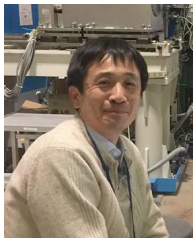


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*Solid State Physics*
*Strongly Correlated Electrons*
*Electron Multipole*
*Phase Transition and Symmetry*
*Neutron & X-ray Scattering*

## *REPRESENTATIVE PUBLICATIONS*


[1] Kazuya Suyama, Kazuaki Iwasa*, Yuka Otomo, Keisuke Tomiyasu, Hajime Sagayama, Ryoko Sagayama, Hironori Nakao, Reiji Kumai, Yoshinori Kitajima, Françoise Damay, Jean-Michel Mignot, Akira Yamada, Tatsuma D. Matsuda, and Yuji Aoki, Chiral-crystal-structure transformations and magnetic states of $R_3Rh_4Sn_{13}$ ($R$ = La and Ce), *Phys. Rev. B* **2018**, *97*, 235138 [9 pages], DOI: 10.1103/PhysRevB.97.235138.

[2] Kazuaki Iwasa*, Fumitoshi Iga, Taketo Moyoshi, Akiko Nakao, and Takashi Ohhara, Magnetic-Ordering Propagation Vectors of Terbium Hexaboride Revisited, *J. Phys. Soc. Jpn.* **2018**, *87*, 064705 [5 pages], DOI: 10.7566/JPSJ.87.064705.

[3] Kazuaki Iwasa*, Yuka Otomo, Kazuya Suyama, Keisuke Tomiyasu, Seiko Ohira-Kawamura, Kenji Nakajima, and Jean-Michel Mignot, Crystal-electric-field excitations and spin dynamics in $Ce_3Co_4Sn_{13}$ semimetallic chiral-lattice phase, *Phys. Rev. B* **2017**, *95,* 195156 [9 pages], DOI: 10.1103/PhysRevB.95.195156.

[4] Kazuaki Iwasa*, Keisuke T. Matsumoto, Takahiro Onimaru, Toshiro Takabatake, Jean-Michel Mignot, and Arsen Gukasov, Evidence for antiferromagnetic-type ordering of *f*-electron multipoles in $PrIr_2Zn_{20}$, *Phys. Rev. B* **2017**, *95*, 155106 [10 pages], DOI: 10.1103/PhysRevB.95.155106.

[5] Kazuaki Iwasa*, Ryuji Higashinaka, Yuji Aoki, Seiko Ohira-Kawamura, and Kenji Nakajima, Broad Excitation Spectra between Crystalline-Electric-Field Levels Associated with Non-Kramers Doublet Ground State of *f* Electrons in $PrNb_2Al_{20}$, *J. Phys. Soc. Jpn.* **2016**, **85**, 123704 [5 pages], DOI: 10.7566/JPSJ.85.123704.

[6] Yuka Otomo, Kazuaki Iwasa*, Kazuya Suyama, Keisuke Tomiyasu, Hajime Sagayama, Ryoko Sagayama, Hironori Nakao, Reiji Kumai, and Youichi Murakami, Chiral crystal-structure transformation of $R_3Co_4Sn_{13}$ ($R$ = La and Ce), *Phys. Rev. B* **2016**, *94*, 075109 [8 pages], DOI: 10.1103/PhysRevB.94.075109.


## *RESEARCH OVERVIEW*

Solid state physics is aiming at pursuing new properties and functions associated with electrons in a host media. Many electrons interacting with each other give rise to nontrivial and exotic phenomena, which are not explained only by single spin and charge. Magnetic orderings, structural transformations, and phase transitions between insulator–metal–superconductor as functions of temperature, pressure, and magnetic fields are typical phenomena. It is indispensable to determine material structures, in order to reveal many-body electron correlation and relevant degrees of freedom. Elementary excitations (dynamics of atoms, magnetic moments, and charges) are also keys for the novel electron behaviors. Neutron and X-ray scattering reveal such static and dynamical structures. X-ray measurements are available at the university laboratory (left panel photo) and the synchrotron radiation facilities (Photon Factory and SPring-8). Neutron studies are available in J-PARC and the atomic reactors (right panel), for example.

I have studied nontrivial and exotic *f*-electron states appearing in rare-earth-based intermetallic compounds. We synthesized target materials by ourselves, as shown in middle panel photo using furnaces. Recently, the 4*f*-electron multipole ordering at the Pr sites in $PrIr_2Zn_{20}$ were determined using the neutron diffraction measurements, which is responsible for the new electron-mass-enhancement mechanism in this material [publication 4]. Chiral structural phase transitions and spin dynamics in $Ce_3Tr_4Sn_{13}$ (*Tr*: transition metals) were also evidenced in the X-ray and neutron scattering studies, which are expected to mediate characteristic mass-less electrons suggested by the theory of relativity [publications 1, 3 and 6].