# Condensed Matter Research Center

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The Condensed Matter Research Center (CMRC) was established in the Institute of Materials Structure Science on April 1st, 2009. The mission of the CMRC is to pursue cutting-edge researches of condensed matter science by comprehensive use of multi-probes (synchrotron light, neutron, muon etc.). CMRC is also expected to be a center of excellence in materials structure science fields by a tight collaboration with researchers of universities and other institutes in the world.

CMRC has four research groups: correlated electron matter group (Group Leader (GL): R. Kadono), surface/interface group (GL: K. Amemiya), matter under extreme condition group (GL: T. Kondo), and soft matter group (GL: H. Seto). These groups are promoting the following six projects, which include cross-sectional research among these groups.

1. Hybridized orbital ordering project (Project Leader (PL): H. Nakao): The hybridized orbital ordering between localized and itinerant electrons is studied using resonant hard and soft x-ray scattering and inelastic neutron scattering. The orbital hybridization is a central problem in strongly correlated electron systems.
2. Geometrical correlation project (PL: R. Kadono): This project goal is to determine a characteristic correlation-time of fluctuation in itinerant systems under the influence of geometrical frustration using muon, neutron, and synchrotron, which are probes with different observation-time scale.
3. Molecular crystal project (PL: R. Kumai): Charge, spin, orbital ordering and their fluctuations in molecular crystal systems are investigated under external fields such as electric, magnetic fields and high pressure.
4. Surface/interface project (PL: K. Amemiya): Crystal structure and electronic structure at surface and interface of magnetic thin films and multilayers are studied by depth-resolved magnetic circular dichroism (MCD)/x-ray absorption spectroscopy (XAS), resonant x-ray scattering (RXS), and neutron reflectivity. The research is important for materials development of a new electronics: spintronics.
5. Extreme condition project (PL: T. Kondo): Physical and chemical properties of compounds in core of the earth are elucidated by diffraction and spectroscopy techniques of synchrotron x-ray and neutron.
6. Soft matter project (PL: H. Seto): This project has three targets: spontaneous motion under non-equilibrium condition, hierarchical structure of soft matter complex, and functional soft matter interfaces. Complementary use of synchrotron and neutron makes these structures clear.

We are carrying out these studies using synchrotron beamlines (BL) of PF and PF-AR at Tsukuba campus and neutron and muon BL of J-PARC at Tokai campus. BL-8A and 8B of PF are used to analyze the crystal structure; High-resolution powder diffractometer of J-PARC is useful for the magnetic structure analysis. BL-3A and 4C of PF are frequently used to examine the orders of electronic degrees of freedom such as charge, spin, and orbital orders under high pressure and strong magnetic field. BL-16A of PF is used for the measurements of MCD, RXS, XAS; resonant soft x-ray scattering diffractometer is installed this year. The experiments of high pressure are carried out at PF-AR beamlines: NE1 for the diamond anvil cell and NE3 for the large press. The chopper spectrometer (HRC) of J-PARC makes it possible for the high-resolution experiments of inelastic neutron scattering. The experiment used muon BL of J-PARC gives us information about local magnetization.