

## Outline of Selected Project

Host institution	Hiroshima University
Center name	International Institute for Sustainability with Knotted Chiral Meta Matter (SKCM <sup>2</sup> )
Head of host institution	Mitsuo Ochi
Prospective Center director	Ivan I. Smalyukh

### <Project Summary>

The need of securing sustainable, prosperous future strongly motivates us to conduct highly fundamental research that also has the potential of helping to address challenging global problems, like the growing energy demand and climate change. In our interdisciplinary approach, we develop knotted structures of physical fields (like the magnetic field or molecular alignment field) that have properties of particles, resembling atoms, molecules and other building blocks of the natural world. To gain the ability of designing such artificial atoms and molecules at will, we fuse the knowledge in math, physics, chemistry, biology & material science, across space & time scales. Synergistic with Feynman's words "What I cannot create, I do not understand", we deepen understanding of physical phenomena by re-creating their artificial analogs, thus gaining insights into the behavior of physical systems that are relatively inaccessible to experiments, like Early Universe cosmology. This our approach also allows for making new forms of artificial matter by design, with physical properties not encountered in the naturally occurring systems, allowing us to achieve highly desirable material properties. Knotted structures of fields in magnets can be used for data storage and the ones in liquid crystals can enable new types of displays. On the other hand, porous crystals made from knotted molecules can enable new breeds of building materials with thermal superinsulation properties, helping to save a fraction of about 40% of all energy generated globally that currently goes into heating and cooling of energy-inefficient buildings to maintain comfortable indoor environment. Our basic research is poised to foster technological innovation to address some of the biggest global challenges, like the need to reduce the growing energy demand and mitigate climate change caused by generating this energy.

### <Remarks>

1. The project is novel and interdisciplinary, involving mathematics and material science, as it looks for and designs materials that have interesting topological and symmetry properties. Though somewhat converse to the usual approach of finding interesting properties in materials existing in nature, knotted chiral matter has potential for substantial development given the

excellent PIs from diverse disciplines gathered worldwide at the center.

2. The prospective center director Ivan I. SMALYUKH is an excellent scientist with visions and successes in the field of chiral liquid crystals. He is a strong leader with management experience and is able to motivate students and transfer his enthusiasm to the public.

3. The overseas training and exposure opportunities for both postdocs and administrative staffs as well as the center's unique degree programs are innovative elements at the system level.

4. The proposed center receives very strong support and commitment from the president of Hiroshima University, who views the center as being a spearhead for reforming the University in terms of internationalization and diversity.