Materials Structure Physics Group

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Aim of our research is to discover and to understand various physical phenomena of materials from points of view on static and dynamical structures of atoms and electrons inside materials. Our recent research activities cover phase transitions and elementary excitations in magnetic and multipolar ordering systems, heavy-fermion systems, anharmonic low-energy phonon modes in cage compounds, highly frustrated magnetic oxides, spin molecules, hydrogen storage materials, and so on. These attractive phenomena originate from interaction between electrons which carry degrees of freedom of charge, spin, and orbital. Our main techniques are neutron and x-ray scattering, which reveal precisely the microscopic structure of electronic states and crystal structures. In addition, we search for typical materials exhibiting the attractive properties, grow high quality crystal samples, and measure fundamental properties. Development of new instruments and experimental methods are also carried out in order to identify various materials structures. Figure 1 shows examples of our research results of the ordering and dynamics of electronic degree of freedom revealed by neutron and x-ray scattering techniques.

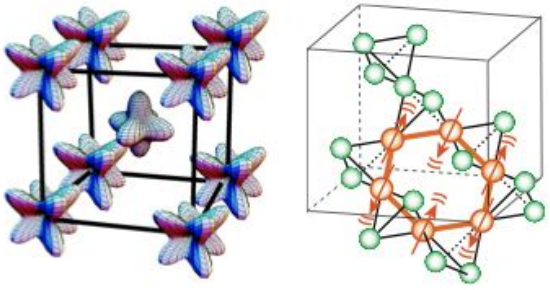

Fig.1 (Left) An image of electron orbital ordering at atomic sites observed in rare-earth compounds. (Right) A schematic view of a spin molecule in the pyrochlore lattice.

We own and operate a triple-axis neutron spectrometer TOPAN with polarization analysis option installed in the research reactor JRR-3 of Japan Atomic Energy Agency (Tokai, Ibaraki). We also use pulsed neutron scattering instruments installed at Materials and Life Science Experimental Facility in J-PARC. Sometimes, we visit other neutron facilities all over the world. X-ray scattering experiments are performed on four-circle diffractometers equipped with a rotating anode x-ray source in our university laboratory as well as at various synchrotron radiation facilities such as Photon Factory (KEK, Tsukuba) and SPring-8 (JASRI, Harima). For synthesis of high quality samples of typical materials, we have installed various furnaces including floating-zone type and Bridgman type. We succeeded in synthesizing large volume of single-crystalline samples.

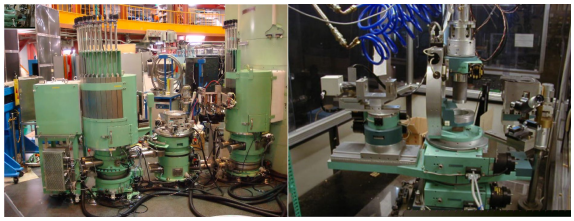

Fig.2 (Left) The neutron spectrometer TOPAN. (Right) Four-circle X-ray diffractometer in the university laboratory.

The last year was the International Year of Crystallography 2014, centennial anniversary of the discovery and the Nobel-prize award of x-ray diffraction, and 70 years after the discovery of neutron diffraction. In the new century of this scientific field, our group wish to contribute to further progresses together with young people who are interested in this research activities. Let's see materials inside by using powerful beams!