiting professors (formerly coPIs) are not responsible for independent projects but rather collaborate with PIs to support the PI-driven research efforts, as described in the original proposal. The re-designation of titles will help us to both achieve better focus and more effectively pursue fusion research. A new cohort of coPIs (with the titles of specially appointed Associate Professors at HU) are being hired at HU to work for the PIs from outside HU, so that these coPIs can represent respective PIs. Overall, we have successfully engaged international PIs with the highest research visibility and from top institutions globally, who already actively participate in our WPI's effort. While we have only one international satellite currently being established at CU-Boulder, we strongly engage the international PIs and visiting professors, as well as the young researchers, as key contributors to all research and education missions of our WPI center. This is done by inter-knitting our activities through joint advising/mentoring of young researchers who mediate inter-PI interactions & partnerships.

Young researchers are commonly being hired through international searches while HU PIs are making the selections/recruitments jointly with PIs at the international nodes, so that candidates for these positions can meet everyone's high expectations, as needed for fruitful international collaborations. The Director oversees key decisions related to internationalization, including personnel, hiring, etc. His leadership team assists with the implementation of the vision and goals of the proposed project. HU supports foreign PIs strongly in an effort to increase the time they can spend at HU, e.g. through long-term sabbatical & other stays, cross-appointment, consulting & various other agreements. Foreign PIs are the primary advisors for their postdocs hired at HU, who are planning to spend 50% time abroad in the labs of these PIs. All Center-supported PhD candidates have foreign PI co-mentors (currently, in most cases still in the process of selection), spending 6 months or more time abroad within their Ph.D. career. We do everything to ensure that joining a research group within our WPI is like becoming a family member for our Center's PIs, so that the foreign PIs will be all inter-knotted with family-like links & knots to their HU-employed group members. International PIs will be great role models for HU young researchers to follow, giving them global research perspectives & collectively integrating knowledge of best practices in mentoring from ~100 top institutions globally. Young researchers connect the top global research centers with HU & erase disciplinary boundaries between the fields (by working with multiple co-mentors), ranging from math to physics & planetary science. A regular in-person seminar series at HU has a Zoom component, allowing international researchers to join, with the timing to start at noon chosen to make this comfortable for WPI members in US & Asian time zones while recording all the presentations to provide access for European members of our WPI. Our PIs disseminate research outcomes and make them more visible by visiting top international institutions & promoting the WPI during plenary/keynote or similar high-visibility presentations, disseminating our findings through very top international journals, and so on.

In terms of diversity, our WPI Center stands out as a WPI with nearly perfect gender balance at the level of PIs (with women actually being the majority among international PIs); we will keep it this way or even bring to the perfect 50:50 balance in the future. Beyond the PI level, more work is needed to attract more female doctoral students and postdocs. Towards this goal, we organize gender balance promoting activities like symposia featuring prominent female scientists (e.g Prof. Helen Gleeson of U. Leeds in the UK and our own affiliate member, Prof. Sonia Mahmudi of Tohoku University, who can be role models for young female researchers). We also held several symposia in US and Europe dedicated to promote our center among young researchers and doctoral candidates.

Our young WPI Center has early indicators of becoming a truly global center of excellence in preparation future leaders in the field that we are establishing. An indicator of this early success of our center is the success of SKCM^2-supported postdocs in securing faculty and senior researcher jobs in top international institutions. The specific examples include Ziga Kos (co-mentored by primary mentor PI Dunkel, SKCM2 at HU/MIT & now starting as an Assistant Professor at U Ljubljana in Slovenia), Fabrizio Camerin (co-mentored by PI Dijkstra, SKCM2 at HU/UUtrecht & now starting as an Assistant Professor at Lund Univ, Sweden), Shigehiro Yasui (co-mentored by PI Sasaki, SKCM2/HU & now moving to Tokyo in a professorial position), Vlad Cherpak (SKCM2 at HU & now moving to NREL, USA), Satoshi Yano (co-mentored by PI Shigaki, SKCM2 at HU & staying at HU but now in a professorial position). On the other hand, several postdocs affiliated with our WPI were successful in obtaining prestigious postdoctoral fellowships that are now the main sources of support for them (Luke Turnbull, Marisel Di Pietro, Rikako Yamamoto, among others). We anticipate that the recruitment of young talented doctoral students and postdocs will be boosted further with the help of our new North American Satellite of SKCM2 on the CU-Boulder campus in Colorado, USA.

Among visiting researchers of our center are distinguished mathematicians like Louis Kauffman of Univ. of Illinois at Chicago and internKNOTshippers, like the doctoral student Shunsuke Takano of Waseda U. On the other hand, our SKCM^2 doctoral students, PIs and postdocs are being hosted by top research centers in the USA, Germany, UK, Spain, Poland, Taiwan, among many other. Following our original proposal, and now that the new building is under construction, we will be hiring new faculty members at HU as new PIs and Project Professors. In the process of adding new PIs, we will consider promoting to the PI status some of the visiting professors through hiring at HU while accounting Site Visit's Working Group's feedback and contributions to fusion research across disciplines represented in our Center. Following Site Visit Working Grooup's feedback, Prof. Murakami, a World-leading theorist in this area, is now hired as a new PI of SKCM^2. We very much want to hire postdocs and students in this area too and hope to succeed. Showcasing our WPI center to prominent visitors during reserch exchanges, seminar visits and conference or school participation also helps recruting talented new members at all levels, and in fact many junior and senior researchers expressed interest in open positions after their visits.

2-2. Making Organizational Reforms

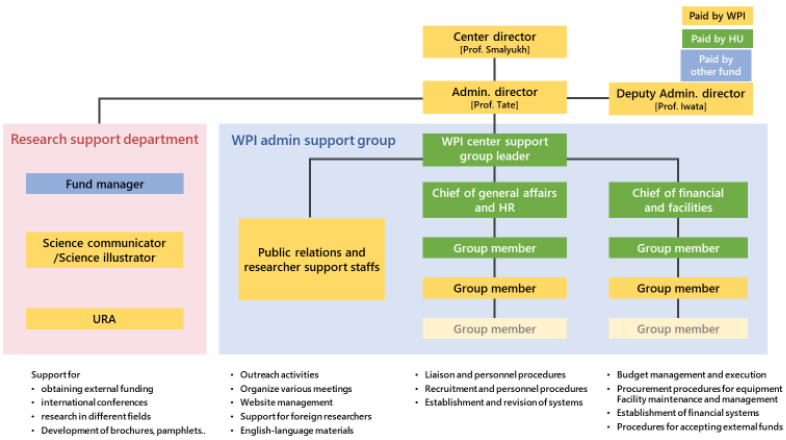
* Describe the system reforms made to the center’s research operation and administrative organization, along with their background and results.
* Describe the measures taken and results achieved in implementing the center's gender-balance plan.
* If innovated system reforms generated by the center have had a ripple effect on other departments of the host institutions or on other research institutions, clearly describe in what ways.
* Describe the center’s operation and the host institution’s commitment to the system reforms. (Include measures taken made by the host institution to provide a support system and to work toward improving the environment for achieving gender balance.)

Based on the feedback from the Site Visit and Program Committee, Director put the bonus system on hold entirely already during the Site Visit discussion. Using the funds, we have now established a startup system of 1M yen to doctoral students and postdocs, consistently with feedback. To promote fusion research, we provide meritocracy-based small travel subsidy to PIs (to visit collaborators and to present collaborative research) if they publish fusion multi-PI co-authored research, which is a pre-requisite. The director invited feedback on these new initiatives from PIs and other members by posting documents like Travel Subsidy procedure, postdoc ads and this response to Working Group's feedback on Google Docs web pages so that everyone can contribute not just through discussions at PI meetings or during coffee/tea time, but also by direct means of editing and formulating the vision and reforming our operations. These reforms were well received and strongly supported by both the faculty members and students and postdocs.

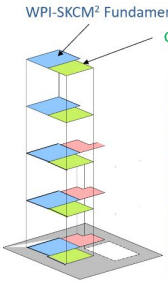
It is very unfortunate that the numbers of doctoral students are rather low so far, as well as that very few of the doctoral candidates come from other countries, especially North America and Europe. Attracting top students has been a challenge. Once seeing the challenge, the director formulated the plan of hiring doctoral students with the help of international PIs, including through formation of a satellite at CU-Boulder and joint/dual degree programs, in addition to various other agreements between institutions of our international PIs and HU/SKCM2. These plans are being implemented and we hope to see more progress soon. For example, the establishment of a satellite at CU-Boulder will allow for recruiting 3 doctoral students through University of Colorado admissions system, who will be partly supported by SKCM2 (~50%) and partly by other programs at CU-Boulder; we will meanwhile work to do the needed paperwork for giving them dual/joint degrees at CU and HU, or at least Doctoral Program's Certificates from our WPI Center. Building on this experience, we will make similar arrangements with institutions of other international PIs, in addition to recruiting students directly to HU with their help. While following the Working Group's guidance not to spread too thinly with too many non-PI members and focus on PIs as key leaders of research efforts in our WPI project, the Director asked Administrators to develop such agreements with all international PIs as the top priority, though such agreements with other WPI members and their institutions can be also eventually developed.

The host institution's commitments to administrative operations

Allocation of experienced staff members dedicated to the WPI-SKCM² administration.
The host institution's commitment to running the WPI-SKCM² is substantial under the strong support of President Ochi. Hiroshima University has allocated five well-experienced office members to manage the department operations, including budget handling and personnel since FY2023. To run the WPI-SKCM² as one of the independent Institutes of Hiroshima University, the administration office has to keep in touch with various departments in the university head office.
Within 2024, a deputy administrative director (Prof. Iwata) was assigned to assist the administrative director and the director in October 2024, becoming the new Admin Director starting from the new fiscal year (April 1, 2025). The director, the administrative director and the deputy administrative director have been discussing with the staff members how to amend the existing rules to implement things to reform the administration required for the WPI-SKCM² operation. The staff members negotiate with the representatives in responsible departments of the head office to ensure the successful execution of missions within the WPI-SKCM². Their dedication to reforming the existing rules and systems is indispensable. They keep the connection to the university head office to help the WPI-SKCM² operate in cooperation with the entire direction of the university.
In the administrative office's operation, we consider gender balance and diversity as important factors. Our supporting office leader is female. The administration office consists of a support office (8), a secretary team (7), and URAs (3); the numbers in parenthesis indicate the number of members, including the people hired by the WPI-SKCM². 13 out of 18 (72%) are female staff members, and 3 out of 18 (17%) are members of foreign origin, with many members having substantial international experiences and English language skills. The diagram below depicts the overall structure of administrative operations within our WPI, as well as the different sources of support of respective staff members (e.g., WPI grant, HU or other grants and funding sources).



Construction of a new building for the WPI-SKCM² research under one roof is secured. With the strong support of President Ochi, we secured the funds for constructing the WPI-SKCM² research center building. The five-story building for the WPI-SKCM² will be launched in December 2025. The head office made great efforts to secure the funds to make the WPI-SKCM² building a reality. Their commitment to this is substantial. Working with the HU headquarters' building department, we started designing the floors for the research areas to facilitate interdisciplinary collaborations using advanced instruments. The new building for the WPI-SKCM² also will have various facilities to accommodate collaborations with private companies commercializing the innovations of the researchers of the WPI-SKCM². The new building will help promote fundamental multidisciplinary fusion research oriented to the values of the future. The schematics, graphics and the photograph of the construction site (right) below reveal the vision for the building and its current stage of implementation, as of the end of the last fiscal year.



WPI-SKCM² New Building


WPI-SKCM² New Building location in the Higashi-Hiroshima Campus


WPI-SKCM² New Building appearance

3. Values for the Future

3-1. Creating and Disseminating the Societal Value of Basic Research

* Describe the content of measures taken by the center to widely disseminate the results of its basic research to the general public.
* Describe what was accomplished in the center's outreach and other activities last year and how they have contributed to creating the Societal Value of Basic Research. In Appendix 6, describe concretely the contents of these outreach activities. In Appendix 7, describe media reports or coverage, if any, of the activities.

Research meetings, symposia, and schools to boost international collaborations. We have invited many outstanding researchers from around the globe who work in fields related to the WPI-SKCM²'s missions to the annual institutional meetings, symposia, winter and summer schools, and weekly seminars. We have welcomed 70 foreign researchers and young scholars (women researchers, 14) in total to those activities. Through these uninterrupted activities, we have promoted our institute to world-renowned scholars and excellent young researchers, ultimately boosting the global recognition of the WPI-SKCM².

WPI- SKCM² Schools

WPI-SKCM² Schools aim to provide interdisciplinary expert training in knot topology and chirality, which is not easily accessible within the traditional system of graduate education and postdoctoral apprenticeship. WPI-SKCM² Schools also aim to foster the growth of early-career researchers. The Schools provide a forum for them to showcase their research through both oral and poster presentations, strengthen networks through community-building activities, enhance professional development through special symposia and forums, and learn about the world and culture of Japan. The main audience is WPI-SKCM² students, postdocs, however, the programs are open to all. Lectures were also delivered online to allow the audience to attend remotely. This is particularly helpful for young researchers in groups of our foreign-based PIs as not all of them can attend in-person.

To raise awareness of the center and to attract young researchers, we financially supported some of the foreign doctoral students and postdocs, who are not yet members of the WPI-SKCM², to attend the schools. The respective participants were nominated by our PIs, coPIs, and affiliate members and went through a selection process. Many of these event participants expressed interest in returning to WPI-SKCM² for internships and postdoctoral positions, and in fact some of them came back as newly recruited WPI-SKCM2 postdocs after graduating in their home institutions. All the lectures are archived and open for the internal members of the SKCM²; some of them are accessible as YouTube videos when we secured permissions to make the material open to the public.

Accumulating these lecture videos creates a useful archive of informative material for young researchers/students joining WPI-SKCM² in the following years.

SKCM² Summer School, ICREDD *Joint Symposium & Entrepreneurship Forum.* The School, which was held from 10 to 19 Jul 2024, featured tutorials and research reports by five guest lecturers (4 international), invited Affiliate Members, and the majority of our domestic and international PIs and co-PIs. Throughout the two weeks, a maximum of 113 participated in one day, including 11 early career researchers supported from the institutions of our international PIs. Contents delivered in the School are available: https://wpi-skcm².hiroshima-u.ac.jp/conferences/wpi-skcm%c2%b2-summer-school-at-hu%c2%b2-joint-wpi-icredd-research-symposium/

Week 1: Tutorial Lectures were delivered by many of our PIs, including Dunkel, Dijkstra, Sabetta, Matsumoto, Donnelly and Hsu. Additionally, we had a highly esteemed Professor Shanhui Fan (Stanford U) present on "Synthetic frequency dimensions in modulated ring resonators." We also connected our researchers through a 1-day symposium with WPI-ICREDD, which is a WPI center focused on the design and discovery of chemical reactions to enable humanity to purposefully craft chemical reactions to any design. Our PIs and invited speakers also formed a panel to discuss career opportunities and guidance for navigating academic careers.

Week 2: Along with lectures from invited speakers, we also hosted an entrepreneurship forum to learn about the opportunities at HU and more broadly. Invited keynote speaker Professor Hidetoshi Tahara of the HU Graduate School of Biomedical and Health Sciences, who serves as the Vice President of Academia-Government-Industry Collaboration, covered essential aspects of innovation, intellectual property management, and the commercialization of research. Dr. Tahara and a panel discussion with other experts from abroad provided the audience with ideas and inspiration for translating academic research into market.

SKCM² Winter School, Science Communication Session & I²CNER *Joint Symposium.* The Winter School, held from 9 to 20 Dec. 2024, featured tutorials and research reports by 36 lecturers, including 18 foreign scholars. In addition to WPI-SKCM² graduate program students and postdocs, 23 more early career researchers from abroad were supported to attend the school. Contents delivered in the School are available: https://wpi-skcm².hiroshima-u.ac.jp/conferences/2024-winter-school/

We have organized an entire dedicated week of the winter school (jointly with WPI I2CNER) to discuss the sustainability related matters, with the director articulating the vision and top global experts in sustainability (like Amory Lovins of Stanford U and Rocky Mountain Institute Director/founder) contributing to the discussion. We have articulated how our center strives to contribute to sustainability missions through fusion research. We are also organizing the future series of summer schools that will train our young researchers in terms of opportunities for doing research that contributes to sustainability. Regarding the relation to past projects, indeed there were successful efforts like development of insulating materials in the past, which were important for establishing credibility of our center in terms of contributing to sustainable future, but the approaches pursued by the WPI-SKCM2 are totally different even if having goals common with the ones of past projects, like boosting energy efficiency of buildings. We will be sure to better communicate this at the upcoming Site Visit. We truly believe that winter schools and summer schools are essential for preparing young researchers for fusion-focused research with the aspiration to contribute to sustainable future.

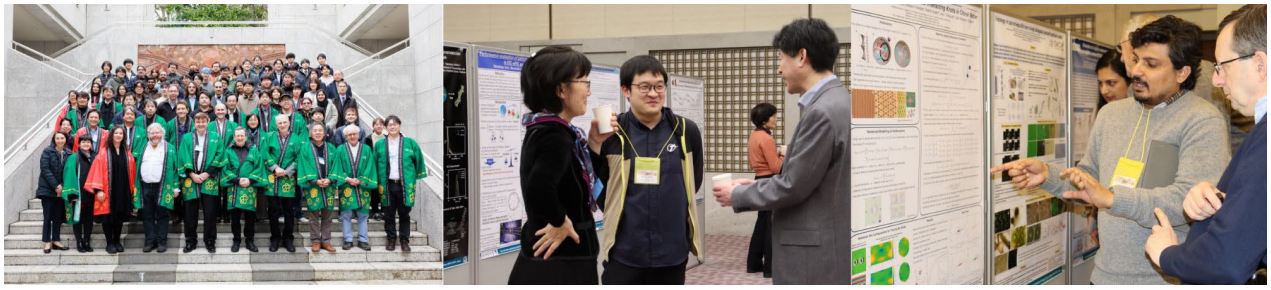
Week 1: Monday, December 9-13, 2024 – Knotted Chiral Meta Matter with a focus on Math & Science Communication. The scientific program was developed by Affiliate Member Louis Kauffman. The tutorial lectures provided excellent introductions for students and researchers to interdisciplinary research. In particular, Prof. Kauffman's lectures on topology mathematics and its linkage to material science, chemistry, and biology made mathematical techniques accessible to non-mathematical researchers, grasping entangled observables through numerical treatments with topological polynomial invariants. Week one concluded with a special session co-organized with HU's Writing Center, inviting Amos Martinez (Nature Materials) and Saad Bhamla (Georgia Tech) to discuss publishing and storytelling fundamentals important for various modes of communication.

Week 2: Monday, December 16-20, 2024 – Sustainability and SKCM²-I²CNER Joint Symposium. The second week focused on sustainability, and fundamental research that has sustainability applications. One notable lecture was given by Professor Amory Lovins (Stanford U & RMI) entitled "Astonishing Energy Futures." To connect with applied researchers, we also held a 1-day symposium with WPI-I²CNER, which is a WPI center dedicated to the science underlying energy technologies that promise significant reductions in carbon emissions over the next few decades.

Lou Kauffman Special Lecture Series. Lou Kauffman (UIC), renowned professor in knot topology and affiliate member of SKCM², had a 2-month sabbatical stay at Hiroshima University, and conducted a 9-part lecture series that was well attended by both local members in person and other global members online. https://wpi-skcm².hiroshima-u.ac.jp/seminars/9-part-special-lecture-series-from-professor-louis-kauffman/

Spring Symposium in Hiroshima. The spring symposium (4-5 March 2025) in Hiroshima City invited 12 speakers (6 speakers from foreign institutions). The speakers came a wide variety of fields, and all pointed out cross-disciplinary connections and open questions in their field that could be tackled by viewing problems through the lens of knot topology or chirality, such as Raphael Tieulent's (ITER

Organization) talk highlighting the potential for members of our institute to help improve the control and stabilization of plasma in nuclear fusion reactors.



We had 101 participants in the symposium. In addition to the scientific program, researchers and students had poster presentations to discuss their progress with foreign scholars. During the symposium, we also had a panel discussion with invited scholars and panel members about the opportunities and overcoming challenges for the institute, especially related to interdisciplinary collaboration and recruitment. The discussion highlighted the need for young researchers to become specialists in their own fields but then talk widely with others to bring together many great minds, and that SKCM² is already providing such an environment for young researchers to take advantage of.

Weekly SKCM² seminar series. Our weekly seminars constitute another excellent resource to foster interdisciplinary researchers. Researchers and students in SKCM² can join stimulating talks and discussions every week. In FY2024, we had 41 seminars across a range of topics related to the institute. After seminars, we have lunch time, where attendees can continue the discussion with invited speakers in a relaxed yet stimulating environment. The weekly seminars will help construct an international research environment that is not widely available in Hiroshima University's existing departments and institutes.

Career development symposia to promote diversity. We encourage diversity by hosting this year's diversity event entitled 'The People Behind the Science' Diversity Forum: Thriving Across Cultures with Professor Sonia Mahmoudi on 6 March 2025. Following the keynote by Affiliate Member, Mahmoudi (Tohoku U), a panel discussion will explore key topics, including the experiences of living and working in different countries, navigating cultural differences and language barriers, and institutional initiatives that foster inclusive and supportive academic environments. The panel featured Prof. Riho Sakurai (The HU Institute for Diversity & Inclusion)
Prof. Tony Z Jia (Institute of Science Tokyo) and Dr. David Burke (SKCM²). In addition, participants learned a brainstorming method, useful for any collaborative project, to discuss ideas for inclusive academic environments.

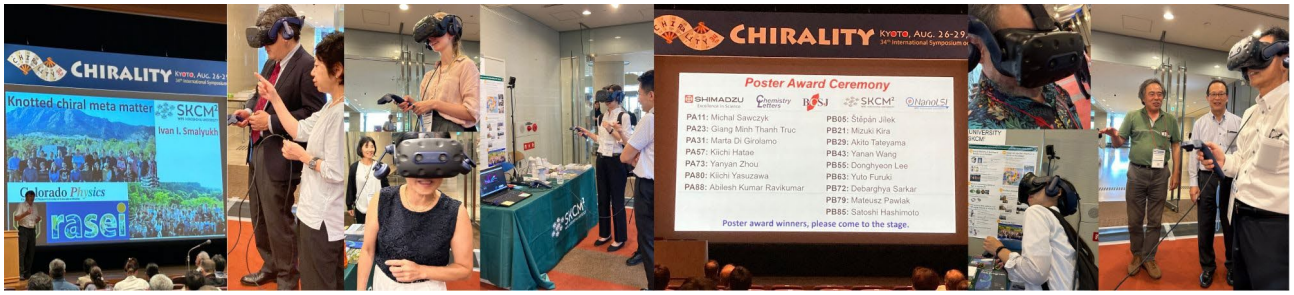
Promoting interactions & getting together as a collaborative community. Modeling our collaboration-promoting required activity based on that of WPI Kavli-IPMU, we strongly encourage students and young researchers to meet for coffee/tea time every day from 15:00 to 16:00. We think informal discussions among young people will harness the motivation to work on interdisciplinary research. Coffee/tea time is an essential daily event in SKCM² to ensure 'cross-pollination' among the research running in SKCM². We periodically use coffee/tea time for the students' short presentations or mini-poster sessions to share the research among the students who attend the events in SKCM², such as winter school. Even without any events, students, young researchers, and sometimes the invited speakers who gave a seminar talk come to the coffee room to discuss various subjects. It is interesting to see the whiteboards telling us what they discussed during the coffee/tea time. Young people are getting acquainted with the way global researchers live their lives.

Visibility to international academic communities

Director Presentations. Director Smalyukh was an invited speaker at many conferences and universities around the world in FY 2024 to present on research and vision related to the institute. Some venues include the 34th International Symposium on Chirality, WPI-MANA, Harvard, Princeton, three Max Planck institutes, American Physical Society in Anaheim.

Promotional activities at international conferences/ symposia. To enhance the visibility of WPI-SKCM² and attract young researchers, we participated as sponsors at two large international

conferences and symposia in relevant research fields. The 34th International Symposium on Chirality was held from August 26th to 29th, 2024, with over 300 people registered and 52 visitors to our booth. Similarly, the Science Japan Meeting 2025 took place on March 10, 2025, attracting more than 300 attendees, with 98 people visiting our booth. We introduced our institute and research through poster presentations, VR demonstrations, and 3D modeling displays. These promotional activities have effectively increased awareness of our institute among researchers and graduate students, generating interest and understanding of our research.



Video archives of lectures delivered at WPI-SKCM². We are archiving the lecture videos taken at weekly seminars and tutorials in the winter/summer schools. These videos are shared among the people of the WPI-SKCM². Furthermore, some video lectures are open through YouTube if the presenters approve public release, while others are only internally accessible to members of WPI-SKCM². These video archives are a valuable treasure for students and researchers who want to learn various aspects of the chiral and knot sciences in depth. These resources may help promote interdisciplinary research & will help with the global visibility of our WPI.

Using social media/networks to disseminate the daily activities in the WPI-SKCM². We disseminate the research and events via platforms such as X, Facebook, Instagram, LinkedIn and YouTube. Our dedicated pages are updated frequently to showcase and promote WPI-SKCM² activities, including seminars, meetings, awards, and other related events.

Academic Recruitment. The recruitment of doctoral fellows was advertised on the graduate recruitment website findaphd.com for the previous recruitment cycle to enhance international visibility, under the recommendation of external Board Member Mark Dennis.

3-2. Human Resource Building: Higher Education and Career Development

* Describe the content of measures taken by the center to foster young researchers, including doctoral students, through their participation in a research system that creates new interdisciplinary domains within a rich international environment.
* Describe measures taken for fostering researchers with a view to achieving gender plans, and measures taken for domestic and international promotion activities to attract female researchers to the center.

The plans have been developed to boost the doctoral student admissions. We consider this the priority and had many dedicated efforts even before this feedback (including the plans to involve international PIs in recruiting doctoral candidates), but their implementation has been challenging. We hope this will be accomplished, with tangible progress already demonstrated during the upcoming site visit. Among different measures, we now provide 1M yen startups to doctoral students to allow them be more important stakeholders in their interactions with mentors and co-mentors. We advertise the new doctoral program through creating a series of ads, articles, workshops, as well as with the help of our PIs (e.g. recruiting with the help of doctoral programs at the satellite in Colorado, USA) - we hope this will yield larger incoming classes of talented doctoral students.

Co-mentor system for students and postdoctoral researchers. We have launched the WPI-SKCM² graduate program. We currently have 23 graduate students (M: 12, D: 11). The number of female students is 5 (22%). 7 students come from foreign countries (30%). All the students are financially supported. Each student is supervised by a primary mentor and two co-mentors who are

experts in different fields. They can choose co-mentors from all the PIs/coPIs, including members of foreign institutes. Ph.D. students will have graduate training opportunities in foreign institutes, including the Topological Design Ph.D. training course at the University of Birmingham. The recruitment of doctoral fellows was advertised on the graduate recruitment website findaphd.com for the previous recruitment cycle to enhance international visibility.

Education and events. Graduate students and postdoctoral researchers are encouraged to attend weekly seminars, schooling, and symposia organized by the WPI-SKCM². We highly recommend that students attend daily coffee/tea time from 15:00 to 16:00. Each year, we select outstanding students and postdocs to attend other relevant scientific events. In FY 2024, we supported selected early career researchers to attend the 34th International Symposium on Chirality, which was held from 26-29 August 2024 in Kyoto. Ms. Giang Minh Thanh Truc, a Master's student and WPI-SKCM² fellow, was awarded the Shimadzu Poster Award at Chirality 2024 for her research on "Crystal Growth of Layered Chiral Inorganic Magnets Using the Chemical Transport Method." This work was conducted in collaboration with PI, Katsuya Inoue, and postdoc, Hadonahalli Munegowda Shashanka. Ms. Truc was one of nine recipients chosen from 200 presenters at the symposium.

These events and activities allow students and researchers to engage with researchers from a wide variety of disciplines, backgrounds, and cultures. The aim is to provide a rich environment to expose them to diverse ideas from researchers working on topology and chirality across the globe.

Teaching Experiences. These experiences are intended to prepare our young researchers for academic career opportunities, whenever they express such interest. Some postdoctoral researchers have taken on teaching responsibilities on behalf of PIs, along with respective titles of specially appointed assistant/associate professors, and several graduate students were provided opportunities to have teaching experiences as teaching assistants (TAs). These teaching roles provide valuable opportunities for early-career scientists to develop their communication and instructional skills, which are essential for a career in academia. In addition, engaging with students through teaching helps reinforce their own understanding of core scientific concepts and builds confidence in presenting complex material.

Exchanges through Expansion of International Partnerships. Partnership agreements are being established between the universities/institutions of our international PIs and WPI-SKCM² to promote international collaboration, following the strict guidance from the Site Visit's Working Group. Such agreements will be part of the re-quired co-employment of our international PIs by HU and their home institutions. Unfortunately, the processes take some time due to the complexity related to inter-institutional international agreements, but they will be the very top priority moving forward. The agreements, which will be formally signed soon, will aim to facilitate the exchange of students and postdoctoral researchers between our SKCM² center at HU and global nodes of the WPI.

3-3. Self-sufficient and Sustainable Center Development

* Describe the state of implementation of the host institution's mid-to-long term measures for supporting the center toward becoming self-sufficient and sustainable after the 10-year funding period ends, such as reforming the host institution's organization, providing personnel with priority allocation of tenured posts to the center, providing fundamental financial support, and material support including land and buildings.

Raising external funds by involving foreign members & postdocs of the WPI-SKCM².
International-based PIs, visiting faculty and affiliate members have the ability of applying for research grants through the WPI-SKCM² and HU. Our URAs support them in these applications. While several applications have been submitted, so far none were funded. On the other hand, several postdoctoral fellows have been successful in such applications. Albeit the staring grant amounts are small, they can be of great value to both promoting collaborative research and boosting confidence of young researchers, so that the can later pursue more challenging, bigger opportunities.

Building connections to the private sector for funding. In January 2025, a new URA-level staff member was recruited for dedicated fundraising activities. From then, a total of six (6) actions for this fiscal year were initiated. Our primary objectives were to enhance "networking within markets and industries" and to "identify collaboration opportunities through discussions in the consortium." To strengthen communication networks within relevant industries and support fundraising initiatives, we engaged in various events and conducted outreach targeted activities. During a manufacturing consortium seminar, we introduced the concept of "joint collaborative research" to industry participants. We participated in a consortium focused on collaborative research

opportunities. The implementation of actual collaborative activities is planned for the next fiscal year.

4. Others

* In addition to the above 1-3 points, if there is anything else that deserves mention regarding the center project's progress, please note it.

Web page updated. Our Web page was updated to disseminate information more attractively. We reformed the page to give site visitors more information at a glance on the front page with an attractive movie banner of the research conducted at WPI-SKCM^2.
https://wpi-skcm^2.hiroshima-u.ac.jp/
WPI-SKCM^2 Outreach Video. To broaden public understanding of the institute's mission and the value of our research, we produced an outreach video introducing our work in an accessible and engaging format in English and Japanese. The video highlights the center's interdisciplinary focus on topology, chirality, and sustainability, and showcases how fundamental research in these areas can lead to future technologies and applications. The videos were designed to appeal to a wide audience, including students, the general public, and potential students and postdocs. They are posted on YouTube and will be used in our booths and other outreach activities:
https://youtu.be/qOPLE_5W2K0?si=0szzuaMRIFA1NhLW (en); https://youtu.be/NOIkfERcB4E?si=ktYJ50RL5K7veQpd (jp)

5. Center's Response to Results of Last Year's Follow-up

* Transcribe the item from the "Actions required and recommendations" section in the site visit report and the Follow-up report, then note how the center has responded to them.
* If you have already provided this information, indicate where in the report.

Actions required and recommendations in the site visit report

1) Research at SKCM2 seems to be somewhat fragmental, and urgently needs both boosting and focusing. Currently, the projects by PIs are done too much on their own, mostly at the host institutions/universities of the PIs. We suggest that PIs hold a strategic planning discussion with the center director in an atmosphere where opinions can be freely expressed to identify what projects the center should pursue to fulfill the scientific mission of SKCM2. Those projects can be called "flagship" projects, in which several groups with different disciplines should participate to organize interdisciplinary collaborative teams. In this process, the cessation of some research directions may be required to make a more cohesive center with a unique and readily identifiable identity.
Action/Response: *We held such a brainstorming meeting as part of the Winter School (December 2024) and will hold one more in May 2025. The recommended Flagship Projects have been formally introduced starting from early 2025, where they help to structure, organize and highlight our fusion research. The projects are typically centered around one, two or three PIs who lead multidisciplinary efforts involving multiple other PIs and non-PI members from different other disciplines. For example, a flagship project led by PIs Shigaki and Sasaki focused on particle and nuclear physics connects to material sciences and mathematics in terms of re-creating physical behavior of subatomic physics phenomena in condensed matter analogues as well as in terms of developing better detectors for subatomic physics research. On the other hand, a flagship project on computational designs of chiral metamaterials, led by PI Dijkstra, connects to soft condensed matter physics, planetary sciences, chemistry and cosmochemistry and materials science, providing the machine-learning assisted guidance for many of our PIs in these fields doing fusion research. While similar plans were described in the original proposal (see, e.g. requirements for co-mentoring postdocs and doctoral students by PIs from different fields working on fusion research projects), we are now highly encouraging and more strongly enforcing these plans, and we hope to be able to show outcomes at the upcoming site visit. When needed, as recommended by the Site Visit team, cessation of intellectually disconnected projects is also pursued to achieve these goals. The Site Visit presentations this year will be organized to highlight these Flagship Projects and the fusion research that the PIs pursue within them. The director and our WPI leadership overall will appreciate the Site Visit team's specific recommendations on cessation or expansion of areas, when appropriate.*

2) The foreign PIs should stay at SKCM2 for longer periods of time to supervise graduate students

and postdocs and to fulfill their collaborative research responsibilities. Research activities of foreign PIs at HU need to be more visible even though the environment may not permit long term stays with their families, such as schooling. One way to achieve this would be for foreign PIs to each set up their own labs at HU, with co-PIs conducting daily research in close contact/communication with the PIs at their home institutions.
Action/Response: *Thank you for proposing the good way to accomplish this, which we adopt by re-designating the roles of coPIs so that coPIs will be only at HU and will be representatives of foreign PIs. Some PIs have already hired their coPI representatives and some identified them, with hiring now under way. We will report details at the Site Visit.*

3) In this connection, it is problematic that foreign PIs including the center director are still under consulting contracts with HU, which we understand were made to expedite the start of the center in 2022. HU urgently needs to make contracts of employment with foreign PIs and the director. Having a formal employment contract of the director with HU is significantly important as it relates to the execution of an intellectual property agreement between HU and the University of Colorado. Importantly, the center director should be responsible for the various SKCM2 tasks at HU as a faculty member, not as a consultant.
Action/Response: *This has been done (or nearly done) in the Director's case, where a comprehensive agreement has been developed between HU and CU-Boulder, and for some international PIs. We will strive to have the process completed before the Site Visit, with the new Admin Director Prof. Iwata now prioritizing this and hoping to accomplish this expeditiously.*

4) The center is recommended to reform its "meritocracy" approach and re-align the allocation of supplementary resources to programs that benefit the goals of the center. The director failed to convince the WG that the salary bonus system is working correctly as an incentive for intellectual commitments to the center. There are other, more pressing items, including the hiring of excellent young researchers, initial support for them, and installing advanced instruments for experiments, which should be given much more weight at this stage of the center development.
Action/Response: *We appreciate this guidance. Already during the discussion at the site visit, based on the feedback, Director put the bonus system on hold (canceled). Using the funds, he established a startup system of 1M yen to doctoral students and postdocs, which will allow young researchers more effectively engage in fusion research while collaborating with multiple PIs. To promote fusion research, we provide meritocracy-based small travel subsidy (to visit collaborating PIs & to present collaborative research) to PIs who publish fusion research, which is a pre-requisite.*

5) Many co-PIs (ca 13) and affiliate members (ca 70) have been appointed from all over the world, and some of them have published papers with SKCM2 in the affiliation name. At the moment, it is not clear whether some members are contributing only via working on their own research topics, with little involvement beyond that role. The center is recommended to evaluate the impact of its very large affiliates program on its research efforts. To reduce the total number of co-PIs and affiliate members, only co-PIs and affiliate members with strong collaborative research ties to the center's PIs should be carefully selected. "Co-PI" is usually used to designate a researcher who pairs with a foreign PI and helps to run the PI's lab at the WPI center. This is not how the term is used at SKCM2; it is recommended that SKCM2 use a wording that's more in line with its meaning of co-PI.
Action/Response: *We very much appreciate this feedback. Following this suggestion and related remarks, we have re-defined the titles and roles of coPIs to be consistent with the use of definition by other WPIs in Japan (our initial use of the term was based on its use in the USA). The former coPIs from outside HU will now be referred to as just visiting professors who visit HU to collaborate with PIs. As originally intended even for the former coPI title, they are not responsible for independent projects but rather collaborate with PIs to support the PI-driven research efforts (see the original proposal). This will be even more so with the new use of the title, where coPIs will be selected by international PIs to represent them at HU. Therefore, a new cohort of coPIs (with the titles of Specially Appointed Associate Professors at HU) is being hired at HU by the international PIs from outside HU, so that these coPIs can represent respective PIs. They are highly accomplished young researchers at appropriate career level, after several years of postdoc*

experiences. For example, a coPI representing MIT PI Jorn Dunkel will be Petur Bryde, originally from Island, with PhD from Harvard U and with several years of postdoc experience working with Jorn Dunkel at MIT, he will help to enhance our Center's fusion research. Also, only affiliate members nominated by PIs and supported by multiple other PIs will be considered for the Affiliate Member titles. We are re-evaluating contributions of current coPIs and Affiliate Members, so that only ones with significant contributions will retain the titles. This is done taking into account joint publications and collaborative research efforts/grants. Only the ones significantly contributing to the Center's missions will have the titles and access to opportunities like co-mentoring our students and postdocs. We will be very selective in giving these Affiliate Member titles and, at the same time, we will build/engage a broader SKCM2 community that will effectively help with the visibility of our Center and recruitment of young talented researchers purely on volunteering basis.

6) The center is recommended to assemble a plan to boost the number of Ph.D. graduate students within its graduate program.

Action/Response: *The plans have been developed. We consider this the priority and had many dedicated efforts even before this feedback (including the plans to involve international PIs in recruiting doctoral candidates), but their implementation has been challenging. We hope this will be accomplished, with tangible progress already demonstrated during the upcoming site visit. Among different measures, we now provide 1M yen startups to doctoral students to allow them be more important stakeholders in their interactions with mentors and co-mentors. We advertise the new doctoral program through creating a series of ads, articles, workshops, as well as with the help of our PIs (e.g. recruiting with the help of doctoral programs at the satellite in Colorado, USA) - we hope this will yield larger incoming classes of doctoral students.*

7) An intellectual property agreement is still missing. In relation to the director's employment contract at HU and the University of Colorado, a specific agreement on intellectual property should be made between the universities as soon as possible.

Action/Response: *This now has been developed by CU and HU. The intention was that the agreements start as of April 1, 2025, with the new fiscal year in Japan*

Actions required and recommendations in the Follow-up report

Many of the recommendations made last year are still unresolved. The Program Committee expects to receive clear and concrete responses to the recommendations below at the next year's Program Committee meeting.

1) SKCM2 should urgently establish a systematic and concrete research program unifying the diverse areas of research under the founding concept of "knotted chiral meta matter", without which the center will fragment into collaborations without substantial progress in any direction. It is very important to work quickly to prioritize key research topics and areas.

Action/Response: *Director & PIs have established a series of Flagship Projects & plan presenting on how our initial vision of the new research field of knotted chiral meta matter is implemented and becoming globally visible as the one defining the unique character of our institute.*

2) Foreign PIs need to stay longer at the center. HU should play a central role as the hub of all the activities. HU should immediately provide research space for foreign PIs until the time when the new research building is completed.

Action/Response: *Following this and related remarks from the Site Visit's Working Group committee, we have re-defined the roles of coPI titles to be consistent with the use by other WPIs in Japan. A new cohort of coPIs (with the titles of specially appointed Associate Professors at HU) is being hired at HU by the PIs from outside HU, so that these coPIs can represent respective PIs. Also, international PIs are strongly encouraged to spend more time at HU. The former coPIs will become visiting professors who visit HU to collaborate with PIs, with extended stays required. As originally intended, they collaborate with PIs to support the PI-driven research efforts, as described in the original proposal. Following our original proposal, and now that the new building is under construction, we will be hiring new faculty members at HU as new PIs. In the process of*

adding new PIs, while being very selective, we will consider recruiting some of the visiting professors. This will be done while accounting for the Site Visit's Working Group's feedback and individual candidates' contributions to fusion research across disciplines represented in our Center.

3) The center should clearly and more seriously articulate in the center's research plans how research on "knotted chiral meta matter" can contribute to the realization of a sustainable society and what specific goals they try to achieve.

Action/Response: *We are grateful for this recommendation. As articulated in the project's original vision, the unique contribution to sustainability that our WPI pursues is that we develop metamaterials with properties needed to address sustainability-related challenges, which do not exist in nature or even in research designs outside our center. The report above described many such examples, including knotted porous materials for carbon capture, building insulation, solar heat harnessing, data storage, spintronics, etc. The fusion-focused research would even allow pure mathematicians to contribute to sustainability through mathematical designs of such materials with desired properties. It is the insufficient level of fusion research that up to recently impeded this our highly ambitious research effort, but we work hard and recruit new personnel as needed in order to successfully gain visibility specifically as the WPI Center developing meta matter and contributing to sustainability through fundamental research of the WPI project as well through more applied research efforts enabled by the WPI's fundamental research breakthroughs. We hope that this year's Site Visit presentations of such fusion research for sustainability within each Flagship Project will help articulating the vision and highlighting the clear first outcomes.*

4) Plans should be formulated to increase the number of Ph.D. students within the interdisciplinary graduate program.

Action/Response: *We appreciate this recommendation. It is very unfortunate that the numbers of doctoral students are very low so far, as well as that very few of them come from other countries, especially North America and Europe. Attracting top students to apply has been a challenge. Once seeing the challenge, the director formulated the plan of hiring doctoral students with the help of international PIs, including through formation of satellites and establishing joint/dual degree programs. These plans face challenges in being implemented but we hope to see more progress soon. For example, the establishment of a satellite at CU-Boulder will allow for recruiting 3 doctoral students through University of Colorado admissions system, who will be partly supported by SKCM2 (50%) and partly by other programs at CU-Boulder; we will meanwhile work to do the needed paperwork for giving them dual/joint degrees and/or Certificates at both CU and HU. Building on this experience, we will make similar arrangements with institutions of other international PIs, in addition to recruiting students directly to HU with their help.*

5) The metrical system for bonus has not been well received and should be reviewed.

Action/Response: *We appreciate this helpful recommendation. Based on it, Director put the bonus system on hold entirely already during the Site Visit discussion. Using the funds, starting from Fall 2024, he established a startup system of 1M yen provided to doctoral students and postdocs in good standing, consistently with this feedback. To promote fusion research, we also provide meritocracy-based small travel subsidy (to visit collaborating PIs and to present collaborative research) to PIs if they publish fusion research, which is a pre-requisite. Additionally, we are in the process of establishing "SKCM2 Sabbatical" system to support long stays of HU PIs abroad and international PIs at HU while providing the needed support to respective PIs. We also intend to use some of the funds from the original bonus allocations in order to make our new building (construction finishing in December 2025) better equipped for fusion research.*

6) The cross-appointment of the center director at HU and the University of Colorado and a concrete intellectual property agreement between HU and the University of Colorado should be made immediately.

Action/Response: *Such detailed comprehensive agreements have been developed by HU and CU-Boulder, though the agreement was not yet formally signed by CU & HU as of March 31, 2025.*

Appendix 1 FY 2024 List of Center's Research Results and Main Awards

1. Refereed Papers

- List only the Center's papers published in 2024. (Note: The list should be for the calendar year, not the fiscal year.)

(1) Divide the papers into two categories, A and B.

A. WPI papers
List papers whose author(s) can be identified as affiliated with the WPI program (e.g., that state "WPI" and the name of the WPI center (WPI-center name)). (Not including papers in which the names of persons affiliated with the WPI program are contained only in acknowledgements.)

B. WPI-related papers
List papers related to the WPI program but whose authors are not noted in the institutional affiliations as WPI affiliated. (Including papers whose acknowledgements contain the names of researchers affiliated with the WPI program.)

Note: On 14 December 2011, the Basic Research Promotion Division (the Basic and Generic Research Division at present) in MEXT's Research Promotion Bureau circulated an instruction requiring paper authors to include the name or abbreviation of their WPI center among their institutional affiliations. From 2012, the authors' affiliations must be clearly noted.

(2) Method of listing paper
- List only refereed papers. Divide them into categories (e.g., original articles, reviews, proceedings).
- For each, write the author name(s); year of publication; journal name, volume, page(s) (or DOI number), and article title. Any listing order may be used as long as format is consistent. (The names of the center researchers do not need to be underlined.)
- If a paper has many authors (say, more than 10), all of their names do not need to be listed.
- Assign a serial number to each paper to be used to identify it throughout the report.
- If the papers are written in languages other than English, underline their serial numbers.
- Order of Listing

A. WPI papers
1. Original articles
2. Review articles
3. Proceedings
4. Other English articles

B. WPI-related papers
1. Original articles
2. Review articles
3. Proceedings
4. Other English articles

(3) Submission of electronic data
- In addition to the above, provide a .csv file output from the Web of Science (e.g.) or other database giving the paper's raw data including Document ID. (Note: the Document ID is assigned by paper database.)
- The papers should be divided into A or B categories on separate sheets, not divided by paper categories.

(4) Use in assessments
- The lists of papers will be used in assessing the state of WPI project's progress.
- They will be used as reference in analyzing the trends and whole states of research in the said WPI center, not to evaluate individual researcher performance.
- The special characteristics of each research domain will be considered when conducting assessments.

(5) Additional documents
- After all documents, including these paper listings, showing the state of research progress have been submitted, additional documents may be requested.

A. WPI papers

[Original articles]

1. Ishigaki, S; Matsumoto, M; Yoshii, R - A domain wall and chiral edge currents in holographic chiral phase transitions - JOURNAL OF HIGH ENERGY PHYSICS - 2024 – doi : 10.1007/JHEP05(2024)274
2. Ghavampoor, A; Bahri-Laleh, N; Sadjadi, S; Nekoomanesh, M; Vahid, A; Duran, J; Spiegel, M; Poater, A - A green approach to synthesize polybutene lubricants from mixed C4 monomers using supported dendritic ionic liquids - JOURNAL OF MOLECULAR LIQUIDS – 2024 – doi : 10.1016/j.molliq.2024.125814

3. Mondal, A; Mondal, M; Das, R; Ghosh, M; Bhowmik, A; Biswas, B; Banerjee, P - A homobimetallic nickel(II) complex for discriminative chromogenic recognition of aqueous cyanide and silver(I) from medicinal products: Role of end-on thiocyanate bridging - INORGANICA CHIMICA ACTA – 2024 – doi : 10.1016/j.ica.2024.122322
4. Subert, R; Campos-Villalobos, G; Dijkstra, M - Achiral hard bananas assemble double-twist skyrmions and blue phases - NATURE COMMUNICATIONS – 2024 – doi : 10.1038/s41467-024-50935-4
5. Kenny, S; Lai, CH; Chiang, TS; Brown, K; Hewitt, CS; Krabill, AD; Chang, HT; Wang, YS; Flaherty, DP; Hsu, STD; Das, C - Altered Protein Dynamics and a More Reactive Catalytic Cysteine in a Neurodegeneration-associated UCHL1 Mutant - JOURNAL OF MOLECULAR BIOLOGY – 2024 – doi : 10.1016/j.jmb.2024.168438
6. Blaschke, F; Romanczukiewicz, T; Slawinska, K; Wereszczynski, A - Amplitude modulations and resonant decay of excited oscillons - PHYSICAL REVIEW E – 2024 – doi : 10.1103/PhysRevE.110.014203
7. Yagi, S; Tagami, S - An ancestral fold reveals the evolutionary link between RNA polymerase and ribosomal proteins - NATURE COMMUNICATIONS – 2024 – doi : 10.1038/s41467-024-50013-9
8. Parton, TG; Parker, RM; Osbild, S; Vignolini, S; Frka-Petesic, B - Angle-resolved optical spectroscopy of photonic cellulose nanocrystal films reveals the influence of additives on the mechanism of kinetic arrest - SOFT MATTER – 2024 – doi : 10.1039/d4sm00155a
9. Sekiya, R; Haino, T - Application of Exciton Coupling for Characterization of Nanographene Edge - CHEMPHYSCHEM – 2024 – doi : 10.1002/cphc.202300740
10. Sekiya, R; Haino, T - Assessment of Edge Modification of Nanographene - CHEMPHYSCHEM – 2024 – doi : 10.1002/cphc.202400792
11. Qiu, ZB; Nitta, M - Baryonic vortex phase and magnetic field generation in QCD with isospin and baryon chemical potentials - JOURNAL OF HIGH ENERGY PHYSICS – 2024 – doi : 10.1007/JHEP06(2024)139
12. Neder, I; Sirote-Katz, C; Geva, M; Lahini, Y; Ilan, R; Shokef, Y - Bloch oscillations, Landau-Zener transition, and topological phase evolution in an array of coupled pendula - PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES OF THE UNITED STATES OF AMERICA – 2024 – doi : 10.1073/pnas.2310715121
13. Tanaka, H; Okazaki, S; Kobayashi, M; Fukushima, Y; Arai, Y; Iimori, T; Lippmaa, M; Yamagami, K; Kotani, Y; Komori, F; Kuroda, K; Sasagawa, T; Kondo, T - Broken Screw Rotational Symmetry in the Near-Surface Electronic Structure of AB-Stacked Crystals - PHYSICAL REVIEW LETTERS – 2024 – doi : 10.1103/PhysRevLett.132.136402
14. Abdulameer, NJ; Acharya, U; Adare, A; Aidala, C; Ajitanand, NN; Akiba, Y; Akimoto, R; Al-Ta'ani, H; Alexander, J; Shigaki, K; etc - Centrality dependence of Levy-stable two-pion Bose-Einstein correlations in √sNN=200 GeV Au + Au collisions - PHYSICAL REVIEW C – 2024 – doi : 10.1103/PhysRevC.110.064909
15. Abdulameer, NJ; Acharya, U; Adare, A; Aidala, C; Ajitanand, NN; Akiba, Y; Alfred, M; Apadula, N; Asano, H; Shigaki, K; etc - Charm- and bottom-quark production in Au plus Au collisions at √sNN=200

GeV - PHYSICAL REVIEW C – 2024 – doi : 10.1103/PhysRevC.109.044907

16. Acharya, S; Adamová, D; Agarwal, A; Rinella, GA; Aglietta, L; Agnello, M; Agrawal, N; Ahammed, Z; Ahmad, S; Shigaki, K; etc - Charm fragmentation fractions and c(c)over-bar cross section in p-Pb collisions at √sNN=5.02TeV - EUROPEAN PHYSICAL JOURNAL C – 2024 – doi : 10.1140/epjc/s10052-024-13394-1
17. Mancuso, V; Popescu, MN; Uspal, WE - Chemotactic behavior for a self-phoretic Janus particle near a patch source of fuel - SOFT MATTER – 2024 – doi : 10.1039/d4sm00733f
18. Hirao, T; Kishino, S; Yoshida, M; Haino, T - Hirao, T; Kishino, S; Yoshida, M; Haino, T - CHEMISTRY-A EUROPEAN JOURNAL – 2024 – doi : 10.1002/chem.202403569
19. Kralj, N; Ravnik, M; Kos, Z - Chirality, anisotropic viscosity and elastic anisotropy in three-dimensional active nematic turbulence – 2024 – doi : 10.1038/s42005-024-01720-8
20. Izquierdo, AA; Manton, NS; Guilarte, JM; Wereszczynski, A - Collective coordinate models for 2-vortex shape mode dynamics - PHYSICAL REVIEW D – 2024 – doi : 10.1103/PhysRevD.110.085006
21. Alvim, T; da Gama, MMT; Tasinkevych, M - Collective variable model for the dynamics of liquid crystal skyrmions - COMMUNICATIONS PHYSICS – 2024 – doi : 10.1038/s42005-023-01486-5
22. Shimoyama, D; Sekiya, R; Inoue, S; Hisano, N; Tate, SI; Haino, T - Conformation Regulation of Trisresorcinarene Directed by Cavity Solvation - CHEMISTRY-A EUROPEAN JOURNAL – 2024 – doi : 10.1002/chem.202402922
23. Bej, S; Das, R; Pal, R; Banerjee, P - Conjoining the benefits of an additional phenyl ring in a simple benzophenone hydrazone-based platform @ discriminatory recognition of F-- over CN-with- with quantitation of aqueous Cu2+: 2+: New tricks for an old dog - JOURNAL OF MOLECULAR LIQUIDS – 2024 – doi : 10.1016/j.molliq.2024.125781
24. Laliena, V; Osorio, SA; Bustingorry, S; Campo, J - Continuum of metastable helical states of monoaxial chiral magnets: Effect of boundary conditions - PHYSICAL REVIEW B – 2024 – doi : 10.1103/PhysRevB.109.214424
25. Katuri, J; Kaur, N; Uspal, W; Cornelius, A; Quashie, D Jr; Ali, J - Control of colloidal cohesive states in active chiral fluids - COMMUNICATIONS PHYSICS – 2024 – doi : 10.1038/s42005-024-01787-3
26. Fujii, N; Hisano, N; Hirao, T; Kihara, SI; Tanabe, K; Yoshida, M; Tate, SI; Haino, T - Controlled Helical Organization in Supramolecular Polymers of Pseudo-Macrocyclic Tetrakisporphyrins - ANGEWANDTE CHEMIE-INTERNATIONAL EDITION – 2024 – doi : 10.1002/anie.202416770
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28. Marczenko, M; Redlich, K; Sasaki, C - Curvature of the energy per particle in neutron stars - PHYSICAL REVIEW D – 2024 – doi : 10.1103/PhysRevD.109.L041302
29. Karimi, M; Sadjadi, S; Arabi, H; Bahri-Laleh, N; Poater, A - Design and Synthesis of a Novel Catalytic System Based on Pd Supported on Alumina Extrudates for Hydrotreating of PAO Lubricants - APPLIED ORGANOMETALLIC CHEMISTRY – 2024 – doi : 10.1002/aoc.7730
30. Higuchi, Y; Itaya, R; Saito, H; Toichi, Y; Kobayashi, T; Tomita, M; Terakawa, S; Suzuki, K; Kuroda, K;

Kotani, T; Matsui, F; Suga, S; Sato, H; Sato, K; Sakamoto, K - Determination of the actual valence band of a topological insulator Bi2Se3 - VACUUM – 2024 – doi : 10.1016/j.vacuum.2024.113944

31. Fukuda, J; Takahashi, KZ - Direct simulation and machine learning structure identification unravel soft martensitic transformation and twinning dynamics - PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES OF THE UNITED STATES OF AMERICA – 2024 – doi : 10.1073/pnas.2412476121
32. Amari, Y; Ross, C; Nitta, M - Domain-wall skyrmion chain and domain-wall bimerons in chiral magnets - PHYSICAL REVIEW B – 2024 – doi : 10.1103/PhysRevB.109.104426
33. Eto, M; Nishimura, K; Nitta, M - Domain-wall Skyrmion phase in a rapidly rotating QCD matter - JOURNAL OF HIGH ENERGY PHYSICS – 2024 – doi : 10.1007/JHEP03(2024)019
34. Hashimoto, S; Matsuo, K - Dynamic Observation of the Membrane Interaction Processes of β-Lactoglobulin by Time-Resolved Vacuum-Ultraviolet Circular Dichroism - ANALYTICAL CHEMISTRY – 2024 – doi : 10.1021/acs.analchem.4c00556
35. Nitta, M; Uzawa, K - Dynamical branes on expanding orbifold and complex projective space - PHYSICAL REVIEW D – 2024 – doi : 10.1103/PhysRevD.109.124054
36. Bittencourt, GHR; Carvalho-Santos, VL; Chubykalo-Fesenko, O; Altbir, D; Moreno, R - Dynamics of chiral domain walls in bent cylindrical magnetic nanowires - JOURNAL OF APPLIED PHYSICS – 2024 – doi : 10.1063/5.0188985
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40. Yörük, E; Lecourt, C; Housset, D; Izumi, Y; Ling, WL; Kodjikian, S; Tretyakov, E; Inoue, K; Maryunina, K; Desroches, C; Klein, H; Luneau, D - Electron diffraction unveils the 2D metal-radical framework of two molecule-based magnets - INORGANIC CHEMISTRY FRONTIERS – 2024 – doi : 10.1039/d4qi02257b
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43. Sirote-Katz, C; Shohat, D; Merrigan, C; Lahini, Y; Nisoli, C; Shokef, Y - Emergent disorder and mechanical memory in periodic metamaterials - NATURE COMMUNICATIONS – 2024 – doi : 10.1038/s41467-024-47780-w
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2. Invited Lectures, Plenary Addresses (etc.) at International Conferences and International Research Meetings

- List up to 10 main presentations during FY 2024 in order from most recent.
- For each, write the date(s), lecturer/presenter's name, presentation title, and conference name.

Date(s)	Lecturer/Presenter's name	Presentation title	Conference name
Dec. 5 , 2024	Hikaru Yabuta	What the asteroid Ryugu told us	The 21st Nano Bio Info Chemistry Symposium
Sept. 30-Oct. 2, 2024	Silvia Vignolini	Bio-inspired and Living Material for light-matter control	52nd Biennial Assembly of the German Colloid Society
Sept. 25, 2024	Marjolein Dijkstra	Let's twist again: Colloidal Bananas Assemble into Double-Twist Skyrmions and Blue Phases	Liquid Matter Conference
Aug 26-29, 2024	Ivan Smalyukh	Knotted Chiral Meta Matter	34th International Symposium Chirality 2024
Aug. 20, 2024	Shang-Te Danny Hsu	Use of methyl NMR to probe functional dynamics of human deubiquitinases perturbed by disease-associated mutations	International Congress of Magnetic Resonance in Biological Systems (ICMRBS)
Aug. 12, 2024	Dwaipayan Chakrabarti	Colloids Get Creative: Key to Open Crystals for Advanced Materials	Invited Physics Seminar
July 5, 2024	Claire Donnelly	Mapping and controlling three-dimensional spin textures (semi-plenary)	International Conference on Magnetism 2024
June 22, 2024	Shang-Te Danny Hsu	Functional annotation of viral protein sugarcoats	IUPAB 2024
June, 2-5, 2024	Mykola Tasinkevych	How to steer catalytic nanoswimmers?	The Nanomotors International Conference: 20th Anniversary
May 2, 2024	Akio Kimura	Unveiling Electronic Structure of Heusler-type Mn and Co Based Metamagnetic Shape Memory Alloys	9th International Conference on Superconductivity and Magnetism (ICSM 2024)

3. Major Awards

- List up to 10 main awards received during FY 2024 in order from the most recent.
- For each, write the date issued, the recipient's name, and the name of award.
- In case of multiple recipients, underline those affiliated with the center.

Date	Recipient's name	Name of award
March 27, 2025	Ivan Smalyukh	2024 AAAS Fellow Selection, American Association for Advancement of Science (AAAS)
March 11, 2025	Takuma Iwata, T. Kousa, Y. Nishioka, K. Ohwada, K. Sumida, E. Annese, M. Kakoki, Kenta Kuroda, H. Iwasawa, M. Arita, S. Kumar, A. Kimura, K. Miyamoto, T. Okuda	「Physics Top 100 of 2024」in Scientific Reports
Dec. 5, 2024	Shunichi Murakami	2024 Nishina Memorial Prize
Nov. 28, 2024	Shang-Te Danny Hsu	2024 Grand prix scientifique fanco-taïwanais
Oct. 24, 2024	Silvia Vignolini	Colloid and Polymer Science Lecture Award 2024
July 31, 2024	Hikaru Yabuta	Meteoritical Society 2024 Fellow
June 24, 2024	Claire Donnelly	DFG Heinz Maier-Leibnitz Prize 2024
June 1, 2024	Dwaipayan Chakrabarti	Leverhulme Research Fellowship at the University of Birmingham
April 17, 2024	Kuroda Kenta	"Young Scientists' Award" in the 2024 Commendation for MEXT
April 10, 2024	Ivan Smalyukh	2024 Gray Medal of the British Liquid Cristal Society, United Kingdom

Appendix 2　FY 2024 List of Principal Investigators

NOTE:

*Underline names of principal investigators who belong to an overseas research institution.

*In the case of researcher(s) not listed in the in the latest report, attach a "Biographical Sketch of a New Principal Investigator"(Appendix 2a).

*Enter the host institution name and the center name in the footer.

<Results at the end of FY2024> **Principal Investigators Total: 16**

Name	Age	Affiliation (Position title, department, organization)	Academic degree, specialty	Effort (%)*	Starting date of project participation	Status of project participation (Describe in concrete terms)	Contributions by PIs from overseas research institutions
Center director: Ivan I. Smalyukh	52	(1) Professor/Department of Physics, MSE and Renewable Sustainable Energy Institute/University of Colorado at Boulder (2) Director / SKCM2, Hiroshima University	Ph.D., Topological solitons, knotted matter, self-assembly, predesigned building blocks of matter, soft matter	80	Nov. 11, 2022	He stays at the center (nearly 50%) while also directing WPI-related activities at HU and at Univ Colorado and Globally	He organizes the center and directs its overall activities.
Deputy director for Education: Katsuya Inoue	60	Professor/Academy of Hiroshima University, Graduate School of Advanced Science and Engineering, Chemistry/Hiroshima University	Ph.D., Experimental material sciences, chemistry	70	Nov. 11, 2022	He usually stays at the center.	
Deputy director for Outreach & Dissemination: Yuka Kotorii	40	(1) Associate Professor/Academy of Hiroshima University, Graduate School of Advanced Science and Engineering, Mathematics/Hiroshima University (2) Visiting Scientist/Interdisciplinary Theoretical and Mathematical Sciences Program (iTHEMS)/RIKEN	Ph.D., Mathematics (topology, knot theory)	70	Nov. 11, 2022	She usually stays at the center.	
Deputy director for Science: Hikaru Yabuta	50	Professor/Academy of Hiroshima University, Graduate School of Advanced Science and Engineering, Earth and Planetary System Science/Hiroshima University	Ph.D., Cosmochemistry, geochmistry	70	Nov. 11, 2022	She usually stays at the center.	

Claire Donnelly	33	Lise Meitner Group Leader/Max Planck Institute for Physical Chemistry of Solids	Ph.D., 3D topology in magnets, nanoscale imaging	30	Nov. 11, 2022	She usually stays at Max Planck Institute as a partner institute and visits the center	She co-mentors postdocs and students at HU & hosts one postdoc from HU by July 2024 & sent her student and postdoc to HU. She engaged 3 postdocs in the WPI project.
Kenta Kuroda	38	Associate Professor/Academy of Hiroshima University, Graduate School of Advanced Science and Engineering, Physical Science/Hiroshima University	Ph.D., Solid state physics, momentum-space topology in quantum matter	70	Nov. 11, 2022	He usually stays at the center.	
Elisabetta Matsumoto	38	Associate Professor/School of Physics/Georgia Institute of Technology	Ph.D., Geometry and topology of soft matter	25	Nov. 11, 2022	She usually stays at Georgia Institute of Technology as a partner institute and visits the center	She co-mentors postdocs and students at HU & sent her students to HU.
Hiroshi Sato	44	(1) Specially Appointed Professor/Academy of Hiroshima University, SKCM2/Hiroshima University (2) Unit Leader/Emergent Molecular Assembly Research Unit, Cross-Divisional Materials Research Program/RIKEN Center for Emergent Matter Science	Ph.D., Chemistry, material science	100	Nov. 11, 2022	He usually stays at RIKEN as a partner institute and visits the center every three months.	
Silvia Vignolini	43	Professor/Department of Chemistry/University of Cambridge	Ph.D., Chiral bio-materials, self-assembly	30	Nov. 11, 2022	She usually stays at University of Cambridge as a partner institute and visits the center	She co-mentors postdocs and students at HU.
Andrey Leonov	44	Associate Professor/Academy of Hiroshima University, Graduate School of Advanced Science and Engineering, Chemistry/Hiroshima University	Ph.D., Condensed matter physics theory	70	Nov. 11, 2022	He usually stays at the center.	
Chihiro Sasaki	47	Professor/ Institute of Theoretical Physics/University of Wroclaw	Ph.D., High energy particle physics (theory)	30	Nov. 11, 2022	She usually stays at University of Wroclaw as a partner institute and visits the center	She mentors a postdoc at HU & co-mentors postdocs and students at HU.

Jörn Dunkel	48	Professor/Department of Mathematics/ Massachusetts Institute of Technology	Ph.D., Applied mathematics, and topoloty	25	Nov. 11, 2022	He usually stays at Massachusetts Inst. Tech. as a partner institution and visits the center	He co-mentors postdocs and students at HU & sent his postdoc to HU.
Shang-Te Danny Hsu	49	Research Fellow, Deputy Director/Institute of Biological Chemistry/Academia Sinica	Ph.D., Biophysical chemistry, structural biology, knotted proteins, COVID-19	30	Nov. 11, 2022	He usually stays at Academia Sinica as a partner institute and visits the center	He mentors two postdocs at HU & co-mentors postdocts and students at HU.
Kenta Shigaki	57	Professor/Academy of Hiroshima University, Graduate School of Advanced Science and Engineering, Physics/Hiroshima University	Ph.D., High energy particle physics (experiment)	70	Nov. 11, 2022	He usually stays at the center.	
Marjolein Dijkstra	57	Professor/Faculty of Science, Debye Institute for Nanomaterials Science/Utrecht University	Ph.D., Condensed matter theory, toplogy	30	Nov. 11, 2022	She usually stays at Utrecht University as a partner institute and visits the center once a year.	She mentors a postdoc at HU & co-mentors postdocs and students at HU & sent her postdoc to HU.
Takeharu Haino	60	Professor/Academy of Hiroshima University, Graduate School of Advanced Science and Engineering, Chemistry/Hiroshima University	Ph.D., Chiral supramolecular chemistry	70	Nov. 11, 2022	He usually stays at the center.	

*Percentage of time that the principal investigator devotes to working for the center vis-à-vis his/her total working hours.

e.g., a) usually stays at the center,

b) stays at the center once a month, at XX satellite three times a week, and XX satellite once a year,

c) joins a videoconference from another institution two times a week.

e.g., send/accept young scientists to/from the WPI center (number/period)

Principal investigators unable to participate in project in FY 2024

Name	Affiliation (Position title, department, organization)	Starting date of project participation	Reasons	Measures taken

Appendix 3-1 FY 2024 Records of Center Activities

1. Researchers and center staff, satellites, partner institutions

1-1. Number of researchers in the "core" established within the host institution

- Regarding the number of researchers at the Center, fill in the table in Appendix 3-1a.

Special mention

- Enter matters warranting special mention, such as concrete plans for achieving the Center's goals, established schedules for employing main researchers, particularly principal investigators.
- As background to how the Center is working on the global circulation of world's best brains, give good examples, if any, of how career paths are being established for the Center's researchers; that is, from which top-world research institutions do researchers come to the Center and to which research institutions do the Center's researchers go, and how long are their stays at those institutions.

Prof. Shuichi Murakami of Tokyo Tech, coPI in the WPI-SKCM^2, will be promoted to PI in April 2025 in order to strengthen research activities in the field of momentum space topology in quantum matter. He is expected to lead the projects conducted by the team of Prof. Kenta Kuroda, PI, and Prof. Akio Kimura, coPI, along with their postdoctoral researchers.

Organization with foreign institutes to facilitate student exchange.

One of our missions is to foster young researchers who will gain international recognition. To support this, we provide Ph.D. students with opportunities to conduct research at overseas institutions under the supervision of foreign members of WPI-SKCM². Establishing arrangements with these institutions is essential to facilitate student exchanges between them and WPI-SKCM².

We have reached an agreement with the University of Birmingham, where Prof. Chakrabarti (co-PI of WPI-SKCM²) will host our Ph.D. students for a two-month stay starting in April 2025. We will continue to expand both our educational and research networks by building partnerships with other international institutions affiliated with WPI-SKCM².

Researchers got promotion in FY2024

Three researchers got promoted.

A postdoctoral fellow, Dr. Bohan Cheng became an assistant professor in the University of Tokyo in January 2025.

A postdoctoral fellow, Dr. Kentaro Nishimura will become a JSPS Research Fellowship for Young Scientists (PD) in Niigata University in April 2025.

A postdoctoral fellow, Dr. Luke Turnbull will become a staff member at Diamond Light Source in April 2025.

1-2. Satellites and partner institutions

- List the satellite and partner institutions in the table below.
- Indicate newly added and deleted institutions in the "Notes" column.
- If satellite institutions have been established overseas, describe by satellite the Center's achievements in coauthored papers and researcher exchanges in Appendix 4.

<Satellite institutions>

Institution name	Principal Investigator(s), if any	Notes

< Partner institutions>

Institution name	Principal Investigator(s), if any	Notes

Department of Physics, Colorado University	Ivan I. Smalyukh	Director of SKCM^2
Department of Mathematics, Massachusetts Institute of Technology	Jörn Dunkel	PI
Max Planck Institute for Physical Chemistry of Solids	Claire Donnelly	PI
Department of Chemistry, University of Cambridge	Silvia Vignolini	PI
School of Physics, Georgia Institute of Technology	Elisabetta Matsumoto	PI
Debye Institute for Nanomaterials Science, Utrecht University	Marjolein Dijkstra	PI
Emergent Molecular Assembly Research Unit/RIKEN Center for Emergent Matter Science	Hiroshi Sato	PI
Institute of Theoretical Physics, University of Wroclaw	Chihiro Sasaki	PI
Institute of Biological Chemistry, Academia Sinica	Shang-Te Danny Hsu	PI
University of Lisbon, Portugal	Mykola Tasinkevych, coPI	coPI
Tel Aviv University, Israel	Yair Shokef, co-PI	coPI
University of Birmingham, UK	Dwaipayan Chakrabarti, co-PI	coPI

1-3. Postdoctoral Positions through Open International Solicitations

- In the columns "number of applications" and "number of selections," put the total number (upper) and the number and percentage of overseas researchers in the < > brackets (lower).

Fiscal year	Number of applications	Number of selections
FY 2024	90	7
	〈 70 , 78%〉	〈 6 , 86%〉

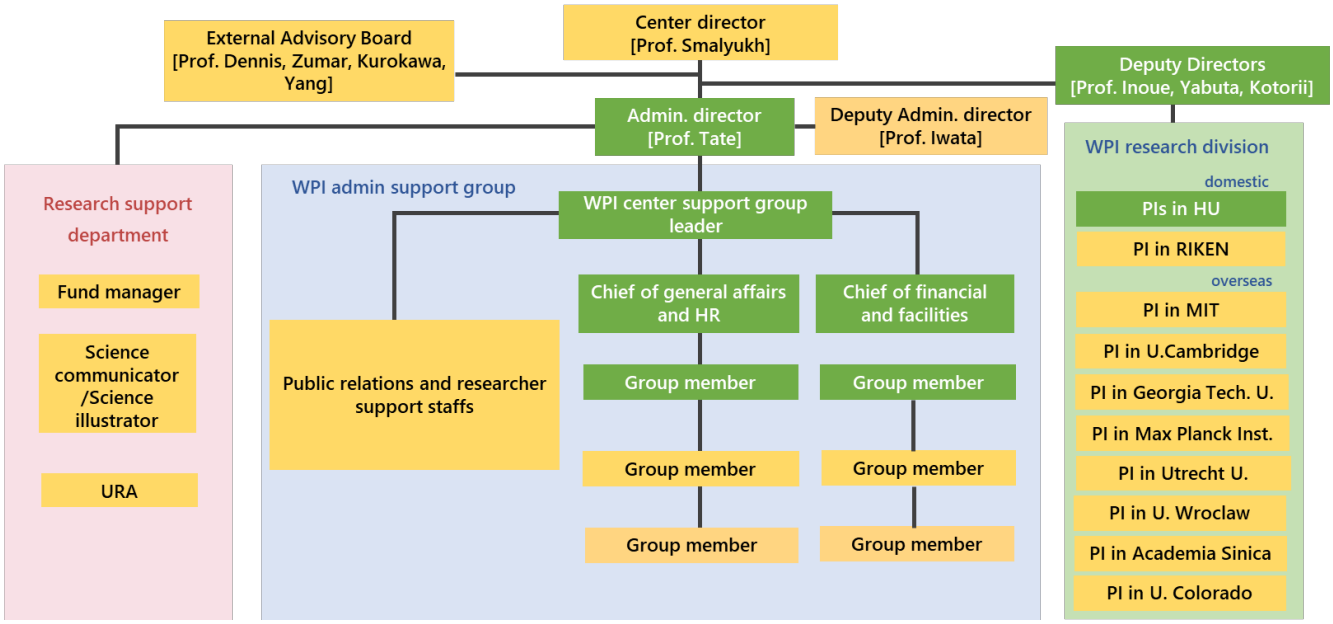
2. Holding international research meetings

- Indicate the number of international research conferences or symposiums held in FY2024 and give up to three examples of the most representative ones using the table below.

FY 2024: 8 meetings	
Major examples (meeting titles and places held)	Number of participants
WPI-SKCM² Spring Symposium, Hiroshima International Conference Center	From domestic institutions: 90 From overseas institutions: 11
WPI-SKCM² Summer School, Hiroshima University and Hokkaido University	From domestic institutions: 52 From overseas institutions: 23
WPI-SKCM² Winter School, Hiroshima University and Kyusyu University	From domestic institutions: 71 From overseas institutions: 44

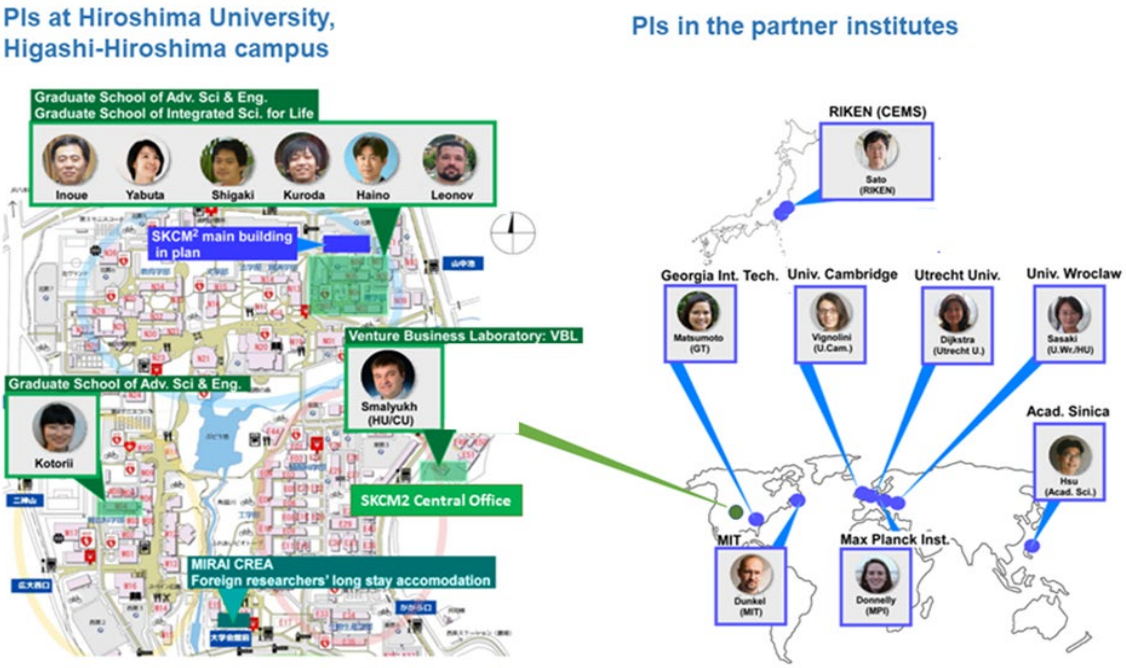
3. Diagram of management system

- Diagram the center's management system and its position within the host institution in an easily understood manner.
- If any new changes have been made in the management system from that in the latest "center project" last year, describe them. Especially describe any important changes made in such as the center director, administrative director, head of host institution, and officer(s) in charge at the host institution (e.g., executive vice president for research).



4. Campus Map

- Draw a simple map of the campus showing where the main office and principal investigator(s) are located.



5. Securing external research funding*

External research funding secured in FY2024

Total: 509,549,000 yen

- Describe external funding warranting special mention. Include the name and total amount of each grant.
* External research funding includes "KAKENHI," funding for "commissioned research projects," "joint research projects," and for others (donations, etc.) as listed under "Research projects" in Appendix 3-2, Project Expenditures.

Type of Funding	Funding Amount
Project supported by other government subsidies, etc.	107,625,000 yen
Grants-in-Aid for Scientific Research (KAKENHI)	65,000,000 yen
Commissioned Research Projects	49,967,000 yen
Joint Research Projects	32,644,000 yen
Others (donation funds, etc.)	254,313,000 yen
Total* (total for above mentioned)	**509,549,000 yen**

Appendix 3-1a FY 2024 Records of Center Activities

Researchers and other center staff

Number of researchers and other center staff

* Fill in the number of researchers and other center staff in the table blow.
* Describe the final goals for achieving these numbers and dates when they will be achieved described in the last "center project."

a) Principal Investigators

(full professors, associate professors or other researchers of comparable standing)

(number of persons)

	At the beginning of project	At the end of FY 2024	Final goal (Date: April, 2027)
Researchers from within the host institution	9	8	10
Researchers invited from overseas	8	8	10
Researchers invited from other Japanese institutions	2	0	4
Total principal investigators	19	16	24

b) Total members

		At the beginning of project		At the end of FY 2024		Final goal (Date: April, 2027)	
		Number of persons	%	Number of persons	%	Number of persons	%
Researchers		30		119		156	
	Overseas researchers	13	43	74	62	79	51
	Female researchers	7	23	36	30	79	51
	Principal investigators	19		16		24	
	Overseas PIs	8	42	8	50	12	50
	Female PIs	7	37	7	44	12	50
	Other researchers	8		83		66	
	Overseas researchers	2	25	51	61	34	52
	Female researchers	0	0	20	24	34	52
	Postdocs	3		20		66	
	Overseas postdocs	3	100	15	75	33	50
	Female postdocs	0	0	9	45	33	50
Research support staffs		2		3		4	
Administrative staffs		3		14		13	
Total number of people who form the "core" of the research center		35		136		173	

		At the beginning of project		At the end of FY 2024		Final goal (Date: April, 2027)	
		Number of persons	%	Number of persons	%	Number of persons	%
Doctoral students		0		23		72	
	Employed	0	-	16	69.6	72	100.0

※b) The number of doctoral students in the lower table can be duplicated in the upper table of overall composition.

Appendix 3-2 Project Expenditures

1) Overall project funding

* In the "Total costs" column, enter the total amount of funding required to implement the project, without dividing it into funding sources.
* In the "Amount covered by WPI funding" column, enter the amount covered by WPI within the total amount.
* In the "Personnel," "Project activities," "Travel," and "Equipment" blocks, the items of the "Details" column may be changed to coincide with the project's actual content.

(Million yens)

Cost items	Details (For Personnel - Equipment please fill in the breakdown of fiscal expenditure, and the income breakdown for Research projects.)	Total costs	Amount covered by WPI funding
Personnel	Administrative director and Deputy Administrative director	13.9	9.7
	Center director and HU Principal Investigators (no. of persons):9	75.3	57.0
	HU & Domestic Co-PIs (no. of persons):11	27.7	12.9
	Posdoc (no. of persons):20	110.9	110.9
	RAs (no. of persons):17	21.2	21.2
	Research support staff (no. of persons):7	22.3	22.1
	Administrative staff (no. of persons):20	89.0	87.7
	Start-up Bonus, etc.	6.5	0.0
	Subtotal	366.8	321.5
Project activities	Rental fees for research space	22.0	0.0
	Facility maintenance costs (utility expenses, etc.)	7.3	0.0
	Consulting Fee (Overseas PIs & Co-PIs, etc.)	89.5	56.3
	Office furniture and equipment	0.0	16.5
	Startup funds of Co-PIs (no. of persons):5	10.7	10.7
	Startup funds of young researcher (no. of persons):23	10.6	10.6
	Article publishing charge	13.3	13.3
	Summer / Winter School and International Symposium	3.7	2.5
	External advisory fee	3.0	3.0
	Advertising expenses	11.8	8.2
	Other costs	42.2	25.2
	Subtotal	214.1	146.3
Travel	Domestic travel costs	20.0	15.1
	Overseas travel costs	47.3	38.4
	Travel and accommodations cost for invited scientists (no. of domestic):17、(no. of overseas):45	17.0	17.0
	Travel cost for scientists on transfer (no. of domestic):1、(no. of overseas):5	1.9	1.9
	Subtotal	86.2	72.4
Equipment	Depreciation of buildings	128.5	2.8
	Depreciation of equipment	157.0	157.0
	Subtotal	285.5	159.8
Research projects (Detail items must be fixed)	Project supported by other government subsidies, etc. *1	107.6	0.0
	KAKENHI	65.0	0.0
	Commissioned research projects, etc.	50.0	0.0
	Joint research projects	32.6	0.0
	Ohers (donations, etc.)	254.3	0.0
	Subtotal	509.5	0.0
Total		1462.1	700.0

Costs (Million yens)

WPI grant in FY 2024	**700.0**
Costs of establishing and maintaining	**128.5**
Establishing new facilities	125.7
(Number of facilities: 1, 5,970m²)	
Repairing facilities	2.8
(Number of facilities: 1, 1,514 m²)	
Costs of equipment procured	**157.0**
Wide-range high-power wavelength tunable femtosecond laser	32.8
(Number of units:1)	
Atomic force microscope system upgrade	31.9
(Number of units:1)	
Viscoelastic measurement system	18.0
(Number of units:1)	
High-precision gas/vapor adsorption measurement device	17.4
(Number of units:1)	
Supercritical drying equipment system	7.1
(Number of units:1)	
High-temperature simple atmosphere electric furnace	5.0
(Number of units:1)	
Others	44.8

*1. Management Expenses Grants (including Management Enhancements Promotion Expenses (機能強化経費)), subsidies etc., indirect funding, and allocations from the university's own resources.
*2 When personnel, travel, equipment (etc.) expenses are covered by KAKENHI or under commissioned research projects or joint research projects, the amounts should be entered in the "Research projects" block.

*1 運営費交付金（機能強化経費を含む）、各種補助金、間接経費、その他大学独自の取組による学内リソースの配分等による財源
*2 科研費、受託研究費、共同研究費等によって人件費、旅費、設備備品等費を支出している場合も、その額は「研究プロジェクト費」として計上すること

2) Costs of satellites

(Million yens)

Cost items	Details	Total costs	Amount covered by WPI funding
Personnel	Principal investigators (no. of persons):OO		
	Other researchers (no. of persons):OO		
	Research support staff (no. of persons):OO		
	Administrative staff (no. of persons):OO		
	Subtotal	0	0
Project activities	Subtotal		
Travel	Subtotal		
Equipment	Subtotal		
Research projects	Subtotal		
Total		0	0

Appendix 4 FY 2024 Status of Collaboration with Overseas Satellites

1. Coauthored Papers

- List the refereed papers published in FY 2024 that were coauthored between the center's researcher(s) in domestic institution(s) (include satellite institutions) and overseas satellite institution(s). List them by overseas satellite institution in the below blocks.
- Transcribe data in same format as in Appendix 1. Italicize the names of authors affiliated with overseas satellite institutions.
- For reference write the Appendix 1 item number in parentheses after the item number in the blocks below. Let it free, if the paper is published in between Jan.-Mar. 2025 and not described in Appendix 1.

Overseas Satellite 1 **Name** (Total: OO papers)

1)
2)
3)
4)

Overseas Satellite 2 **Name** (Total: OO papers)

1)
2)
3)
4)

2. Status of Researcher Exchanges

- Using the below tables, indicate the number and length of researcher exchanges in FY 2024. Enter by institution and length of exchange.
- Write the number of principal investigator visits in the top of each space and the number of other researchers in the bottom.

Overseas Satellite 1:

<To satellite>

	Under 1 week	From 1 week to 1 month	From 1 month to 3 months	3 months or longer	Total
FY2024					

<From satellite>

	Under 1 week	From 1 week to 1 month	From 1 month to 3 months	3 months or longer	Total
FY2024					

Overseas Satellite 2:

<To satellite>

	Under 1 week	From 1 week to 1 month	From 1 month to 3 months	3 months or longer	Total
FY2024					

<From satellite>

	Under 1 week	From 1 week to 1 month	From 1 month to 3 months	3 months or longer	Total
FY2024					

Appendix 5 FY 2024 Visit Records of Researchers from Abroad

* If researchers have visited/ stayed at the Center, provide information on them in the below table.
* Enter the host institution name and the center name in the footer.

Total: 70

	Name	Age	Affiliation		Academic degree, specialty	Record of research activities (Awards record, etc.)	Time, duration	Summary of activities during stay at center (e.g., participation as principal investigator; short-term stay for joint research; participation in symposium)
			Position title, department, organization	Country				
1	Oleg Tretiakov	51	Associate Professor, School of Physics, U of New South Wales Sydney	Australia	Ph.D., Physics, Topological Spintronics and Quantum Materials	- 2025 Unraveling effects of competing interactions and frustration in vdW ferromagnetic Fe3GeTe2 nanoflake devices - 2024 Asymmetric Antibimerons: Statics and Dynamics	Apr. 10 - Apr. 16	Short-term stay for discussion and seminar
2	Malcolm Kadodwala	60	Professor, School of Chemistry, University of Glasgow	UK	Ph.D., Chemistry, Nanophotonics for Chemical Applications, Chirality	- 2024 Evaluating the native oxide of titanium as an electrocatalyst for oxalic acid reduction - 2024 Fluorescent carbazole-derived α-amino acids: structural mimics of tryptophan	Apr. 23 - Apr. 23	Short-term stay for discussion and seminar
3	Surajit Dhara	49	Professor, School of Physics, University of Hyderabad	India	Ph.D., Physics, Soft Matter Physics	- 2021 7th Visitor's Award by the President of India for Research in Physical Sciences - 2020 Shanti Swarup Bhatnagar (SSB) Prize for the year 2020 in Physical Sciences	Jun. 9 - Jun. 15	Short-term stay for discussion and seminar
4	Oleksandr Pylypovskyi	40	Researcher, Helmholtz-Zentrum Dresden-Rossendorf e. V. (HZDR)	Germany	Ph.D., Physics, Micromagnetism, spintronics Soliton dynamics Topological and geometrical effects in magnetic nanosystems Computational methods in physics	- 2025 Manipulation by magnetic frustration in ferrotoroidal spin chains via curvature and torsion - 2024 Bioinspired Design, Fabrication, and Wing Morphing of 3D-Printed Magnetic Butterflies	Jul. 23 - Jul. 26	Short-term stay for discussion and seminar
5	Talal Mallah	62	Professor, School of Chemistry, University of Paris-Saclay	France	Ph.D., Chemistry Spin-Crossover Molecules on surfaces	- 2025 Assessing the Robustness of the Clock Transition in a Mononuclear S = 1 Ni(II) Complex Spin Qubit - 2024 Room-temperature barocaloric effect in [Fe(pap 5NO2)2] spin-crossover material	Jul. 3 - Jul. 5	Short-term stay for discussion and seminar
6	Abhay Deshpande	55	Distinguished Professor, Department of Physics and Astronomy, Stony Brook University	USA	Ph.D., Experimental high-energy particle, Experimental nuclear, High energy physics	- 2024-2026 Distinguished Visiting Professor, IITH, Hyderabad, India - 2024-2026 Distinguished Visiting Professor, IITK, Kanpur, India - 2021-Present Member of the State University of New York, Distinguished Academy - 2021 Fellow of the American Association for Advancement of Sciences (AAAS)	Jul. 31 - Aug. 2	Short-term stay for discussion and seminar
7	Niels Schroeter	35	Researcher, Max Planck Institute for Microstructure Physics	Germany	Ph.D., Physics, Nano-Systems from ions, spin and electrons	2023 - ERC Starting Grant 2021 - IBM Condensed Matter Physics Award of the Swiss Physical Society 2020 - Finalist of the Gerhard Ertl Young Investigator Award (Top 5 candidates, prize was shared between all finalists due to cancellation of DPG spring meeting 2020) 2009-2015, 2017-2018 Scholarship of the Studienstiftung des Deutschen Volkes (German Academic Scholarship Foundation)	Nov. 5 - Nov. 5	Short-term stay for discussion and seminar
8	Louis H Kauffman	80	Professor Emeritus, Department of Mathematics, Statistics, and Computer Science University of Illinois at Chicago	USA	Ph.D., Mathmatics, Knot theory and its relationships with statistical mechanics, quantum theory, algebra, combinatorics and foundations	- 1996: Received the award from the Alternative Natural Philosophy Association for his work in discrete physics. - 2014: Recipient of the Norbert Wiener Award from the American Society for Cybernetics. - 2012: Became a fellow of the American Mathematical Society.	Nov. 11 - Dec. 29	Medium-term stay for discussion and seminar, Participation in WPI-SKCM² 2024 Winter School
9	Yi-Tsu Chan	50	Professor, Department of Chemistry, National Taiwan University	Taiwan	Ph.D., Polymer Science, Developing self-assembly methods for rational construction of functional metallo-supramolecular architectures	- 2022 Distinguished Professor, National Taiwan University - 2022 Zasshikai Lectureship Award, Department of Chemistry, The University of Tokyo - 2021 Outstanding Research Award, Ministry of Science and Technology of Taiwan	Mar. 31 - Mar. 31	Short-term stay for discussion and seminar
10	Ingo Dierking	59	Associate Professor, Physics and Astronomy, University of Manchester	UK	Ph.D., Physics, Soft matter physics, Liquid Crystals, Liquid crystal composites, Chirality, Liquid crystal defects	- 2021 GW Gray Medal, British Liquid Crystal Society - 2016 Samsung midcareer Award for Research Excellence International Liquid Crystal Society - 2009 Hilsum Medal, ritish Liquid Crystal Society	Jul. 10 - Jul. 15	Participation in WPI-SKCM² 2024 Summer School
11	Ulrich Höfer	67	Professor, Department of Physics, Philipps-Universität Marburg	Germany	Ph.D., Physics, Experimental physics, laser spectroscopy of surfaces and interfaces, ultrafast electron dynamics, adsorption on semiconductor surfaces	- 2022 ERC Synergy Grant - 2015 Fellow of the Japanese Society for the Promotion of Science (Japan) - 2011 Ikerbasque Research Professor (DIPC, San Sebastián, Basque Country, Spain)	Jul. 10 - Jul. 14	Participation in WPI-SKCM² 2024 Summer School

12	Fan Shanhui	52	Professor, School of Engineering, Stanford University	USA	Ph.D., theoretical condensed matter physics, nanophotonics, photonic crystals, metamaterials, topological photonics, plasmonics, solar cells	- 2022 R. W. Wood Prize, Optica - 2021 Simons Investigator in Physicsand - 2017 Vannevar Bush Faculty Fellowship - 2015 Thomson Reuters Highly Cited Researcher in Physics	Jul. 15 - Jul. 16	Participation in WPI-SKCM² 2024 Summer School
13	Elisabetta Matsumoto	39	Associate Professor, School of Physics, Georgia Institute of Technology	USA	Ph.D., Physics and Astronomy, Geometry and toplogy of softmatters	- 2020 Cottrell Scholar Class of 2020, RCSA, USA. - 2018 Class of 1969 Teaching Fellow, Georgia Tech, USA. - 2018 Nominated for the Packard Fellowship, David and Lucile Packard Foundation. - 2018 Nominated for the Soft Matter Lectureship, Soft Matter, London, UK	- Oct. 30Dec. 8 - Dec. 1	Participation in WPI-SKCM² 2024 Site Visit, 2024 Program meeting, 2024 Winter School and 2024 Spring Symposium
14	Jorn Dunkel	48	Proffesor, Department of Mathematics, Massachusetts Institute of Technology	USA	Ph.D., Physics, Applied Math (Topology)	- 2023 Schmidt Science Polymath Award, Schmidt Futures - 2020-2023 Robert E. Collins Distinguished Scholar, MIT Mathematics Department, - 2017 Gallery of Fluid Motion Award1, APS/DFD - 2017 Outstanding Referee, American Physical Society - 2016–2022 Complex Systems Scholar Award, James S. McDonnell Foundation	Jul. 13 - Jul. 18	Participation in WPI-SKCM² 2024 Site Visit, 2024 Summer School
15	Marjolein Dijkstra	57	Professor, Department of Physics, Utrecht University	The Netherlands	Ph.D., Physics, Soft condensed matter systems	- 2025 awarded the 2025 Physica Prize - 2020 Elected member Dutch Royal Academy of Sciences (KNAW) - 2020 ERC Advanced grant (250 kEuro)	Jul. 10 -Jul. 18	Participation in WPI-SKCM² 2024 Site Visit, 2024 Summer School
16	Hsu Shang-Te Danny	49	Associate Research Fellow, Institute of Biological Chemistry, Academia Sinica	Taiwan	Ph.D., Chemistry, Structural Biology, Biophysical Chemistry	- 2024 Awarded 2024 Franco-Taiwanese Grand Scientific Prize by National Science and Technology Council of Taiwan and the French Academy of Sciences - 2024 Structural Insight into the ZFAND1-p97 Interaction Involved in Stress Granule Clearance	Jul. 11 - Jul. 19	Participation in WPI-SKCM² 2024 Site Visit, 2024 Summer School
17	Carlos Sánchez Somolinos	50	Tenured Scientist, Institute of Materials Science of Aragón. Liquid Crystals and Polymers Group University of Zaragoza - CSIC	Spain	Ph.D., Physics, Responsive Polymers, Soft Robotics, 4D printing, Liquid Crystalline, Polymers, Biomaterials	- 2025 Magneto-Photochemically Responsive Liquid Crystal Elastomer for Underwater Actuation - 2017 awarded the Prize of the Royal Academy of Sciences of Zaragoza (Physics Section)	Jul. 16 - Jul. 19	Participation in WPI-SKCM² 2024 Site Visit, 2024 Summer School
18	Fabien B.L. Cougnon	42	Associate Professor, Department of Chemistry & Nanoscience Centre, University of Jyväskylä	Finland	Ph.D., Organic chemistry, Molecular knots and supramolecular chemistry	- 2022 Academy of Finland grant (Project NanoPuzzle) - 2022 ERC Consolidator grant (Project ProteoKnot) - 2019 JSP fellowship to attend the Bürgenstock conference, Switzerland	Jul. 10 - Jul. 19	Participation in WPI-SKCM² 2024 Site Visit, 2024 Summer School
19	Mykola Tasinkevych	51	Senior Lecturer, School of Science & Technology, Nottingham Trent University	UK	Ph.D., Chemistry, Liquid crystal-enable nanoparticle self-assembly, Chemically active microswimmers	- 2025 Convolutional Neural Network analysis of optical texture patterns in liquid-crystal skyrmions - 2025 Liquid crystal torons in Poiseuille-like flows - 2025 Hybridization of colloidal handlebodies with singular defects and topological solitons in chiral liquid crystals	Jul. 17 - Jul. 18	Participation in WPI-SKCM² 2024 Site Visit, 2024 Summer School
20	Bruno Frka-Petesic	41	Senior Research Associate, Yusuf Hamied Department of Chemistry, University of Cambridge	UK	Ph.D., Experimental Physics, Chiral colloidal liquid crystals, Chiroptical phenomena	- 2025 Spray-Assisted Fabrication of Cellulose Photonic Pigments on Superhydrophobic Surfaces - 2025 Research data supporting:" Spray-assisted fabrication of cellulose photonic pigments on superhydrophobic surfaces"	Jul. 10 - Jul. 19	Participation in WPI-SKCM² 2024 Site Visit, 2024 Summer School
21	William Uspal	41	Assistant Professor, Department of Mechanical Engineering, University of Hawai'i at Mānoa	USA	Ph.D., Active colloids in complex environments, Self-organization in active matter, Microhydrodynamics	- 2025 Hydrodynamic Stokes flow induced by a chemically active patch imprinted on a planar wall - 2024 Hydrodynamics of Active Colloids - 2024 Active Colloids: From Fundamentals to Frontiers	Jul. 10 - Jul. 19	Participation in WPI-SKCM² 2024 Site Visit, 2024 Summer School
22	Prasanna Ghalsasi	53	Professor, Department of Chemistry, The Maharaja Sayajirao University of Baroda	India	Ph.D., Chemistry, Chirality, Chiral Molecular Magnets, Crystallization, Crystal growth	- 2025 Thermal and pressure response of KHg(CN)2(SCN) - 2006 Young Scientist Project: Department of Science and Technology (DST) Govt of India	Jul. 3 - Jul. 19	Participation in WPI-SKCM² 2024 Site Visit, 2024 Summer School
23	Claire Donnelly	33	Lise Meitner Group Leader, Max Planck Institute for Physical Chemistry of Solids	Germany	Ph.D., 3D systems, 3D topology in magnets, nanoscale imaging	- L'Oreal For Women In Science Fellowship, - European Magnetism Association Young Scientist Award, - 2023 IEEE Magnetics Society Early Career Award	Jul. 13 - Jul. 19	Participation in WPI-SKCM² 2024 Site Visit, 2024 Summer School
24	Boris Malomed	69	Professor, Emeritus in School of Electrical Engineering, Tel Aviv University	Israel	Ph.D., Physics, Nonlinear optics, optical solitons, optical communications Dynamics of Bose-Einstein condensates and matter waves	- 2024 Research.com Engineering and Technology in Israel Leader Award - 2023 Research.com Physics in Israel Leader Award - 2022 Research.com Engineering and Technology in Israel Leader Award-	Jul. 12 - Jul. 19	Participation in WPI-SKCM² 2024 Site Visit, 2024 Summer School
25	Fakhri Nikta	45	Associate Professor, Department of Physics, Massachusetts Institute of Technology	USA	Ph.D., Physics, Chiral and nonreciprocal matter	- 2022 Early Career Award for Soft Matter Research (APS) - 2019 NSF CAREER Award - 2018 IUPAP Young Scientist Prize in Biological Physics	Jul. 17 - Jul. 19	Participation in WPI-SKCM² 2024 Site Visit
26	Pierangelo Metrangolo	53	Professor, Department of Chemistry, Politecnico di Milano	Italy	Ph.D., Industrial Chemistry, Crystal engineering, Fluorine chemistry, Supramolecular, Biomimetic materials	- 2019 Fluorous Technologies Award - 2017 he won the SWITCH2PRODUCT Innovation Challenge of the Politecnico di Milano, with the project MINIRESCrystEngComm Lectureship - 2009 IUPAC Young Chemist Award	Jul. 17 - Jul. 19	Participation in WPI-SKCM² 2024 Site Visit

27	Alenka Mertelj	56	Assistant Professor, Jožef Stefan Institute, U. Ljubljana	Slovenia	Ph.D., Condensed Matter Physics, Fluid Dynamics, Optics	- 2020 Mid-Career Award for the discovery of both magnetic and electric polar order in nematic phase and new spatially modulated splay nematic phase that has macroscopic electric polarization.	Jul. 17 - Jul. 19	Participation in WPI-SKCM² 2024 Site Visit
28	Yair Shokef	49	Professor, School of Mechanical Engineering, Tel Aviv University	Israel	Ph.D., Physics, Soft Condensed Matter Physics	- 2025 Combinatorial Design of Floppy Modes and Frustrated Loops in Metamaterials - 2024 Breaking mechanical holography in combinatorial metamaterials	Dec. 9 - Dec. 11	Participation in WPI-SKCM² 2024 Winter School
29	Amos Martinez	50	Senior Editor, Springer Nature	UK	Ph.D., Physics, Photonics, plasmonics and metamaterials	- At the University of Cambridge, he focused on the commercialization of fibre lasers for coherent Raman microscopy - 2021 joined Nature Materials in June, where he handles manuscripts in photonics, plasmonics, and metamaterials	Dec. 10 - Dec. 13	Participation in WPI-SKCM² 2024 Winter School
30	Sofia Lambropoulou	61	Professor, School of Applied Mathematical and Physical Sciences (SAMPS), National Technical University of Athens	Greece	Ph.D., Mathematics, Knot theory, low-dimensional topology, braids, knot algebras, quantum invariants	- 1995 – 1996: European Commission Return Fellowship - 1993 – 1995: European Commission Individual Postdoctoral Research Fellowship - 1993: MacArthur Fellowship of Prof. Karen Uhlenbeck, U of Texas at Austin	Dec. 10 - Dec. 13	Participation in WPI-SKCM² 2024 Winter School
31	Neslihan Gügümcü	39	Assistant Professor, , Department of Mathematics, Izmir Institute of Technology	Turkey	Ph.D., Mathematics, Knot theory and its generalizations, knotoid theory and combinatorics	- 2020-2022 Dorothea Schloezer Postdoctoral Program for Female Scientists, Georg-August Universit¨at, G¨ottingen - 2019 Leibniz Fellows by Oberwolfach Research Institute for Mathematics, Oberwolfach, Germany	Dec. 10 - Dec. 13	Participation in WPI-SKCM² 2024 Winter School
32	Javier Campo	57	Researcher, Instituto de Nanociencia y Materiales de Aragón, Spanish National Research Council (CSIC) and University of Zaragoza	Spain	Ph.D., Magnetic Chirality, Magnonics, Purely Organic Magnets, Neutron Scattering	-2024 High pressure studies of the T-P phase diagrams of erbium and thulium up to 30 GPa by using ac magnetization experiments -2024 Operando analysis of the positive active mass of lead batteries by neutron diffraction	Dec. 16 - Dec. 19	Participation in WPI-SKCM² 2024 Winter School
33	Tsung Jieh-Wen	39	Associate Professor, Department of Electrophysics, National Yang Ming Chiao Tung University	Taiwan	Ph.D., Experimental Particle Physics, Standard Model and Higgs Mechanism, Symmetry and Symmetry Breaking	- 2025 Selective Color Appearance of Liquid-Crystal-Aided Laser-Induced Periodic Surface Structures - 2024 Array and alignment of topological defects in liquid crystal	Dec. 16 - Dec. 19	Participation in WPI-SKCM² 2024 Winter School
34	Saad Bhamla	38	Associate Professor, School of Chemical and Biomolecular Engineering, Georgia Institute of Technology	USA	Ph.D., Chemical Engineering, Living tangled matter	- 2024 DARPA Young Faculty Award (YFA) - 2024 Moore Inventor Fellow - 2024 Judith H. Greenberg Early Career Investigator, NIH - 2024 Winner, Gallery of Soft Matter, American Physical Society - 2024 Outstanding Faculty Achievement in Research	Dec. 12 - Dec. 16	Participation in WPI-SKCM² 2024 Winter School
35	Antonio DeSimone	62	Professor, Structural Mechanics (Scienza delle Costruzioni), Scuola Internazionale Superiore di Studi Avanzati (SISSA)	Italy	Ph.D., Mechanics, Soft and Biological Matter, Liquid Crystal Elastomers, Magnetic Microstructures	- 2024 Elected member of the Italian Academy of Engineering and Technology - 2024 ERC Starting Grant 2024: Chair of Panel PE8 (Process and Product Engineering)	Dec. 10 - Dec. 13	Participation in WPI-SKCM² 2024 Winter School
36	Slobodan Zumer	80	Professor of Physics & Scientific Adviser, Jozef Stefan Institute, University of Ljubljana	Slovenia	Ph.D., Physics, Theory, modeling, and simulations of soft matter	- 2019 Freederiksz medal of the Russian Liquid Crystal Society - 2017 National Zois Award for lifetime research achievements.	Mar. 3 - Mar. 8	Participation in WPI-SKCM² 2025 Spring symposium
37	Mark Dennis	48	Professor of Theoretical Physics, School of Physics and Astronomy, University of Birmingham	UK	Ph.D., Theoretical Physics, Structured light and singular optics, Applied knot theory, Applied topology	- 2024 Weaving the rainbow: properties of classical light - 2024 Designing knotted fields in light and electromagnetism	Mar. 3 - Mar. 6	Participation in WPI-SKCM² 2025 Spring symposium
38	Harry Laurence Anderson	61	Professor, Department of Chemistry, University of Oxford	UK	Ph.D., Chemistry, Molecular engineering and supramolecular materials chemistry	- 2013 ERC Advanced Investigator - 2013 Alexander Todd – Hans Krebs Lectureship (RSC/GDCh) - 2012 Tilden Prize (Royal Society of Chemistry) - 2012 Distinguished Lecturer, Hong Kong Baptist University	Mar. 4 - Mar. 5	Participation in WPI-SKCM² 2025 Spring symposium
39	Jonathan Selinger	62	Professor of Physics and Ohio Eminent Scholarand, Kent State University	USA	Ph.D., Physics, theory of liquid crystals, nanoparticle suspensions, and related topics in soft materials	- 2020 Elected as a Fellow of the American Association for the Advancement of Science (AAAS) - 2014 Named a Fellow of the American Physical Society (APS) - 2025 Selected as an Outstanding Referee by APS	- Mar. 5Mar. 13 - Ma	Participation in WPI-SKCM² 2025 Spring symposium, Short-term stay for discussion and seminar
40	Pawel Pieranski	78	Directeur de Recherches émérite at CNRS, Laboratoire de Physique des Solides, Université Paris Saclay	France	Ph.D., Liquid, Crystalsphysique, Colloidal crystals	- 2024 Discovery of necklace-like links made of dislocations - 2024 Discovery of necklace-like links made of dislocations-Supporting Informations - 2024 Collisions of monopoles, disclinations and dislocations - 2024 Unknots, knots, links and necklaces made of dislocations in cholesterics	Mar. 4 - Mar. 6	Participation in WPI-SKCM² 2025 Spring symposium, Short-term stay for discussion
41	Raphael Tieulent	49	Diagnostics Coordinating Scientist, Department of Physics, Institute of Nuclear Physics of Lyon	France	Ph.D., Elementary Particle Physics, experimental nuclear and particle physics	- 2024 ALICE luminosity determination for Pb–Pb collisions at√ s NN= 5.02 TeV - 2023 Charm production and fragmentation fractions at midrapidity in pp collisions at = 13 TeV	Mar. 4 - Mar. 5	Participation in WPI-SKCM² 2025 Spring symposium

42	Joel Moore	51	Chern-Simons Professor, Department of Physics, University of California, Berkeley	USA	Ph.D., Physics, Condensed Matter Physics And Materials Science	- 2022 Elected member of US National Academy of Sciences - 2016-Present Chern-Simons Professorship, UC Berkeley - 2014-2017 Henley Memorial Lecturer, Cornell; Perimeter Institute Distinguished Visiting Research Chair	Mar. 4 - Mar. 5	Participation in WPI-SKCM² 2025 Spring symposium
43	Yoshitaka Hatta	48	Senior Scientist, Physics Department, Brookhaven National Laboratory	USA	Ph.D., Physics, Electron-Ion Collider (EIC), the nucleon mass and spin structure, multi-dimensional tomography, gluon saturation at small-x	- 2009 Young Researcher Encouragement Award (Theoretical Nuclear Physics Division)	Mar. 4 - Mar. 5	Participation in WPI-SKCM² 2025 Spring symposium
44	Yi Ruiqin	36	Associate Professor, Guangzhou Institute of Geochemistry, Chinese Academy of Sciences	China	Ph.D., The origin of life, organic chemistry, prebiotic chemistry, RNA synthesis	- 2025 Primitive homochiral polyester formation driven by tartaric acid and calcium availability - 2025 Probing the Limits of Reactant Concentration and Volume in Primitive Polyphenyllactate Synthesis and Microdroplet Assembly Processes	Mar. 4 - Mar. 5	Participation in WPI-SKCM² 2025 Spring symposium
45	Luke Turnbull	30	Postdoctoral Researcher, Max Planck Institute for Physical Chemistry of Solids	Germany	Ph.D., Condensed Matter Physics, Topological Magnetism, X-ray Imaging	- 2025 Altermagnetic nanotextures revealed in bulk MnTe - 2025 Unidirectional motion of topological defects mediating continuous rotation processes	Jul. 10 - Jul. 19	Participation in WPI-SKCM² 2024 Site Visit, 2024 Summer School
46	Nico Stuhlmüller	27	Postdoctoral Researcher, Utrecht University	The Netherlands	Ph.D., Theoretical Physics, Soft Condensed Matter	- 2025 Topologically cloaked magnetic colloidal transport - 2025 Magnetic colloidal single particles and dumbbells on a tilted washboard moiré pattern in a precessing external field	Jul. 10 - Jul. 19	Participation in WPI-SKCM² 2024 Site Visit, 2024 Summer School
47	Antonio Carone	30	Postdoctoral Researcher, Max Planck Institute of Colloids and Interfaces	Germany	Ph.D., Chemistry, Nanomaterials, Gold Nanoparticles	- 2023 Colloidal Assemblies of Chiral Plasmonic Nanoparticles Induce Tunable Circular Dichroism Response - 2023 Gold nanoparticle shape dependence of colloidal stability domains	Jul. 10 - Jul. 19	Participation in WPI-SKCM² 2024 Site Visit, 2024 Summer School
48	Lu Xingyuan	32	Postdoctoral Researcher, Soochow University	China	Ph.D., Physics, Coherent Optics, Coherent Diffractive Imaging	- 2025 Inverse vortex beams: Reverse control of radius - 2025 Self-Assembled Magnetic Nanoparticle Layers: Structural Control for Reconfigurable Magnetism and Functional Applications	Dec. 9 - Dec. 20	Participation in WPI-SKCM² 2024 Winter School
49	Shakil Ahmed	30	Postdoctoral Researcher, University of Jyväskylä	Finland	Ph.D., Inorganic and Physical Chemistry, Supramolecular Chemistry, Molecular Nanotopology	- 2023 A benzothiadiazole-based Pt(II) coordination polymer as an efficient heterogeneous photocatalyst for visible-light-driven aerobic oxidative coupling of amines.	Dec. 9 - Dec. 20	Participation in WPI-SKCM² 2024 Winter School
50	Petur Bryde	30	Postdoctoral Associate, Massachusetts Institute of Technology	USA	Ph.D., Engineering, Thin Structures, Soft Matter, Dynamical Systems, Control Theory	- 2024 Postural control in an upright snake - 2023 Optimal strategies for kiiking: active pumping to invert a swing	Dec. 9 - Dec. 20	Participation in WPI-SKCM² 2024 Winter School
51	Ishant Tiwari	31	Postdoctoral Researcher, Georgia Institute of Techology	USA	Ph.D., Physics, Coherent Optics, Organismal Biophysics, Soft Topologically Complex Systems, Active Matter, Nonlinear Dynamics	- 2024 Reversible kink instability drives ultrafast jumping in nematodes	Dec. 9 - Dec. 20	Participation in WPI-SKCM² 2024 Winter School
52	Nadege You	31	Postdoctoral Researcher, University of Jyväskylä	Finland	Ph.D., Chemistry, Supromolecular Chemistry, Molecular Nanotopology	- 2025 Why (k)not?	Dec. 9 - Dec. 20	Participation in WPI-SKCM² 2024 Winter School
53	Sinuhe Perea	27	Postdoctoral Researcher, Max Planck Institute for Colloids and Interfaces	Germany	Ph.D., Photonics and Nanotechnology, Novel Nanophotonic Phenomena	- 2024 Complex refraction metasurfaces for locally enhanced propagation through opaque media LPR, lpor.202300867 - 2023 GRACYASK: Graph Rewriting for Lattice Topological Invariants	Dec. 9 - Dec. 20	Participation in WPI-SKCM² 2024 Winter School
54	Hamdi Kayaslan	34	Postdoctoral Researcher, Izmir Institute of Technology	Turkey	Ph.D., Mathematics, Topology	- 2025 A Geometric Interpretation of Virtual Knotoids	Dec. 9 - Dec. 20	Participation in WPI-SKCM² 2024 Winter School
55	Jeffrey Neethirajan	25	Ph.D. Student, Max Planck Institute for Chemical Physics of Solids	Germany	Masters, Physics, Three-Dimensional Magnetic Systems	- 2024 Soft X-Ray Phase Nanomicroscopy of Micrometer-Thick Magnets. Physical Review X 14, 031028, pp. 1 - 20	Jul. 10 - Jul. 19	Participation in WPI-SKCM² 2024 Site Visit, 2024 Summer School
56	Sabrina Grenda	28	Ph.D. Student, Universite Claude Bernard Lyon 1	France	Masters, Inorganic Chemistry, Molecular Magnetism	- 2024 An Open-Shell Functionalization of Inorganic Benzene	Jun. 21 - Aug. 27	Participation in WPI-SKCM² 2024 Site Visit, 2024 Summer School
57	Toky Andriamanalina	23	Ph.D. Student, University of Potsdam	Germany	Masters, Applied Geometry, Topology	- 2025 The untangling number of 3-periodic tangles	Dec. 9 - Dec. 20	Participation in WPI-SKCM² 2024 Winter School

58	Avijit Jaiswal	31	Ph.D. Student, University of Jyvä skylä	Finland	Masters, Chemistry, Suprimolecular Chemistry, Molecular Nanotopology	- 2017 Trainee at CSIR-NBRI Phytochemical screening & antioxidant activity of Ageratum conyzoides	Dec. 9 - Dec. 20	Participation in WPI-SKCM² 2024 Winter School
59	Claudia Nardone	24	Ph.D. Student, Georgia Institute of Technology	USA	Bachelors, Physics, Experimental Condensed Matter Physics, Charge Transfer in Oxide Semiconductors	- 2022 Optical transitions of gallium vacancies in neutron irradiated β -Ga2O3	Dec. 9 - Dec. 20	Participation in WPI-SKCM² 2024 Winter School
60	Mouhamadoul Habib GAYE	25	Ph.D. Student, Universite Claude Bernard Lyon 1	France	Masters, Inorganic Chemistry, Molecular Magnetic Materials	- 2024 Master 2 in Chemistry Topic: Hydrogen, the clean fuel of the future filtered with membranes based on Percolating Pd nanoparticles system	Dec. 9 - Dec. 20	Participation in WPI-SKCM² 2024 Winter School
61	Saikat Das	27	Ph.D. Student, University of Hyderabad	India	Masters, Physics, Soft and Active Matter	- 2025 Topologically reconfigurable nematic emulsions	Dec. 9 - Dec. 20	Participation in WPI-SKCM² 2024 Winter School
62	Djordje Mihajlovic	24	Ph.D. Student, University of Edinburgh	UK	Masters, Mathematics, Theoretical Physics, Computational Mathematics, Machine Learning	- 2023 School of Physics and Astronomy Summer Career Development Scholarship - 2020 Pre-honours Certificate of Merit	Dec. 9 - Dec. 20	Participation in WPI-SKCM² 2024 Winter School
63	José Ignacio Costilla Pinedo	28	Ph.D. Student, Federal University of Viçosa	Brazil	Masters, Physics, Skyrmions, Spintronics	- 2025 Computational prediction of phase-stability skyrmion maps, internal magnetic configuration, and size of magnetic skyrmions in confined magnetic nanostructures	Dec. 9 - Dec. 20	Participation in WPI-SKCM² 2024 Winter School
64	Jader Carlos Moreira	36	Ph.D. Student, Federal University of Viçosa	Brazil	Masters, Physics, Topological Matter	- 2024 Channeling skyrmions: Suppressing the skyrmion Hall effect in ferrimagnetic nanostripes	Dec. 9 - Dec. 20	Participation in WPI-SKCM² 2024 Winter School
65	Nianjia Zhang	23	Ph.D. Student, University of Shanghai for Science and Technology	China	Masters, Ph.D., Physics, Coherent Optics, Coherent Diffractive Imaging	- 2024 Spatiotemporal hologram	Dec. 9 - Dec. 20	Participation in WPI-SKCM² 2024 Winter School
66	Marek Czyszczoń	23	Ph.D. Student, Wroclaw University of Science and Technology	Poland	Masters, Chemistry, Photodynamic Therapy, Photosensitizers, Liquid Crystrals, Microscopy	- 2024 PhoBiA Annual Nanophotonics International Conference: PANIC 2024 Oral presentation Incorporation of carbon nanodots into poly (N-isopropylacrylamide) hydrogel structure	Dec. 9 - Dec. 20	Participation in WPI-SKCM² 2024 Winter School
67	Karolina Saczuk	26	Ph.D. Student, Wroclaw University of Science and Technology	Poland	Masters, Chemistry, Photodynamic Therapy, Photosensitizers, Liquid Crystrals, Microscopy	- 2024 Advancements in molecular disassembly of optical probes: a paradigm shift in sensing, bioimaging, and therapeutics.	Dec. 9 - Dec. 20	Participation in WPI-SKCM² 2024 Winter School
68	Alexander Cachine	23	Ph.D. Student, Georgia Institute of Technology	USA	Masters, Physics, Topology, Soft Materials	- 2024 Pulling apart the mechanisms that lead to jammed knitted fabrics - 2024 Programming mechanics in knitted materials, stitch by stitch	Dec. 9 - Dec. 20	Participation in WPI-SKCM² 2024 Winter School
69	Elisa Marelli	28	Ph.D. Student, Politecnico di Milano	Italy	Masters, Materials Engineering and Nanotechnology	- 2024 Engineering the interaction of short antimicrobial peptides with bacterial barriers - 2024 Nanocellulose-Short Peptide Self-Assembly for Improved Mechanical Strength and Barrier Performance	Dec. 9 - Dec. 20	Participation in WPI-SKCM² 2024 Winter School
70	Matthew J. Deutsch	27	Ph.D. Student, Kent State University	USA	Masters, Physics, Soft Matter, Computational Physics, Statistical Physics	- 2025 Spontaneous Optimal Mixing via Defect-Vortex Coupling in Confined Active Nematics - 2024 Agent-based simulation study of confined active nematic filaments	Dec. 9 - Dec. 20	Participation in WPI-SKCM² 2024 Winter School

Appendix 6 FY2024 State of Outreach Activities

* Fill in the numbers of activities and times held during FY2024 by each activity.
* Describe the outreach activities in the "3-1. Societal Value of Basic Research" of Progress Report, including those stated below that warrant special mention.

Activities	FY2024 (number of activities, times held)
PR brochure, pamphlet	74 flyers
Lectures, seminars for general public	22
Teaching, experiments, training for elementary, secondary and high school students	12 (For details, see "Outreach Events for Junior/Senior High School Students)
Participating, exhibiting in events	4 events
Press releases	8 times
Others（TV program, Newspaper, Magazine for general public etc.）	29
Others（Fundraising Activities）	6 activities, 181 flyers handed over
Others（Weekly Seminars）	57 seminars (including special seminars)
Others（Lectures, Events, Activities for undergraduate/graduate students. postdocs）	19 (For details, see "Outreach Events for undergraduate/graduate students, postdocs" below.)
Others（Social Media Sites）	403 postings (Facebook, X, Instagram, Linkedin), 4,148 views/ 38 postings (Youtube)
Others（VR demonstrations）	397 times

*If there are any rows on activities the center didn't implement, delete that (those) row(s). If you have any activities other than the items stated above, fill in the space between parentheses after "Others" on the bottom with the name of those activities and state the numbers of activities and times held in the space on the right. A row of "Others" can be added, if needed.

Outreach Activities and Their Results

List up to three of the Center's outreach activities carried out in FY 2024 that have contributed to enhancing the brand or recognition of your Center and/or the brand of the overall WPI program, and describe its concrete contents and effect in narrative style. (Where possible, indicate the results in concrete numbers.)

Examples:
- As a result of using a new OO press-release method, a OO% increase in media coverage was obtained over the previous year.
- By holding seminars for the public that include people from industry, requests for joint research were received from companies.
- We changed our public relations media. As a resulting of using OO to disseminate information, a OO% increase in inquiries from researchers was obtained over the previous year.
- As a result of vigorously carrying out OO outreach activity, \ OO in external funding was acquired.

1) Outreach Events for Junior/Senior High School Students: By conducting twelve (12) outreach events in the form of a lecture and/or a science workshop at two (2) junior and senior high schools in Hiroshima prefecture, and at Open Campus event of Hiroshima University etc., a total of 1,157 students participated in these events, learned science related to knotted chiral meta





matter, and experienced VR demonstrations, microscope observation, topological rope work shop, poster presentation and more. We collected questionnaires from 61 participants in total, of which 93% were very satisfied with the events.


2) Outreach Events for Undergraduate/Graduate students, Postdoc Researchers:

The outreach events were held for undergraduate and graduate students, as well as postdoc researchers with the aim of encouraging many of them to take an interest in WPI-SKCM^2 and gain a deeper understanding of the


research. Various types of outreach events, such as were conducted such as VR/MR demonstrations, topological rope work shop etc. during Summer/Winter Schools and Symposiums. WPI-SKCM^2 also had a Science Chat lecture and workshop as a part of Hiroshima University undergraduate student course. A total of 272 students and postdocs, who study at Hiroshima University and came from all over the world, interacted with Professors, InternKNOTshipers, Postdoctoral researchers, and graduate students from the WPI-SKCM$_2$.


3) Fundraising Activities: Fundraising activities were initiated in January 2025.

A total of six (6) actions were taken during this fiscal year. The key focus areas were "networking within markets and industries" and "identifying collaboration opportunities through discussions in consortium." To strengthen communication

networks within relevant industries and support fundraising efforts, we participated in various events and conducted targeted outreach activities. In a manufacturing consortium seminar, we proposed the idea of "joint collaborative research" to industry participants. For the healthcare sector, we participated in a consortium focused on collaborative research opportunities. The implementation of actual collaborative activities is planned for the next fiscal year.

Appendix 7 FY 2024 List of Project's Media Coverage

* List and describe media coverage (e.g., articles published, programs aired) in FY2024.
* Enter the host institution name and the center name in the footer.

	Date	Types of Media (e.g., newspaper, magazine, television)	Description
1	April, 2024	(magazine) Hiroshima University Update	Introduced about SKCM2's mission to knot and knit a sustainable world as special feature
2	April 25, 2024	(web magazine) Higashi Hiroshima Press Net	Article referring to PI Dr. Kenta Kuroda and his research
3	May 2024	(magazine) Hiroshima University Plus	Introduced about SKCM2's research focus below Research contents studied by PI Dr. Hikaru Yabuta
4	May 22, 2024	(web media) PHYS.ORG	Article referring to Co-PI Dr. Yair Shokef's research result
5	June 2024	(web magazine) Mirai book	Article written by PI Dr. Yuka Kotorii
6	June 3, 2024	(web media) y.net	Article referring to Co-PI Dr. Yair Shokef's research result
7	June 3, 2024	(web media) Georgia Tech web page	Article referring to PI Dr. Elisabetta Matsumoto's research result
8	June 4, 2024	(web media) PHYS.ORG	Article referring to PI Dr. Elisabetta Matsumoto's research result
9	June 20, 2024	(web media) earch.com	Article referring to PI Dr. Elisabetta Matsumoto's research
10	August 2024	(web media) Guiness World Record	Article referring to Director/PI Dr. Ivan Smalyukh's research result (Record for the most transparent material)
11	August, 2024	(magazine) Hiroshima University Update	Introduced about SKCM2's the below three research focus Knitting meets engineering by PI Dr. Elisabetta Matsumoto Quest for particle physics' holy grail sparks discovery by PI Dr. Ivan Smalyukh Study reveals twisted origin of dead stars' mysterious 'heartbeats' by co-PI Dr. Muneto Nitta

12	August 15, 2024	(web media) University of Colorado Boulder	Article referring to Director/PI Dr. Ivan Smalyukh's research result (Record for the most transparent material)
13	September 2024	(magazine) Kenkyusha Shoukai Poster	Article written by PI Dr. Yuka Kotorii
14	September 9, 2024	(magazine) Japan Physical Society Hot Topics	Article referring to PI Dr. Katsuya Inoue's research result
15	September 28, 2024	(Journal cover) Journal of Applied Physics	Journal cover related to PI Dr. Katsuya Inoue's research result
16	October 30, 2024	(TV program) RCC Broadcasting	Introduced SKCM2 by Hiroshima University President Dr. Ochi and PI Dr. Katsuya Inoue (during Imanama program)
17	November 2024	(magazine) Gendai Suugaku	Article written by PI Dr. Yuka Kotorii
18	November 14, 2024	(web media) Asia Research News	Article referring to PI Dr. Takeharu Haino's research result
19	December 11, 2024	(web media) Asia Research News	Article referring to PI Dr. Takeharu Haino's research result
20	January 2025	(web media) Hiroshima Daigaku Kenkyu Selection	Article written by PI Dr. Yuka Kotorii
21	January, 2025	(magazine) Hiroshima University Update	Introduced about SKCM2's the below two research focus When is a hole not a hole? Researchers investigate the mystery of 'latent pores' by PI Dr. Takeharu Haino Team uses achiral hard banana-shaped particles to assemble skyrmions and blue phases by PI Dr. Marjolein Dijkstra
22	January 18, 2025	(web media) CNRS top page & CNRS-Asia top page of HP	Article referring to PI Dr. Katsuya Inoue's research result
23	January 31, 2025	(web media) The Biophysical Society of Japan, Asia Research news!,	News of 2025 WPI-SKCM2 Spring Symposium on 4-5/Mar/2025
24	February 2025	(web media) Scientific American Instagram	Article referring to PI Dr. Jorn Dunkel's research result

25	February 11, 2025	(web media) grey dynamics	Article referring to PI Dr. Elisabetta Matsumoto's research
26	February 20, 2025	(media conference) Hiroshima University mon	By Hiroshima University President Dr. Ochi Introduced SKCM2 Spring Symposium on 4-5/Mar/2025 at monthly press conference and then uploaded to Youtube.
27	March 2025	(magazine) Suugaku Seminar	Article written by PI Dr. Yuka Kotorii
28	March 7, 2025	(newspaper) Kagaku Shimbun	Article referring to PI Dr. Katsuya Inoue's research result
29	March 25, 2025	(web media) Youtube	Lecture video performed by Director/PI Dr. Ivan Smalyukh at JPEAKS seminer
30	March 27, 2025	(web media) Colorado Arts and Science Magazine	Article referring to Director/PI Dr. Ivan Smalyukh (AAAS Fellow)