Increasing collaborators in the world

A MEXT project named "A Consortium to Exploit Spin Chirality in Advanced Materials", an international consortium including partners who study chiral magnets in Japan, Russia, UK and more, was adopted by Japan Society for the Promotion of Science in 2015. The purpose of the Consortium is to facilitate international collaboration in this field. The Consortium has been expanding, and now it includes 163 researchers from 28 institutions in 7 countries.

Access

To Higashi-Hiroshima campus

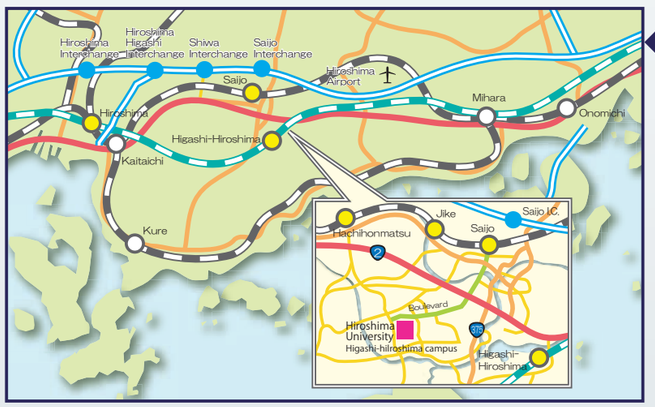
Travel time from major airports to Hiroshima Airport

- From Narita International Airport: about 1 hour 40 minutes
- From Haneda Airport: about 1 hour 15 minutes

Travel time from Hiroshima Airport to Higashi-Hiroshima campus

- about 45 minutes by buses and train

  Hiroshima Airport → Shiraichi Station (15 minutes by bus) → Saijo Station (10 minutes by train) →Higashi-Hiroshima campus (15 minutes by bus)



Access to "Chirality Research Center"

Address: Chirality Research Center (CResCent)
Building of the Graduate school of Science,
Hiroshima University (Higashi-Hiroshima campus)
1-3-1 Kagamiyama, Higashi-Hiroshima city,
Hiroshima, 739-8526, Japan

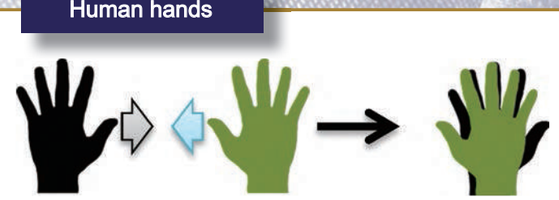
E-mail: kxi@hiroshima-u.ac.jp

Web page: http://home.hiroshima-u.ac.jp/~kotai/chiral/en

chiral hiroshima

What is "chiral"?

Human hands

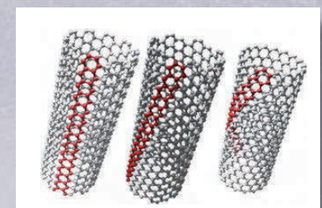


Chiral Molecule

"Chirality" is a concept concerning asymmetric geometrical shape. The term was first coined by Lord Kelvin in 1884 after the Greek word "χείρ" meaning human hands. When an object or system does not coincide with its mirror image, we describe that it has "chirality". The term is recently refined to include the concept of dynamics and can be applied to physical properties. We see many chiral objects or phenomena at all length scales from microscopic to macroscopic level.

They are "chiral"!

DNA



SWNT (Chiral Nanotube)

Quartz Crystal

Shell

Typhoon

HIROSHIMA UNIVERSITY

Hiroshima University CResCent Chirality Research Center

Chirality Research Center

Aims to gain uniform understanding and control of all chiral materials/phenomena in nature

Message from the Director

Professor Katsuya Inoue

The concept of chirality, which is symbolized by the relation between the right and left hand, was present under the surface of our consciousness well before the modern era, when we started to become aware of the relation between human beings and nature. As an object of academic consideration, this issue was first addressed in the field of philosophy. In his essay "Prolegomena to any Future Metaphysics", the Prussian philosopher Immanuel Kant argued the question of whether space or a physical thing occupying it came first and arrived at the conclusion that "We humans can define the concept of left-right asymmetry only through the shape of the body that we were born with." In the field of natural sciences, Lord Kelvin, a member of the Royal Society of London, stipulated in his Baltimore Lectures in 1884 that a set of asymmetric shapes such as right-handedness and left-handedness is referred to as chirality and that things in such a relation are defined as chiral.

On the contrary, in the field of elementary particles, as the inversion symmetry of radionuclides is broken by their disintegration, it has been considered that spatial inversion symmetry is broken by the birth of elementary particles. In the 20th century, LD Barron of the University of Glasgow in the United Kingdom observed that a combination of rotation and translation also has chirality, including the concept of helicity to the definition of chiral. This definition integrated the relation between the spin and the momentum of elementary particles (helicity) and the concept of geometric chirality.

Today, chirality plays an important role as a universal concept that encompasses the concepts of geometric structure and movement on every scale of the realm of nature from the world of elementary particles to the structure of space. However, chirality has been phenomenologically defined by researchers in both social and natural sciences, and few studies have been accomplished that capture its gist. In this research, we want to approach the essence of chiral space and chirality beginning with the study of chiral properties and chiral magnetism.

Organization

Chirality Research Center is one of the virtual research centers at Hiroshima University (HU) established in 2014, which has been selected as one of the thirteen Promising Research Initiatives in HU and receives management support by the Research Planning Office in HU. The center is composed of twenty-four researchers including half from other universities with a variety of the expertise such as condensed matter theories, numerical simulations, material syntheses, physical property measurements, or electron microscopy. Our main goal is to reveal integration of basic notions of chirality from both basic and application-oriented viewpoints.

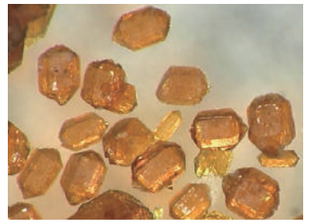
Our Research

We focus on studies of chiral magnetic materials that exhibit a special class of chiral magnetic structures; for instance, a number of atomic-sized magnets are arranged helically and a chiral twisting structure is formed in chiral magnets, as shown in the right figure. We examine various functions of the materials in multilateral approaches. As for material syntheses, about 90% of molecule-based materials and nearly half of inorganic crystals of chiral magnets ever reported are grown by the members of the Center. One recent significant finding is that researchers experimentally showed that the winding number of the twists can be detected and controlled by changing the strength of the external magnetic field. This breakthrough may lead to the development of multiple-valued magnetic memories with high storage capacities owing to the unique characteristic features of this material.

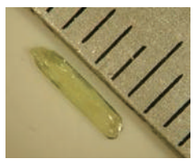
*Y. Togawa et al., Phys. Rev. B 92, 220412(R) (2014). DOI http://dx.doi.org/10.1103/PhysRevB.92.220412

"Twisting magnets enhance data storage capacity"
Eurek Alert! (2016.2), AlphaGalileo (2016.2)
https://www.hiroshima-u.ac.jp/en/news/36350

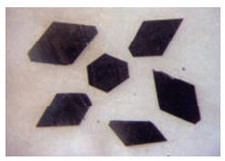
Chiral magnet materials we synthesized



▲T_C = 35 $KP6_3$22 $[Cr(CN)_6]Mn((S)\text{-aminoala})] \cdot 2H_2O$



▲Green needle

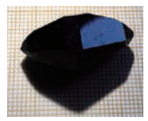


▲$[Cu\{(S)\text{-pn}\}H_2O]_4[Cu\{(S)\text{-pn}\}]_2[W(CN)_8]_4 \cdot 2.5H_2O$

◀P61, TC = 53
$KK_{0.4}[Cr(CN)_6][Mn(S)\text{-pn}](S)\text{-pn}H_{0.6}$

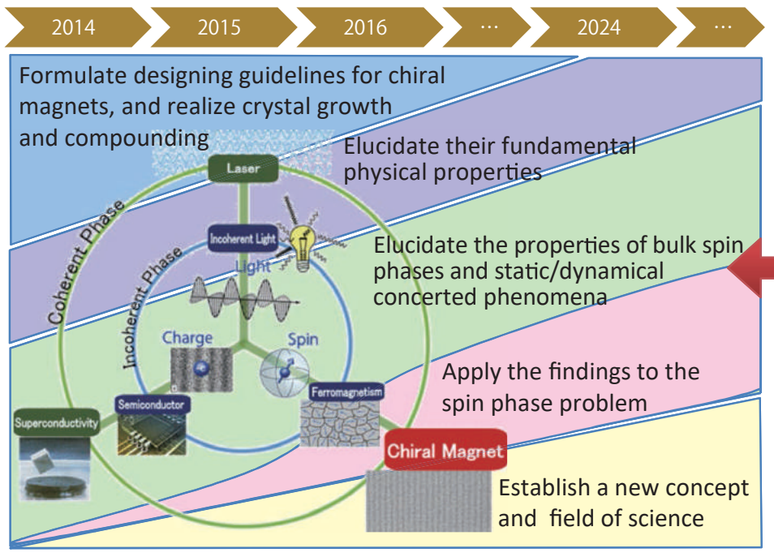
▲$P6_1$, triMeOPhNN-Mn$(hfac)_2$

In February 2017, our collaborator, Dr. Isabelle Luneau and Dr. Jullien Zaccaro team have succeeded to growth chiral single domain crystals of $CsCuCl_3$.



▲©J.Zaccaro @Neel Inst. &

Plans



- Annual conferences on resource allocations
- Support for interdisciplinary projects led by young researchers' initiatives
- Monthly meetings about research progress and for brainstorming
- Domestic and international conferences (Held in alternate years respectively)